Collaborative governance in the Rideau Canal: barriers and opportunities

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ABSTRACT

The environmental management of watersheds presents a complex governance issue due to their large spatial scales that include overlapping jurisdictions, competing interests in resource use, and lack of coordination among stakeholders. The Rideau Canal, spanning 200 km between the cities of Ottawa and Kingston, is an interesting case study as it is a multi-watershed system over which municipal, provincial and federal governments have authority. However, these governments have been unsuccessful in addressing system-wide issues such as shoreline development, erosion and invasive species that have significantly impacted the ecological integrity of the canal. A shift toward polycentric governance, which are systems of multi-scale governance, in which well-informed publics can contribute to the Rideau Canal's management is required. This thesis examines how co-governance can be conceptualized for the RC by (1) analyzing convergences in stakeholder perspectives about the environment and governance, and (2) comparing collaborative causal mapping exercises with various stakeholders to current government engagement efforts. A tiered co-governance framework that intentionally links existing small-scale activities to system-wide formal venues of knowledge sharing could democratize environmental governance on the Rideau Canal to improve its management. Beyond its practical contributions, this research also contributes to developing the academic literature on co-governance for multi-watershed waterways that have both constructed and natural aspects.

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1. INTRODUCTION

Management of watersheds is a complex governance issue that has traditionally been approached through top-down strategies, which are now considered ineffective in achieving desirable ecological and social outcomes (Homsy et al., 2018). Watersheds need to be managed in a holistic manner due to their large spatial scale, multiple associated uses, and overlapping jurisdictional responsibilities (Kim et al., 2015). There has been a shift toward using collaborative approaches to watershed governance by coordinating jurisdictional responsibilities and incorporating multiple perspectives in decision-making processes (Davidson & de Loë, 2016; Medema et al., 2017). This approach helps to create a holistic understanding of the socio-ecological system of the watershed (Dunn et al., 2017).

Considering the extensive research on watersheds, it is somewhat surprising that there is relatively little research on canal systems, especially the Rideau Canal. My thesis research is integrated with a 3-year Strategic Partnership Grant funded by the Natural Sciences and Engineering Research Council (NSERC), which aims to use science to support the management of (1) the Rideau Canal (RC), a UNESCO World Heritage Site, National Historic Site of Canada and a Canadian Heritage River (Watson, n.d.-b), and (2) the Trent-Severn Waterway (TSW), a National Historic Site (see Appendix A for maps). Partners include Parks Canada (PC), and researchers from multiple disciplines at Carleton University, the University of Ottawa, and l'Université de Sherbrooke. The grant's aim is to expand PC's scientific capacity to address ecological and social concerns. The findings associated with this research will help to inform decision-making and priority-setting, for example in the review of the management plans for the RC and TSW.

The three objectives of the NSERC project are to:

1) Determine the influence of dam and lock station presence and operations on abiotic and biotic connectivity at a system and reach scale.

2) Identify the effects of shoreline habitat development and aquatic plant management strategies on ecosystem structure.

3) Use social science strategies to identify opportunities and barriers to operationalizing scientific findings.

I worked with the social science team to gather data on stakeholder perspectives of environmental issues, governance and collaborative efforts to improve the environmental management of the RC and TSW. Although my research derives data from both waterways, my focus is on the RC.

The Rideau Canal as a socio-ecological system

While there have been many studies conducted on managing river basins, watersheds and landscapes, the RC has both natural and constructed elements, creating a unique dynamic in terms of environmental management (Lin et al., 2020). This feature highlights the interconnectivity of human and natural systems, contextualizing the RC as a socio-ecological system (SES). A watershed-scale approach considers various aspects of SESs including different types of terrestrial activity. Moreover, the RC requires a novel management approach since it spans two watersheds (Nguyen et al., 2016). Currently, two Conservation Authorities (CAs) provide scientific capacity and monitoring for their respective watersheds: the Rideau Valley

Conservation Authority and Cataraqui Conservation. The waterway itself, including the bed, is managed by Parks Canada (Parks Canada Agency, 2017). The federal[1] and provincial[2] governments have many acts that manage the RC, thus forming a fragmented legislative framework.

The ecological integrity of the Canal has been significantly impacted by algal blooms, shoreline erosion, shoreline development, and invasive species. These issues are exacerbated by fragmented management structures and uncoordinated efforts to address ecological concerns (Imperial, 2005; Larson et al., 2013), a key finding by Kim, Keane and Bernard (2015). The complex legislative structure reduces possibilities for co-management since creating new bodies or power-sharing agreements would require new legislation – a task that requires government funds and time, which politicians may be unwilling to commit. However, observations from my preliminary field experience indicate that there are many uncoordinated initiatives to improve the environmental integrity of the RC and raise awareness. In these efforts there is an opportunity for stakeholders at multiple levels to take leadership, but mechanisms to enable such polycentric modes of collaborative governance (i.e. multi-scalar governance) to inform environmental management are lacking.

Organizing knowledge production activities is a necessary component of effective co-governance (Armitage et al., 2011; Dunn et al., 2017; Larson et al., 2013; Plummer et al., 2013).

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[1] *Transport Canada Act – Historic Canals Regulations, Historic Sites and Monuments Act, Canada Shipping Act – Small Vessel Regulations, Canadian Environmental Assessment Act, Canada Wildlife Act, and the Navigable Waters Protection Act* (Watson, n.d.-a).
[2] *Planning Act, Heritage Act, Game and Fish Act, Conservation Authorities Act and the Fill, Construction and Alteration to Waterways Regulations, Environmental Protection Act and the Regulations, and the Endangered Species Act* (Watson, n.d.-a).

The wealth of local knowledge and enthusiasm to improve the environmental health of the RC can support environmental management. However, consolidation of this knowledge and of stakeholders' views on how the RC should be managed is lacking. Despite efforts to encourage dialogue, there have been limited opportunities for stakeholders to learn from each other in order to enhance understanding of the RC system's socio-ecological dynamics. Such social learning activities help stakeholders understand each other's positions and values, enabling them to prioritize sustainability and implement policy (Homsy et al., 2018). Social learning is iterative in nature and examines others' values and viewpoints, leading one to reflect on their own assumptions and values. Additionally, the differences in status or authority of a group may hinder their ability to participate in social learning activities, influence policy, and affect decision-making. These power asymmetries can be interactional (among groups) or structural (between groups and authorities). My research addresses these gaps by (1) conducting workshops with different stakeholder groups based on the Collaborative Conceptual Modelling framework, and (2) proposing a conceptual framework for co-governance in the RC based on these workshops and interviews with stakeholders.

For this research, I used sociological methods to elicit and analyze stakeholder views about environmental health and management. This approach helps identify ways to establish a more effective governance regime where stakeholders can influence environmental decision-making and policy. While there are many quantitative methods that can be used for such research, I chose to use multiple qualitative research methods, which have been used in the conservation context (Rust et al., 2017). Using qualitative methods provides detailed information about stakeholder experiences and perceptions that could be missed with pre-determined methods such as surveys, especially when there is a lack of social science research in an area

(Bryman et al., 2012; Rust et al., 2017). While quantitative methods are useful for testing hypotheses and conducting statistical analyses to test the significance of results, qualitative research methods are appropriate for exploratory research as findings can be used to build hypotheses for future research.

Research questions

Through the use of mixed methods, my research aims to address the question: *What are the barriers and opportunities to establishing co-governance in the Rideau Canal system?* The sub-questions I focus on are:

1) What are the various stakeholder perspectives about the factors influencing the environmental health of the Rideau Canal through the lens of a socio-ecological system?

2) What elements of current stakeholder engagement practices are useful in fostering social learning and managing power asymmetries for the Rideau Canal?

3) How can we enable co-governance to foster social learning and manage power asymmetries in the Rideau Canal?

This thesis presents findings of exploratory research on the RC to determine the best approach to co-governance, which is informed by both stakeholder views and my interpretation of these views as a researcher. I used stakeholder workshops (qualitative and quantitative analysis) and interviews (qualitative analysis) to provide insight on perceived environmental concerns and possible solutions to improving the environmental management of the RC. Understanding these perspectives can help inform an approach to establishing co-governance by

considering various barriers and identifying opportunities. It is also important to understand how stakeholder perspectives can be effectively engaged in governance processes, which the second research question aims to analyze by examining the engagement sessions in this research and those initiated by the federal government. I evaluated the useful elements of each workshop and which method was most effective in addressing social learning and power asymmetries, which is informed by (1) stakeholder feedback from the research workshop participants, (2) participant observation of the federal government stakeholder engagement sessions, and (3) my retrospective analysis of these two sets of engagement. I synthesize the findings from the first two research questions to inform the last research question about how to best approach co-governance while considering social learning and power asymmetries; these are discussed in the literature review section.

2. LITERATURE REVIEW

The literature on watershed governance can be used as a reference for the management of historic waterways, such as the RC and TSW. However, waterways are unique because they span multiple watersheds and, in this case, jurisdictional boundaries of various federal departments, provincial ministries, municipal governments and CAs. Armitage and Plummer (2010) argue that the static nature of interactions between actors in governance via centralized structures reduces ecological resilience and renders these structures inadequate at dealing with ecological surprise (i.e. unexpected environmental changes). This indicates a need to shift from the current single-watershed governance approach in the RC towards a system that can manage and respond to changes in more than one watershed.

Governance is defined as "the means for achieving direction, control, and coordination of individuals and organizations with varying degrees of autonomy to advance joint objectives" (Imperial, 2005, p. 282). It is a combination of formal and informal relationships among institutions, the public and industry that in practice requires collaboration to move toward a common goal (Imperial, 2005). Collaborative governance, or co-governance, is a way to understand and manage such complex SESs (Ansell & Gash, 2007). A collaborative approach involves coordinating jurisdictional responsibilities and incorporating multiple perspectives in decision-making to gain a holistic understanding of socio-ecological systems (Davidson & de Loë, 2016; Dunn et al., 2017; Medema et al., 2017). This approach provides a space for networking and making horizontal and vertical linkages that develop relationships among actors, thus building adaptive capacity and resilience (Armitage et al., 2011). These polycentric modes of governance, defined as systems with multi-scale organizations, have emerged to include

multiple perspectives to inform decision-making about policy (Eversole, 2011; Medema et al., 2014; Welsh & Wynne, 2013). In the RC, these perspectives range from private sector, environmental groups, cottager's and lake associations, heritage conservation groups, governments, Indigenous communities, and academics. This range of actors indicates that there is also a range of possibly competing interests along the RC, which may make holistic management of the Canal difficult; this problem is often seen in the water governance literature (e.g. Armitage et al., 2008; Lin et al., 2020; Medema et al., 2014; Montgomery et al., 2016). Adaptive co-management is a framework that operationalizes collaboration among such actors in natural resource management, which could help inform a feasible approach to co-governance.

Adaptive collaborative management (ACM)

ACM has been defined in the literature as a combination of adaptive management and collaborative management, in which scholars including Buzz Holling, Carl Walters, Kai Lee, and Evelyn Pinkerton and Elinor Ostrom, respectively, have made significant contributions (Armitage et al., 2007; Plummer et al., 2012). The ACM framework enables environmental governance because of its collaborative and adaptive capacity (Olsson et al., 2004; Plummer et al., 2013). Berkes (2009) states that adaptive management focuses on learning-by-doing to address uncertainty, complexity, evaluation and adaptation, which are done horizontally. Collaborative management (co-management) involves power- and responsibility- sharing agreements between government and local resource users (Berkes, 2009) while considering vertical linkages among local communities and higher orders of government (Plummer et al., 2012). In the context of natural resource management, adaptive management lacks legitimacy

without collaboration, while co-management cannot address surprises or emerging issues without the iterative learning aspect, thus indicating a need for ACM (Berkes, 2009).

Plummer, Armitage and Berkes are contemporary scholars who have advanced the literature on ACM. They argue for a multi-scale approach by merging the domains of adaptive and collaborative management to encourage horizontal and vertical linkages that will lead to iterative learning (Armitage et al., 2008; Berkes, 2009; Plummer et al., 2012). Although characteristics of ACM like power-sharing may not be feasible for the RC due to a complex legislative framework, ACM outcomes can help identify barriers and opportunities for co-governance. Plummer et al.'s (2012) systematic review of ACM indicates that successful outcomes include stakeholder participation through social networks, learning, conflict resolution and the development of adaptive capacity. However, more research is required to evaluate these outcomes in empirical cases and further develop theory (Plummer et al., 2012).

There are many terms related to environmental governance that encompass aspects of ACM, for example, adaptive governance, collaborative management, and collaborative governance. Co-management refers specifically to power sharing arrangements that often include developing a body that represents relevant authorities and stakeholder representatives that partake in continuous problem solving (Carlsson & Berkes, 2005). However, in systems such as the RC such arrangements are not manageable because of the lack of capacity and/or mandate, complex legislative structures, and numerous stakeholders. In such contexts, broader governance processes such as co-governance, are more appropriate. Co-governance is defined as:

> *A governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal,*

consensus-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets (Ansell & Gash, 2007).

Co-governance enables flexibility in governance arrangements and could offer engagement opportunities for a variety of stakeholders to provide their input. The literature on co-management can inform co-governance processes since they share the core purpose of collaboration to improve environmental management.

Table 1: Summary of features of successful collaborative governance from the literature.

Scholarly Publication	**Characteristics of successful collaborative governance**
Armitage et al. (2007)	[Dimensions of co-management] Power sharing; institution building; trust building; process; social learning; problem solving; good governance
Berkes (2009)	[Faces of co-management] Power-sharing; institution building; trust and social capital; process; problem-solving; governance; knowledge generation; social learning
Butler et al. (2015)	Legal mandates and structures; government's legal power; willingness of stakeholders to compromise
Carlsson & Berkes (2005)	[Specific to co-management] allocation of tasks among various stakeholders; exchange of resources where power asymmetries are not necessarily bad; linking organizations; reducing transaction costs; risk sharing; conflict resolution mechanisms
Lundmark, Matti, & Sandström (2014)	Social networks; deliberation; learning; legitimacy
Montgomery et al. (2016)	Accountability; adaptability; participation; rule of law; transparency
Olsson et al. (2004)	Legislation that transfers power to create social space; funding; monitoring with locals that fosters learning; information and social networks; combining sources of knowledge; sense-making through developing a strong vision for ecosystem management; arena for collaborative learning

Plummer et al. (2013)	Accountability and legitimacy; actors and roles; fit, interplay and scale; adaptiveness, flexibility and learning; evaluation and monitoring; knowledge
Schröter et al. (2014)	Agreement of common rules; formal rules; informal rules; norms; sanctions; relations of trust among stakeholders; reciprocity and exchanges; connectedness in networks and groups; equality of participation; empowerment; social capital linked to governance processes
Schultz et al. (2011)	Local community and government involved in decision-making; socio-ecological systems approach; collaboration through dialogue and integration of different objectives; monitoring and adapting to ecosystem feedback through combining knowledge systems; shared vision
Wyborn (2015a)	Coproduction of knowledge; experience and expertise; networks; transparency; trust; commitment; leadership; legitimacy; accountability; collaboration; flexibility

I developed Table 1 to understand the various successful features of collaborative management and governance that scholars have studied in previous research, case studies and literature reviews. This table demonstrates that co-management is complex and has many components and dimensions to consider, but I limited the scope of my research to exploring the themes of social learning and power asymmetries as they also apply to co-governance. I view these themes as foundational for engagement practice in collaborative water governance because they can be used to address the other features of co-governance (e.g. building accountability and legitimacy, institution building etc.) and they can also be applied to other natural resource management contexts (e.g. impact assessment). Also, these themes are useful to examine co-governance in the RC considering my preliminary research that reveals the lack of mutual understandings among stakeholders and existing structural and interactional power asymmetries.

Social learning

Social learning is an important part of decision-making in environmental management (Berkes, 2009) as it increases adaptive capacity to respond to dynamic SESs (Dale & Armitage,

2011). Medema et al. (2014) characterize social learning as a change in understanding and behaviour through communication and deliberation in a democratic process. Although collaborative initiatives do not necessarily mean social learning is occurring (Medema et al., 2014), dialogue facilitates identification of points of convergence to encourage more difficult conversations about points of disagreement (Carr & Heyman, 2012; Jean et al., 2018; Montgomery et al., 2016). Cundill and Rodela (2012) frame the emergence of social learning in the context of rights-based discourses as a way to resolve conflict. A deliberative forum can facilitate multiloop learning (Medema et al., 2014) by providing a venue for participants to understand various worldviews and values (Cundill & Rodela, 2012). Thus, as Wyborn (2015a) argues, we need flexible spaces for relationship building and knowledge co-production rather than rigid, technical structures that are common in adaptive governance.

Knowledge co-production can be defined as "the collaborative process of bringing a plurality of knowledge sources and types together to address a defined problem and build an integrated or systems-oriented understanding of that problem" (Armitage et al., 2011, p. 996). Knowledge co-production has less to do with technical knowledge (objective) but more to do with revising assumptions and worldviews (subjective) (Dale & Armitage, 2011) in a logical manner (Lundmark et al., 2014), leading us to consider the different ways of governing (Eversole, 2011) that may increase internal legitimacy (Lundmark et al., 2014). Wyborn (2015a) stresses the importance of bridging knowledge and action by building co-productive capacity for adaptive governance. This is how collaborative management enhances adaptive management in ACM theory. However, such processes must also consider whose worldviews and perspectives are included.

Power asymmetries

Overlooking power asymmetries can limit social learning so both must be investigated together to build and maintain relationships (Ansell & Gash, 2007). Although considering power asymmetries is not novel (Wyborn, 2015a), its link to knowledge co-production and design of mechanisms has not been well researched, specifically in the case of the RC. Natcher et al. (2005) suggest that power asymmetries can be managed by developing trust within a group through valuing various knowledge contributions.

Explicitly discussing underlying normative assumptions and competing understandings of the environment depends on the method of stakeholder engagement (Natcher et al., 2005; Wyborn, 2015b). Decisions about the process of stakeholder input are often made by authorities that possess power, which is another way for power asymmetries to manifest (Armitage et al., 2008; Wyborn, 2015b). For example, Fennell et al. (2008) discuss the ethics of ACM as processes designed by those sitting in an office may be harmful to local communities that are directly impacted. Therefore, we must be cognizant of how we approach stakeholder engagement; it has often been used to legitimize policy decisions without genuinely integrating the knowledges of various stakeholders (Eversole, 2011). Therefore, a better design for co-governance that addresses power asymmetries requires further investigation.

Co-governance design

Current command and control governance structures have limited ability to respond to change and uncertainty as their inflexible design hinders adaptive planning (Armitage et al., 2009; Armitage & Plummer, 2010; Carlsson & Berkes, 2005). The ACM literature explores co-

management structures, such as boards and councils, that have representation from various stakeholders or rights-holders. However, they are often attached to rigid Western government processes and lack flexibility in how stakeholders are engaged, which is especially important when engaging with Indigenous peoples (Nadasdy, 1999). Some examples include the Ottawa Riverkeepers, the Mackenzie River Basin Board and Conservation Authorities (*Ottawa River Watershed Governance: Making the Case for a Watershed Council*, 2017). Although changes at the socio-political scale, the sheer complexity and scale of problems, the existence of alternative venues of collaboration (Medema et al., 2017), and the lack of capacity, political support and common understandings can hinder ACM efforts (Baird et al., 2016; Medema et al., 2017), there are opportunities to overcome these limitations. Research by Montgomery et al. (2016) suggests using network governance and collaboration that is initiated and supported by the public.

Bridging organizations (BOs) have been widely referenced as intermediaries in the watershed governance literature (Medema et al., 2014, 2017; Olsson et al., 2007; Schröter et al., 2014; Schultz et al., 2011) and have been shown to enhance collaboration because they provide a space for knowledge coproduction (Jean et al., 2018), relationship building, and conflict resolution (Ansell & Gash, 2007; Hahn et al., 2006; Medema et al., 2017). BOs stem from boundary theory (Stange et al., 2016), which suggests that bringing together various domains can trigger learning through knowledge exchange (Jean et al., 2018; Medema et al., 2014). These organizations act as entry points for actors to collaborate across boundaries (Stange et al., 2016), which is especially helpful to deal with uncertainty and surprise (Olsson et al., 2007). They also facilitate efficiency, effectiveness, and responsiveness (Sullivan et al., 2013). Furthermore, the interplay of collaborative activities create nested boundary spaces that can transmit information from micro to macro scales, and vice versa (Erickson, 2015; Stange et al., 2016; R. Thomas et

al., 2007). This nested localization approach (Erickson, 2015) can accommodate multiple ways of governing, which Eversole (2011) discusses as important for community participation in governance, to appropriately include local perspectives. However, the methods used to engage stakeholders and their respective frames of thinking in co-governance must also be considered if the goal is to facilitate collaboration (Dewulf et al., 2011; König & Ravetz, 2018).

Systems thinking

Systems thinking is a theoretical framework adopted by sociologists that helps address complex problems. It provides an opportunity to enhance understanding of a system by combining multiple perspectives and knowledges through mapping, which can inform environmental decision-making (Meadows, 2008; Özesmi & Özesmi, 2004). A systems-oriented approach encourages collaboration which in turn facilitates social learning and integrates mental models of stakeholders to promote mutual understandings (Armitage et al., 2007; Dale & Armitage, 2011; S. Gray et al., 2012; S. R. J. Gray et al., 2014; Medema et al., 2014; Schultz et al., 2011; Vennix, 1996; Walsh et al., 2013). Collaborative activities involving systems thinking can also enable ethical decision-making processes (Fennell et al., 2008) as they can result in well-informed decisions by engaging multiple perspectives. Such activities can thus reduce bounded rationality (Meadows, 2008) to improve sustainability outcomes (Walsh et al., 2013). Therefore, systems thinking exercises that integrate stakeholder mental models should be linked to governance and policy (Armitage et al., 2009; Dale & Armitage, 2011; Vennix, 1996). In fact, Lin et al. (2020) emphasize the need for managers to use structured decision-making in the conservation of historic canals, which can be facilitated by systems thinking.

A method called Collaborative Conceptual Modelling (CCM) that uses systems thinking with multiple perspectives has recently emerged in the literature (König & Ravetz, 2018). It aims to create shared understandings through causal mapping by revealing points of convergence and divergence and helps identify leverage points in systems. This framework gathers a variety of stakeholders to better understand a problem and results in a list of actionable items that can holistically address a problem. However, it remains to be seen how such activities can be (1) made more accessible to non-experts and (2) used to improve governance, specifically in the case of the RC. I used the CCM framework in my research to understand stakeholder perceptions through the mapping exercise, but I also investigated how it could fit into the governance of the RC.

Stakeholder engagement

The beginning of the movement for the inclusion of publics to aid decision-making in environmental management can be found in the science and technology studies literature. Welsh and Wynne (2013) and Ottinger (2013) explored case studies of environmental injustice in which public inclusion better informed decisions through local knowledge of environmental changes and social factors, but engagement was done poorly. These cases among others serve as an impetus to include publics in decision-making, but they do not provide operational tools to do so in a legitimate manner (McCormick, 2009). This complexity of public engagement indicates that we require a combination of engagement mechanisms tailored to community cultures for effective inclusion (Eversole, 2011), which Rowe and Frewer (2005) define as being fair and efficient. Since there is limited research on what such engagement practice could look like, I evaluated useful elements of existing engagement (both research-driven and government

initiated) in order to determine how it fits into collaborative governance in the RC. My research focuses on stakeholder engagement rather than wider engagement of the publics and rights-holders, such as Indigenous people. For my research, I define stakeholders as actors that live and/or work in the Rideau Canal who have a vested interest.

In summary, understanding stakeholder views and engaging actors in systems thinking can help address socio-ecological concerns. Fostering social learning and balancing power asymmetries are useful features of ACM that can help fill the gap in the literature on natural resource management for human-built canal systems that link multiple watersheds. While many studies indicate the need for these features in co-governance efforts and outline what they entail (e.g. social learning involves ongoing knowledge sharing and deliberation), they lack discussion on what social learning would look like in the context of existing constraints such as lack of capacity and political will. My research investigates how these barriers can be addressed by combining the ACM literature with the domains of systems thinking and stakeholder engagement. The literature presents tools such as cognitive mapping to create shared understandings, however, there is a lack of research on (1) if these tools are achieving their intended goals (i.e. social learning) and more importantly (2) how such exercises can be used for stakeholder engagement in co-governance.

3. METHODOLOGY

I used exploratory methods to understand stakeholder views on the complexity of managing the RC's environment, which helped reduce the influence of my bias and assumptions in recommending an approach for co-governance (Rust et al., 2017). The social science research team with the NSERC project and I collected stakeholder perspectives about the RC as a socio-ecological system using multiple methods including workshops, interviews and observations. The research activities and corresponding objectives are summarized in Figure 1. Two researchers (myself and my colleague) were involved in data collection and analysis. "We" is used to describe activities that were conducted by both researchers whereas "I" refers to my sole contributions.

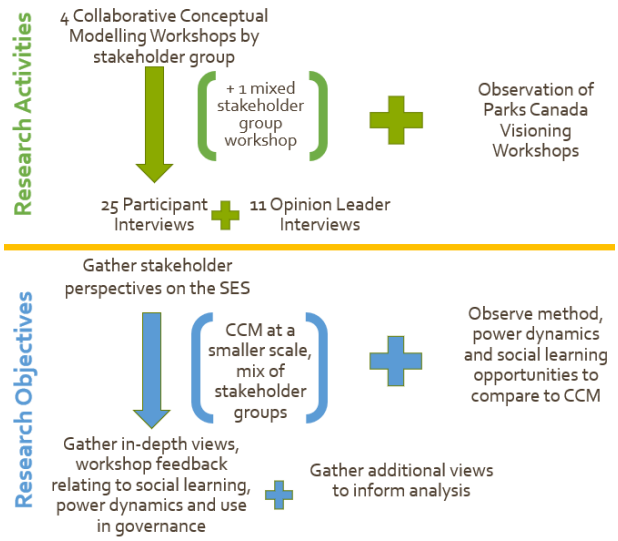


Figure 1: An outline of research activities and their objectives.

Data collection

Collaborative Conceptual Modelling Workshops

We conducted a total of four workshops on environmental health for the following stakeholder groups: community, economic interest, government representatives, scientists in the NSERC grant. We held an additional workshop on water quality in the Lower Cataraqui Region containing a mix of stakeholder groups to analyze social learning and power asymmetries in a different setting. The four workshops were split into different stakeholder groups to compare perceptions on environmental health of the RC and for manageability. The CCM framework requires various stakeholder groups to be present in the same workshop to foster social learning, but since this was our first research activity in the Canal, we wanted to avoid inter-group conflict to ensure there would be productive discussions. There was sufficient homogeneity in perspectives within the stakeholder groups.

The population was selected based on directed sampling, input from Parks Canada, and input from a resident who was interested in assisting with this research. We limited each group to a maximum of 15 participants to ensure the process was manageable (Medema et al., 2017). Although our research was limited to groups that were accessible and available to attend, we tried to include the views of those unable to attend them through follow-up interviews.

The aim of CCM is to articulate, extend and blend mental models to help determine a course of action (Newell & Proust, 2012). Mental models are the different ways in which people think that reflect their values and worldviews. This framework was developed to create mutual understandings of such values and interests, which can enhance systemic understandings (König

& Ravetz, 2018). Figure 2 shows the adapted activities we employed. The process is iterative since the last activity feeds into the first activity, however our research only completed one iteration due to lack of time. We hope future activities will consider the CCM approach with iterations of the cycle.

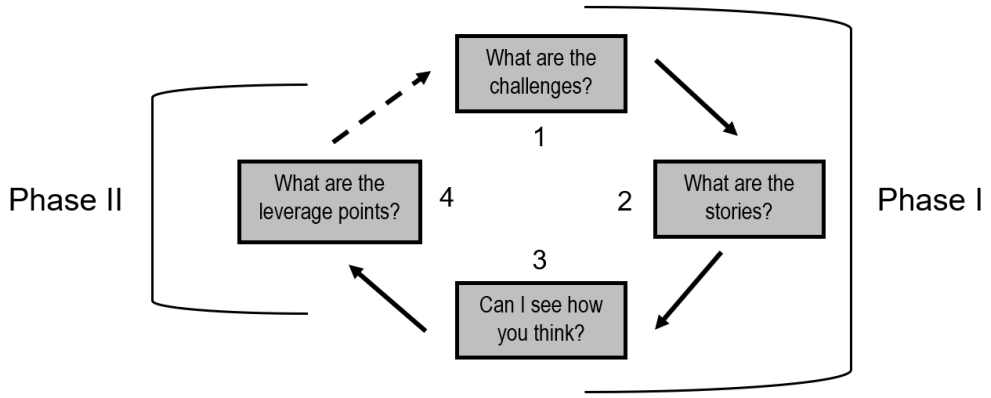


Figure 2: The four Collaborative Conceptual Modelling activities adapted from König and Ravetz (2018). The approach was adapted to fit a three-hour workshop and to suit the exploratory nature of this research. The dotted arrow shows that ideally there should be a repetition of this process, but it was not done due to time and scope limitations.

Each of the five workshops were held in central locations for the convenience of the participants (see Appendix B for the logistics of each workshop). The overarching question for the stakeholder group workshops was: *What can be done to maintain or improve environmental health of land and water in the Rideau Canal?* Each of the activities had a sub-question to help guide participants in addressing this overarching question.

Activity 1: What factors enhance or diminish the environmental health of the Rideau Canal?

For the first activity, we instructed participants to list the top five measurable factors that they thought positively or negatively influence environmental health in the RC. Participants were

encouraged to think beyond environmental factors and include social, economic, cultural and political factors. The lists were posted on the wall for sharing.

Activity 2: How did these factors come to be?

For this activity, participants collectively created a historical timeline of events impacting environmental health. Each participant shared dated information, studies and events in a roundtable which were posted on the timeline. The timeline was from 2000 to the present (mid-2019), because (1) it was around the time the first management plan was created, and (2) to provide focus, but participants were encouraged to think beyond these temporal boundaries.

Activity 3: What are the relationships among the factors?

For the third activity, we provided instructions on drawing causal maps and annotating relationships as being either positively or negatively correlated (e.g. the link between level of pollution and water quality would be negatively correlated since an increase in the level of pollution would lead to a decrease in water quality). We provided some examples and encouraged participants to ask questions if they did not understand. First, we instructed each participant to draw a map detailing their perspective of the relationships between factors impacting water quality. They were encouraged to consider the timeline and listing exercise when linking factors. Next, we instructed participants to combine their maps with someone else. We partnered participants based on differences in their educational or professional backgrounds and affiliations. Participants who we saw knew each other or had similar backgrounds based on their affiliation were intentionally kept apart when creating pairs. We did not provide specific instructions for how participants would merge their individual maps but provided guidelines such

as considering the factors from the first activity and the timeline from the second activity. We communicated that the aim of this activity was for participants to work collaboratively to determine the top 20 factors involved in impacting the Canal's environmental health and their linkages. If there was an odd number of participants, there was one group of three and they were given the same instructions. After this activity, each pair briefly presented their map to the rest of the group.

Activity 4: What can be done to improve the environmental health of land and water in the Rideau Canal?

We ended the workshop with a group discussion in which we instructed participants to identify leverage points based on the previous activities through a roundtable. Leverage points are specific actions that could be taken by any actor in order to cause a change in the system. We encouraged participants to think about ways of intervening in the system based on the mapping exercise and translate these ideas into actionable items.

<u>Water quality case study: Lower Cataraqui region</u>

In addition to the RC-scale CCM workshops, we held a workshop for a working group of concerned residents who mobilized around water quality issues in the lower reach of the RC (see Mistry et al., under review). This workshop was collaboratively planned with Cataraqui Conservation, Queen's University and local residents, who also recommended participants for the workshop. We combined participants representing multiple stakeholder groups, which is another point of comparison between having more homogenous (grouping by stakeholder) versus heterogenous (mixing stakeholders) groups. This workshop informs all three research questions.

Note that the purpose of these workshops was to understand stakeholder values, perceptions and priorities regarding the environmental health of the RC, which have implications for governance processes.

Interviews

Following the workshops, we conducted semi-structured interviews with workshop participants to gain more insight on their perspectives (see Appendix C for the interview schedule) (Acheson, 2013; Armitage et al., 2011; Medema et al., 2017). We included questions about their views on the CCM workshops to obtain feedback on the activities and to evaluate the effectiveness of the method in fostering social learning and managing power asymmetries (Baird et al., 2016). For example, we asked participants if they felt that the workshop activities changed their perspective or if they learned something new to evaluate if social learning occurred. We also asked participants if they felt their voice was heard to evaluate if the workshop was able to manage interactional power asymmetries.

We used directed sampling to include other "opinion leaders" who have knowledge about the RC or are active in environmental advocacy relevant to sections of the Canal. These individuals have spent a lot of time on the Canal and are familiar with environmental and governance concerns. Carr and Heyman (2012) and Montgomery et al. (2016) use the Q method, which is similar to this method as they chose leaders of groups in order to understand their biases to enhance regulatory mechanisms in commercial fishery management and water governance respectively. We interviewed 39 individuals; this sample size was based on data saturation and the response rate of interview requests. Interviews were on average 90 minutes in length and

were conducted in-person, over video call or over the phone. Each interview was recorded, and transcripts were automatically generated using Rev.com and then manually edited by the researchers. These interviews also inform all three research questions.

Observations of the Parks Canada visioning workshops

As a part of the NSERC Strategic Partnership Grant, we were able to attend PC's public engagement process. The PC staff conducted visioning workshops, which are outside their mandated consultations, prior to drafting the management plans for the historic canals. PC held these workshops for the RC early in 2018, which was before the NSERC grant. However, they conducted six workshops for the TSW in June and August 2019, which the research team was invited to attend. A PC Planner facilitated the first five workshops and an External Relations staff facilitated the last workshop. The Interim Director and Operations staff were present for the discussions. Public Relations staff were present to take notes and participate in the discussion. Workshop details can be found in Appendix B.

We introduced ourselves and the NSERC project at the workshops and we listened to the conversations. We made notes on concerns, reactions, and comments about the PC process as well as power dynamics between groups. Interactional power asymmetries were noted through observations based on how vocal groups were about concerns and views during the workshops. Dominating the conversation or inhibiting others to speak are examples of observations that were noted. We also noted the facilitator's ability to navigate such situations in order to assess the method's ability to balance power asymmetries. Comments made about inclusivity were also noted as well as any indication of structural power asymmetries regarding the engagement

session and in the RC generally (e.g. comments about other groups or authorities). Any indication of learning (such as changes in statements, behaviour within the session or attitudes) was also noted. Although these workshops were for the TSW, valuable information about views on governance and the engagement process contributed to a better understanding of co-governance processes for both canals. This method informs the second and third research question.

Data analysis

Triangulation of data

The mixed methodology of my research has many complementary components, thus triangulation of data can help identify emerging themes (Denzin, 2017). Triangulation of data involves using findings from multiple methods to answer a question or address a problem. In triangulation, different methods reveal "peculiar elements of symbolic reality" thus overlapping findings can provide higher evidentiary strength for recommendations on how to improve the governance of the RC (Carr & Heyman, 2012; Denzin, 2017, p. 298). I triangulated the interview transcripts, PC workshop observations and CCM workshop maps (descriptive and quantitative analysis) to provide a holistic understanding (Denzin, 2009, 2017; Olsson et al., 2004) of stakeholder perspectives and viable ways to enhance co-governance. I synthesized the convergences and divergences in findings as well as my interpretation of the findings to answer the research questions.

CCM Workshops

I analyzed each activity in the adapted CCM framework by stakeholder group to determine convergences and divergences.

Activity 1: Listing exercise

We made a list of all factors in each workshop and determined the top five from each group. These were then recoded across workshops to compare responses from each group.

Activity 2: Timeline exercise

The timelines were condensed for each workshop by grouping events by category and time period. Since the purpose of this activity was to prepare participants for the mapping activity, the analysis is limited to identifying significant items that were common among the timelines and items that stood out between groups. Significance was subjective and also based on items mentioned in other data collection.

Activity 3: Mapping exercise

We used the paired maps from each workshop to create an aggregate map for the respective workshops to analyze them qualitatively and quantitatively. For the quantitative analysis, my team and I used tools from social network analysis as they generate indices to help describe the structure of relations (Giordano et al., 2017; S. R. J. Gray et al., 2014; Özesmi & Özesmi, 2004; Papageorgiou & Kontogianni, 2012; Stakias et al., 2013).

We converted the maps created by each pair into binary adjacency matrices in MS Excel. These were aggregated to represent the frequency of relationships across maps by summing the presence of relationships, which added a weight to the linkages. We used the 'sna' package in RStudio to calculate the network measures (size, density and centrality measures including eigenvector, betweenness, indegree and outdegree centralities) and 'igraph' to generate the network maps for better visualization (Butts, 2019; Csardi & Nepusz, 2006; Turney & Bachhofer, 2016). Eigenvector centrality indicates the connectedness of highly connected nodes with other highly connected nodes. Betweenness is an indicator of "bridging" i.e. nodes are classified as mediators in the system because they lie on the shortest path between other nodes (Zhang & Luo, 2017). The degree centrality measures indicate the amount of incoming and outgoing links with other nodes (Zhang & Luo, 2017). These scores are reported for each map and each node. Scholars have used social network analysis tools for socio-ecological networks because the theoretical assumption for SES is that ecological type nodes can also be actors that mediate change (Bodin & Prell, 2011; Bodin & Tengö, 2012; Sayles & Baggio, 2017). The causal mapping is a descriptive element of the mapping exercise that reveals the narratives of stakeholders on environmental health in the RC. The centrality measures provide quantitative tools to determine the most important nodes in the networks as depicted by stakeholders. Please refer to Appendix D for more details on creating network graphs from the workshop maps and the code for R.

The process for determining the most influential nodes was as follows. I excluded the nodes representing the central focus of the workshops (environmental health for the four and water quality for the case study). I took the top five nodes (six if scores were tied) for each

centrality measure for each workshop. I then cross-examined the top five nodes for each centrality measure and listed the nodes that appeared in at least two workshops as the most influential nodes in the system. To determine overall convergence in views of nodes and linkages among all stakeholders, I created a merged network graph of all workshops (see Appendix D for details).

Activity 5: Leverage points

I compared the summarized leverage points between groups to note differences and commonalities in approaches to maintain or improve environmental health. I organized these leverage points into broader categories to inform the analysis of stakeholder perspectives and co-governance in the RC.

As a follow-up, we provided participants a summary of the results from their respective workshop. Future publications that use these results will be sent to participants as well, including this thesis.

Interviews

Interviews were automatically transcribed using Rev.com and then manually edited. Responses were coded using NVivo 12 and analyzed using an inductive thematic approach. The following approach outlined by Thomas (2006) was used as a guideline to help inductively code by research question.

1. Prepare raw data files in a common format

2. Read text closely to gain familiarity with the content and identify relevant texts

3. Conduct coding of emerging themes[3] using NVivo 12

4. Reduce overlapping and redundant categories

5. Revise categories further and select quotations and insights from texts

The data collected in interviews were analyzed for themes relevant to social learning, power dynamics and suggestions to improve the governance of the RC. I used NVivo functions including crosstab, matrix coding and text search queries to find commonalities and differences between stakeholder groups.

Parks Canada visioning workshop observations

The PC observation notes were coded specifically for social learning, power dynamics, governance and views on PC's engagement process. Any points relating to the design of co-governance were also coded, especially PC's responses, to gain insight on interest and feasibility. Although the management plan is a key aspect of governance, my research does not focus on its contents. Nevertheless, it was important to consider comments referring to the management plan that relate to governance. I compared the CCM workshop feedback provided in the interviews to the participant observation notes and made inferences about useful elements of these engagement

[3] emerging themes were coded by research question

sessions based on my knowledge as a researcher. There were no direct measures used to quantify the differences in social learning and power asymmetries due to the limitations of data collection in this fieldwork.

4. RESULTS

CCM Workshops

Activity 1: Top 5 factors influencing environmental health

Table 2 is a summary of the most frequently mentioned factors among the five stakeholder groups. Not every participant followed instructions for providing specific, measurable factors. Appendix E lists factors for each workshop.

Table 2: A summary of the most frequently mentioned factors across stakeholder groups. Factors were coded into broader categories and mentions of these categories across each workshop was counted.

Count	Category	Description
7	Governance	Various aspects of governance were mentioned ranging from specific details on regulations to broader topics like political will. Participants across workshops mentioned jurisdictional fragmentation. The lack of enforcement of regulations, collaboration and strategic long-term vision were listed, as well as municipal by-laws.
6	Development	Both system-wide and shoreline development were mentioned, though there was emphasis on shoreline development and preserving riparian areas. Historic patterns and canal construction were also listed.
4	Biodiversity	The presence of many species, both native and invasive, were mentioned. Habitat loss and algal blooms were also listed.
3	Education and awareness	Participants listed perceptions of a healthy environment, ignorance, education campaigns and programs, research and data, and sense of responsibility as specific points for this factor.
3	Hydrology and human impacts	This factor refers to natural water flow, levels and connectivity as well as human manipulation of the water system through dams, lock operations and hydropower.
3	Boating activity	Factors included traffic, wake erosion, speeding, vegetation and boat launches.

Participants in workshop 2 and 3 listed contamination and nutrients, which was different from other workshops. We noticed that many participants framed factors as negative rather than neutral and measurable (e.g. poor water quality instead of water quality).

Activity 2: *Timeline*

The timelines overlapped across the groups. Changes in the governance regime, specifically mandates, political parties and introduction of legislation and designations, were mentioned in all the workshops. There was mention of the Harper government regime and corresponding federal cuts in capacity (starting in 2012) across groups as well. The introduction of various invasive species was also noted by all groups. Some groups mentioned climate change (community, economic interest and water quality groups) and some mentioned Canada 150 as positively influencing the Canal (economic interest and scientist groups).

All the timelines had different starting points. The government group timeline had insight on municipal plans, previous initiatives, regulations, acts and land use plans. The community group emphasized enforcement, a confusing governance regime and the Canal's recognition internationally. The economic interest group mentioned items relating to visitation and tourism, the border, and studies about tourism and the area. Ongoing activities they identified were misalignment between development and natural timelines as well as miscoordination in engagement with economic interest groups. The scientists shared information about previous studies and their knowledge about the area, development and bass tournaments. The water quality workshop participants shared items relating to the changes in hydrology of the lakes and canal, observations of algal blooms, boat traffic, and sedimentation.

Activity 3: *Collaborative mapping*

The next few pages show the merged maps of pairs for each workshop, followed by a merged map of the four stakeholder groups from workshops 1, 2, 4 and 5. Thicker lines

correspond to more frequently cited relationships among pairs of participants. Note that environmental health as well as indicators of the state of environmental health were considered to be measurable, causal variable. This characterization helps to understand the factors that are most important in influencing environmental health for each stakeholder group.

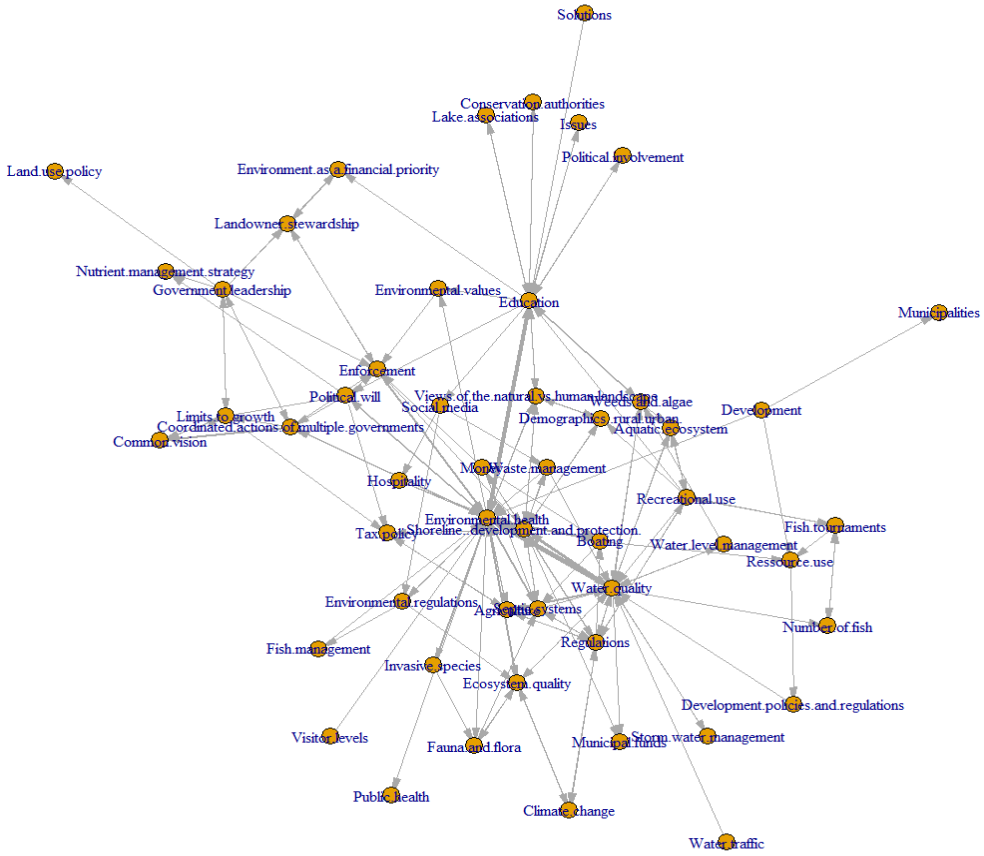


Figure 3: Workshop 1 - community group. Merged map made of the maps of each pair of participants in this workshop. Thicker lines correspond to more frequently cited relationships among pairs of participants

Community groups

The most influential nodes were education, water level management, resource use, recreational use, government action and enforcement. Education, water level management, and resource use have the most linkages and they also mediate impacts. For example, CAs impact education which indirectly impacts views of the natural versus human landscape. Resource use, water level management and recreational use are connected with many nodes that are also very connected. Many pairs in this group cited the linkage between environmental health and education. Multiple pairs also linked water quality and shoreline development to environmental health. Other links cited by more than one pair within the group include coordinated action of multiple governments with common vision and environmental health, and land stewardship with environment as a financial priority.

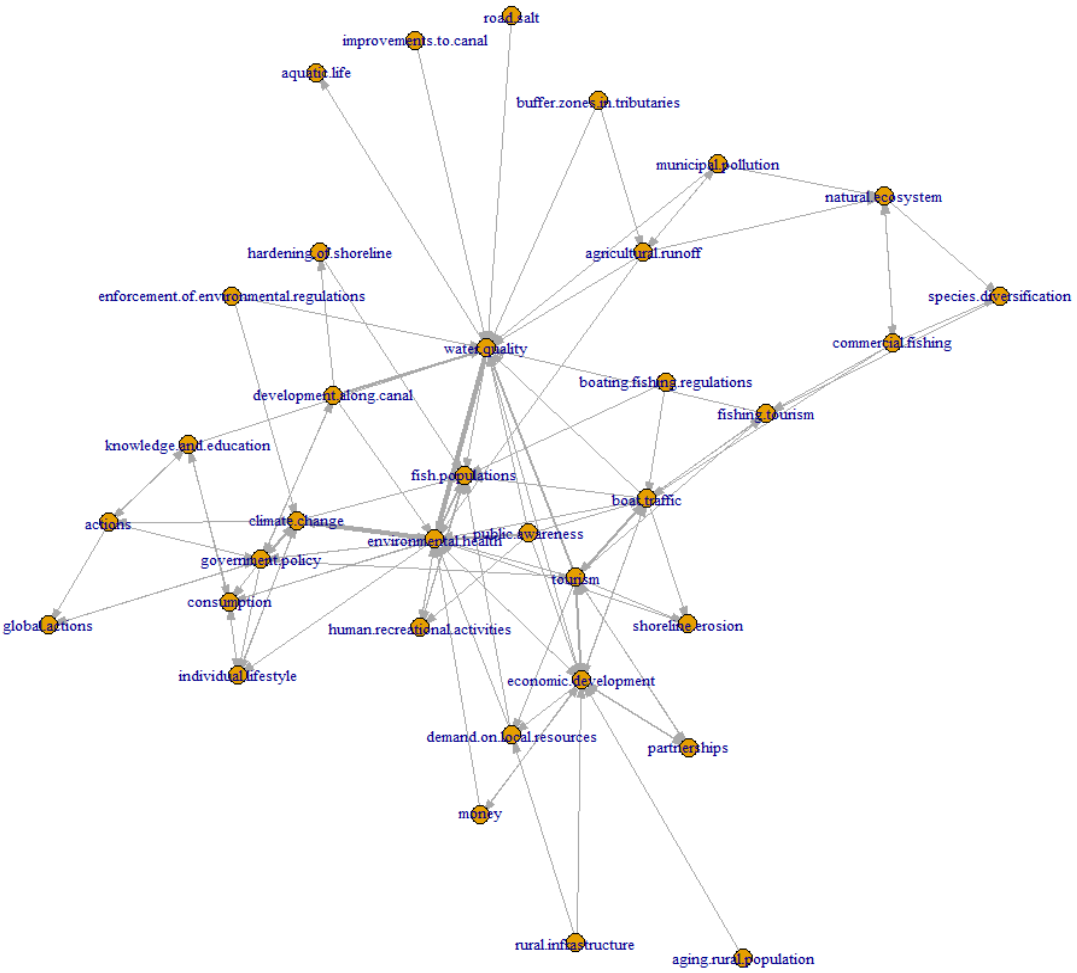


Figure 4: Workshop 2 – economic interest group. Merged map made of the maps of each pair of participants in this workshop. Thicker lines correspond to more frequently cited relationships among pairs of participants.

Economic interest groups

Economic development, boat traffic, tourism, and government policy, in order of importance, were the top influential nodes. According to this group, economic development is an effective mediator followed by government policy and boat traffic; these nodes lie on the shortest path of other relationships. For example, economic development impacts environmental health directly, but it also mediates impacts from partnerships, rural infrastructure and money. Tourism and economic development are connected to other highly connected nodes. Pairs in this group thought water quality was linked to environmental health, but also tourism. Boat traffic and fishing were also linked by more than one pair. The link between climate change and environmental health was also made by a few pairs.

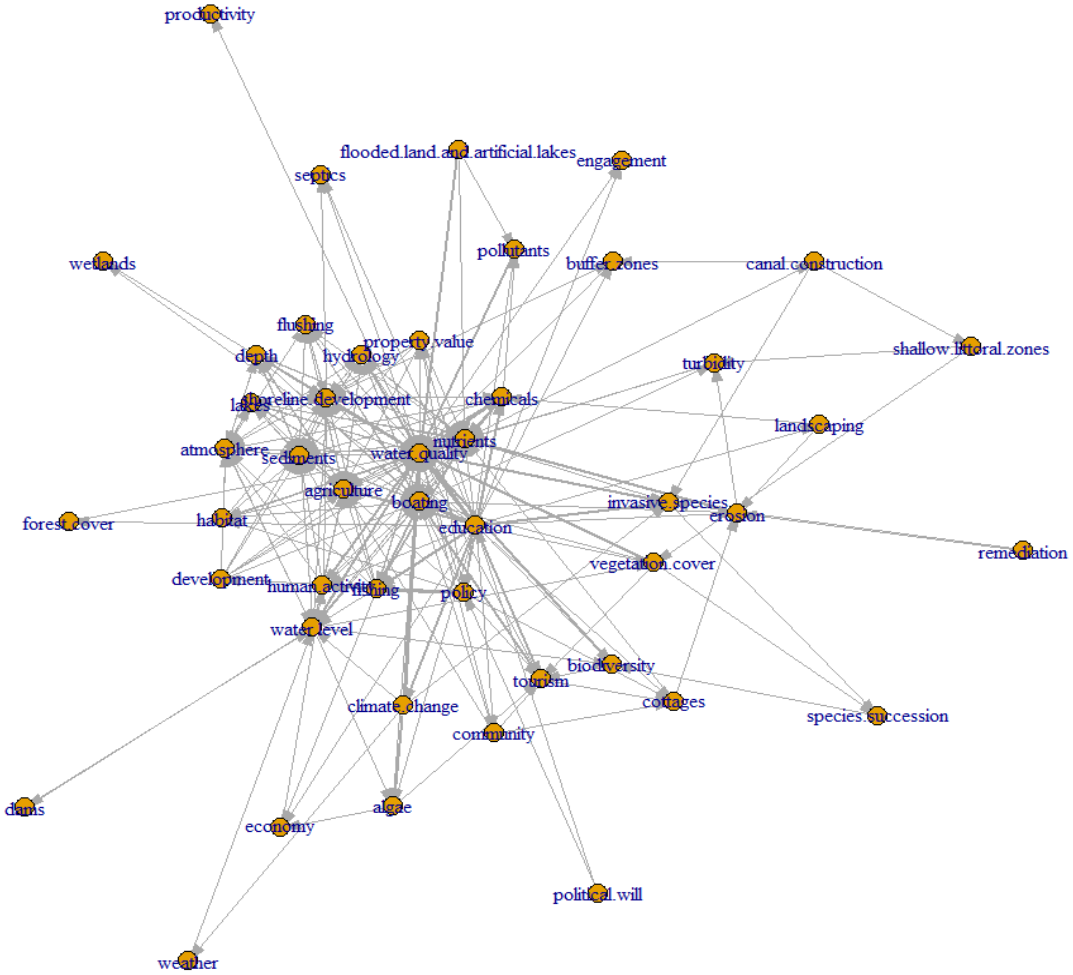


Figure 5: Workshop 3 – water quality. Merged map made of the maps of each pair of participants in this workshop. Thicker lines correspond to more frequently cited relationships among pairs of participants.

Water quality workshop

Education, sediments and nutrients, agriculture, policy, and development were the highest scoring for centrality overall for this workshop. Sediments and nutrients, education, boating, and policy have the most linkages. Nutrients, boating, and water level are the mediators in this network. Education, sediments, and policy are well connected to other popular nodes. Participants made links between water quality and education, nutrients, climate change, pollutants, and hydrology. Education was linked to boating, invasive species, tourism, climate change, fishing, agriculture, and nutrients by many pairs. Policy and human activity were also linked, which connects to other factors that directly link to water quality.

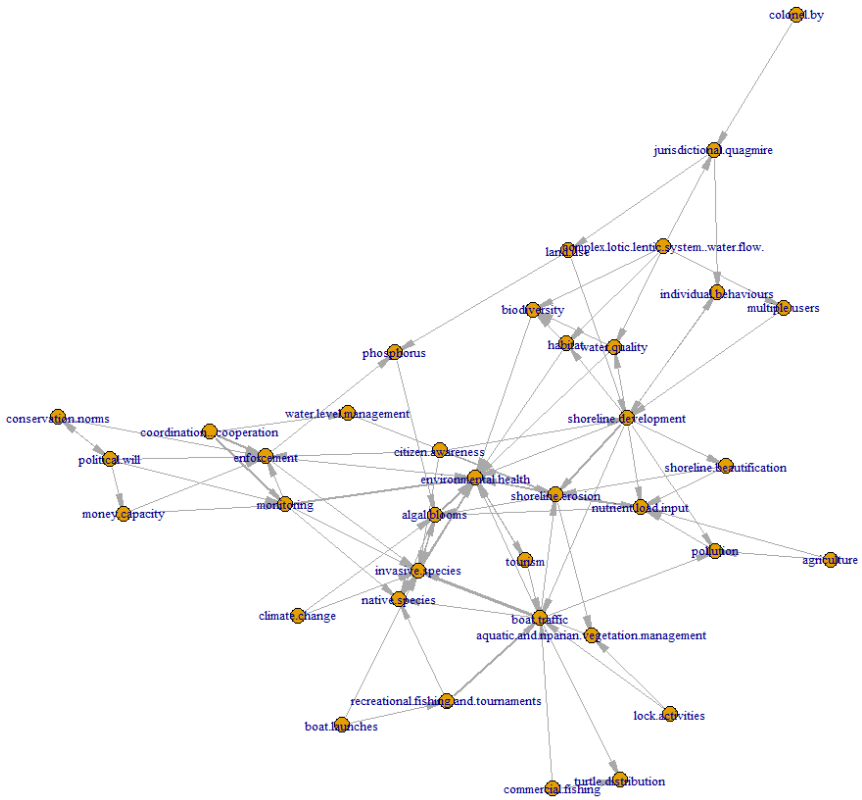


Figure 6: Workshop 4 – NSERC scientists. Merged map made of the maps of each pair of participants in this workshop. Thicker lines correspond to more frequently cited relationships among pairs of participants.

NSERC Scientists

Shoreline development, enforcement, boat traffic, erosion, and complex water systems were the most central nodes for the scientist group. Invasive species, shoreline development, boat traffic, and enforcement have the most linkages. Boat traffic, tourism, and shoreline development are nodes that connect other nodes directly and indirectly. Shoreline development, citizen awareness, and political will are nodes that are connected to well connected nodes. The scientists cited the link between environmental health and invasive species in addition to boat traffic. They also cited coordination and cooperation as being connected to monitoring. Recreational fishing was linked to boat traffic, and shoreline erosion was linked to nutrient load input, shoreline development, and environmental health. This was the only workshop where Colonel By, who supervised the construction of the RC, was mentioned as influencing the RC system; in this case the scientists saw this factor directly influencing jurisdictional quagmire.

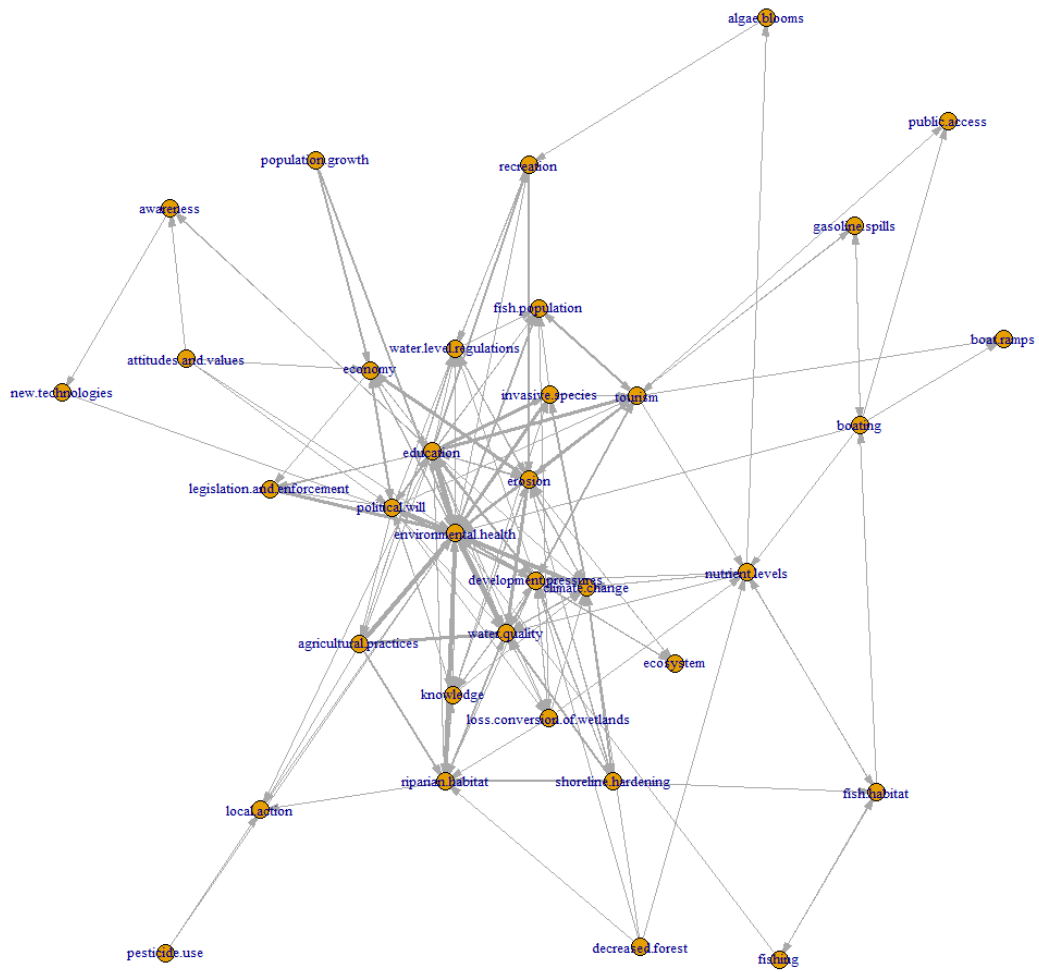


Figure 7: Workshop 5 – government representatives. Merged map made of the maps of each pair of participants in this workshop. Thicker lines correspond to more frequently cited relationships among pairs of participants.

Governments

Education, development pressures, erosion, political will and tourism were top central nodes. Nodes that have many linkages are development pressures, water quality, erosion, education, and political will. High scoring mediator nodes are education, tourism, and development pressures. Education, development pressures, and political will also have influence over the whole network. The relationships that were the most cited were between environmental health and water quality, riparian habitat, education, agricultural practices, political will, development pressures, and legislation and enforcement. Other links between erosion and water quality, economy, tourism, and environmental health; and education and invasive species and tourism were cited by pairs within the group.

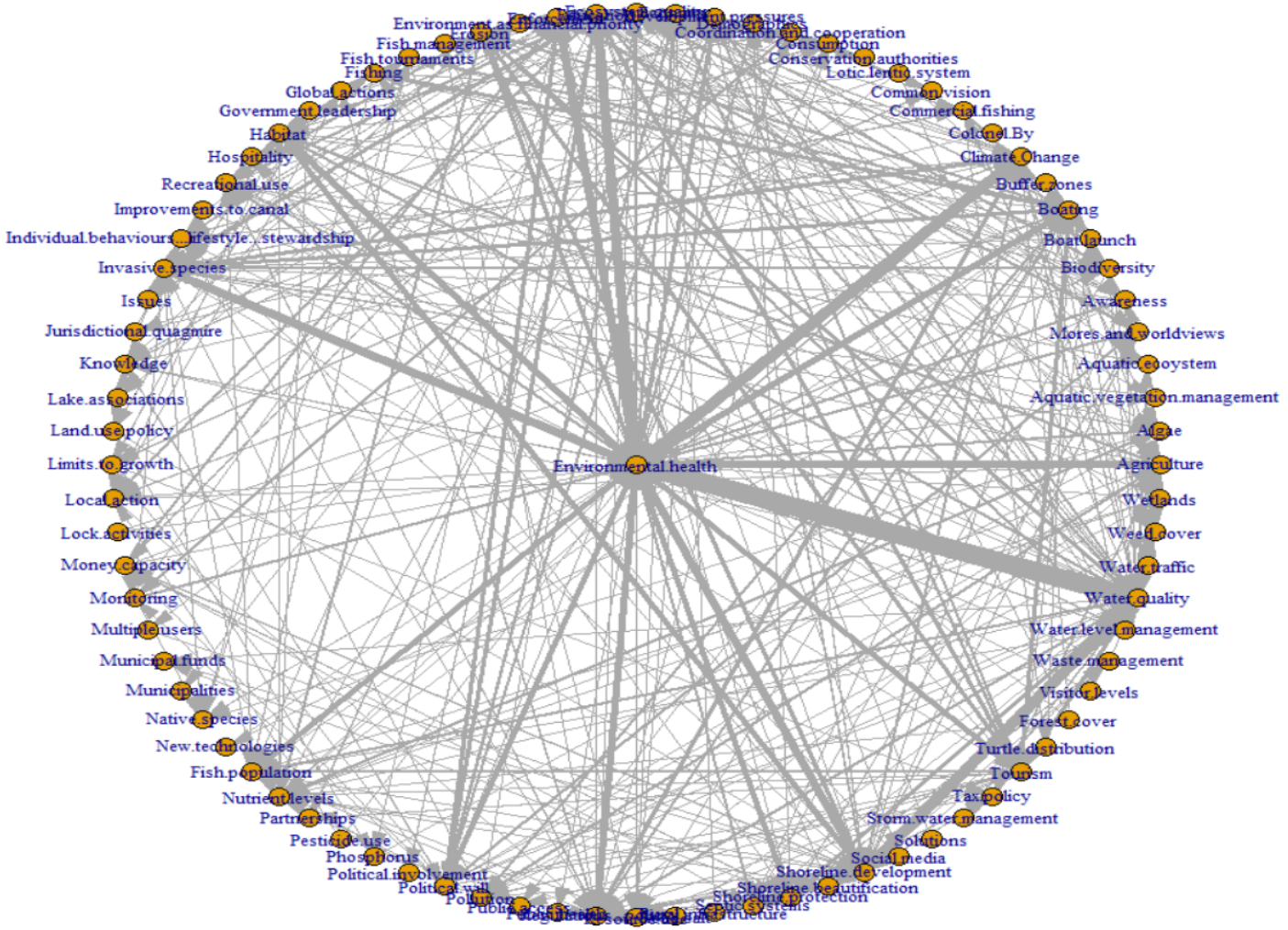


Figure 8: A merged map of Workshops 1, 2, 4, 5 (community groups, economic interest groups, NSERC scientists and government representatives). Illegible labels at the bottom and top from left to right are as follows. Bottom: public access, public health, regulations and policy, resource use, road salt, rural infrastructure. Top: enforcement, education, ecosystem quality, economy and development pressures. Thicker lines correspond to more frequently cited relationships among pairs of participants.

The nodes that have the most linkages to environmental health in the merged map (Figure 8) are water quality, education, shoreline development, and regulations and policies. Invasive species and fish population have high incoming links and boating has high outgoing links. Education, water quality, and shoreline development are also good mediators of influence in the network followed by regulations and policy, and boating. The top nodes that are connected to other well-connected nodes also include education and shoreline development as well as political will. Regulations and policies, and development pressures also have connections to popular nodes. The most cited relationships are those between environmental health and water quality, climate change, enforcement, ecosystem, habitat, invasive species, political will, regulations and policy, shoreline development, tourism, and agriculture. Invasive species was cited by many pairs across workshops as being linked to climate change and boating. Tourism was linked to erosion and ecosystem. Political will was linked to enforcement and ecosystem, and shoreline development was linked to water quality.

Table 3: Centrality scores for the merged maps for each workshop and the merged stakeholder map.

Workshop	Number of nodes	Eigenvector	Network density	Betweenness centrality	Indegree centrality	Outdegree centrality
community groups	52	0.33	0.06	0.41	0.30	0.24
economic interest groups	37	0.24	0.09	0.31	0.36	0.15
water quality	47	0.26	0.11	0.28	0.51	0.51
NSERC scientists	37	0.30	0.07	0.11	0.30	0.19
governments	35	0.30	0.14	0.25	0.59	0.37
merged map	85	0.25	0.07	0.23	0.45	0.27

Each stakeholder group had similar nodes that appeared in the top five nodes for each centrality measure. Table 4 shows the nodes that appeared at least twice across the top five nodes for the various centrality scores.

Table 4: Emerging nodes across centrality measures per stakeholder group. These nodes appeared at least twice across the top five nodes for the various centrality scores in each workshop.

Workshop	Emerging nodes across centrality measures
community groups	education water level management resource use recreational use government leadership & action enforcement
economic interest	economic development government policy boat traffic tourism water quality commercial fishing
water quality	education sediments/nutrients agriculture policy development (shoreline) boating
NSERC scientists	shoreline development enforcement boat traffic erosion complex lotic/lentic system (water flow)
government representatives	education development pressures erosion political will tourism climate change

Table 5: Nodes with the top centrality scores (1) across stakeholder workshops (same line of analysis as Table 4), (2) for the merged map, and (3) for the water quality workshop. The top emerging nodes (nodes that appeared at least twice) across centrality measures are presented based on the three categories of workshops. Emerging nodes that were similar in theme across centrality measures were recoded to a thematic node (e.g. policy or political will were recoded to governance).

Centrality measure	Emerging nodes across stakeholder workshops	Emerging nodes in merged map	Emerging nodes for water quality workshop
Indegree centrality	Water quality Development (economic & shoreline) Boating Enforcement Erosion Climate change	Water quality Education Shoreline development Invasive species Fish population Regulations & policy	Nutrients Boating Sediments Agriculture Shoreline development
Outdegree centrality	Education Development (economic & shoreline) Tourism Boat traffic Government policy/will/action Erosion	Education Shoreline development Political will Regulations & policy Boating	Education Policy Sediments Shoreline development Water level
Betweenness centrality	Education Boating Tourism Development (economic & shoreline) Enforcement	Education Water quality Shoreline development Regulations & policy Boating	Nutrients Boating Water level Shoreline development Tourism
Eigenvector centrality	Education Development (economic & shoreline) Policy/political will Resource/land use Hydrology	Education Political will Shoreline development Regulations & policy Development pressures	Education Sediments Policy Agriculture Boating Fishing
Emerging nodes across centrality measures	**Development (economic & shoreline)** **Education**	**Development (economic and shoreline)** **Education**	**Education** **Sediments/nutrients** **Agriculture** **Policy**

	Governance **Boating** **Erosion** **Tourism** **Enforcement**	**Governance (policy, political will, structure)** **Boating** **Erosion** **Tourism** **Enforcement**	**Development (shoreline) boating**

Across all workshops and centrality measures, development (including economic and shoreline development), education, governance, boating, erosion, tourism, and enforcement were the emerging points of convergence in how participants viewed influence on environmental health. These nodes are reported in the "Emerging nodes in merged map" column in Table 5, confirming the consensus among workshops about the importance of these nodes. There is some overlap with the water quality workshop's emerging nodes, but they are more specific to environmental concerns in the Lower Cataraqui region.

Activity 5: *Leverage points*

Since I am focusing on convergences in my analysis, below are key action items that I determined by examining the leverage points participants mentioned. See Appendix E for a list of the leverage points for each workshop. These items are by no means a to-do checklist, but rather a portfolio of areas that were raised by participants, that require collaborative work and could act as a starting point for collaborative governance.

Table 6: Themes of action items that were derived from the leverage points across all five workshops.

Themes	**Specific action items**
Need for leadership to coordinate management	○ Build a common vision and consolidate knowledges and experiences to have a consistent approach to management across levels of government

	○ Assign a leader to champion a multi-partner, RC-wide body or forum ○ Learn from other governance models
Invest in education for public and stakeholders	○ Develop education and programs for targeted audiences (farmers, cottagers, visitors) ○ Use various media (social media, Lake Associations, newsletters, etc.) to tell a story that fosters stewardship and a sense of responsibility ○ More transparency in governmental communication, especially regarding decisions
Take a watershed approach to planning	○ Holistic land use planning at municipal levels ○ More effective municipal by-laws
Prioritize the environment in management	○ Change PC mandate to focus on ecology as an asset ○ Improve shoreline management through riparian revegetation, mandatory setbacks, increasing the buffer zone
Strengthen and enforce existing regulations (boating, fishing, shoreline)	○ Build local capacities for enforcement
Target research and share data	○ Share success stories and best practices ○ Consolidate research, knowledge, initiatives and experiences in an accessible database/repository ○ Mobilize existing and new knowledge in governance processes

The community workshop had leverage points directed toward influencing government. The economic interest group was oriented toward knowledge, communication and legislation. The participants in this workshop suggested pooling resources to overcome lack of capacity. They also wanted to promote climate change adaptation and environmental awareness. The government workshop offered points on governance and collaboration. These participants also mentioned including perspectives from youth and Indigenous people and moving beyond

partisanship. The scientist workshop focused on collaboration, communication, and coordination. Though there were some specific suggestions based on research, such as increasing sanctuaries. The water quality workshop had a mix of all these themes in their list of leverage points.

Participant and opinion leader interviews

Although some participants consented to being named in publications, I used pseudonyms as their real names are not necessary to use in this context. This section provides a synthesis of participants views on the RC's environmental health and governance.

Perspectives on environmental health of the Rideau Canal as an SES

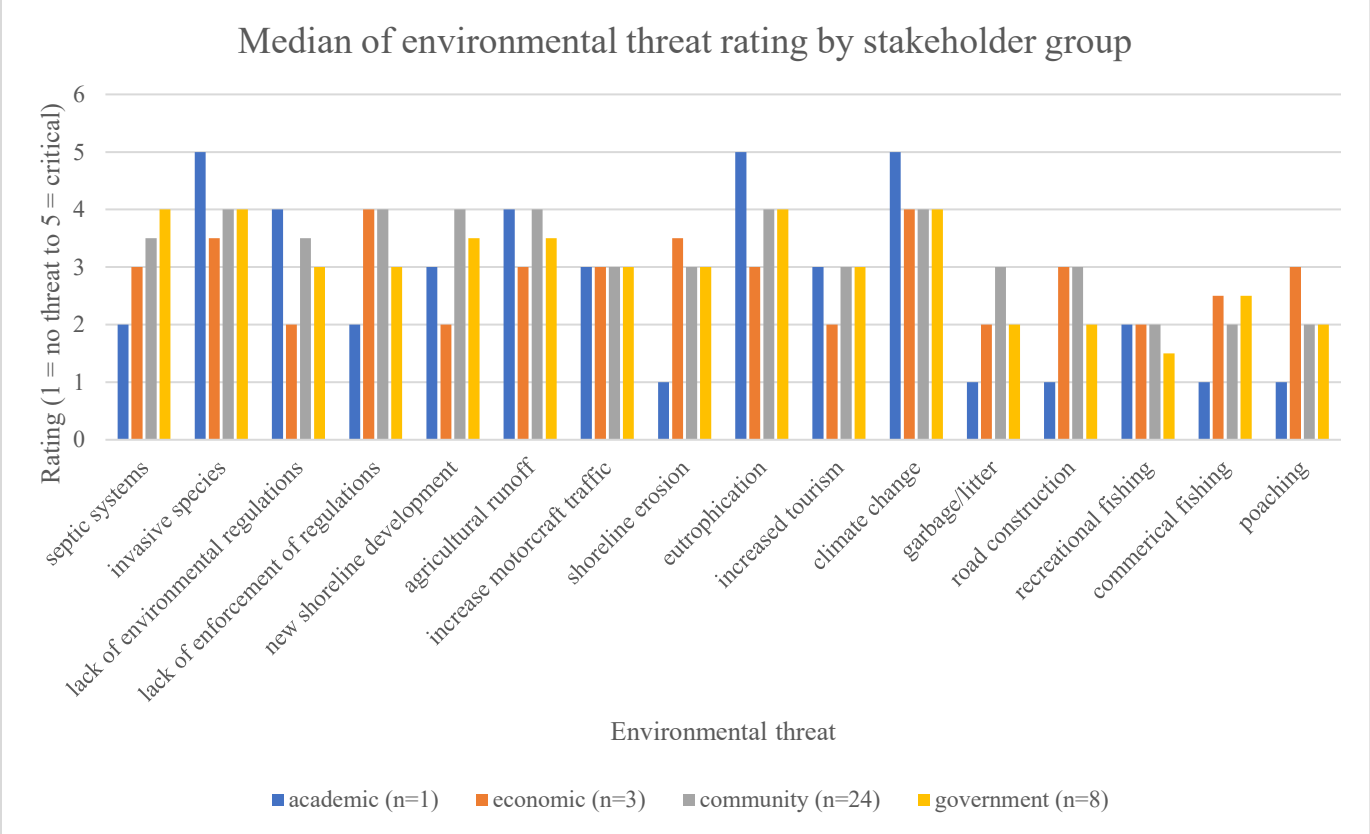


Figure 9: A graph showing the median rating of environmental threats for each stakeholder group.

Figure 9 shows Likert scale data for rating environmental threats. The data provide a general idea of each group's views despite the uneven sample size among groups. Other threats mentioned by participants are shown in Figure 10. There is consensus among groups on motorcraft traffic being a lower threat and climate change being a higher threat. The severity of threat for septic systems, commercial fishing, and lack of environmental regulations was more controversial with groups having different views. Both economic interest and community groups thought lack of enforcement was a serious threat, contrary to government representatives who were the most concerned about septic systems.

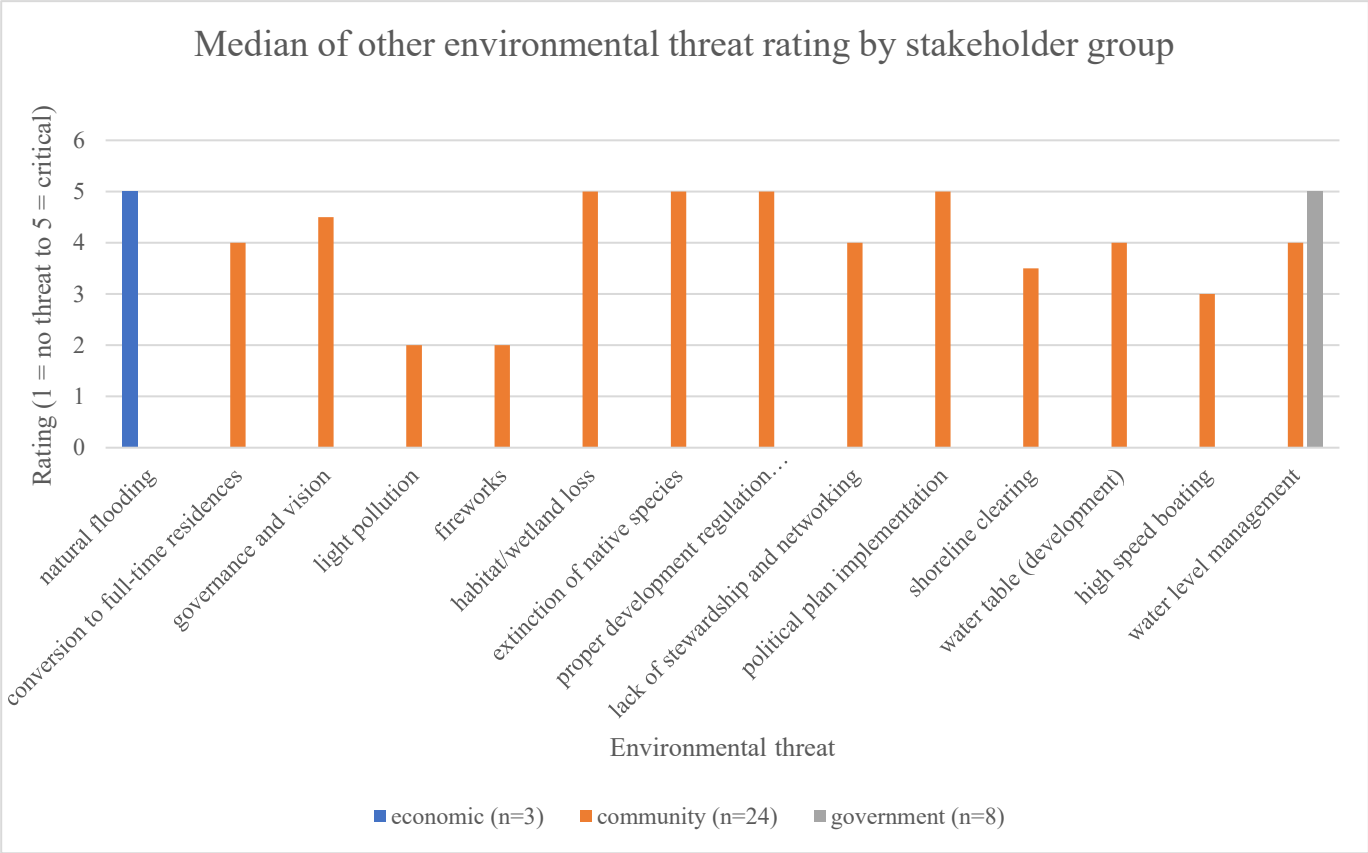


Figure 10: A graph showing the median rating of environmental threats for each stakeholder group. Sample size was based on the number of participants that listed additional factors.

It is interesting to see that many community group participants added governance and social factors to the list of environmental threats (Figure 10). For example, they listed governance and vision, political plan implementation, and lack of stewardship and networking as severe threats to the environment among others.

In addition to the Likert scales, interview participants mentioned economic, social and ecological factors that influence environmental health. Below is a synthesis of the results pertaining to these categories.

Economic factors

Tourism and development were emerging themes under economic factors that impact the environmental health of the RC. Government and community participants thought these were tied to the identity and value of the RC: "we can't lose our identity for the sake of money because then [we] will shoot ourselves in the foot and we'll have nothing left to offer if we over-develop" (Brianna). Community groups had varying views about tourism. Some thought tourism could lead to more people caring for its environment, as a business owner stated:

> *if you want them to connect and you want them to care, they have to be in it….If regulation goes so far that we're literally stopping people from using it, enjoying it, and feeling it and being connected to it, economically, that's bad, really bad. Like delaying Americans coming up for fishing season, that just means they're going to do it in the States and not here. (Fatima)*

Some community participants in the lower reach of the RC were more cautious about tourism being promoted in their region due to the negative impacts of motorboats and tourist

traffic. The community groups thought LeBoat, a boat rental business "is probably going to create more interest in the Rideau Canal system than anything else," (Griffin) though they are missing the education piece.

Government representatives and economic interest groups supported sustainable development as they recognized the value of having clean water and environmental attractions that provide experiences and raise awareness. The community participants recognized the need for PC to commercialize the Canal due to budget cuts in 2012. However, they also wanted the federal government to recognize the importance of the lakes in the RC system to tourism. Government and economic interest participants agreed on the importance of revenue from tourism as a way to run the Canal, and that actors must promote the RC while balancing development and environment in their mandates.

Economic interest groups want people in the water and using the Canal but "any big company coming in needs to spread the wealth and not just focus on directly themselves" (Simon). LeBoat was welcomed differently in sections of the Canal as some places profited more off private boats than rental boats. Partnership with businesses could help other efforts to preserve the Canal as seen between PC and LeBoat, though Simon, a business representative, stated that there needs to be fairness in revenue distribution, infrastructure investment, and tourist attraction.

Social factors

Government participants expressed concern about losing the identity, namely historical heritage feel, of the Canal due to development. Community participants noted the organization of

lake associations to protect environmental identity and also preserve Canadian identity. Community and economic interest participants compared polluted European canals to clean Canadian canals as well. A community participant's comment highlighted the interconnectedness with cultural and ecological identity: "heritage and ecology are intertwined because the way the Rideau was built is a slack water system, our current environment is a manmade environment. They go hand in hand. You can't separate the two" (Kaleb).

Not everyone identifies the same way with the Canal because of their own interests, perceptions, and life experiences. There are competing interests about development on which there is polarization according to community groups. But they also recognized the need to work together to address multiple interests (George) because "engineering staff really want the best solution, engineering solution, and that's not always the best heritage solution and so there are going to be compromises" (Kaleb). There are also distinct lifestyles and attitudes across the RC with each community wanting to preserve their knowledge about their area such as the Tay Canal, which one participant from the area felt PC does not include in their messaging and priorities. There is also less awareness locally about the Tay Canal.

Government, community and economic interest group participants agreed that there is a lack of appreciation of the RC due to differences in mindset of human-nature interactions. A government representative stated that we can get only so far with legislation and that a change in mentality is needed. A community participant commented that we need to build relationships with people to influence any change. Others commented on the lack of consideration of the RC's impacts on human health.

There have been changes in use over time (Ryan) and the challenge is "to try to come to grips with the human perceptions about environment" (Matthew). Urbanization and changing lifestyle preferences have impacted the type of development, which stem from value systems. Many community participants talked about this theme and pointed to competing interests, "between the natural weediness of the system versus people's desire to use the system for recreational purposes," (Andy) causing conflict. For example, there are negative perceptions about bass tournaments (noisy, harmful to fish etc.), but an angler argued this is because of a lack of information and understanding about tournaments. After explaining to cottagers, the angler was able to create a better understanding of bass tournaments and dissipate some tensions. There is also a sense of entitlement and ownership of the Canal that seems to stem from wealthier users, as stated by a government participant. Some community participants thought the government was catering to wealthier clientele to generate revenue, which a representative from LeBoat mentioned as well. A community participant commented that changing personalities in government can cause a shift in the value systems involved in decision-making about the RC.

Knowledge and research

All groups agreed that "there's woefully inadequate knowledge about the…natural environment in order to make good decisions for conservation and development" (Matthew). The academic participant thought there was a lack of a holistic view of the system (e.g. connecting different domains of knowledge) and lack of consideration of historical context when addressing environmental concerns. A government participant talked about the lack of data for modelling, which hinders understanding of the current state of lakes and future impacts. Government participants agreed that they "haven't kept up with keeping information current for the part [they

are] responsible for" (Lily) because research is task-driven and limited by budget (Heidi). Community participants emphasized the reduction in scientific capacity from budget cuts in 2012. An angler commented, "we probably have almost no scientific knowledge" (Rory), which community participants think is essential to inform policies that may impact environmental health.

Besides scientific knowledge, government and community group participants valued local, historical and Indigenous knowledge in environmental decision-making. Some community participants wanted to see more information on boating statistics, cultural knowledge and demographics. Politicians need to be aware of these knowledges and value systems to make informed decisions for their constituency. Instead of government, lake associations and local groups are taking on the responsibility of knowledge generation, but a government participant commented that there is a gap between knowledge and action. Even the community agrees that their environmental data is underutilized. For example, when the interviewer asked a lake association member about sharing their data with government, they had not thought of that idea but supported it. Government would also like to see knowledge being shared and other community groups would like data to be consolidated and accessible.

Government and community groups emphasized that people should know the responsibilities that come with living on the water, which can be done through education. Gaps in education are best farming and boating practices, importance of regulations, and shoreline erosion. Community group participants wanted to see education starting at a more fundamental level, not just about the RC specifically. These participants saw education leading to understanding, and thus support for environmental protection and behaviour change. The angler

also agreed based on the bass tournament example. Participants across groups wanted more knowledge exchange, especially among experts, community members and government because "unless there's an effort made to extract it and write it down and record it, then it gradually is lost over time" (Parker).

Governance factors

This sub-section speaks to participants' attitudes and perceptions on the different levels of government because each level impacts the management of the RC, thus its environmental health. I discuss the effectiveness of the overall governance regime in the following section.

Government and community participants both recognize the complexity of multi-level systems of governance. Many community members advocate for a more collaborative approach since each level influences the environment in different ways. Government representatives acknowledged that the public holds valuable knowledge about their region, however, some participants also recognized that "the general public doesn't understand…who has jurisdiction over what" (Andy). In contrast, a participant from the Tay Canal area thinks the PC government does not value community knowledge. The participant received a response from PC regarding a request for information that contained "frankly a demeaning statement that says [they] don't provide this information because [the community doesn't] understand this data" (Daniel) despite the community's efforts to track these data for over 25 years. Such perceptions have influenced a majority of stakeholders to view the governance regime as ineffective.

Federal. Community members do not agree with what they perceive to be PC's priorities (e.g. favouring LeBoat over local charities), reducing focus on the environment, and catering to

motorboat users. Although there is negative sentiment among community members regarding PC's priorities, PC is doing "a very good job of educating people and getting their word out with the limited resources that they have" (Simon). However, community members want to see different aspects of the RC being communicated, especially in Parliament (Kaleb). A shift in the PC mandate from navigation to being more ecologically driven is necessary (Matthew, Henry) and one participant went as far as to say "I think the days of Parks Canada leadership are behind us at this point," because the new management plan will not make that change (Matthew). Even municipalities are frustrated as according to a Mayor, "when they make these commitments [management plan review] to do this on a regular basis, they need to meet those commitments, otherwise they lose a considerable amount of credibility. And we don't want to see Parks Canada as the bad guys…In some circles, they are the bad guys" (Andy).

There was common sentiment among community members in that they wanted "Parks Canada stepping up to the plate" (Parker) and taking leadership, though they recognized the difficulty in doing so considering cutbacks during the Harper period (Milo). These cuts also reduced local ecological knowledge within government departments, resulting in science being "pushed out of the system. They don't have the expertise" (Kaleb). For example, there were some concerns about erosion from water level management and the change in staffing led to the loss of background knowledge on water in the system (Kaleb, Henry, Ryan, Mariam). The ground operations staff do phenomenal work and possess a lot of knowledge, which could be capitalized to advance environmental initiatives. We need to influence those that control the budget to bring the environment to the forefront of decision-making for the RC (Bradley).

PC is absent in the environmental discourse and according to a participant this stems from not knowing "if they're a park, a waterway [or a] heritage site" (Griffin). Some community and government participants thought that the existing legislative framework is effective but could be improved. For example, Parks Canada needs to communicate with communities, improve environmental understanding within the department, and enforce regulations. Regarding working relationships, a municipal employee in the commerce field commented that they are difficult for PC to maintain with other governments, especially municipalities who may view them as an "absentee parent" (Brianna).

Provincial. A federal government representative stated that the province is responsible for water quality, but a community participant pointed out that this only includes impacts to human health (Matthew). The province is not environmentally oriented (Daniel) as they withdrew their support from stewardship councils that had one full-time person in charge and a budget of $25,000 (Bradley). Although community members are trying to keep those running, they have limited resources. The community participants want to see the province stepping up as well.

Community representatives raised similar concerns as with the federal government such as the lack of political will and capacity within ministries, and understanding of local realities. They also cited erosion of environmental regulations due to "the horrible play to slay legislation of the Ford government. What a disaster" (Margaret, Tristan). Thus, some responsibilities are delegated to municipalities (Jacob) who have limited resources as they rely on tax revenue for income.

Provincial government staff stated that they are restricted in how they can help the community due to the current mandate and cuts in staffing (Ryan). They agree that the governance regime is ineffective at the provincial level in that, “you have different ministries with different mandates and sometimes that's conflicting” (Jordan), which also has municipalities confused on the province’s stance on the environment (Andy). A new government often brings with it “a shakeup within ministry bodies,” (Kathryn) leaving many actors confused about the specifics of the current mandate.

Municipal. Municipalities along the RC have their own priorities, which are often related to increasing revenue and this depends on their development plans. According to municipal representatives, urban and economic growth around the water is important for them, but they also recognize that they have to balance that with the environment (Andy). According to a community member, variations in sizes of municipalities can create an uneven quality of planning and development policies because of the types of development that they attract. Small towns discourage farmers from owning waterfront properties by raising waterfront property taxes, which favours wealthy developers who can afford to pay these taxes (Matthew). On the other hand, bigger cities like Ottawa and Kingston have other means to increase revenue that have different types of environmental impacts.

Community members believe municipalities favour development and want to see more focus on the environment (Margaret). A community participant commented on the weak implementation of municipal plans, such as in the Township of Rideau Lakes, due to lack of legal tools (Parker). Minor variances were also mentioned by community participants as ways for development to be approved without much environmental consideration of cumulative impacts.

Although municipal plans are controlled by provincial policy statements, there is pressure to find revenue which is often through development from residential properties, shifting away from commercial and industrial sectors since their migration offshore (Paul, Parker). A municipal councillor recognized this system as flawed and expressed a need to change it. Municipalities are too focused on approval processes and technicalities of permitting rather than broader objectives (Beau, Griffin).

According to a municipal representative, municipalities want to be engaged as they have the greatest stake in protecting the RC (Ryan). However, cooperation between municipalities depends on the personalities involved: “unless there's a pressing matter or we let little things like recreation sharing agreements get in the way of things that we do, we focus on the things we differ on rather than what we agree on” (Paul). There is some willingness in Smiths Falls and the Township of Rideau Lakes to work collectively. For example, the Mayor of Rideau Lake is meeting with lake associations quarterly, which community groups appreciated and thought should be replicated by other municipalities. But there is not much incentive or support for this type of collaboration, leading community members to believe that municipalities will act only when there is a crisis (Jacob). A federal representative thought that municipalities are key in planning, the plans just need to be stricter about shoreline developments. The provincial representatives expressed that they do not want to download responsibilities on municipalities, but they serve a key purpose to protect the environment on the forefront by enforcing setbacks and buffer zones, for example.

Conservation Authorities. Generally, the CA framework was viewed as an effective governance mechanism, especially since all municipalities within their boundaries are

represented on their boards (Andy, Matthew). However, according to a community participant, many people are unaware of the work they do (Bradley). Community and government participants differentiated between the effectiveness of Cataraqui Conservation (CC) and the Rideau Valley Conservation Authority (RVCA). There is conflict and disconnect between the public and the RVCA because they are too strict and are "perceived as the police body" (Brianna), thus "building tension around government interfering in our lives" (Parker, Mariam).

Many participants praised the education programs and scientific work of the CAs, more so for CC. A provincial staff member commented that there is no need for the province to do some of that work (Jordan) due to the effectiveness of the CAs. Though a municipal representative was concerned about the provincial government reducing CAs' responsibilities, leading them to create memorandums of understandings with municipalities for services. This cutback could reduce environmental programs by putting the onus on municipalities who may have different priorities (Andy).

CAs are great at helping citizen groups according to some participants from the community. Some participants want to see the CAs given more authority, such as enforcement (Ariel), and want their education to extend to those not being reached because CAs are "preaching to the converted" (Beau). A representative from CC commented that education is a "big part of our regulatory role to ensure that people understand why we're regulating" (Kathryn). They are good at working with other governments such as with their federal and municipal counterparts in the permitting process.

Overall (in)effectiveness of governance regime

There was high agreement among groups regarding: jurisdictional fragmentation and gaps/inconsistencies in legislative responsibilities (government and community groups); lack of coordination and communication (all groups); politics and political will; lack of capacity; lack of holistic management of the RC; unclear mandates; and lack of a common vision and strategic plan for the region. Since governance was intricately tied to environmental and social factors, I used NVivo 12 to examine the convergences in views based on thematic nodes (Table 7).

Table 7: Stakeholder views on the ineffectiveness of the governance regime. The green boxes represent a high percentage of participants in each stakeholder group that mentioned those nodes; orange means less than 30% of participants talked about those nodes, the lighter green means there was a moderate percentage (>30%), and red means those nodes were not explicitly discussed. The boxes contain some quotes to highlight aspects of the nodes that represent the overall views of the groups.

Node	Academic (n=1)	Government (n=8)	Community (n=24)	Economic (n=3)
Jurisdictional fragmentation and gaps	"I would say [governance is] not effective due to a lack of collaboration and communication between different levels of government." (Anthony)	"there's that lack of connection between provincial and federal regulation and managing species at risk." (Lily) "it's just completely fragmented and no body talks to the other body." (Brianna) "we work together where we have to…. It's hard to pick up those relationships on a regular basis." (Heidi)	"The big hole is the Algonquin people." (Bradley) "Parks Canada makes no contact to Lake associations. There is no dialogue" (Kaleb) "the inability… [of] the three levels of government [to work together] towards a common set of objectives is the biggest detriment to the long-term survival of the Rideau system and the wildlife it sustains" (George)	"I'm not sure why we need three or four levels of government to manage a park." (Rory) "There's a lot of duplication, but I understand again, why, because everyone wants their facts and they're all trying to collect." (Fatima)
Lack of capacity		"there's just no field staff there in order to deal with issues that we see locally" (Ryan) "But our contribution as a ministry, very little, apart from professional expertise…We don't have much money." (Jordan)	"We have Parks Canada who really don't have the resources to administer legislation" (Kaleb) "Parks Canada had cut back budgets dangerously….so some critical functions and…knowledge about the rideau canal was lost" (Henry) "the Ontario Ministry…they're underfunded and don't have the personnel." (Margaret)	"I think if [the governance system] was properly staffed, it could probably work better. The other thing is that people rotate in and out of the job" (Fatima)
Lack of holistic management		"everybody's advocating for…what thing benefits them instead of it being a bit more holistic." (Brianna)	"if their management plan still includes tributaries and stuff, then it has to be more a watershed approach" (Mariam)	"they need more systems thinking" (Fatima)

		"you're trying to solve one problem and you're in fact ignoring the impact that might have on another area in the system, again speaks to the need to treat this system as a watershed" (Andy)	"land management agencies and environmental agencies are not developing means of coordinating mandates and activities towards a common objective" (George)	
Lack or mismatch of tools, enforcement and mechanisms		"the regulations, if they had more teeth and you would have stronger regulations, then that would dictate the ability to enforce" (Jordan) "ecological integrity…are the terms that we use in our national parks…. We don't use those terms on the Rideau canal…so we don't have a mandate for that." (Heidi)	"I think the enforcement of regulations and the lack of environmental regulations. It's probably the combination" (Beau) "they haven't done a great job of implementing their existing official plan in the township of Rideau Lakes" (Parker) "It would be nice if Parks Canada updated their legislation" (Griffin)	"I think the regulations are there, whether they're being enforced or not is a whole other ball of wax" (Rory)
Politics & lack of political will and consistency		"[Parks Canada] prioritize navigation over everything else regardless of the time of year. And they shouldn't" (Jordan) "there has to be a level of consistency through the entire watershed and clear lines of responsibility" (Andy)	"it's a systemic problem that needs a systematic, considered multi-level solution. And that's where science comes in and political will comes in" (Ruth) "so much depends on the personalities as well, and that changes" (Margaret) "it's the way [regulations are] implemented that needs to be consistent along the entire canal" (Beth)	"every time there's a government switched, then the emphasis switches. The policy's changed" (Fatima)

As indicated by the green boxes, stakeholder groups have common views regarding the ineffectiveness of the governance regime. Participants across groups agreed that the current "governance regime, it works, but it's complex and it's not at all intuitive for a third party looking in" (Jordan). Government participants understood the significance of collaboration and mentioned that it is facilitated when necessary, but most community participants thought this could be improved. Community participants were also pleased with the work authorities are doing with limited resources, such as lock operations or education. Many participants referred to higher level management as being ineffective, while they perceived local staff as being more effective in fulfilling their mandates.

Towards a collaborative governance design

In the interviews, participants made many suggestions about how to improve the governance regime, which helps to answer the last research question. Many participants mentioned previous or existing partnerships or collaborative initiatives related to governance, which are important to consider for the design of co-governance. Current collaborative efforts include the Rideau Lakes Township initiative to bring together lake associations (Andy), the Rideau Corridor Landscape Strategy led by PC that brings together various stakeholders (Kaleb), and a biannual lake association meeting in Perth in collaboration with Watersheds Canada (Shelby). An advisory committee for the RC provided input to the superintendent but got disbanded in 2010 due to federal government changes. Our NSERC study was mentioned as an existing initiative that helped bring people together and translate research to decision-making. LeBoat was mentioned as an example of collaboration among governments, which was a huge challenge (Simon). The Rideau Roundtable is an ongoing form of collaboration focusing on

visitor experiences. They were involved with the Visitor Experience Opportunities Concept study led by PC in 2008 (Patrick). Lake Links is an annual conference that brings together the community, governments and local initiatives to showcase their work. The Township of South Frontenac also meets with local groups to hear their concerns.

Participants also talked about developing good relationships and trust among governments as well as between governments and the public to be able to collaborate effectively. Participants across stakeholder groups wanted to see an annual forum that brings together all stakeholders to develop a common vision and discuss the RC system as a whole. Community and government participants thought PC should take leadership of such a forum to bring together other authorities. However, some participants were hesitant to commit to PC leadership because political agendas change when a new government is elected (Margaret). A PC representative also could not see how that would fit into the current workload. A provincial representative cautioned against requiring any significant resource commitments (Jordan). The purpose of such a gathering would also have to be agreed upon internally by PC (Heidi).

Some participants thought a dedicated council or committee representing stakeholders should be created and be given power to make decisions. Some government participants emphasized that final decisions are up to the politicians (Andy, Ryan), however, community groups, such as lake associations, tend to be knowledgeable and could inform decisions (Andy, Paul). A model similar to the council for fisheries management in eastern Ontario (Fisheries Management Zone 18) could be used. This council is led by the Ministry of Natural Resources and Forestry and represents various stakeholder groups who inform decision-making related to fisheries in their management zone. The current governance structure is not set up to think

holistically and address the human versus nature question, but collaboration may bring forth that mindset to guide management (Heidi).

Whatever the model, participants would like to see system-wide issues discussed as well as a way to implement resulting actions in different contexts across the RC (e.g. urban versus rural) (Henry, Brianna). There is no organization that has a full mandate for the RC so a forum bringing together "all the different levels of government and their agencies, and industry and citizen groups" (Margaret) and First Nations could clarify jurisdictional responsibilities (Jordan) and provide up to date information on the environmental health of the RC (Lily, Daniel). These collaborations should have "people [that] are good willed and informed, are speaking to one another, presenting their points of view and attempting to understand what the other person's position is and then trying to accommodate each other" (Dawson).

Other participants from the community and government group thought that a single body would not effectively address local concerns and the agenda may be hi-jacked by other interests as seen with the Rideau Corridor Landscape Strategy. Local advisory boards or subcommittees were favoured by these participants as the commitment level is also low (Bernard, Harrison, Shelby, Brianna). A participant commented that "with a system like this, you've got to have collaborative governance at all levels" (Gavin). Some participants thought the CA is the appropriate scale of governance as they bring together local actors, but the academic participant wanted to see more collaboration between townships regardless of their respective CA.

Social learning

Social learning was not explicitly discussed in the interviews except for the questions on workshop feedback (see next section). However, participants recognized the need to make learning intentional as "collaboration starts with a consistent exchange of ideas and viewpoints" (George) between various knowledge holders to help put the pieces together (Patrick). Especially councillors and politicians (Griffin, Beth) because "if they don't have a background in environmental protection, they don't really understand how their decisions affect the environment…There's a real need to engage with both planning departments and council members" (Beth). Education and training were seen as a method to develop understandings of the system and "hearing about what others are doing raises the possibility of alliances around common issues" (Henry).

Power asymmetries

Participants alluded to power asymmetries in the context of various voices being represented in governance. A community participant noted that councils should not be too large but also representative (Gavin). The lack of participation in governance from First Nations was noted by a few community participants despite invitations to collaborative efforts (Matthew, Jasmine, Gavin). A PC representative stated that we must ensure "appropriate people are at the table" (Heidi). Community members believed that PC values certain parts of the Canal system more than others. For example, "Parks Canada seldom includes the Tay's history when discussing the Canal's history" (Daniel). PC also keeps the power by keeping the knowledge and not being transparent the with information they collect (Tristan).

Many community participants felt unheard and wanted more opportunities to participate in governance. Some applauded the efforts of the Township of Rideau Lakes' engagement with lake associations as a good process in terms of being heard. However, on a broader scale there are too many special interest groups with their own agendas to provide the opportunity to speak (Matthew, Patrick). For example, a deputy mayor commented that lake associations tend to immediately object to development proposals due to their own interests, without providing a rational explanation (Ryan).

NSERC CCM workshop feedback

Our workshops were appreciated and stood out to other workshops that are generally held by government. The opportunity to participate was well worth people's time "because there isn't enough opportunities to understand the whole system" (Paul). Participants would like to see more of these types of workshops as long as there is appropriate follow-up, which they thought was a bit delayed on our end. "The real stakeholders were there, or the most stakeholders I guess I would say that I've ever seen at a meeting where people have a vested interest, people like yourselves that are trying to understand what's going on," (Ryan) is a comment that summarizes most participants' thoughts about our workshops.

Social learning

Participants learned new information about the RC such as invasive species, commercial fishing, governance, and existing initiatives. Sixteen participants explicitly said they learned something new from the workshops, compared to six who said they did not take away anything new. Many participants commented that they learned about others' perspectives and that there

was an impressive amount of knowledge about the RC around the table. Having a diversity of views, even within stakeholder groups, contributed to this learning aspect. In fact, some people thought we could have gone broader. For example, a participant from the government workshop indicated, "it would be interesting to put maybe some other groups even like members of the public who are a part of an association in this room to hear their points of views as well" (Kathryn). Having more diversity, especially bringing "business and government together so that there's an understanding of why on both sides," (Fatima) was emphasized by a business owner among other participants.

The activities helped people see "more than just [their] own little tunnel vision, you know, somebody else's tunnel vision. How do you join them?" (Harrison). Another participant observed commonality of interest and philosophies in the discussions, which was surprising to another participant who was expecting conflict due to the heterogeneity of views. Participants found our workshops informative and appreciated that if "you got a point of view and if I understood it better, and I will try to, then it would have some effect of what I think" (Dawson). For example, a participant from the scientist workshop "realized that [they] may be the most militant among them re: enforcement of rule breaking. That prompted introspection" (Julian). A participant commented on the mapping exercise:

> *You paired me with a guy from Queens biology and he started with, so invasive species, you know, like it was all gonna be about it. I said, well, we need to look at a bigger picture here. He quite quickly said, Oh yeah, okay. And so when we did our little map, it was much different than I, if I hadn't been as outspoken as I was, that mapping might've been very different (Griffin).*

Although not everyone learned something new, some views were reinforced e.g. views on the threat of climate change. An older male participant thought, “your intuitive choices are probably the right ones and you shouldn't ruminate on them too much cause then you're just going to confuse yourself. What you see right away is usually what's right. Unless someone can really change your perspective” (Milo).

Power asymmetries

Most participants thought the facilitators were mindful of people dominating the conversation, though one person thought the facilitator for their workshop could have been more assertive to avoid tangents. Having a roundtable discussion made participants feel that they had a chance to speak and that their voices were heard. The method allowed for smaller group activity and “splitting the people up and working as teams helped” (Tristan). Some people tried to be aware of being a “white man with power” (Parker) and took the time to listen by “[reining] it in” (Julian). Others also commented on the dominance of older white males in these conversations.

Participants appreciated the neutral set up though there was a split opinion on whether government representatives should have been included in all the workshops. Participants wanted to see Parks Canada, Transport Canada, the Boating Ontario Association, First Nations, developers, and business or property owners at these workshops. The absence of First Nations in particular was brought up for the power dynamics question a few times as they “have been entirely left out of the whole equation of what's going on in the Rideau system and what's going on in the lakes, and even down to what's going on in [the] township” (Jasmine). Some

participants mentioned technology as a way to help increase accessibility and also be a creative way to present data live through polling (Paul).

Workshop structure

Overall, participants found the workshops conducive to participation due to the structure. It had good focus and "the way you absorb the information or got it out of us, the stickies on the wall, the vision aspect of it, very visual, and I think the picture's worth a thousand words" (Simon). Although the interactive elements were appreciated, the timeline was a bit confusing for one participant. They commented that we would have benefitted more from the exercise if people came more prepared. The timing of the workshop was generally perceived to be sufficient, but some participants comments that it was too short to understand the causal mapping and to network with others. On the other hand, others found it interesting to work together to make linkages despite the challenging mapping activity. A participant compared PC's visioning workshops on the RC as being too broad, leading participants to favour personal interests rather than the RC as a whole.

These workshops were seen as a good networking opportunity and way to build relationships with others along the RC that also want to protect it. Participants felt it encouraged follow-up with new people, for example, one Mayor received a phone call afterward asking about their town's initiatives. Some participants thought more could have been done to initiate partnerships after the workshops.

Role in decision-making

Generally, participants thought this workshop could be useful to inform decision-making and make resulting decisions more credible due to its rigor and "partly because of the systems approach that [we] took" (Henry). A PC staff member said, "it will paint a picture of the valued components and largest issues, and where funds and time could be best focused" (Heidi). A Mayor commented that it was only useful for information gathering that may not necessarily impact decisions since those are up to council (i.e. political will). The politicians are responsible for decision-making, but a Deputy Mayor said, "if that group is the right group, then it's easy for people like myself to make a decision from recommendations from that group because they mean something" (Ryan).

Although these workshops created an inclusive environment, there is high tension between some groups which requires relationship building. Some participants were uncertain if this workshop would be able to forge relationships and address tensions effectively in a decision-making context. Some participants thought the outcomes should lead to action for it to be useful for decision-making. One participant wanted their community to have some decision-making power. Though to influence decisions, we need an understanding of the current decision-making process.

Parks Canada visioning workshops

PC held these workshops to obtain stakeholder input on the long-term vision for the waterways and strategies to achieve it, which would be used to inform the mandated review of the Management Plan per the *Parks Canada Agency Act*. There were a series of steps involved in

the plan's review starting with information gathering and assessing the state of the waterway. Following these mandated steps, PC created a non-mandated step of engaging with the public through visioning workshops to incorporate their views in a draft that is internally formulated. The draft plan was supposed to be out for both in-person and multi-media consultation in early 2020, 10 years later than the mandated review of 5 years. However, this step has been further delayed due to the COVID-19 pandemic. The structure of the PC workshops centered around three questions:

1. What does the TSW look like to you in 10 years from now? (Take ten minutes to jot down ideas)

2. What does success look like? What are priorities we should collectively focus on to achieve this vision? How do we measure it? (Use the SMART goals framework)

3. What are the results you wish to see achieved? How do we track and monitor progress?

Workshop 1 – Orillia

Although there were no women participants at this workshop, a diversity of perspectives were represented from private and public sectors (e.g. Lake Simcoe Region Conservation Authority and community groups). This workshop had open discussion and was loosely structured, despite the prepared questions, where not everyone contributed equally. Sticky notes were used to jot down ideas for the first question, though they were not used for discussion. A few individuals dominated the conversation, though at the end everyone was given an opportunity to speak briefly.

The group discussed water quality/levels, governance, lock hours, tourism, sustainable development, need for a governance body to provide cohesive information, climate change, and year-round visitation. A representative from the local CA responded to technical questions and concerns from stakeholders and shared knowledge on watershed management to clarify misperceptions about environmental issues (e.g. invasive species and water quality). PC clarified some misperceptions about their review process and other topics. Participants wanted more transparency and explanation for PC's decisions about the RC (e.g. lock hours). There was also a question about how they were defining success for their workshop objective.

Workshop 2 – Haliburton

The discussion in this workshop was dominated by a group that was concerned with PC's framing of the TSW system as a waterway instead of watershed. They criticized PC's ignorance of the importance of the reservoir lakes. They felt that PC's wording limited attention to communities only living along the main waterway. There were many interruptions throughout the workshop as participants and PC were speaking different languages: ecological versus legal boundaries. PC had less control over the flow of conversation though staff were able to bring focus to the conversation after some time. The structure of the three questions was loosely followed as a result of these interruptions.

Participants raised concerns about the current management structure and the lack of transparency in public engagement and consultation. The participants also wanted to see a mechanism to gather the right people at the right time for such discussions because more ways to work together are required; PC staff suggested holding a lake association conference. There was

also a desire for more data sharing. Participants felt some people were not included in communications from PC because they were not using the same means for communication. Participants also commented on the lack of diversity (i.e. CAs and other associations were not present) at the table and the federal government's lack of interest in working with communities. There was a question on how these visioning workshops were approved and funded. Other topics participants mentioned were revising the school curriculum and improving public education and awareness.

Workshop 3 – Kirkfield

The nature of this workshop was more visionary and had a higher attendance of younger women who were more vocal. Despite there being a separate Indigenous consultation, participants felt Indigenous communities should have been invited to these general workshops. The sticky notes were used as intended and everyone shared their ideas on education, tourism, sustainable development, connecting communities through the waterway, governance, Indigenous inclusion, historical context, and difficulty forming partnerships due to red tape. Participants made connections between school education, sustainability, and tourism but there was no follow-up on how these items could be connected in practice. PC responded to concerns about liability and the lack of government flexibility which appeared to have created some understanding of gaps.

There was a suggestion to co-create the management plan with partners to develop a sense of ownership. Participants also wanted to have regular engagement since it is the people's plan as much as PC's. Participants suggested having a venue for coaching in knowledge

dissemination so partners can effectively communicate messaging and information to the wider public as well as facilitate plan implementation. Some participants were still unclear on the purpose of the workshop as well as PC's priorities. PC clarified by stating that these workshop exercises will inform their priorities, which will be more transparent through the new annual implementation report. Everyone agreed to having collective action led by PC, but the opportunity to have multiple people at the table was stated as a need to quickly move forward together.

Workshop 4 – Campbellford

There was a much smaller group of mainly older women in this workshop. The sticky notes were used again and the conversation was dominated by the same group from Haliburton. Although PC added the TSW watershed map to the presentation, there was still tension regarding PC's lack of inclusion of the reservoir lakes causing more time to be spent on clarifications. Topics covered in this workshop included outreach and education, partnerships, attracting younger generations, tourism, and PC leadership in networks and partnerships. Stakeholders made linkages between economic development and ecological integrity which appeared to broaden PC's view of the TSW, though participants wondered how it could be implemented considering changing priorities.

Power asymmetries between smaller and larger communities was a theme we noticed as smaller groups felt that they were not appropriately represented. The potential of a rolling mechanism, with PC as the facilitator due to liability, was discussed. However, a past effort to create a water management advisory council was hijacked by economic development interests.

Workshop 5 – Peterborough

Attendance was low for this workshop, contrary to expectations. There were more vocal women at the table. Presenting the vision elements on the screen helped prompt ideas and conversation. There was a focus on tourism and boating since some participants were business owners. Participants recognized the need to balance heritage, environment, and development through communication and partnerships. They also expressed the need for more knowledge sharing between stakeholders.

PC stated they would like to do such roundtables more often, especially in light of the new annual reporting requirement. Participants wanted PC to lead such a roundtable but the federal government may be restricted by their lack of resources. PC also admitted to struggles of knowledge sharing. Participants suggested building communication networks to facilitate collaboration and partnerships. Regional Tourism Organizations were identified as a major actor in the TSW for collaborations. Relations with other canals was also identified as an opportunity for collaboration. Overall, people wanted these discussions to continue.

Workshop 6 – Peterborough lift lock

This workshop was added to compensate for low attendance in the previous session. There was a higher diversity of attendees in this workshop with a good mix of men and women from varying generations. The facilitator for this workshop explained the activities well and how they tie together. They were also more assertive. Some knowledge sharing was observed as people provided information about invasive species and some participants commented that they

learned something new. Participants would appreciate more information from PC as the staff were unable to answer technical questions.

Stakeholders shared current initiatives and success stories, which other participants seemed interested in learning more about. Some people thought that the management plan is not the right tool for strategic thinking. Participants understood that PC has limited resources and will be using these sessions to set priorities.

General observations across PC workshops

The staff and facilitators in particular were patient and open to ideas. There was much interest from both PC and participants for more regular engagement that is flexible. PC suggested that they could lead an annual forum to pull together actors. Similar forums existed before but it was difficult to implement actionable items.

Participants shared knowledge and developed some understanding of social dynamics in these communities, as well as about PC's capacity, interest and efforts to work within restricted mandates. There were many PC staff present to answer questions and offer insight at these workshops, though we noticed that having a higher percentage of PC staff in the room restricted the overall openness for discussion sometimes. PC was grateful for the input and their engagement efforts seemed genuine, but participants raised some concern about follow-up. The PC Operations staff was well known among participants and changed the dynamic of the conversation for some workshops. In fact, some participants would like to see all PC staff to have the same attitude and accessibility as Operations staff in public engagement and communication.

5. DISCUSSION

The discussion follows the three research questions as outlined in the introduction (page 5). I synthesize the results from multiple research activities to answer the three research questions. First, I analyze the stakeholder perspectives about pertinent factors that influence environmental health based on workshop and interview data. Next, I compare the CCM and PC workshops from an engagement perspective, specifically looking at social learning and power asymmetries. These analyses and interview data inform the last research question about how we can enable co-governance in the RC to foster social learning and manage power asymmetries.

5.1 What are the stakeholder perspectives about the factors influencing the environmental health of the Rideau Canal through the lens of a socio-ecological system?

In this section, I analyze by theme rather than stakeholder group since there are many overlapping views across groups, but also some nuanced differences. The main themes that emerged from the interviews and workshop activities are governance, development, education, water quality, and boating activities. Note that these themes are interconnected as expected for an SES.

Governance

Stakeholders described the governance of the RC as a jurisdictional quagmire that impacts environmental health. Governance is an influential factor in the system as policy and regulations impact other factors that have multiple linkages, which can mediate influence across the system. For example, the community, economic interest and scientist groups linked

enforcement of shoreline development regulations to environmental health, whereas government representatives focused on lack of political will and limited capacity. Economic interest groups criticized the governance regime's fragmented nature because it is an obstacle to scaling up business operations. For example, LeBoat's operations could not expand without coordination between governments regarding allowable docking locations for rental boats. Those who are familiar with the ins and outs of the governance regime consider it to be effective, but most stakeholders find it difficult to navigate because of multiple overlapping jurisdictions.

There were convergences in views regarding the governance regime's inability to coordinate and communicate with the public and different authorities. There are minimal efforts to communicate with the public openly about the hurdles in the system, preventing initiatives to work effectively within these fragmented political-scapes. Generally, there was consensus about the limited collaboration within the RC's governance regime, which government staff mentioned occurs only on a need-to basis. Although stakeholders acknowledged the constraints under which governments are operating for environmental protection, community groups would like to see more coordination and communication among government agencies, and between these agencies and the public; these are important missing pieces of effective co-management in watershed governance (Berardo et al., 2019; Olsson et al., 2004).

On the other hand, participants had different views about each of the three levels of government and the CAs. Many stakeholders wanted PC and the provincial government to take leadership, which according to Berardo et al. (2019) can reduce jurisdictional fragmentation. Actors such as LeBoat, who have a mutually beneficial relationship with PC, were satisfied with PC's current performance. However, municipalities and community groups that receive minimal

contact from PC have weaker working relationships with them, leading to a lack of understanding of PC's stance on the environmental front. Community, municipal, provincial, federal and some economic interest participants' comments indicate there is a lack of attention to environmental concerns for the RC system at all levels of government, posing more challenges for holistic environmental management. Priorities and political will at higher levels impact funding, staff allocation and consistent operations at lower levels, which creates barriers for small-scale initiatives to be sustained and replicated across the system.

CAs are viewed as effective in educating the public and providing support (expertise and networking) to various actors. However, the disconnect between the RVCA and CC is another feature of jurisdictional fragmentation since it also separates knowledge about different sections of the waterway. Addressing this disconnect can help us think about the design of co-governance. Inconsistencies in governance, exacerbated by jurisdictional fragmentation and the lack of coordination among the various authorities, deprioritize environmental issues across the RC. These spatial differences result in misalignments between ecological systems and their management when a more holistic approach is needed for interconnected watershed systems (Armitage et al., 2007; Olsson et al., 2007).

Development

Development was a significant theme that groups stated had potential to protect but also deteriorate the RC's environment. Government and economic group participants wanted economic development, often related to increased tourist traffic and shoreline development, in order to generate revenue. They were also cognizant of protecting the RC as an attraction. Some

government participants wanted a balance between economic development and environmental protection to sustain local economies for residents. Economic group participants also realized that ensuring that local communities benefit from their business operations in some way is an important aspect of the RC's environmental health. Small-scale economic development drives attraction to that area, which ultimately influences behaviours that protect the Canal. These causal linkages were evident in the stakeholder group maps since groups (government and economic interest groups specifically) linked water quality and tourism, which was linked to education that was linked to action and environmental health. These two stakeholder groups care about environmental health and the community in their areas as they are interrelated. However, the ineffective governance regime makes it difficult for entrepreneurs and municipal governments with low funds to balance the protection of the RC system with development.

Contrarily, some community members viewed economic development as diminishing the RC's value and negatively impacting their identity. Some participants agreed that tourism and development attract attention to the RC, but this attention does not necessarily translate into improved environmental management and effective governance. Therefore, there need to be effective linkages between economic development and environmental governance. However, community group participants perceived economic interest groups being mostly profit-driven. They did not consider them as entities that could create opportunities to benefit the environment and participate in co-governance. Instead, many stakeholders framed community members and groups as key participants in co-governance due to their local knowledge and activism. These perceptions indicate that such governance spaces must engage a variety of actors, especially

those who are intuitively perceived as contributing to environmental deterioration like economic interest groups (Stange et al., 2016).

Shoreline development was seen as a threat to environmental health by all stakeholders. While municipal governments benefit economically from shoreline development, community participants wanted stricter enforcement of setbacks and waterfront residential development since erosion deteriorates water quality, thus impacting their enjoyment of the water. Despite current efforts of CAs to protect the shoreline, the lack of enforcement, communication, relationship building, and jurisdictional coordination (e.g. inconsistent implementation of regulations and approvals of permits) between actors makes efforts to mitigate the impacts of shoreline development difficult. Since enjoyment of the water is the common denominator of shoreline development among users, conservation efforts should move towards linking conservation as being a part of development to holistically improve environmental health (Schultz et al., 2011). This shift can be achieved by managers of the shoreline who could be more mindful of social capital to create a sense of ownership as a way of improving relations with actors (Carr & Heyman, 2012), thus creating a united front on balancing conservation and development.

Each type of development (economic and shoreline, though they can be interconnected) impacts environmental health differently but they are often perceived by community groups as being undesirable as a whole without considering the positive impacts of certain development. The lack of dialogue about the priorities of actors creates misunderstandings about intentions for environmental protection, contributing to a messy, inconsistent landscape of development across the RC system. Competing perceptions inhibit cooperation and they create power differentials,

which is counterproductive to protecting the RC's environment. Explicitly addressing these barriers is necessary to facilitate creative problem solving that simultaneously addresses environmental, social and economic concerns (Natcher et al., 2005).

Water quality

All groups were concerned about poor water quality since they are affected by it in different ways. Residents living on lakes in the RC system were concerned about ecosystem and human health, as well as social factors tied to the water (e.g. lifestyle, recreation, and future use). Businesses rely on good water quality to attract tourists. Governments have varying reasons for concern: federal government has no mandate for water quality, but received criticism for impacting water quality through water level management; municipal governments want good water quality to attract residents to live on the shoreline, thereby increasing tax revenue; provincial government has a mandate for water quality; and CAs have a mandate to protect environmental health. These linkages identified in the interviews and workshops demonstrate that each group has a stake in improving water quality, but there is a gap in addressing differing conditions across the Canal. This gap can be attributed to the lack of consideration of the connectedness of water quality with other factors and its ability to bridge various types of factors across the RC to environmental health. The water quality workshop revealed a variety of interconnections to social (boating, fishing, education), economic (tourism, development), governance (policy, water level management) and ecological (nutrients) factors. Therefore, it was effective to bring together a mix of stakeholder groups in this workshop because it helped develop a list of leverage points that addressed multiple types of factors specific to the Lower Cataraqui region.

Education and knowledge

Education was also perceived to be a key factor in influencing environmental health as indicated by its high eigenvector centrality scores across workshops. It is connected to factors of varying nature such as recreational use, habitat, and invasive species, which are also perceived as well-connected to other factors including environmental health. The linkages to education in the maps indicate that it has potential to change behaviour in the RC, but it is not being used to its full potential to foster social learning (Medema et al., 2014). Therefore, we need mechanisms to facilitate education and provide opportunities for actors to better understand linkages between factors and also other points of view, which can be done through conducting more CCM workshops (Medema et al., 2014).

Participants across stakeholder groups viewed the environmental knowledge of users as valuable in informing environmental management. Although CAs are delegated the responsibility for education, potential restrictions in their mandate and capacity could reduce educational programs that help protect environmental health. Linking local knowledge holders to decision-makers could benefit environmental health since provincial and federal governments have limited dialogue with local users (Berardo et al., 2019; Medema et al., 2014; Özesmi & Özesmi, 2004). This creates an opportunity to work with actors on knowledge co-production and dissemination.

Boating and fishing activity

The Canal's construction for navigation purposes makes it ideal for recreational activities like boating and fishing, which were often directly linked by participants. Scientists and

economic interest groups perceived boating as central to environmental health, though in different ways. While scientists viewed boating as a mechanism that propagates invasive species, economic interest and municipal government participants tied boating to tourism and economic development. They thought that experiencing the RC system through boating promotes tourism, which creates more attention for environmental management to continue attracting users. This linkage creates a cycle to further improve environmental health since these activities generate revenue for environmental efforts, though this is a restricted view of the SES. Community participants were concerned with the nuisances caused by recreational boaters, such as noise, speeding, and traffic. They also have ecological concerns that directly impact their enjoyment of the Canal (e.g. shoreline erosion from wakes, impacts on fish from tournaments, invasive species). Boating is a bridge between social and ecological factors, making it an effective activity to target regarding education and regulations. However, the conflict between users with differing boating preferences and federal government priorities requires coordination among scientists, different levels of government, concerned property owners, and recreational users to manage the water and shoreline for the enjoyment of all (Berardo et al., 2019).

Using collaborative mapping to identify stakeholder convergences

Although points of convergence can be used as evidence for decision-making (Montgomery et al., 2016), divergent views provide a starting point to improve environmental management. Examining the structural features of these maps can provide some indication of the differences or similarities in how stakeholder groups think (Özesmi & Özesmi, 2004), though the small sample size limits the ability to test for significant differences. The centrality scores for the stakeholder group maps show that scientists had less bridging among factors than the community

groups, revealing that local residents may have a more nuanced view of the system than experts. The government group's map had a smaller network size and less bridging as well. The water quality workshop with mixed stakeholders had similar or higher centrality scores overall, emphasizing the contribution of diverse perspectives to more well-articulated systems maps. The merged map (page 39) shows the convergences, but the separate stakeholder workshops reveal the different ways in which stakeholders perceive environmental issues and solutions. It is therefore useful to further examine these specific differences in future research to reveal underlying value systems that may be reconciled and debated through collaborative mapping exercises (S. Gray et al., 2012; Özesmi & Özesmi, 2004).

To summarize, collaborative mapping was a useful heuristic to identify stakeholder views and develop a systems-oriented understanding of environmental health (Dale & Armitage, 2011; S. R. J. Gray et al., 2014). The CCM workshops engaged stakeholders in productive conversations that can inform management strategies. The interviews were helpful in learning about the nuances in views that the quantitative CCM workshop analysis may have missed. In the next section, I compare CCM workshops with government-initiated methods of stakeholder engagement by examining the PC visioning workshops.

5.2 What elements of current stakeholder engagement practices are useful in fostering social learning and managing power asymmetries for the Rideau Canal?

In this section, I reflect on the CCM workshop feedback and the PC workshop observations to make inferences about (1) the most useful elements of each engagement session,

and (2) the engagement practice that is more effective in fostering social learning and managing power asymmetries.

The goal of the PC workshops was to gather information on what stakeholders would like to see for the TSW waterway to integrate in its Management Plan. In contrast, the CCM workshops aimed to integrate knowledge using guided systems thinking activities to advance solutions using leverage points. Table 8 shows a comparison of some key features between the PC and CCM workshops. According to my observations, PC's efforts to facilitate an open engagement session on visioning became a venue for them to clarify misperceptions and address participants' questions about government decisions. Such tangents seemed to reduce the effectiveness of the visioning exercise, but it filled the communication gap between stakeholders and PC. The deviation from workshop objectives indicates that governments, specifically PC, need to develop better relationships with local communities, improve public engagement practices, and ensure effective facilitation (Jean et al., 2018). In contrast, our workshops were more on task and result-driven since they targeted social learning and attempted to reduce interactional power asymmetries.

Table 8: Comparing the elements of the PC and CCM workshops.

	PC elements	**CCM elements**	**Common elements**
Purpose	Create a vision for the TSW	Develop leverage points for action in the RC	- Three questions to structure discussion - Multi-stakeholder - Gain understanding of how people perceive and feel about system
Method	Traditional engagement using open discussion	Knowledge integration using guided activities	
Output	Draft of Management Plan	Summaries, follow-up interviews and publications	

Social learning

From comparing the CCM workshop feedback and our impression of the PC workshops, I infer that social learning was more evident in the CCM workshops. This may be because knowledge integration using systems thinking was a specific objective of my research (Burns, 2007). The activities were designed for participants to create new understandings by combining worldviews, which Dale and Armitage (2011) and Armitage et al. (2009) include as important characteristics of ACM processes. Although my research did not directly measure the change in participants' assumptions, worldviews and future behaviours from attending the workshops (Dale & Armitage, 2011), participant feedback showed evidence of a reduction in bounded rationality (Meadows, 2008) i.e., a broadening of participants' view of the RC system (see interview results page 65) based on others' "real-world perspectives" (Milo). From our observations, the PC workshops prompted some knowledge sharing that created new understandings even though this social learning was unintentional. Participants' appetite for partnering and knowledge sharing from both workshops indicates that people want to understand other perspectives in order to influence change. These characteristics are essential for social learning according to the ACM literature (Armitage et al., 2007; Plummer et al., 2013).

Such spaces where actors can deliberate and build trust could ultimately influence behaviour (Armitage et al., 2007; Berkes, 2009; Medema et al., 2014). For example, participants from the reservoir lakes in the TSW changed PC's framing of the system from waterway to watershed for future workshops. This shift could change the framing of the RC system in the Management Plan, and therefore inform decisions made about lock operations or even how various user groups utilize the RC system. Based on this analysis, I infer that regular

opportunities for governments to understand local realities and for communities to understand specific government responsibilities and capacities (Medema et al., 2014) are required. In this way, environmental protection is dependent on engagement opportunities and their ability to mediate mutual understandings. Engaging various stakeholders routinely can lead to some degree of social learning, though based on the CCM feedback and PC workshop observations, I infer that the CCM workshop was effective in fostering social learning because of the guided activities that required collaboration. Including Indigenous and youth voices in such engagement can enhance social learning while further reducing power asymmetries.

Power asymmetries

The facilitation of both workshops seemed to impact interactional power asymmetries by either allowing or restricting tangential conversations. Facilitation by PC staff members brought a different power dynamic than for the CCM workshops facilitated by researchers. The facilitator holds power in framing the objectives and influences resulting outcomes. The focus of PC's sessions shifted to discussing grievances which can be partly attributed to the inconsistent use of roundtable discussion. The higher number of PC staff compared to attendees in some workshops is indicative of the presence of power structures, which may have influenced the nature of discussions. For example, the presence of the Director of Waterways and the Operations staff resulted in more complaints or questions about specific decisions. Also, PC's framing of the activity as eliciting the public's vision may have been inappropriate since their contributions to the discussion while also facilitating the workshop could have biased the conversations. The CCM workshops on the other hand fostered a more collaborative environment since there was

less of an “us versus them” mentality; discussion among participants was guided by structured activities while the facilitator’s role was restricted to explaining the activities.

Furthermore, PC’s framing of the RC system as a “waterway” instead of “watershed” exposed the presence of power structures. The federal government’s use of “waterway”, which is the legal term for the RC, implied to the communities around reservoir lakes that they were less important. As mentioned earlier, this framing influences other policy documents where the nuances about the reservoir lakes may be missed by using the legal terminology. This example shows that government was setting the agenda for communities from whom they are disconnected (Fennell et al., 2008). The geographical disconnect between the main channel and reservoir lakes also creates a social divide since the communities differ in culture. These disconnects paired with PC staff as facilitators appeared to have exacerbated power asymmetries, indicating the need for neutral facilitators as seen in the CCM workshops where such tensions were relatively easily dissipated. This change could avoid reinforcement of traditional power structures by placing PC from being an authority at the head of the table to being a part of the table (Berkes, 2009).

Many of our participants were cognizant of their power during discussion (see page 67 for examples), which could have been influenced by the engagement method and objectives of the workshop. The presence of younger participants (including student researchers i.e. myself and my colleague) in both workshops was appreciated by older participants who wanted youth to carry forward efforts to improve the environmental health of the RC. While both workshops were invite-only, we were able to capture some missing opinion leaders through interviews. Additionally, PC’s decision to host exclusive engagement sessions for Indigenous people

emphasized the need to bridge the long existing divide between the public and Indigenous communities. This selectivity could be negatively perceived by stakeholders who feel excluded, exacerbating structural power asymmetries. Future government workshops should consider sending invitations to Indigenous groups to provide them another venue to participate rather than restricting them to separate sessions.

The call for inclusivity in today's governance context does not necessarily make stakeholder engagements legitimate. We must go beyond open discussions and critically engage stakeholder knowledge and worldviews to facilitate systemic change (Burns, 2007; Dale & Armitage, 2011). Burns (2007) argues that representativeness does not necessarily remedy power asymmetries, but rather resonance – i.e. energized and motivated participants willing "to support a line of action because it makes sense of the reality that they experience" (Burns, 2007, p. 53). Although the participants of the water quality workshop were representing different stakeholder groups, we chose them based on their knowledge and passion to improve water quality in their region. This workshop is an example of how action research paired with CCM workshops could increase the effectiveness of stakeholder participation and create more democratic processes (Burns, 2007; Mistry et al., under review).

Table 9 identifies components of each workshop that are useful for effective engagement practice in co-governance.

Table 9: Useful elements of CCM and PC workshops for stakeholder engagement in co-governance.

CCM Workshop	PC Visioning Workshop
- Neutral facilitator - Structured activities promoting knowledge sharing (i.e. causal mapping, but exclude the correlations if time is limited, and timeline) - Holistic view of the system	- Visioning prompts - Communication opportunity with PC staff - Direct connection to the management plan

Comparing the two workshops provides a benchmark for government-initiated stakeholder engagement while examining the potential for using research-based methods (CCM workshops). Collaborative mapping was more effective in fostering social learning and managing interactional, and to some extent structural, power asymmetries. It could also provide a way to systematically develop a vision, which could inform priorities (Özesmi & Özesmi, 2004). Thus, politicians could make decisions based on consensus from converging views and not based on compromise, which has been a contentious point in the ACM and public engagement literature (Butler et al., 2015; Irwin, 2006).

5.3 How can we enable co-governance to foster social learning and manage power asymmetries in the Rideau Canal?

Engagement methods determine the knowledge and perspectives that are included in the broader narrative about the RC (Wyborn, 2015a), which grants more power to those voices. For example, the NSERC research and PC engagement sessions were informed by only those that were invited. However, missing voices can limit social learning (i.e. youth and Indigenous perspectives). The ACM and co-governance literature points to formal ways to address this reciprocal relationship by representing various actors on councils or co-management boards. However, I argue that activities at the local level create opportunities for larger scale

engagements. The small-scale engagements allow for relationship building and expand social networks, which is the starting point for co-governance as these can leverage large-scale engagements that could feed into decision-making and policy. In this section, I provide a conceptual framework that shows how we can enable co-governance for holistic environmental management of the RC that considers social learning and power asymmetries.

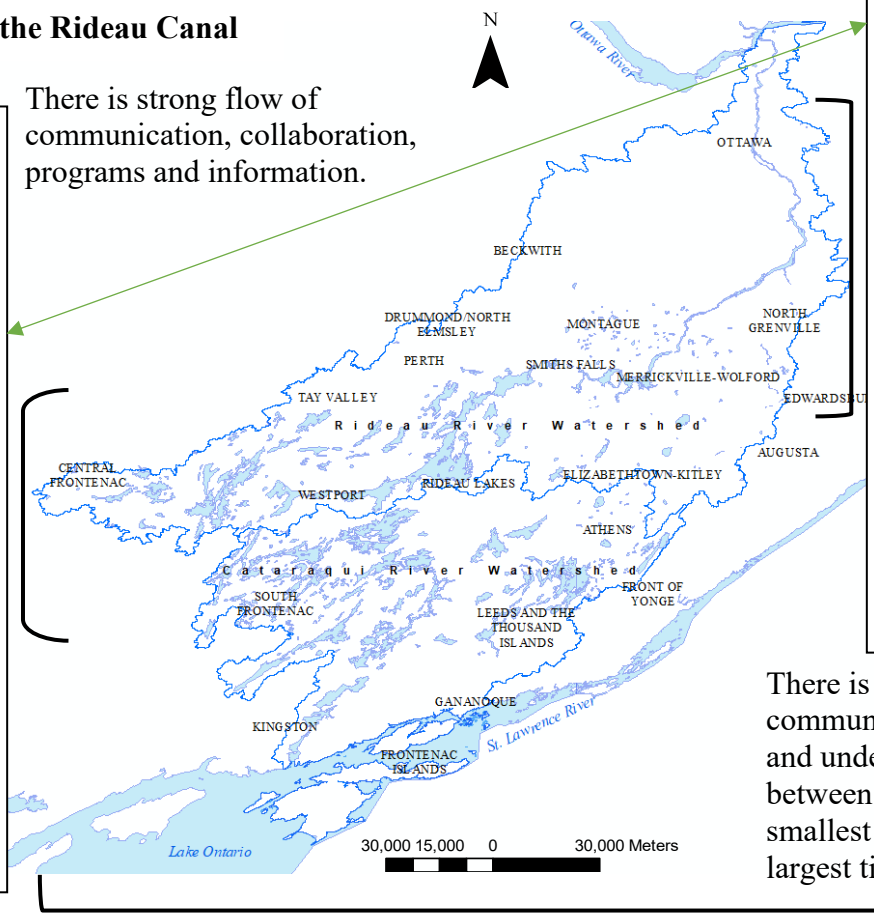
A conceptual framework to enable co-governance for the Rideau Canal

The goal of ACM, according to Olsson et al. (2004), is to build resilience in SESs through improved coordination and cooperation rather than building new institutions, which is more helpful for specific conservation concerns (Butler et al., 2015). As such, we can create boundary spaces to address conflicting views and interests by using existing activities as entry points for actors to collaborate (Stange et al., 2016). Such spaces can also trigger new activities to further support social learning and effectively engage actors (Stange et al., 2016). These informal processes support a "redesigning of existing governance norms, protocols and structures" (Medema et al., 2014, p. 27) that are embedded in ideas of centralized government leadership and public engagement (Montgomery et al., 2016).

Figure 11 displays a framework that combines existing and missing elements in the governance of the RC. I developed this framework by synthesizing the results and using the literature to suggest a feasible approach to co-governance, keeping in mind the differing views among stakeholders about how the RC's governance could be improved. Although I separate actors and their roles, the actors are dynamic and can play roles in other "tiers" (i.e. boundary spaces). These tiers also have reciprocal interactions.

Co-governance in the Rideau Canal

There is strong flow of communication, collaboration, programs and information.



Tier 1 – intra-watershed scale
Key Leaders: Municipalities, community groups, NGOs/charities, businesses, local CA, academic researchers (not an exhaustive list)

Examples of existing initiatives: Township of Rideau Lakes Lake Association Council, Three Lakes Water Quality Group, Township of South Frontenac, NSERC grant research

Role: partnerships to address local concerns, CCM workshops to address conflicting views and interests, knowledge sharing, coordination and cooperation

Tier 2 – inter-watershed scale

Key Leaders: RVCA and CC Conservation Authorities as leaders with support from provincial government, federal government, organized community/academic initiatives (not an exhaustive list)

Examples of existing initiatives: Lake Links, NSERC grant research

Role: mediate connections between local and system-wide tiers, responsible for public education and communication, facilitators of partnerships among actors between and across scales

There is a lack of communication and understanding between the smallest and largest tiers.

There is some coordination with CAs for permitting and planning, as well as funding and mutually beneficial collaborations.

Tier 3 – system-wide interactions
Key Leaders: federal and provincial governments (Parks Canada, Department of Fisheries and Oceans, National Capital Commission, Ontario Ministry of Natural Resources and Forestry, Ontario Ministry of Environment, Parks and Conservation), academic researchers (not an exhaustive list)

Examples of existing initiatives: Management Plan Review visioning workshops, NSERC grant research

Role: annual forum to collect data for implementation report, communicate government updates, showcase new initiatives, prompt collaboration among actors

Figure 11: A conceptual framework for co-governance in the Rideau Canal, identifying existing activities and links, and missing elements. The green line indicates strong linkages between tiers and flow of information, whereas orange and red lines represent progressively weaker linkages between tiers.

The different interests, knowledges and concerns of communities along the RC require context-specific engagements, but the RC also requires a holistic approach to address system-wide environmental impacts. I propose this co-governance framework as a strategy to address

this dilemma that is recurrent in the watershed governance literature – how can we better govern such large, geographically and sociologically variable waterbodies considering the aforementioned barriers? The disconnects between and among various governments and authorities and communities (specifically the red and orange lines in Figure 11) could be reduced through a change in mandate and increased capacity. However, since these elements cannot be controlled by those outside of the political arena, other actors must take leadership in the governance of the RC. Thus, a shift toward polycentric systems of governance in which bridging organizations, such as CAs (Medema et al., 2017; Schröter et al., 2014), mediate interactions must involve a variety of actors to foster social learning (Berardo et al., 2019; Berkes, 2009; Medema et al., 2014; Wyborn, 2015a). This conceptualization of co-governance in the RC enables small-scale groups to take ownership of local issues that could be transmitted to higher tiers via the CAs, and vice versa. The CAs must intentionally link these tiers since it helps reduce power asymmetries by creating a democratic process. However, direct communication between higher and lower tiers is equally important (as shown between Tier 1 and 3).

Tier 1

Small-scale initiatives, such as regular meetings held by municipalities with community groups, can help address immediate and local concerns by using tools for collaborative systems thinking as shown in my research. They are also a starting point for creating space to exchange knowledge, thus creating internal legitimacy (Lundmark et al., 2014). Interactions in the first tier connect local groups with their CA, academic experts and other local actors through action research like in the water quality workshop (Mistry et al., under review), which improves co-management (Berkes, 2009). The workshop and interview results indicate that the stakeholder

groups speak from predictable values-based positions, and the CCM workshop feedback shows there was some social learning even within the stakeholder group workshops. Therefore, hosting mixed stakeholder group CCM workshops at smaller scales could facilitate social learning. Also, barriers such as political will, coordination, and capacity are easier to address at this scale, providing a starting point to develop ways to overcome them for the entire system.

Tier 2

Scaling up to the second tier, the interview and workshop results show that CAs are effective bridging organizations since they connect actors across watersheds and provide institutional support (e.g. expertise, venues for meetings, expanding networks). The impact of CAs on coordinated environmental management could be enhanced by increased communication between the two CAs. Their familiarity with different watersheds that are linked by the Canal can better inform system-wide practices. Although regular coordination between CAs may require additional resources, boundary spaces created by events such as Lake Links (mentioned by interview participants) are an opportunity to communicate about positive outcomes and emergent concerns from the past year. Based on interview results, the missing elements in the second tier are regular coordination and communication between the two CAs and between CAs and provincial and federal governments on system-wide topics. The third tier could address this gap by providing collaboration opportunities through large-scale activities.

Tier 3

This conceptual framework presents an annual forum led by PC as a boundary space. Its purpose would be to address specific system-wide concerns by inviting actors across scales to participate. Although interview results indicate hesitancy for PC to accept this undertaking due to

the lack of resources, the PC workshop observations reveal that it is an opportunity for the federal government to have a regular dialogue with stakeholders and reduce fragmentation by coordinating with lower tier actors (Berardo et al., 2019). Pairing this forum with internal processes, such as the new annual implementation report requirement for the waterways, can justify dedicating additional resources. The province's involvement is also important due to their legislative responsibilities. Moreover, creating this space must have set objectives to ensure effective use of resources and time. These include motivating collaboration, facilitating knowledge sharing, and linking co-produced knowledge to policy (Berkes, 2009; Butler et al., 2015; Stange et al., 2016; Wyborn, 2015a).

This forum should be a flexible space (Armitage et al., 2007; Carlsson & Berkes, 2005) that integrates efforts from all tiers to trigger activities and transform knowledge (Stange et al., 2016). It should not be driven by political agendas, therefore, facilitation by an independent actor (e.g. researchers or consulting firm) may be the best approach. An example would be to scale up the Lake Links model by offering residents, community group leaders, politicians, bureaucrats, experts, etc. to showcase successful initiatives from across the system and to speak at the forum. Multiple actors on a rotational basis could help organize and host this annual meeting around a topic relating to aspects of the environment (e.g. the factors mentioned in the workshop maps or the themes discussed in chapter 5.1) to help relieve the burden of hosting for other actors and balance power asymmetries between actors (Acheson, 2013). The details of the design of this forum is beyond the scope of my research, but the results and this analysis offer a starting point for governments to begin to think about it. For example, a workshop combining the useful

elements of the PC and CCM workshops discussed in chapter 5.2 or linking CCM workshops in tier 1 to tier 3 activities are possible next steps.

This framework shows the key leaders and the roles that they play, or could play, at each scale of governance. It demonstrates that actors govern the RC system in their own fragmented ways (Eversole, 2011). The framework also provides a way of thinking about co-governance for the RC as fluid rather than static. Although key leaders often act within their boundary spaces, they influence other tiers and can temporarily move beyond their tier to join and/or include other boundary spaces (e.g. Stange et al., 2016 and R. Thomas et al., 2007). This behaviour in the system indicates the dynamic nature of co-governance that can be facilitated by actors ranging from small groups or grass-roots initiatives to large-scale authorities.

A systems perspective in co-governance

Unlike co-management structures, this framework does not create formalized organizations that take time, resources and mental stress which exhausts participants (Berardo et al., 2019; Young et al., 2020). Rather, it builds on existing ties between key leaders to leverage informal collaborations in ways that could help sustain large-scale formal engagements. This framework increases resilience of the RC through redundancy (i.e. the layers of informal and formal relationships at different scales) (Carlsson & Berkes, 2005) – similar to the nesting seen in panarchical organizations (Gunderson & Holling, 2002) – to withstand changes in bureaucratic and political processes (Armitage et al., 2007; Olsson et al., 2007; Plummer et al., 2012). Thus co-governance is an emergent property of complex SESs (Armitage et al., 2007) that

must be recognized as a way to improve management of the RC and other comparable natural resources.

The mere inclusion of actors in governance is insufficient to improve environmental management of historic waterways, especially when social learning and power asymmetries are not considered (Carlsson & Berkes, 2005; Natcher et al., 2005). A systems approach to governance through this framework can help balance these power differentials and foster mutual understandings among actors across scales. A tiered governance framework offers a way to have productive conversations that allow multiple viewpoints and ways of governing to come together to develop a strategic, targeted approach to environmental management of the RC (Burns, 2007).

6. CONCLUSION

This research demonstrates the complexity of holistic environmental management, but it also reveals how perceived barriers can be opportunities to create more resilient systems. The environmental health of the RC has been influenced by many types of factors acting on various spatial and temporal scales. Taking a collaborative systems approach revealed governance, shoreline development, economic development, water quality, and education as top influential nodes for all stakeholders in the RC system. Using scientific engagement methods like collaborative causal mapping to foster understanding of stakeholder views among actors is helpful to inform a vision for the waterway and evidence-based policy. The CCM workshops also helped create a sense of unity through knowledge sharing. Even though social learning was limited, it was useful to analyze the perspectives and values of each stakeholder group, which government-initiated workshops failed to achieve.

Environmental management has been ineffective on a system-wide scale due to jurisdictional fragmentation and political will. These barriers cannot be overcome without radical changes in our political and social systems, which are infeasible for many water systems. Therefore, we must find innovative ways to work within these limitations to address the various social and ecological contexts along connected waterway systems. This research demonstrates that multi-watershed systems require a thorough investigation of stakeholder perceptions to understand socio-ecological dynamics. Causal mapping is a powerful tool that can be effectively used in stakeholder engagement to have productive dialogue between competing interests.

In this case study, many older people and invested businesses and governments had time and interest to contribute to this research. This may not be the case for other SESs, such as the TSW which is much larger and complex than the RC. However, I learned through this research that co-governance arrangements require an inductive approach where stakeholder views on environmental health and management can inform a context-specific framework – this insight prompts us to revisit the definition of co-governance as being formal and government-dependent. The tiered co-governance framework I propose provides a flexible and democratic way to sustain co-governance efforts by using existing collaborations, which can apply to similar cases in watershed governance. Although granting decision-making authority to non-government stakeholders may not be an option for every case, this framework links stakeholders to policy makers and builds trust. This research can inform practitioners in the impact assessment and land use planning fields because the lack of tools to foster social learning and manage power asymmetries is a recurring theme in natural resource management. Developing planning documents based on one-off engagement is no longer sufficient to address environmental problems, competing interests, and ineffective environmental governance; we must shift our focus to on-going relationship building. In this way, my research is a starting point to achieve mutually reinforcing, lasting gains for sustainable futures.

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APPENDIX A: Maps of the Rideau Canal and Trent-Severn Waterway

Figure 12: Map of the Rideau Canal. Image credit to Ken W. Watson (2020), used with permission.

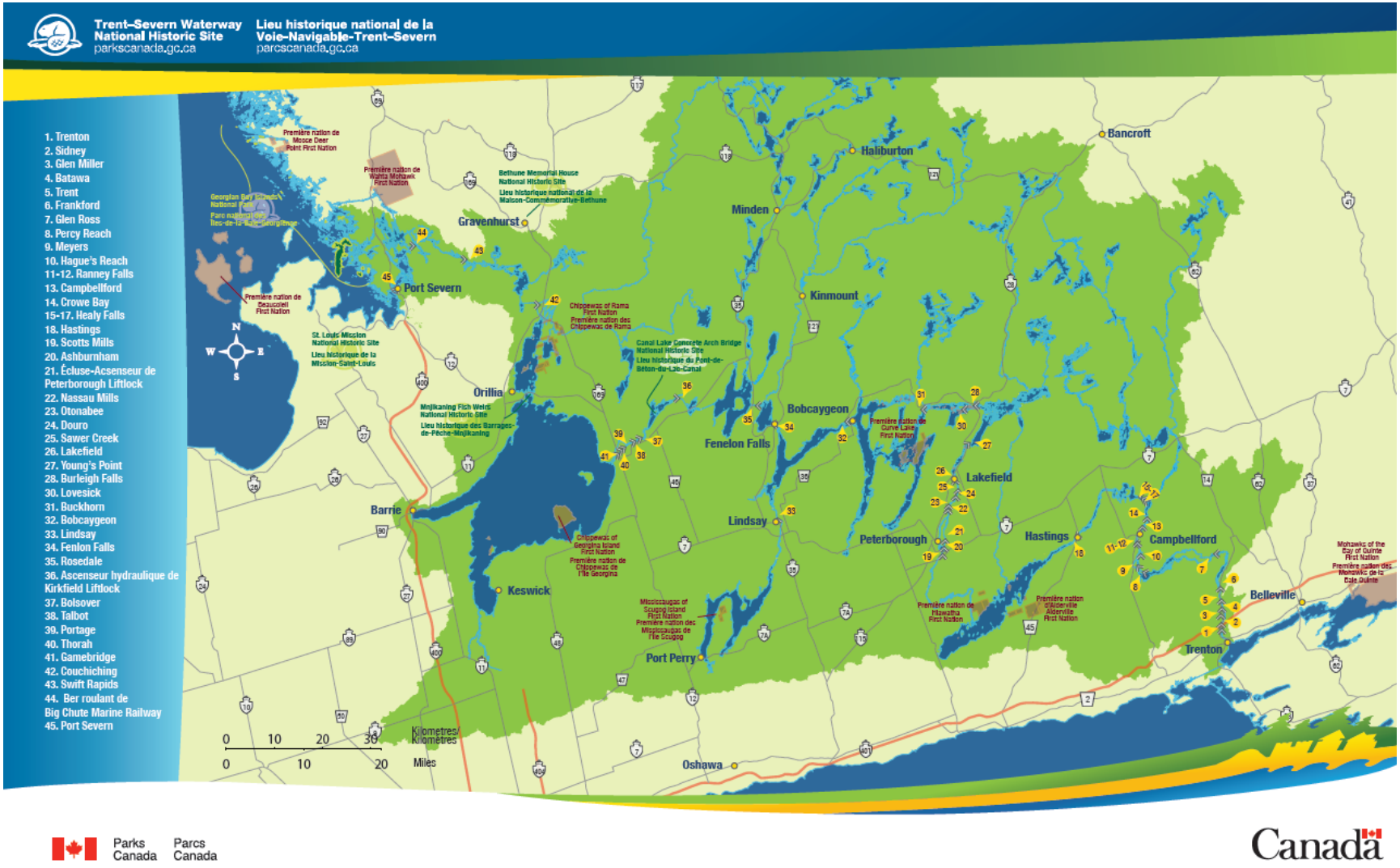


Figure 13: Map of the Trent-Severn Waterway, available from Parks Canada.

APPENDIX B: Workshop logistics

CCM workshop details

Workshop logistics

Workshop #	Stakeholder group	Location	# of Attendees
1	Community groups	Smiths Falls, Valley Heartland Community Futures Development Centre	15
2	Business interest groups	Smiths Falls, Valley Heartland Community Futures Development Centre	9
3	Lower Cataraqui region	Battersea, Ontario, Battersea United Church	10
4	NSERC SPG scientists	Carleton University	9
5	Government representatives	Smiths Falls, Memorial Community Centre	10

Workshop agenda

9:30 am - 9:35 am	*Arrival*
9:35 am - 9:50 am	*Introductions and Objectives*
9:50 am - 10:25 am	*Activity 1: What is the challenge?*
10:25 am - 10:40 am	*Activity 2: What is the story?*
10:40 am - 10:50 am	*BREAK*
10:50 am - 11:50 am	*Activity 3: Can I see how you think?*
11:50 am - 12:20 pm	*Discussion and Synthesis*
12:20 pm - 12:30 pm	*Conclusion and Questions*

Parks Canada Workshop details

Workshop logistics

Workshop #	Location	Date	Attendance (PC staff:public)
1	Orillia	June 11, 2019	5:7
2	Haliburton	June 19, 2019	5:9

3	Kirkfield	June 20, 2019	4:9
4	Campbellford	June 25, 2019	5:5
5	Peterborough	June 26, 2019	5:6
6	Peterborough - liftlock	August 12, 2019	3:11

Workshop agenda

10:00 am	*Introductions*
10:15 am	*Overview of the Management Plan Review Process*
10:30 am	*Review of Supporting Documentation*
11:00 am	*Vision Elements*
12:00 pm	*Lunch*
1:00 pm	*Strategic Thinking*
1:30 pm	*Performance Measurement*
2:30 pm	*Break*
2:45 pm	*Next Steps*
3:00 pm	*Roundtable and Closing*

APPENDIX C: Interview schedule

Interview questions

The interviews are semi-structured, meaning that they are guided by a list of scripted questions but digressions are expected.

Background

1. Do you own property or a business within 10 kilometres of the Rideau Canal waterway?

   a. If yes, in which reach? [Higher reach (blue), mid reach (orange) or lower reach (green)]

   b. [Ask participant to put a circle/dot to identify the approximate location of their property]

   c. Is this a primary residence? Seasonal cottage? Business? Investment property? [keep in mind could be multiple]

d. Is one or more of your properties on a waterfront?

e. [If relevant]: How long have you owned property in the area?

2. Are you a member of a community group, such as a conservation organization, a lake or cottagers' association, a trail association, or other group relevant to the waterway and its environment? If yes, please specify.

Environment/Ecological integrity

3. What types of recreational activity do you engage in, on or near the Rideau Canal? [e.g., swimming, fishing, boating, hiking, cycling, birdwatching, special occasions, maintenance, etc.]

a. How many days do you spend on or near the Canal in a typical year? [Probe for the different seasons]

4. In your opinion, how healthy or unhealthy is the natural environment of the Rideau Canal?

a. How would you score the environmental health of the RC, on a scale of 1 to 10, with 10 being very healthy and 1 being very unhealthy?

5. In your opinion, what are the most serious threats to the environmental health of the Rideau Canal?

6. In your opinion, what could or should be done to improve the environmental health of the Rideau Canal?

7. In your opinion, how much of a threat do the following factors pose to the environmental health of the Rideau Canal? [Pay attention to comments and reasoning provided]

a. [In-person interviews: Give the print out and after completion probe for reasoning. Skype interviews: Verbally asses each item and probe for reasoning]

	No threat	Minor	Moderate	Major	Critical	Don't know
Septic systems	○	○	○	○	○	○
Invasive species (including fish, invertebrates & aquatic vegetation)	○	○	○	○	○	○
Lack of environmental regulations	○	○	○	○	○	○
Lack of enforcement of regulations	○	○	○	○	○	○

New developments on the shoreline	○	○	○	○	○	○
Agricultural runoff	○	○	○	○	○	○
Increased motorcraft traffic (any vessel with an engine)	○	○	○	○	○	○
Shoreline erosion	○	○	○	○	○	○
Eutrophication (e.g., blue-green algae)	○	○	○	○	○	○
Increased tourism	○	○	○	○	○	○
Climate change	○	○	○	○	○	○
Litter/garbage	○	○	○	○	○	○
Road construction and maintenance	○	○	○	○	○	○
Recreational fishing	○	○	○	○	○	○
Commercial fishing	○	○	○	○	○	○
Poaching of fish or animals	○	○	○	○	○	○
Other: _____	○	○	○	○	○	○

Collaborative management and governance

PREAMBLE: The Rideau Canal is a complex system that is affected by the decisions and actions of multiple levels of government. This includes the federal government (Parks Canada), the provincial government (Ontario Ministry of the Environment, Conservation and Parks, Ministry of Natural Resources and Forestry), municipal governments, and agencies such as the National Capital Commission and Conservation Authorities. The division of responsibilities across these ministries and agencies is what we call a "governance regime".

8. Do you think that the current governance regime for the RC is effective? Why or why not? [Probe for specifics, each level of government & agencies] [Probe for definition of effective]

9. In your opinion, what could or should be done to improve the Canal's governance and/or management?

10. How would you rate the performance of the current governance regime in achieving the following goals?

	Very poor	Poor	Adequate	Good	Very good	Don't know
Protecting species at risk in the waterway	○	○	○	○	○	○
Controlling the spread of invasive species in the waterway	○	○	○	○	○	○

Maintaining water quality in the waterway	○	○	○	○	○	○
Promoting economic development of communities along the waterway	○	○	○	○	○	○
Promoting tourism along the waterway	○	○	○	○	○	○
Enforcing boating regulations along the waterway	○	○	○	○	○	○
Enforcing environmental regulations along the waterway	○	○	○	○	○	○
Managing water levels under normal conditions	○	○	○	○	○	○
Managing water levels during extreme events	○	○	○	○	○	○
Preserving the historical heritage of the Rideau Canal	○	○	○	○	○	○
Planning for future environmental challenges	○	○	○	○	○	○
Preserving nature along the Rideau Canal	○	○	○	○	○	○
Reconciliation with indigenous peoples along the Rideau Canal	○	○	○	○	○	○
Other: _____	○	○	○	○	○	○

11. Do you think that Parks Canada does a good job communicating with the public about the RC?

    a. What about consulting and/or engaging with the public, in general?

PREAMBLE: The term "collaborative governance" refers to efforts to involve multiple levels of government and different local groups in management and policy decisions. Collaborative governance initiatives can range from consulting people before making a decision, to requiring that decisions be made together in a power-sharing arrangement.

12. Have you ever personally been involved in any collaborative governance initiatives related to the RC? How about your organization?

    a. [If yes], what did you think of these initiatives?

    b. [If no], is it something you would like to do?

c. [Probe for PC consultation, management plan]

13. What role, if any, do you think that community groups should play in policy-making or decision-making about the RC? [For example, lake associations, trail associations, or chambers of commerce?]

a. [Probe for specifics: what organisations should be involved, in what capacity/how would the collaboration look like?]

Collaboration, cooperation and conflict

14. Have you ever personally been involved in a neighbourhood or community effort doing activities relevant to the RC? [e.g., shoreline clean-up, public education campaign]

a. [If yes]: Can you please tell me about it?

15. [If member of an organization]: Does your organization cooperate with other groups or organisations around the RC? [Probe: including government]

a. [If yes], Can you please tell me what this cooperation entails? [what exactly is shared?]

b. [All] How could greater cooperation be achieved?

16. Have you ever witnessed or heard about conflicts or tensions on the RC? [Any conflict between or among groups?] [Probe for specifics, i.e., overt vs. hidden]

a. [If yes] How could we better manage these tensions?

Knowledge

PREAMBLE: Knowledge is an important part of environmental decision-making. The next few questions will be on this topic.

17. In your opinion, are there any gaps in current knowledge about the RC? Please explain.

18. Have you or your organization ever been involved in producing knowledge about the RC?

a. [If yes] Please describe the details of this activity? What were your impressions?

b. [If no], is it something in which you would like to participate?

19. In your opinion, do non-scientific types of knowledge, such as local knowledge, experiential knowledge, and traditional knowledge, have a role to play in decision-making about the RC? Please elaborate. [Probe for specifics]

For workshop participants only

PREAMBLE: Thank you for participating in the workshop on environmental health in [month, year, location]. My next few questions will be about your views on the workshop.

20. What did you think of the workshop activities?

    a. [Probe: Likes and dislikes, how can the workshop be improved?]

21. Did you learn anything at the workshop that you didn't previously know? [Probe: Did anything stand out to you?]

    a. About the Rideau Canal and its environmental health?

    b. About the views and perspectives of the other participants? [Probe: did you learn anything new from this activity? change in perceptions and beliefs?]

22. Did you feel like your concerns were adequately addressed through the activities? [Probe: power dynamics]

23. Would it be useful to do the workshop with a more diverse group of stakeholder representatives? [Probe: a "mixed" workshop]

24. Do you think the workshop is useful for decision-making?

    a. Why or why not?

In closing

25. Generally speaking, are you optimistic or pessimistic about the future of the Rideau Canal? [Probe for details]

26. Have you ever lived close to, or spent a lot of time using another body of water before?

    a. Can you tell us about your relationship to this body of water? How does/did it compare with your relationship to the RC? [Probe for TSW]

27. What is your current age [18-24, 25-34, 35-44, 45-54, 55-64, 65+]

28. What is the highest level of formal education you have completed [high school, college, bachelors, graduate or professional degree]?

29. Please state your occupation (paid or unpaid) (former occupation if retired): _____

30. Do you identify as an indigenous person?

Thank you for participating in our study. Would you like to be kept informed of any future publications or reports coming from our project? _____.

May we contact you in the future if we have follow-up questions? _____.

APPENDIX D: Steps on creating network graphs from stakeholder maps

This Appendix provides details on how the network graphs were developed using the causal maps stakeholders created in the workshops. There are two levels of analysis: (1) analysis for each workshop and (2) analysis of the workshops combined.

Workshop-level analysis

This analysis produced the stakeholder group maps and the map for the water quality case study.

Step 1: standardize codes across pairs and create an adjacency matrix for the pair-level

The factors that each pair of participants included in their blended map were listed in MS Excel. These factors were standardized across pairs by myself and my research teammate (henceforth referred to as two researchers). Once these factors were standardized and given a code, a binary adjacency matrix was created for the maps of each pair of participants. 1 indicated the presence of a linkage whereas 0 indicated absence of a linkage. The factors listed as rows were treated as starting factors and those listed as columns were treated as destination factors.

Step 2: merge pair-level adjacency matrices to generate workshop-level adjacency matrix

Once the pair-level matrices were created, they were merged into a workshop-level adjacency matrix that contained all the factors and linkages across pairs in that workshop. This process entailed listing all the unique factors across pairs of participants as starting and destination factors in the adjacency matrix and transferring the linkages between factors from the pair maps. Any linkages that were cited more than once across the pair-level maps were summed to add weights to the linkages. This merge resulted in a weighted adjacency matrix that represented all

the nodes and links made by participants within a workshop. The weights could range from 0 to the number of pairs in the workshop (four to seven).

Step 3: import adjacency matrix in R and use packages 'sna' and 'igraph' to calculate network measures and create network graph

The workshop-level matrix was converted to a CSV file and imported in R (the code script is provided at the end of this Appendix). Centrality measures were calculated using the 'sna' package and 'igraph' was used to create the visualization.

Across-workshop Analysis

This analysis produced the merged map that integrated the four stakeholder group maps.

Step 1: standardize codes across workshops and create adjacency matrix for the workshop-level

The factors from the adjacency matrix of each workshop from the workshop-level analysis were standardized across workshops by two researchers and given codes. The across-workshops adjacency matrix was created from the workshop-level maps.

Step 2: merge workshop-level adjacency matrices to generate merged matrix of stakeholder workshops

This process entailed listing all the unique factors across workshops. The factors listed as rows were treated as starting factors and those listed as columns were treated as destination factors. Linkages between factors from the workshop-level maps were transferred. 1 indicated the presence of a linkage whereas 0 indicated absence of a linkage. Any linkages that were cited

more than once across the pair-level maps were summed to add weights to the linkages. This merge resulted in a weighted adjacency matrix that represented all the nodes and links made by participants across workshops. The weights could range from 0 to four (the total number of stakeholder workshops) since only presence or absence of the linkages was considered for each workshop. If the frequency of linkages for pairs across workshops was used in this analysis, normalizing the numbers would make more sense since the number of pairs differed between workshops.

Step 3: import adjacency matrix in R and use packages 'sna' and 'igraph' to calculate network measures and create network graph

The merged workshop matrix was converted to a CSV file and imported in R (the code script is provided at the end of this Appendix). Centrality measures were calculated using the 'sna' package and 'igraph' was used to create the visualization.

In both these analyses, the researchers made decisions about the wording of factors when being standardized. These new codes were not necessarily worded the same as participants. Some factors were grouped to reduce the size of the network and simplify analysis.

R Script to generate maps and centrality scores for nodes and maps

```
#read csv file

w3df <-read.csv(
  'C:\\Users\\mistr\\Google Drive\\Rideau-Trent Severn project, shared folder\\7-Publications_presentations\\Papers\\LCWG paper - Local Environment\\Analysis of maps\\updated analysis map\\W3 frequency matrix.csv', header = TRUE, row.names = 1, sep = ";")
```

```
#create matrix

w3matrix <-as.matrix(w3df)

#load sna package

library(sna)

#create network

w3network <- as.network(w3matrix, matrix.type='adjacency',directed =
TRUE,ignore.eval=FALSE, names.eval='weight')


#see density

gden(w3network, mode="digraph", ignore.eval=FALSE)

#indegree and outdegree per node

idw3 <- degree(w3network, gmode="digraph", cmode="indegree", rescale=TRUE,
ignore.eval=FALSE)

odw3 <- degree(w3network, gmode="digraph", cmode="outdegree", rescale=TRUE,
ignore.eval=FALSE)

View(idw3)
View(odw3)

#betweenness per node

betw3 <- betweenness(
  w3network, gmode="digraph", cmode="directed", rescale=FALSE, ignore.eval=FALSE)

View(betw3)

#eigenvector per node

eigenw3<-evcent(
  w3network,g=1,gmode="digraph",rescale=TRUE,ignore.eval=FALSE)

View(eigenw3)

#centralization scores for graph
```

```
centralization(w3network, mode = "digraph", degree, cmode="indegree", ignore.eval=FALSE)

centralization(w3network, mode = "digraph", degree, cmode="outdegree", ignore.eval=FALSE)

centralization(w3network, mode = "digraph", betweenness, ignore.eval=FALSE)

centralization(w3network, mode = "digraph", evcent, ignore.eval=FALSE)

#load igraph to plot

library(igraph)

w3graph <- graph_from_adjacency_matrix (w3matrix, weighted=TRUE,  mode="directed")

plot(

w3graph,edge.arrow.size=0.03,edge.arrow.width=0.8,edge.width=E(w3graph)$"weight",vertex.l
abel.cex=0.8,vertex.size=4,vertex.size2=4,margin=-0.18
)

#if merged map

plot(
  w3graph,layout = layout_as_star,edge.arrow.size=0.04,edge.arrow.width=0.8,edge.width
=E(final2graph)$ "weight",vertex.label.cex=1,vertex.size=4,vertex.size2=3,margin=-0.1)
```

APPENDIX E: Workshop results and analysis

Workshop results

Activity 1: Top five factors

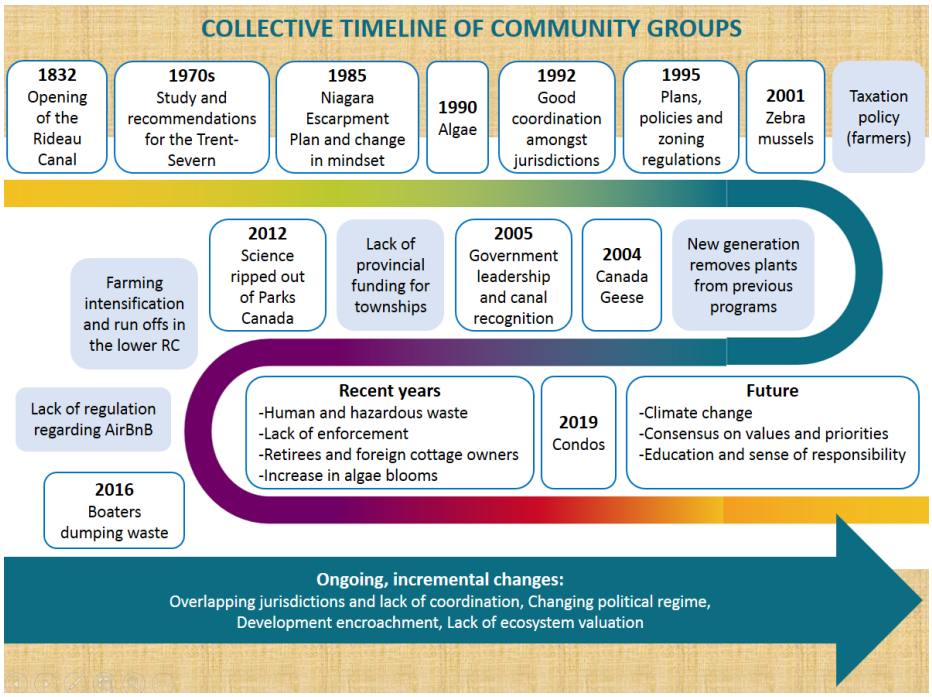
Count	Workshop 1 – community groups	Challenge	Recoded
11	Shoreline development (inadequate policies, human population and density, vegetation loss and wake erosion, tributary degradation, sense of entitlement, waterfront residential development)	Shoreline development	Shoreline development
9	Education and awareness (lack of knowledge and understanding: Rideau history and heritage, water quality, public apathy/ignorance, communication, voter unawareness)	Education and awareness	Education and awareness
6	Invasive species (zebra mussels, Canada geese, Asian carp, direct and indirect effects on native biodiversity)	Invasive species	Biodiversity
5	Government action (corrective action, political will, good relationships with all levels of government)	Government action	Governance
4	Jurisdictional coordination (single governing body and organizational strength)	Jurisdictional coordination	Governance
Count	**Workshop 2 – economic interest groups**	**Challenge**	**Recode**
9	Contamination (regulation, waste waters, pesticides, agricultural run-off)	Contamination	Contamination and nutrients

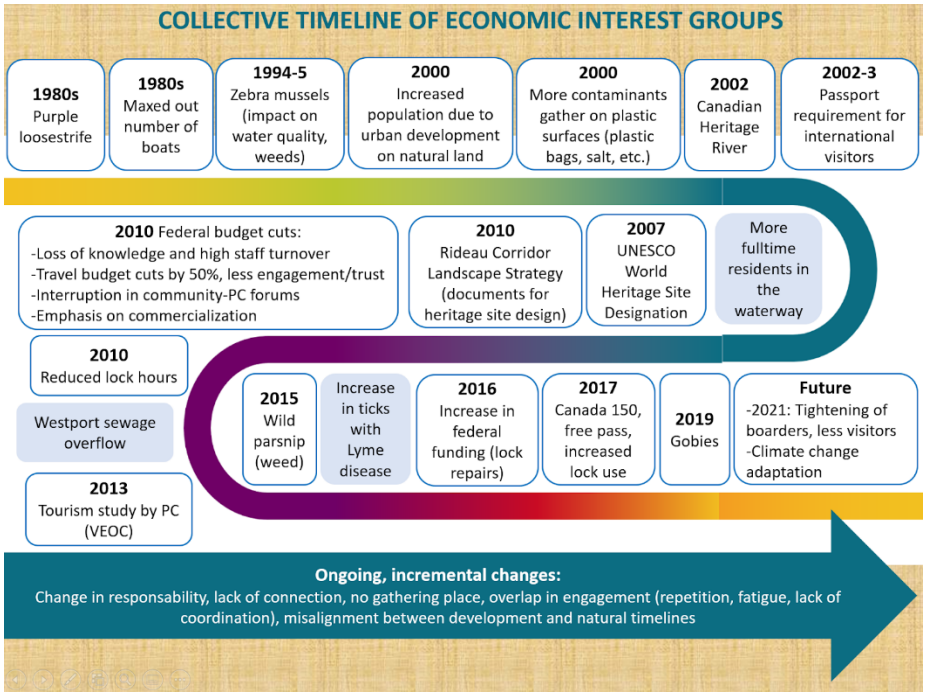
7	Regulation and policies (enforcement, environmental and other, inconsistency among different governments, long-term common vision)	Regulation and policies	Governance
6	Biodiversity (invasive species, weed cover, forest health)	Biodiversity	Biodiversity
6	Shoreline development (small communities, erosion, waterfront, hardening)	Shoreline development	Shoreline development
4	Boating related concerns (wake, erosion, vegetation)	Boating concerns	Boating concerns
Count	**Workshop 3 – water quality**	**Challenge**	**Recode**
13	Incoming nutrients (loading, internal nutrients, septic systems, fertilizers, agricultural runoff) and chemicals (mercury, pesticides, garbage) and its impact on pH levels	Nutrients	Contamination and nutrients
9	Development (canal construction affecting wetlands, cottage development, altering watershed drainage, buffer zones, human impact)	Development	System-wide development
8	Water flow (upstream sources, fluctuating levels, flushing, shallow bodies, flooding)	Water flow	Hydrology and impacts
5	Education (education, stakeholder awareness, increased popularity and interest, engaging programs)	Education	Education and awareness
5	Governance (grassroots initiatives trying to improve water quality, political will at all levels of government, lack of response to	Governance	Governance

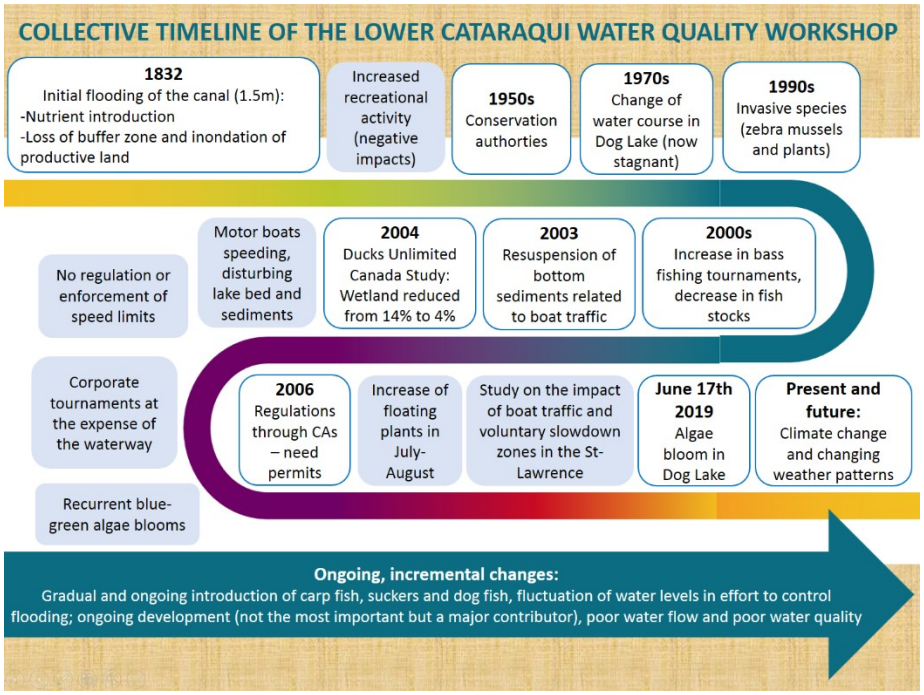
	reduce plastics and other contaminants, poor restriction of shoreline development by municipalities, water level regulations)		
5	Ecology (biodiversity, invasive species, remediation and moving towards a 'normal' ecology)	Ecology	Biodiversity
Count	**Workshop 4 – NSERC scientists**	**Challenge**	**Recode**
8	State of shoreline (shoreline development, increased urbanization, erosion from land use change, lack of riparian zones, lack of policy to increase buffer zones)	State of shoreline	Shoreline development
8	Governance (cooperation and coordination, jurisdictional issues and confusion, lack of consistent monitoring, enforcement and regulations, municipal taxes)	Governance	Governance
7	Awareness and education (research, lack of responsibility and awareness, misguided perceptions of what is "clean", diffusion of conservation norms, public interest)	Awareness and education	Education and awareness
7	Fish, vegetation and algae (invasive and non-native species, fish sanctuaries, aquatic vegetation in main channels, algal blooms)	Fish, vegetation and algae	Biodiversity
5	Water levels (lock operations, water level management, hydropower operations)	Water levels	Hydrology and impacts
5	Boating (erosion, boat launches, traffic and activities)	Boating	Boating concerns
Count	**Workshop 5 – government representatives**	**Challenge**	**Recode**

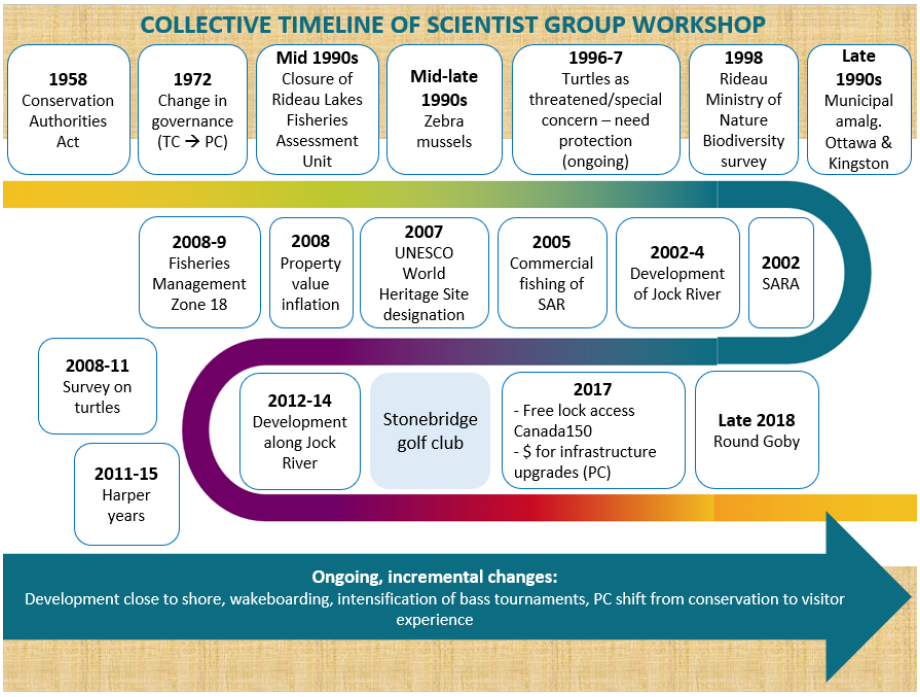
11	State of the shoreline (development, erosion, alterations/expansions, cumulative impacts, balance, historic patterns)	State of shoreline	Shoreline development
8	Water management (headwater loss, water quality, water levels, connectivity, variability, flooding)	Water management	Hydrology and impacts
7	Governance regime (political will, public buy-in, legislation, coordination between jurisdictions, monitoring, watershed approach, changing priorities)	Governance regime	Governance
7	Municipal role (storm drainage, planning, enforcement, economy, setbacks for septic systems and development)	Municipal role	Governance
7	Land use (wetland and forest loss, impervious surfaces, shift to permanent occupancy)	Land use	System-wide development

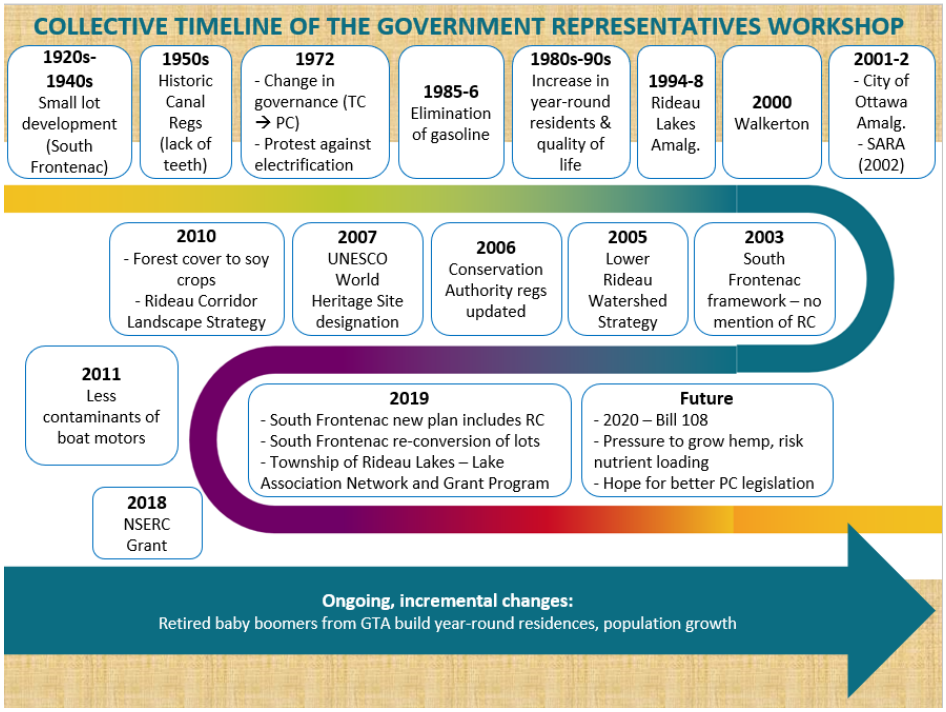
Activity 2: Timelines (summarized)




COLLECTIVE TIMELINE OF ECONOMIC INTEREST GROUPS
1980s Purple loosestrife
1980s Maxed out number of boats
1994-5 Zebra mussels (impact on water quality, weeds)
2000 Increased population due to urban development on natural land
2000 More contaminants gather on plastic surfaces (plastic bags, salt, etc.)
2002 Canadian Heritage River
2002-3 Passport requirement for international visitors
2010 Federal budget cuts:
-Loss of knowledge and high staff turnover
-Travel budget cuts by 50%, less engagement/trust
-Interruption in community-PC forums
-Emphasis on commercialization
2010 Rideau Corridor Landscape Strategy (documents for heritage site design)
2007 UNESCO World Heritage Site Designation
More fulltime residents in the waterway
2010 Reduced lock hours
Westport sewage overflow
2013 Tourism study by PC (VEOC)
2015 Wild parsnip (weed)
Increase in ticks with Lyme disease
2016 Increase in federal funding (lock repairs)
2017 Canada 150, free pass, increased lock use
2019 Gobies
Future
-2021: Tightening of boarders, less visitors
-Climate change adaptation
Ongoing, incremental changes:
Change in responsability, lack of connection, no gathering place, overlap in engagement (repetition, fatigue, lack of coordination), misalignment between development and natural timelines


COLLECTIVE TIMELINE OF THE LOWER CATARAQUI WATER QUALITY WORKSHOP
1832
Initial flooding of the canal (1.5m):
-Nutrient introduction
-Loss of buffer zone and inondation of productive land
Increased recreational activity (negative impacts)
1950s Conservation authorties
1970s Change of water course in Dog Lake (now stagnant)
1990s Invasive species (zebra mussels and plants)
No regulation or enforcement of speed limits
Motor boats speeding, disturbing lake bed and sediments
2004 Ducks Unlimited Canada Study: Wetland reduced from 14% to 4%
2003 Resuspension of bottom sediments related to boat traffic
2000s Increase in bass fishing tournaments, decrease in fish stocks
Corporate tournaments at the expense of the waterway
Recurrent blue-green algae blooms
2006 Regulations through CAs – need permits
Increase of floating plants in July-August
Study on the impact of boat traffic and voluntary slowdown zones in the St-Lawrence
June 17th 2019 Algae bloom in Dog Lake
Present and future:
Climate change and changing weather patterns
Ongoing, incremental changes:
Gradual and ongoing introduction of carp fish, suckers and dog fish, fluctuation of water levels in effort to control flooding; ongoing development (not the most important but a major contributor), poor water flow and poor water quality


COLLECTIVE TIMELINE OF SCIENTIST GROUP WORKSHOP
1958 Conservation Authorities Act
1972 Change in governance (TC → PC)
Mid 1990s Closure of Rideau Lakes Fisheries Assessment Unit
Mid-late 1990s Zebra mussels
1996-7 Turtles as threatened/special concern – need protection (ongoing)
1998 Rideau Ministry of Nature Biodiversity survey
Late 1990s Municipal amalg. Ottawa & Kingston
2002 SARA
2002-4 Development of Jock River
2005 Commercial fishing of SAR
2007 UNESCO World Heritage Site designation
2008 Property value inflation
2008-9 Fisheries Management Zone 18
2008-11 Survey on turtles
2011-15 Harper years
2012-14 Development along Jock River
Stonebridge golf club
2017 - Free lock access Canada150 - $ for infrastructure upgrades (PC)
Late 2018 Round Goby
Ongoing, incremental changes:
Development close to shore, wakeboarding, intensification of bass tournaments, PC shift from conservation to visitor experience


COLLECTIVE TIMELINE OF THE GOVERNMENT REPRESENTATIVES WORKSHOP
1920s-1940s Small lot development (South Frontenac)
1950s Historic Canal Regs (lack of teeth)
1972 - Change in governance (TC → PC) - Protest against electrification
1985-6 Elimination of gasoline
1980s-90s Increase in year-round residents & quality of life
1994-8 Rideau Lakes Amalg.
2000 Walkerton
2001-2 - City of Ottawa Amalg. - SARA (2002)
2003 South Frontenac framework – no mention of RC
2005 Lower Rideau Watershed Strategy
2006 Conservation Authority regs updated
2007 UNESCO World Heritage Site designation
2010 - Forest cover to soy crops - Rideau Corridor Landscape Strategy
2011 Less contaminants of boat motors
2018 NSERC Grant
2019 - South Frontenac new plan includes RC - South Frontenac re-conversion of lots - Township of Rideau Lakes – Lake Association Network and Grant Program
Future - 2020 – Bill 108 - Pressure to grow hemp, risk nutrient loading - Hope for better PC legislation
Ongoing, incremental changes:
Retired baby boomers from GTA build year-round residences, population growth

Activity 3: Collaborative mapping results

Nodes with highest centrality scores across workshops						
Centrality Measure	1 – community groups	2 – economic interest groups	4 – NSERC scientists	5 – governments	Emerging nodes across stakeholder workshops	*3 – water quality*
Indegree	water level management	water quality	invasive species	water quality	water quality	*nutrients*
	resource use	fish populations	enforcement	development pressures	development (economic & shoreline)	*boating*
	education	economic development	boat traffic	erosion	boating	*sediments*
	enforcement	boat traffic	shoreline erosion	tourism	enforcement	*agriculture*
	recreational use	government policy & climate change	algal blooms	climate change	erosion	*shoreline development*

					climate change	
Outdegree	education	tourism	shoreline development	education	education	*education*
	water level management	economic development	boat traffic	development pressures	development (economic & shoreline)	*policy*
	resource use	boat traffic	complex lotic/lentic system (water flow)	political will	tourism	*sediments*
	recreational use	government policy	shoreline erosion	tourism	boat traffic	*shoreline development*
	government leadership	commercial fishing & agricultural run-off	monitoring	erosion	government policy/will/action erosion	*water level*
Betweenness	education	economic development	boat traffic	education	education	*nutrients*

	water level management	government policy	tourism	tourism	boating	*boating*
	resource use	boat traffic	shoreline development	development pressures	tourism	*water level*
	coordinated actions of multiple governments	water quality	shoreline erosion	nutrient levels	development (economic & shoreline)	*shoreline development*
	enforcement	commercial fishing	enforcement	climate change	enforcement	*tourism*
Eigenvector	resource use	tourism	shoreline development	education	education	*education*
	water level management	economic development	citizen awareness	development pressures	development (economic & shoreline)	*sediments*
	recreational use	boat traffic	political will	political will		*policy*
	education	government policy	complex lotic/lentic	knowledge		*agriculture*

			system (water flow)		policy/political will	
	tax policy	public awareness	land use	erosion	resource/land use hydrology	*Boating & fishing*
Emerging nodes across centrality measures	education water level management resource use recreational use	economic development government policy boat traffic tourism water quality	shoreline development enforcement boat traffic erosion complex lotic/lentic	education development pressures erosion political will tourism	**development (economic and shoreline)** **education** **governance** **boating**	***education*** ***sediments/nutrients*** ***agriculture*** ***policy***

	government leadership & action enforcement	commercial fishing	system (water flow)	climate change	**erosion** **tourism** **enforcement**	***development (shoreline)*** ***boating***

Activity 5: Leverage points

Workshop 1 - community	Workshop 2 – economic interest	Workshop 3 – water quality	Workshop 4 – NSERC scientists	Workshop 5 – government
- Incentives for behavioural change - Build a common vision that is executed by strong leadership - Invest in public education - Responsible and sustainable development - Bring institutions together - Use existing planning tools - Enforce existing regulations - Protect the ecosystem and biodiversity - Expand the knowledge base of the system	- Connect individual actions to outcomes - Prioritize conservation - Public awareness and education - Use new media to communicate - Transmit knowledge and caring about the Canal through experiential learning - Create a comprehensive document about activities and assessments for RC - Pool resources to level playing field - Strengthen laws, regulations and enforcement - Promote climate change adaptation	- Engage smaller communities through a watershed approach - Undertake more research - Set reasonable targets - Increase buffer zones - Revegetate riparian areas - Storytelling for communication to support action - Encourage volunteering - Education for farmers and residents - Adopt adaptive management practices	- Protect more areas from development (17% national target) - Improve shoreline management - Increase sanctuaries for time periods - Restrictions for visitors re boat cleaning - Coordinated management reform - Watershed approach with CAs - Enforce existing regulations and legislation - Targeted education - Storytelling - Increase transdisciplinary and interdisciplinary collaboration	- Consistent official plans and bylaws - Mechanisms for enforcement in low capacity areas - Tile drain outlet control - Provincial and federal funding for wetlands - Self-regulation - Multi-partner collaborative approach - Move beyond partisanship - Lake Association led education, including Indigenous ways of knowing - Science stewardship and measuring success scientifically

	and environmental awareness	- Improve municipal bylaws to be more effective	- Standardize data collection and long-term monitoring	- Show off success through such workshops - Include youth - Paradigm shift for decision makers in Queens Park required - Relationship building between governments and governments and community - Look at other models - Annual workshop for RC led by a jurisdiction - Coordinated action

Workshop analysis

Centrality measures per node

Workshop 1 – community groups

#	Node	Indegree *100	Outdegree *100	Betweenness	Eigenvector *100
1	Environmental values	1.27	0.63	7.37	0.27
2	Agriculture	2.53	2.53	42.09	3.84
3	Aquatic ecosystem	1.90	1.27	32.19	1.72
4	Boating	1.90	1.90	83.32	2.35
5	Climate change	1.27	1.27	1.75	1.49
6	Common vision	1.27	0.63	0.00	0.18
7	Conservation authorities	0.63	0.63	0.00	0.73
8	Coordinated actions of multiple governments	1.90	3.16	194.63	2.10
9	Demographics (rural/urban)	1.90	1.27	5.60	1.98
10	Development	0.00	1.90	0.00	1.50
11	Development policies and regulations	0.63	0.63	45.00	1.08

12	Ecosystem quality	3.16	2.53	75.10	3.06
13	Education	5.70	7.59	582.37	4.09
14	Enforcement	4.43	1.27	182.26	1.51
15	Environment as a financial priority	1.90	0.63	12.90	0.05
16	Environmental health	11.39	9.49	1111.49	8.15
17	Environmental regulations	1.27	1.90	54.82	2.27
18	Fauna and flora	1.90	1.27	2.34	1.41
19	Fish management	0.63	0.63	0.00	1.46
20	Fish tournaments	1.27	1.90	53.00	0.69
21	Government leadership	1.27	4.43	57.23	0.88
22	Hospitality	0.63	1.27	11.88	2.75
23	Invasive species	0.63	1.27	0.00	1.71
24	Issues	0.63	0.63	0.00	0.73
25	Lake associations	0.63	0.63	0.00	0.73
26	Land use policy	0.63	0.00	0.00	0.00

27	Landowner stewardship	1.90	1.27	48.92	0.28
28	Limits to growth	1.90	2.53	51.08	0.99
29	Money	0.63	2.53	2.35	2.84
30	Municipal funds	1.27	0.00	0.00	0.00
31	Municipalities	0.63	0.00	0.00	0.00
32	Number of fish	1.27	0.63	33.20	0.12
33	Nutrient management strategy	1.27	0.00	0.00	0.00
34	Septic systems	0.63	0.63	0.00	0.73
35	Political involvement	1.90	3.16	128.39	2.46
36	Political will	0.63	0.00	0.00	0.00
37	Public health	1.90	3.80	128.47	3.54
38	Recreational use	3.80	4.43	101.74	5.24
39	Regulations	1.90	0.63	45.00	0.19
40	Resource use	6.33	6.96	281.99	7.21
41	Shoreline (development and protection)	0.63	1.90	60.92	1.59

42	Social media	0.00	0.63	0.00	0.73
43	Solutions	0.63	0.63	0.00	1.08
44	Storm water management	2.53	1.27	35.32	1.98
45	Tax policy	2.53	2.53	47.12	3.84
46	Views of the natural vs human landscape	0.00	0.63	0.00	1.46
47	Visitor levels	1.27	1.90	20.30	3.83
48	Waste management	0.63	1.27	0.00	1.41
49	Water level management	8.86	6.96	510.40	6.03
50	Water quality	0.00	0.63	0.00	1.08
51	Water traffic	1.90	1.27	40.28	1.82
52	Weeds and algae	1.88	1.25	40.28	1.77

Workshop 2 – economic interest groups

#	Node	Indegree * 100	Outdegree *100	Betweenness	Eigenvector *100
1	environmental health	13.04	6.09	387.14	6.43
2	water quality	11.30	2.61	115.65	2.00

3	boat traffic	5.22	6.09	129.73	6.92
4	knowledge and education	1.74	2.61	8.50	1.88
5	improvements to canal	0.00	0.87	0.00	0.47
6	road salt	0.00	0.87	0.00	0.47
7	enforcement of environmental regulations	0.00	1.74	0.00	1.62
8	climate change	4.35	4.35	62.75	4.83
9	agricultural runoff	1.74	5.22	23.92	2.97
10	buffer zones in tributaries	0.00	1.74	0.00	1.18
11	aquatic life	0.87	0.00	0.00	0.00
12	public awareness	0.00	4.35	0.00	5.90
13	rural infrastructure	0.00	1.74	0.00	2.26
14	fish populations	6.96	1.74	34.50	2.00
15	boating/fishing regulations	0.00	1.74	0.00	2.11
16	demand on local resources	2.61	1.74	7.67	2.00
17	economic development	6.96	6.09	169.71	7.55

18	aging rural population	0.00	0.87	0.00	1.79
19	tourism	3.48	6.96	71.61	7.61
20	shoreline erosion	1.74	0.87	0.00	1.52
21	development along canal	0.87	3.48	36.50	3.69
22	government policy	4.35	6.09	162.26	6.69
23	fishing tourism	3.48	1.74	26.00	2.11
24	commercial fishing	2.61	5.22	74.61	2.82
25	species diversification	3.48	0.87	5.00	0.50
26	natural ecosystem	2.61	1.74	4.54	0.79
27	municipal pollution	0.87	4.35	0.00	1.74
28	human recreational activities	2.61	1.74	0.25	2.00
29	money	0.87	1.74	0.00	3.31
30	partnerships	1.74	1.74	0.00	3.59
31	hardening of shoreline	0.87	0.87	0.33	0.47
32	individual lifestyle	3.48	1.74	1.08	1.71

33	consumption	3.48	2.61	39.67	2.37
34	actions	1.74	3.48	13.50	3.55
35	global actions	1.74	0.87	0.00	1.58
36	weed cover	2.61	1.74	4.54	0.79
37	invasive species	2.61	1.74	4.54	0.79

Workshop 3 – water quality

#	Node	Indegree *100	Outdegree *100	Betweenness	Eigenvector *100
1	water quality	11.34	6.88	619.93	5.11
2	algae	1.62	0.81	19.31	0.12
3	atmosphere	4.86	2.83	13.02	3.55
4	biodiversity	1.62	0.40	36.35	0.07
5	boating	6.88	4.05	209.22	4.26
6	buffer zones	1.21	0.40	13.07	0.62
7	canal construction	0.40	1.21	50.44	0.18
8	chemicals	2.02	3.24	72.32	3.82

9	climate change	0.40	2.02	2.00	1.24
10	community	0.81	1.62	19.39	1.20
11	cottages	1.62	0.81	15.64	0.58
12	dams	0.40	0.40	0.00	0.48
13	depth	2.83	2.83	27.09	3.75
14	development	0.40	2.83	1.41	3.75
15	economy	1.21	0.40	14.97	0.45
16	education	0.40	11.34	31.59	7.14
17	engagement	0.81	0.00	0.00	0.00
18	erosion	2.02	0.81	19.50	0.64
19	fishing	1.62	3.64	41.04	4.26
20	flooded land and artificial lakes	0.00	1.21	0.00	1.19
21	flushing	2.83	2.83	27.09	3.75
22	forest cover	0.40	0.40	0.00	0.62
23	habitat	0.81	2.83	12.08	3.75
24	human activity	2.02	2.83	61.44	3.75

25	hydrology	3.24	2.83	27.48	3.75
26	invasive species	2.43	0.81	67.41	0.62
27	lakes	2.83	2.83	27.09	3.75
28	landscaping	0.40	0.81	0.00	0.54
29	nutrients	7.69	4.05	231.24	4.16
30	policy	0.81	4.86	12.41	4.67
31	political will	0.00	0.81	0.00	1.42
32	pollutants	1.21	0.40	0.00	0.62
33	productivity	0.40	0.00	0.00	0.00
34	property value	1.21	2.83	12.47	3.75
35	remediation	0.00	0.81	0.00	0.15
36	sediments	6.88	4.45	40.11	5.39
37	septics	0.81	0.40	0.00	0.62
38	shallow littoral zones	11.34	6.88	619.93	5.11
39	shoreline development	1.62	0.81	19.31	0.12
40	species succession	4.86	2.83	13.02	3.55

41	tourism	1.62	0.40	36.35	0.07
42	turbidity	6.88	4.05	209.22	4.26
43	vegetation cover	1.21	0.40	13.07	0.62
44	water level	0.40	1.21	50.44	0.18
45	agriculture	2.02	3.24	72.32	3.82
46	weather	0.40	2.02	2.00	1.24
47	wetlands	0.81	1.62	19.39	1.20

Workshop 4 – NSERC scientists

#	Node	Indegree *100	Outdegree *100	Betweenness	Eigenvector *100
1	environmental health	14.61	1.12	151.00	1.15
2	climate change	0.00	2.25	0.00	2.26
3	land use	1.12	2.25	21.00	4.49
4	phosphorus	2.25	1.12	7.58	1.13
5	algal blooms	5.62	3.37	27.50	2.44
6	invasive species	10.11	3.37	30.17	2.44

7	boat traffic	5.62	6.74	161.00	4.17
8	tourism	1.12	2.25	126.00	2.47
9	coordination + cooperation	0.00	3.37	0.00	3.26
10	enforcement	6.74	3.37	30.83	2.19
11	monitoring	3.37	4.49	16.42	3.46
12	conservation norms	1.12	2.25	0.00	3.57
13	political will	1.12	4.49	2.50	5.50
14	money/capacity	1.12	2.25	0.00	2.62
15	water quality	2.25	2.25	4.17	0.78
16	habitat	2.25	2.25	4.17	0.78
17	biodiversity	3.37	1.12	0.67	0.53
18	complex lotic/lentic system (water flow)	0.00	5.62	0.00	4.64
19	shoreline development	4.49	10.11	90.33	8.55
20	jurisdictional quagmire	2.25	2.25	22.33	3.93
21	colonel by	0.00	1.12	0.00	1.83

22	individual behaviours	2.25	1.12	14.33	3.97
23	multiple users	1.12	1.12	10.67	3.97
24	nutrient load/input	5.62	2.25	23.67	1.67
25	shoreline erosion	5.62	4.49	65.42	2.96
26	agriculture	0.00	2.25	0.00	1.13
27	pollution	3.37	1.12	10.50	0.77
28	shoreline beautification	1.12	2.25	0.00	2.15
29	turtle distribution	2.25	0.00	0.00	0.00
30	commercial fishing	0.00	2.25	0.00	1.94
31	recreational fishing and tournaments	1.12	2.25	6.50	2.71
32	citizen awareness	0.00	4.49	0.00	7.50
33	water level management	1.12	1.12	3.25	1.38
34	native species	5.62	2.25	1.83	1.67
35	boat launches	0.00	2.25	0.00	2.39
36	lock activities	0.00	2.25	0.00	2.46

37	aquatic and riparian vegetation management	2.25	1.12	2.17	1.13

Workshop 5 – government representatives

#	Node	Indegree *100	Outdegree *100	Betweenness	Eigenvector *100
1	environmental health	14.81	5.56	308.52	5.50
2	water level regulations	4.32	3.70	33.42	3.07
3	agricultural practices	1.85	3.09	4.70	2.33
4	education	4.32	10.49	201.51	9.25
5	fish population	4.32	1.23	3.28	1.47
6	tourism	4.94	5.56	169.05	3.97
7	political will	3.09	7.41	29.12	8.16
8	development pressures	6.17	7.41	114.12	8.52
9	loss/conversion of wetlands	1.85	4.32	9.60	4.17
10	water quality	7.41	1.85	18.63	2.01
11	climate change	4.94	4.32	69.67	3.51
12	recreation	1.85	1.85	29.00	2.10

13	nutrient levels	3.70	3.09	86.89	2.34
14	algae blooms	0.62	0.62	3.07	0.32
15	public access	1.23	0.00	0.00	0.00
16	gasoline spills	1.23	1.23	20.14	0.82
17	boat ramps	1.23	0.00	0.00	0.00
18	boating	1.23	3.09	17.98	1.34
19	fish habitat	1.85	1.85	49.56	0.72
20	fishing	0.62	1.23	4.24	0.96
21	shoreline hardening	1.85	3.09	35.61	3.07
22	erosion	5.56	4.32	61.33	4.96
23	ecosystem	1.85	1.23	2.81	2.09
24	knowledge	3.09	4.32	25.01	5.56
25	economy	3.70	3.09	27.99	4.56
26	legislation and enforcement	1.85	1.23	0.97	2.28
27	riparian habitat	4.32	3.09	19.29	3.59
28	invasive species	1.85	1.85	3.31	1.69

29	population growth	0.00	1.23	0.00	1.56
30	new technologies	0.62	0.62	1.12	0.85
31	local action	2.47	0.62	0.00	0.85
32	pesticide use	0.00	1.23	0.00	0.98
33	attitudes and values	0.00	2.47	0.00	3.06
34	awareness	1.23	1.23	32.06	1.56
35	decreased forest	0.00	2.47	0.00	2.78

Merged map (workshops 1, 2, 4 and 5)

#	Node	Indegree *100	Outdegree *100	Betweenness	Eigenvector *100
1	Environmental health	8.98	5.01	1668.51	4.85
2	Agriculture	1.88	2.51	119.17	2.25
3	Algae	1.04	0.84	82.08	0.82
4	Aquatic vegetation management	0.42	0.21	1.83	0.10
5	Aquatic ecosystem	0.63	0.42	1.30	0.46
7	Mores and worldviews	1.25	1.88	85.54	2.66

8	Awareness	0.42	2.30	85.41	2.72
9	Biodiversity	1.67	0.84	31.07	0.87
10	Boat launch	0.42	0.63	4.00	0.27
11	Boating	2.71	3.34	332.91	2.31
13	Buffer zones	0.00	0.42	0.00	0.46
16	Climate Change	2.71	2.71	169.60	2.57
17	Colonel By	0.00	0.21	0.00	0.01
18	Commercial fishing	0.63	1.46	27.29	0.75
19	Common vision	0.42	0.21	0.00	0.05
21	Lotic/lentic system	0.00	1.04	0.00	0.57
22	Conservation authorities	0.21	0.21	0.00	0.46
23	Consumption	1.04	0.84	37.66	1.23
24	Coordination and cooperation	0.63	1.46	327.98	0.95
28	Demographics	0.84	1.04	6.13	1.51
30	Development pressures	2.09	2.92	205.05	3.38

32	Economy	2.51	2.51	197.19	2.86
33	Ecosystem quality	2.09	1.46	76.89	1.65
34	Education	3.76	5.85	1146.52	4.87
35	Enforcement	2.51	1.46	177.88	1.60
37	Environment as financial priority	0.63	0.21	1.09	0.08
39	Erosion	2.51	2.09	199.52	2.39
41	Fish management	0.21	0.21	0.00	0.46
42	Fish tournaments	0.63	1.04	20.30	0.65
43	Fishing	1.25	1.04	49.09	1.18
46	Global actions	0.42	0.21	0.00	0.33
47	Government leadership	0.42	1.46	88.60	0.56
48	Habitat	2.09	1.88	111.32	2.12
50	Hospitality	0.21	0.63	7.78	0.99
51	Recreational use	1.88	2.09	148.67	2.22
53	Improvements to canal	0.00	0.21	0.00	0.25

54	Individual behaviours & lifestyle & stewardship	1.88	1.04	215.75	0.85
55	Invasive species	3.13	1.46	204.45	1.05
56	Issues	0.21	0.21	0.00	0.46
57	Jurisdictional quagmire	0.42	0.42	74.84	0.11
58	Knowledge	1.46	2.09	37.59	2.46
59	Lake associations	0.21	0.21	0.00	0.46
61	Land use policy	0.42	0.42	45.87	0.34
63	Limits to growth	0.63	0.84	75.93	0.52
64	Local action	1.25	1.25	34.73	1.75
65	Lock activities	0.00	0.42	0.00	0.23
66	Money/capacity	0.84	1.67	29.30	1.85
67	Monitoring	0.63	0.84	6.97	0.76
68	Multiple users	0.21	0.21	3.33	0.33
69	Municipal funds	0.63	0.00	0.00	0.00
70	Municipalities	0.21	0.00	0.00	0.00

71	Native species	1.25	0.42	4.97	0.56
72	New technologies	0.21	0.21	0.00	0.46
73	Fish population	3.13	0.84	73.82	0.95
74	Nutrient levels	2.71	1.25	70.95	1.55
75	Partnerships	0.42	0.42	0.00	0.49
76	Pesticide use	0.00	0.42	0.00	0.62
77	Phosphorus	0.42	0.21	4.23	0.08
78	Political involvement	0.21	0.21	0.00	0.46
79	Political will	1.46	3.97	246.61	4.12
80	Pollution	0.84	1.67	14.10	1.39
83	Public access	0.42	0.00	0.00	0.00
84	Public health	0.21	0.00	0.00	0.00
85	Regulations & policy	3.13	3.55	400.73	3.47
87	Resource use	1.25	0.63	23.83	0.87
89	Road salt	0.00	0.21	0.00	0.25
90	Rural infrastructure	0.00	0.42	0.00	0.35

92	Septic systems	1.46	1.04	14.23	1.56
94	Shoreline protection	2.09	2.30	128.48	2.09
95	Shoreline beautification	0.21	0.42	0.00	0.37
96	Shoreline development	3.55	4.18	653.89	3.53
98	Social media	0.21	0.63	85.34	0.54
99	Solutions	0.00	0.21	0.00	0.46
101	Storm water management	0.21	0.21	0.00	0.25
102	Tax policy	1.04	0.63	22.06	0.74
103	Tourism	2.51	2.92	302.67	2.37
105	Turtle distribution	0.42	0.00	0.00	0.00
106	Forest cover	0.00	0.84	0.00	0.91
107	Visitor levels	0.00	0.21	0.00	0.46
108	Waste management	0.63	0.84	10.82	1.24
109	Water level management	1.88	1.67	27.83	1.77

110	Water quality	7.10	3.13	726.00	2.64
111	Water traffic	0.00	0.21	0.00	0.25
113	Weed cover	1.25	0.84	66.05	0.86
114	Wetlands	0.63	1.46	2.28	1.70