Keys to Success:
A Case Study Approach to Understanding Community-Based Water Monitoring Uptake in Governmental Decision-Making

by

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Dedications

This thesis is dedicated to all watershed stewardship organizations across Canada engaged in protecting the health of our watersheds for future generations.

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Abstract

Community-based water monitoring (CBWM) involves volunteers and non-government organization staff in collecting water quality data for the purpose of enhancing our knowledge of watershed health. With reduced government capacity for monitoring, there has been increasing support for CBWM. It has the potential to increase information on watershed health for government and enhance public engagement in water management; however, many well known challenges continue, such as credibility and capacity issues. While the literature highlights these challenges, case studies that include successful instances of CBWM influencing governmental decision-making are lacking. To fill this knowledge gap, my research examined four case studies of Canadian watershed groups involved in CBWM that have been integrated with governmental decision-making. Semi-structured interviews were conducted with watershed group coordinators and government counterparts for each case study and data were analyzed thematically using an inductive/deductive coding method. Findings revealed that collaboration helped to build capacity and credibility for rigorous, long-term CBWM that was useful for informing governmental decision-making.

List of Abbreviations Used

BBEMA	Bedeque Bay Environmental Management Association
BC	British Columbia
CABIN	Canadian Aquatic Biomonitoring Network
CAMP	Community Aquatic Monitoring Program
CBM	Community-based monitoring
CBWM	Community-based water monitoring
CURA H2O	Community-University Research Alliance project titled: *"Community-Based Integrated Water Monitoring and Management in Nova Scotia (CURA H2O"*
EMAN	Ecological Monitoring and Assessment Network
ERA	Ecological Risk Assessment
IWRM	Integrated water resource management
MVIHES	Mid Vancouver Island Habitat Enhancement Society
NB	New Brunswick
NGO	Non-government organization
PEI	Prince Edward Island
QWSS	Quamichan Watershed Stewardship Society
SBWA	Shediac Bay Watershed Association

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Chapter 1: Introduction

1.1 Significance of Research

Water management issues are becoming increasingly complex as human impacts such as industrial development and climate change continue to grow. Drinking water is a major global concern and the general health of waterways is important for ecosystem and human health. Long-term water quality monitoring is a critical tool for tracking changes in the environment and facilitating the mitigation of human impacts before they become too severe (Ramin, 2004). In Canada, federal, provincial, and municipal governments have largely been responsible for water monitoring; however, with increasing decentralization and cuts to environmental budgets at all levels, the availability of high quality monitoring information has become compromised (Morin, 2009; Pilon *et al.*, 1996; WCEL, 2004). Increasing public concern with water management issues as well as public distrust in government's attention to these issues has contributed to growing citizen engagement in community-based water monitoring (CBWM) (Au *et al.,* 2000; Whitelaw *et al*., 2003). While long-term CBWM collected with adequate standardization and training has the potential to be useful for government and inform water management decision-making (Conrad and Hilchey, 2011), there have been many challenges for the integration of such data. For example, professionals have often questioned the accuracy and objectivity of citizen-collected data (Stokes *et al.,* 1990; Legg and Nagy, 2006) and the capacity of non-government organization (NGO) staff/volunteers to conduct consistent monitoring has often been limited (Danielsen *et al.,* 2005; Sharpe and Conrad, 2006). Therefore, CBWM continues to face challenges with producing information that is useful for government.

There is a plethora of research on the challenges for CBWM (along with proposed solutions) (e.g. Conrad and Daoust, 2008; Rankin, 2008; Milne *et al*., 2006), and yet cases of successful integration of CBWM in governmental decision-making have received little attention in the literature (Conrad and Hilchey, 2011). The research herein seeks to address this research gap by focusing on successful cases of CBWM integration

with governmental decision-making. The goal of this thesis is to provide lessons learned from such examples to watershed groups and government agencies either seeking to overcome obstacles to CBWM or to enhance the usefulness of CBWM for government. Expanding the integration of CBWM in government processes would help to increase the availability of sound science for evidence-based decision-making and contribute to enhancing public participation in water management.

1.2 Background

1.2.1 Watershed governance

Global water crisis and integrated water resources management

Water is essential for sustaining human and ecosystem health. Currently, up to 80 percent of the world's population faces substantial risks to water security (Vörösmarty *et al*., 2010), which can be defined as "as the capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development…" (UN-Water, 2013, p.1). Threats to water security are often anthropogenic in origin (Vörösmarty *et al*., 2010) and threats commonly addressed in the literature include: 1) contamination of municipal water supplies, 2) water-related crises such as floods that impact economies and livelihoods, 3) compromised water-based ecosystem services, and 4) variability and severity of weather events related to climate change (Bakker, 2012). These threats are expected to continue growing in severity as we are in a time of 'great acceleration' known as the Anthropocene, which is as an era of booming human population, rising carbon emissions, and expanding resource exploitation (Steffen *et al*., 2007). The global water crisis is primarily one of mismanagement, which has contributed to deteriorating water quality globally (Biswas and Tortajada, 2011; OECD, 2011). It is widely recognized that in order to move towards sustainable water management, we must start to find ways to balance natural resource needs with environmental integrity (Dudgeon *et al*., 2006; Vörösmarty *et*

al., 2010; UNESCO, 2009) and move towards more proactive rather than reactive approaches (Steffen *et al*., 2007; Vörösmarty *et al*., 2010).

Water connects all living things and every natural resource that humans use depends on it, from fisheries and agriculture, to timber and mining. Water flows downhill, crossing many political boundaries on the way to its ultimate destination: the ocean. Water management is thus a highly complex issue, and integrated water resources management (IWRM) has become widely accepted as the most effective way to bring together the multifaceted issues and multiple stakeholders that are involved (Jønch-Clausen and Fugl, 2001). IWRM is a process that seeks to integrate multiple sectors, government levels, ecosystem components, economic and social needs, as well as water quality and quantity in water resource management (Jønch-Clausen and Fugl, 2001). IWRM is defined as:

> …a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP TAC, 2000, p.22).

Despite the fact that IWRM has gained international attention since its introduction at the World Summit in Rio de Janeiro and Dublin in 1992, the term itself has often been used ambiguously which has led to confusion over its meaning and implementation (Jønch-Clausen and Fugl, 2001). Since 1992, 82 percent of United Nations member countries are making changes to water laws based on integrated approaches recommended in Agenda 21 of the UN Conference on Environment and Development (UNEP, 2012). Despite this high portion of countries applying IWRM principles, the process of implementing policies is quite slow and only 34 percent of these countries were at an advanced stage of implementing IWRM plans in 2012 (UNEP, 2012). Strengthening IWRM continues to be a priority as countries face challenges with implementation (e.g. Morin, 2009) and water issues continue to increase in severity and complexity.

Watershed management and monitoring

Watersheds have become an increasingly popular scale for managing water resources over the past few decades (Blomquist and Schlager, 2005). A watershed is an area of land over which water flows downhill into a common water body such as a river, lake, or ocean (USEPA, 2008; Figure 1.1). Watersheds consist of nested scales, from a localised river valley to a region of water drainage (Vodden, 2009). Thus, the users of a watershed can delineate the boundary differently from one another depending on their administrative needs and management contexts (Breen and Minnes, n. d.). The watershed-scale is often promoted for IWRM as it facilitates the integration of multiple stakeholders across jurisdictional boundaries (Ramin, 2004). Watershed management can be implemented in a traditional, top-down approach where government is the central decision-making authority. Alternatively, collaborative watershed management arrangements such as watershed councils can bring together all watershed stakeholders in a shared decision-making process to address issues of common concern (Michaels, 2001). There are many challenges associated with collaborative watershed management, including continued political influence from existing institutions, decision-making authority, issues with accountability, and standing political borders (Blomquist and Schlager, 2005). Watershed management is not a perfect solution although it shows much promise for facilitating IWRM principles, including multi-stakeholder participation.

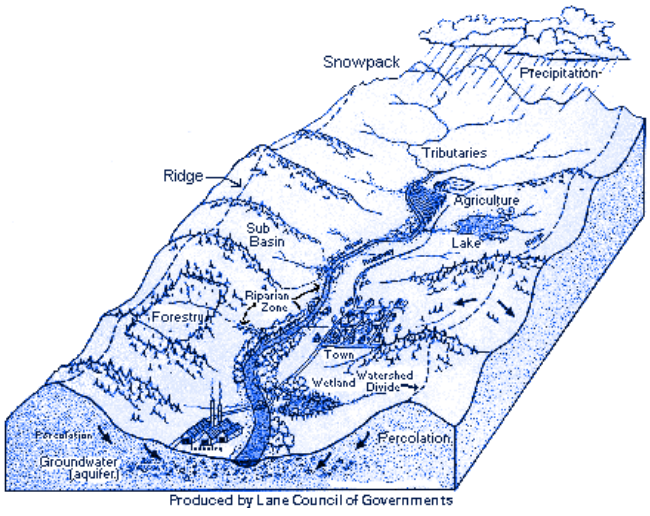

Figure 1.1: Image of a watershed and its various land-use impacts (USEPA, 2008).

Monitoring ecological indicators facilitates the observation of changes in environmental characteristics over time (Fernández-Giménez and Ballard, 2011) and monitoring at a watershed-scale helps to identify linkages between changes in watershed health and human activities on the land (NSE, 2010). Watershed monitoring has several important functions, including: 1) quantifying progress towards ecological goals and commitments, such as national biodiversity conservation objectives (Danielsen *et al*., 2005), 2) quantifying the impacts of ecosystem restoration efforts for evidence-based conservation (Danielsen *et al*., 2005; Sutherland *et al*., 2004), 3) providing early-warning of changes in ecosystem health resulting from human impacts (Fernández-Giménez and Ballard, 2011), 4) detecting contamination of water supplies and mitigating effects on human health (Au *et al*., 2000), and 5) enabling adaptive management by facilitating incremental changes rather than a reactionary approach (Fernández-Giménez and Ballard, 2011). Water quality is a particularly important indicator for watershed monitoring as it has often been neglected in favor of focusing on water quantity (Biswas and Tortajada, 2011). Water quality monitoring can involve physical characteristics (e.g. suspended solids, pH, conductivity), chemical characteristics (e.g. pesticides, nitrates), and observation of macroinvertebrate communities. Water quality monitoring has become an essential tool for supporting watershed management and IWRM as it provides a necessary feedback mechanism for evaluating management practices (Ramin, 2004).

1.2.2 Watershed management and monitoring in Canada

Watershed management in Canada

Canada has traditionally been associated with an abundant supply of freshwater, resulting in a 'myth of abundance' (Sprague, 2007). Realizations of this myth have contributed to increasing federal and provincial government concern over the sustainable management of water resources (de Loë and Kreutzwiser, 2007). Canada has roughly 20 percent of the world's freshwater *volume*; however, the majority of Canada's population (southern region) only has access to 2.6 percent of the world's annual *renewable* freshwater supply, which can be used on a sustainable basis (Sprague, 2007). Increasing pressures on water

quality and quantity from population growth, resource consumption, development, pollution, droughts, and competing water usage have added to the realization of the need for effective water management in Canada (Pearse, 1986).

IWRM has gained increasing support in Canada since its endorsement in the 1980s with the Federal Water Policy. The policy supports watershed-scale management as well as integration across federal and provincial departments, and increasing public participation in water resource management (Environment Canada, 1987). Many provinces have included watershed-based approaches in recent policies and legislation (Nowlan and Bakker, 2010), and a few have implemented watershed-scale management, namely Manitoba, Alberta, Ontario, and Québec. Despite this progress since 1987, many water management issues remain, including involvement of Aboriginal peoples in water management, inter-jurisdictional overlap and cooperation, and international pressures on water use (Bakker, 2007). These ongoing issues demonstrate a lag between IWRM policy and implementation (Bakker and Cook, 2011; Hering and Ingold, 2012) and that more attention is required to move IWRM from a widely accepted concept to common practice within government agencies.

Canada's governance of water involves a fragmented approach (Bakker and Cook, 2011; Hill *et al*., 2008) and is experiencing trends of decentralization (Robins, 2007; Bakker and Cook, 2011) where higher levels of government delegate responsibilities to lower levels of government or third parties. It is indicative of an era of neoliberalism, which involves a complex of ideologies that support individual/corporate freedom and self-interest, government austerity measures, reduced state intervention, and economic growth (Hall, 2011; Newman, 2014) and is arguably promoted at the expense of environmental quality and social equality (McCarthy, 2004). A fragmented, decentralized approach to water governance is contributing to continued challenges for implementing IWRM and protecting watershed health in Canada. Morin (2009) highlights several important challenges for the Canadian government with implementing IWRM: 1) diverse geographic contexts and stakeholders, 2) jurisdictional divisions, and 3) extensive

information needs. The third challenge affects IWRM at the national-scale and is the focus of this thesis.

Jurisdictional division is noted by others as being a major challenge for IWRM (Ramin, 2004; Jønch-Clausen and Fugl, 2001; Bakker and Cook, 2011) and has its roots in the Canadian Constitution. In the Constitution, responsibilities for water management are defined and shared between multiple government levels and departments. Federal responsibilities involving freshwater include fisheries, navigation and shipping, federal crown lands, First Nations reserve lands, and international relations (Environment Canada, n. d.). The provinces (and municipalities by extension) are largely responsible for freshwater on provincial lands (exempting the above uses), and include licensing and regulation of water quality, decisions regarding resource allocation, and regulating drinking water systems (Bakker, 2007). In the federal government alone, over twenty departments involve water in their responsibilities and eight departments have a strong mandate with water (Morin, 2009). As a provincial example, Ontario's water management is shared between conservation authorities, the Province, and municipalities, but within the provincial government there are an additional six ministries with partial responsibility for water management (as of 1996) (Shrubsole, 1996). Effective water management requires collaboration and coordination between government levels and departments; however, it can be difficult to navigate the differing mandates, regulatory mechanisms, and data management regimes (Morin, 2009). Morin (2009) recommends a nation-wide strategy for facilitating increased collaboration and integration across federal and provincial departments with IWRM as well as inclusion of watershed stewardship groups in IWRM processes to overcome these challenges.

Watershed monitoring in Canada

Having adequate information is noted as extremely important for good IWRM decision-making (Morin, 2009; Jønch-Clausen and Fugl, 2001). However, significant gaps in water quality and quantity information have reduced the effectiveness of water management in Canada (Morin, 2009). Decentralization through financial reductions and

shifting priorities in the early 1990s led to restructuring of the provincial and federal governments' existing monitoring programs (Pilon *et al*., 1996; Perrone *et al*., 1998). A stark example of reduced government priorities for monitoring was the discontinuation of Environment Canada's Ecological Monitoring and Assessment Network (EMAN) in 2010, which had engaged multiple stakeholders in supplementing government monitoring of ecosystem changes since 1994 (Vaughan *et al*., 2001). In the same year that EMAN was discontinued, the federal government's water quality monitoring network was deemed to be inadequate by the Commissioner of the Environment and Sustainable Development for tracking and responding to emerging environmental threats (Water Canada, 2010). Provincial governments have also experienced declining staff and financial resources along with reduced capacity for water monitoring (Molot *et al*., 2001; WCEL, 2004). Canada's water management has been deemed "unacceptable" and "shocking" by the Senate of Canada (2005) and as deeply concerning by water governance experts (Bakker and Cook, 2011; Brandes, 2005), pointing towards the need for strengthening IWRM and the monitoring programs that provide the necessary information.

1.2.3 Science and public participation in environmental decision-making

Environmental decision-making

Environmental managers are constantly making decisions that have wide implications for human and ecosystem health and that influence our everyday lives. Governmental decision-making includes, for example, regulatory, policy, managerial, and program-level decisions. To clarify, policies are used to facilitate action (Elmore, 1987) and regulations are one of many instruments that can implement the strategies outlined in policies (Davies and Mazumder, 2003). Decision-making is a complex psychological process that often balances between intuition (or 'gut feelings') and rationality, which is based on the information available (Dane and Pratt, 2007; Khatari *et al.,* 2000). Intuitive decision-making can be favored in certain situations because of the shorter processing time (Burke and Miller, 1999; Khatari *et al*., 2000); however, 'rational' decision-making models have

received the most attention in management literature (Dane and Pratt, 2007) and have often been promoted for conservation decision-making (Addison *et al.,* 2013). Literature in the field of environmental decision-making has been growing substantially since the early 1990s (Pollard *et al*., 2008) and risk-informed, evidence-based decision-making is of increasing interest. Sound science is required for effective evidence-based decision-making (Pollard *et al*., 2008) and for enhancing the legitimacy, legality, and equitability of IWRM (Davies and Mazumder, 2003). Scientific information often comes with varying degrees of uncertainty (Addison *et al*., 2013), and so decision-making cannot rely on science alone. Decision-making must strike a balance between science and other considerations such as traditional knowledge, ethics and culture, legal requirements, political context, etc. (Government of Canada, n. d.). Stakeholder participation in decision-making is thus equally important for effective environmental management decisions (Carolan, 2006). Sound science and consideration of stakeholder interests (along with instrumentation) can be seen as cornerstones for effective policy making involving water (Davies and Mazumder, 2003).

Science and monitoring in decision-making

Science is a necessary part of environmental decision-making, and yet challenges continue for linking scientific information with environmental management (Sutherland *et al*., 2004; Vaughan *et al*., 2003), and water management specifically (Ramin, 2004). Information used by decision-makers often needs to be timely (Colfer, 2008; Vaughan *et al*., 2001), in easy-to-read formats (Colfer, 2008), compiled by credible sources (Government of Canada, n. d.), and able to achieve a high level of 'diagnostic power' or certainty (Vos *et al*., 2000). Information overload can present problems as well, which can paradoxically result in more intuition-based decision-making (Burke and Miller, 1999). A major barrier to the integration of science into policy development is the lack of effective mechanisms (Davies and Mazumder, 2003), which are necessary for meeting the information needs of decision-makers.

There are a variety of mechanisms and tools for including scientific information in decision-making, including systems models (Addison *et al.,* 2013) and ecological risk assessment (ERA). ERA (see Figure 1.2) is a good example of a common tool for including monitoring information, which involves "a systematic approach to organizing scientific information to support environmental decision making" (Barnthouse, 2008, p.304). A scientific advisory board can facilitate this process, where experts produce research reports that provide guidance on key issues (Government of Canada, n. d.). Risk can be defined as "the likelihood of an event occurring (probability) multiplied by the consequence (the measurable effect)" (Davies and Mazumder, 2003, p.282) and decision-makers often seek to balance risks with costs and benefits when considering management options for environmental problems (Pollard *et al*., 2008). Decision-making is inherently based on perceptions of risk (Williams and Noyes, 2007; Keil *et al*., 2000), and effective risk assessment relies on the adequacy of available information (Stanton and Glendon, 1996). Barnthouse (2008) identifies three major challenges to the integration of science in ERA in the future: 1) 'science-lag' or maintaining pace with the development of environmental sciences, 2) 'unrecognized value judgments' or the belief that ERA's are purely objective, and 3) 'mediocrity creep', which includes the effects of limited capacity on scientific data quality over time. The third was highlighted earlier as a major challenge in the Canadian context (see Water Canada, 2010), and the belief that scientific information needs to be removed from personal and political views continues to be supported by government (Government of Canada, n. d.). ERA is one common example of how scientific monitoring can be used in decision-making; however, there are other functions for monitoring information as noted earlier in section 1.2.1 (p.5).

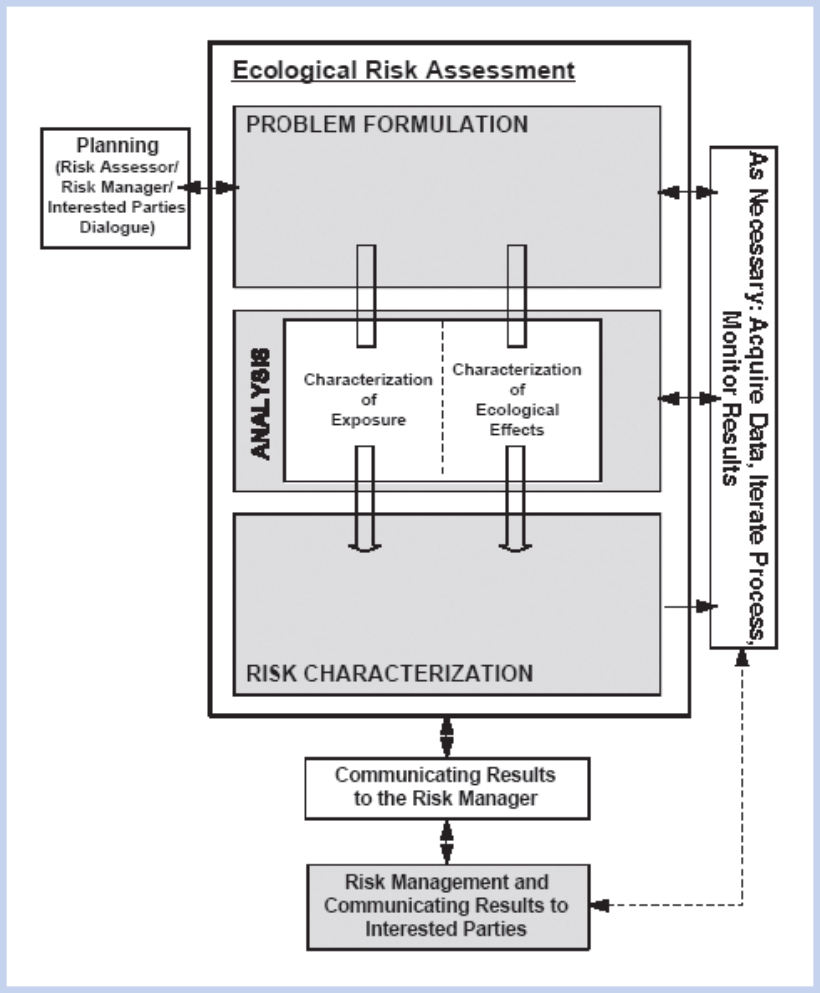

Figure 1.2: Framework for ERA linking science in the risk assessment process (Barnthouse, 2008, p.300).

Watershed monitoring is a form of scientific information gathering that can be useful in evidence-based decision-making. Vos and colleagues (2000) identified two primary uses for monitoring for decision-making: 1) an early warning function, and 2) an early control function. The early warning function requires a high level of certainty or 'diagnostic power' to result in action, unless the precautionary principle is applied. The precautionary principle suggests that "preventative action must be taken when there is reason to believe that harm is likely to be caused, even when there is no conclusive evidence to link cause with effect..." (Eduljee, 2000, p.19). The early control function can serve to immediately

change management or restoration measures as they are evaluated (Vos *et al*., 2000), thus it is often less reliant on the level of scientific uncertainty.

Water monitoring information can be evaluated using water quality guidelines, which are established through consensus between scientists on the best available science (Davies and Mazumder, 2003). However, arbitrary factors such as public safety are often considered when there is scientific uncertainty (Davies and Mazumder, 2003). The use of guidelines as thresholds is especially important when it comes to guiding policy development and implementation (Davies and Mazumder, 2003). Water quality monitoring can help to inform decision-making; however, when there is a high level of uncertainty around the information available (in addition to consideration of a myriad of other factors in decision-making as mentioned earlier) then it is less likely to result in action by decision-makers.

Public participation in decision-making

Decision-making involving complex environmental issues needs to take public concerns and stakeholder views into consideration in order for it to achieve desired results. Public participation is seen as key to sustainable development (Geczi, 2007; UNCED, 1992) and can act to redistribute power from government structures to "have-not-citizens" by including them in priority setting, policy development, and other processes affecting their future (Arnstein, 1969). The extent of public participation in governance can vary greatly, and includes four main types in the context of citizen science (see next section 1.2.4 p. 14): 1) 'consultative', where citizens contribute information to government and maintains status quo, 2) 'functional', where citizens both contribute information and are included in the process, 3) 'collaborative', where citizens work with government to advise on what is needed, and 4) 'transformative', where citizens drive the decision-making process with support from experts when needed (Lawrence, 2006; Conrad and Hilchey, 2011). These types of governance structures reflect a range from 'top-down' to 'bottom-up' range of structures, where citizens become increasingly involved in bottom-up governance.

The top-down and bottom-up conceptualization of public participation has also been applied to IWRM governance structures (Watson, 2014). In England, Watson gave the example of the European Union's Water Framework Directive for top-down (or consultative) governance, which involved England's Environmental Agency in determining the scale for evaluating river basins, deciding which stakeholders would be involved, and citizens were invited to observe in proceedings without any meaningful inclusion. The Community-based Approach, a bottom-up (or collaborative/ transformative) form of governance, was introduced by the Secretary of State as an addition to the Water Framework Directive and involved NGOs within pilot river basins in hosting collaborative watershed planning initiatives and broad stakeholder engagement (Watson, 2014). Top-down governance is the dominant form in Canada, although governments are experimenting with bottom-up governance arrangements similar to the Community-based Approach in England, such as Environment Canada's Atlantic Coastal Action Program (McNeil *et al*., 2006). Bottom-up processes can empower communities and lead to the collection of highly relevant indicators for sustainable development (Fraser *et al*., 2006). Whether public participation happens through top-down or bottom-up governance structures, the inclusion of community stakeholders can lead to decision-making that is more informed and locally relevant.

Increased public participation enables the consideration of facts and information beyond science in decision-making, which is especially important in the face of complex and uncertain problems (Carolan, 2006). Carolan promotes the idea of public expertise when it comes to public participation and integrating local knowledge in decision-making. Extending the view of expertise beyond professionals and scientists helps to consider the different roles that the public can take in governance structures (as described previously). Other forms of expertise outlined by Collins and Evans (2002) include 1) no expertise, 2) contributory expertise, and 3) interactional expertise. "No expertise" refers to a lack of sufficient knowledge for an individual to meaningfully engage in a particular topic (Carolan, 2006). It is often the case that the public will be involved as a source of contributory expertise (e.g. sharing local knowledge on a topic) but will lack interactional

expertise (e.g. conversing with other experts with specialized expertise, such as scientific), which reduces their influence with decision-making (Carolan, 2006). Considering ways to increase interactional expertise, for example by informing experts of local knowledge or the public of scientific knowledge, can promote greater contributions from the public to decision-making processes (Carolan, 2006). Involving citizens in both the collection of scientific information and participatory processes is one such way to start bridging the gap between science, public participation, and decision-making.

1.2.4 Citizen science and community-based water monitoring

Trends and definitions

Public participation in ecological monitoring and research is a growing phenomenon across Canada (Wieler, 2007) and around the world (Conrad and Hilchey, 2011; Dickinson *et al*., 2012; Bonney *et al*., 2014). This 'citizen science' movement has involved volunteers and NGO staff engaging in many aspects of scientific inquiry, including hypothesis testing, recording ecological changes, and reporting (Miller-Rushing *et al*., 2012). Science has been conducted by amateur (i.e. non-paid) experts and naturalists for centuries and it has only been since the latter half of the 19th century that science has become professionalized (Miller-Rushing *et al*., 2012). While citizen science is not new in many respects, its most recent forms can be characterized by greater inclusion of the general public (Silvertown, 2009). A long-running example of citizen science is the National Audubon Society's Christmas Bird Count, which has engaged volunteers across North America in tracking bird populations since 1900. Earthwatch, another international example, matches up volunteers with environmental science research projects and contributed over 350,000 volunteer and scientist hours as well as 80 peer-reviewed publications within a year (Silvertown, 2009; Earthwatch Institute, n. d.). With thousands of projects, millions of volunteers engaged globally, and Citizen Science Associations appearing in Europe and the United States (Bonney *et al*., 2014), citizen science provides an unprecedented capacity for large-scale, long-term ecological monitoring projects (Dickinson *et al*., 2012). This surge in activity has been facilitated

with increasing access to technologies such as smartphones, and the internet has enabled widespread access to information on these programs (Silvertown, 2009; Bonney *et al*., 2014). In Canada, this increasing trend has been partly attributed to the decentralization of government as well as growing knowledge of and concern with environmental issues (Au *et al*., 2000; Whitelaw *et al*., 2003; Conrad and Daoust, 2008; Bliss *et al*., 2001).

Community-based monitoring (CBM), a form of citizen science, is where "concerned citizens, government agencies, industry, academia, community groups and local institutions collaborate to monitor, track and respond to issues of common community concern" (Whitelaw *et al*., 2003, p.410). CBM involves tracking an array of ecological parameters and includes community-based water monitoring (CBWM), which involves the measurement of water quality parameters for the purpose of this study (see section 1.2.1- watershed monitoring p.5). The study herein is focused on water *quality* monitoring rather than water *quantity* monitoring due to the need for increased attention to water quality in management (Biswas and Tortajada, 2011).

Types of CBWM

The seemingly haphazard growth of CBWM across Canada has resulted in a diversity of approaches and types of CBWM, from government-initiated monitoring programs to bottom-up, citizen-driven monitoring activities. Whitelaw and colleagues (2003) identified four main types of CBM (including CBWM) that are commonly accepted:

1) Government-led CBM, which complements government monitoring priorities and often involves long-term monitoring with the engagement of citizens.
2) Multiparty (or collaborative) CBM, which involves a combination of at least two or more government agencies, citizen groups, academic institutions, businesses, and others in monitoring issues of common concern.
3) Educational (or interpretive) CBM, which engages community volunteers in learning about environmental issues through monitoring and often involves less stringent protocols.

4) Advocacy CBM, which tends to involve issues of community concern, is carried out by local citizen groups or NGOs, and is focused on triggering action by relevant government agencies.

Government-led monitoring, the top-down approach, often has limited stakeholder representation and is funding dependent but can be successful in the short-term (Mullen and Allison, 1999). Meanwhile, multiparty monitoring promotes collaboration of multiple stakeholders and has gained increasing acceptance as most likely to influence decision-making (Whitelaw *et al*., 2003; Conrad and Daoust, 2008; Conrad and Hilchey, 2011). Advocacy monitoring has typically been seen as less effective for influencing decision-making due to its tendency to be reactionary and disconnected from legislative frameworks (Conrad and Daoust, 2008; Whitelaw *et al*., 2003). However, there are positive examples of its application such as the Bucket Brigade in the United States, which engaged citizens in community-based nation-wide air quality monitoring and helped to support pollution reductions and increased enforcement (Conrad and Hilchey, 2011). Educational monitoring can promote increased awareness of environmental issues, but its merits are often forgotten when the focus tends to be on the scientific aspects of monitoring (Firehock and West, 1995). CBWM has evolved into a diversity of forms with the common goal of enhancing understanding of local watersheds, and its emergence has thus contributed to several shared benefits and challenges in the context of IWRM.

Benefits and challenges of CBWM

The engagement of citizens in water monitoring comes with many benefits for governments, community members, and the broader society. CBWM produces a wealth of information on the state of watershed health, expanding the geographic coverage of available information on long-term water quality for IWRM (Conrad and Daoust, 2008). When the monitoring data are shared with government, CBWM helps to save costs for government, supplement government monitoring (Cuthill, 2000; Stokes *et al*., 1990), and increases public participation in natural resource management (Whitelaw *et al*., 2003; Au *et al*., 2000). Danielsen and colleagues (2005) found that involvement of the public via

CBM activities contributed to the initiation of local conservation measures as well as increased compliance with conservation laws. Through citizen engagement, CBWM increases community awareness of local environmental issues (Pollock and Whitelaw, 2005; Savan *et al*., 2003) and, when involved in management, CBWM can contribute to empowerment and increased social capital (including trust) in the watershed community (Bliss *et al*., 2001). Furthermore, sharing data between experts and non-experts results in increased scientific literacy for the public and awareness among scientists of community concerns, contributing to the democratization of science (Conrad and Hilchey, 2011; Ely, 2008). Community and societal benefits abound with CBWM; however, the full potential of these benefits is rarely realised due to ongoing challenges.

Citizens engaged in CBWM also face many challenges and these are well studied (Sharpe and Conrad, 2006; Whitelaw *et al*., 2003; Milne *et al*., 2006; Conrad and Daoust, 2008). Conrad and Hilchey (2011) identified three main types of challenges for CBWM: 1) organizational, 2) data collection, and 3) data use issues. NGOs in Canada (including many watershed groups) are increasingly dependent on fluctuating project-based funding that makes it difficult to maintain long-term programs (Baines, 2010). Monitoring is highly resource intensive for any party that is involved and requires a high amount of social capital to maintain consistent, quality data records (Danielsen *et al*., 2005; Sharpe and Conrad, 2006). Volunteers engaged in CBWM can lose motivation and experience burnout when there is limited influence on watershed management (Whitelaw *et al*., 2003; Conrad, 2006). The credibility of CBWM often comes into question with professionals (Sheppard and Terveen, 2011; Kebo and Bunch, 2013), which is related to concerns with participant objectivity (Stokes *et al*., 1990) and data accuracy (Legg and Nagy, 2006; Léopold *et al*., 2009). Yet several studies have found that volunteers can collect adequate monitoring data when properly trained (Fore *et al*., 2001; Shelton, 2013; Finn *et al*., 2010; Gillett *et al*., 2012). However, community groups can encounter difficulties with accessing scientific expertise and training and establishing networks (Milne *et al*., 2006). Citizens engaged in CBWM face many resource and social capital related challenges, which are not unique to citizen scientists but are related to the nature

of long-term water monitoring and unstable funding in the voluntary and not-for-profit sector.

There are additional obstacles for CBWM besides internal organizational and credibility issues, especially when it comes to integrating monitoring in watershed management. Government agencies can experience obstacles to using and sharing CBWM data in general, including limited staff capacity and resources (Danielsen *et al*., 2005; Rankin, 2008; Pollock and Whitelaw, 2005), incompatibility of data formats from external sources (Falke, 2002), and lack of relevance to policy-making (Wieler, 2007). In addition, jurisdictional fragmentation continues to present obstacles to integration and collaboration across boundaries at the watershed-scale (Bakker and Cook, 2011; Blomquist and Schlager, 2005). These challenges result in limitations with the capacity of monitoring groups as well as government agencies to integrate CBWM data into watershed management.

Linking CBWM and governmental decision-making

Citizens engage in CBWM for a variety of reasons, including the collection of information in response to environmental threats, the production of baseline information, and the promotion of community education and awareness (Bliss *et al*., 2001). Many citizens are also interested in influencing local policy and decision-making processes through sharing of CBWM information (Conrad and Daoust, 2008; Milne *et al*., 2006). In a study of macroinvertebrate monitoring in the United States, 19 percent of participants surveyed indicated that they considered influencing policies and legislation to be a main goal of their monitoring program (Nerbonne and Nelson, 2008). When asked about the reasons for monitoring, nearly one third indicated influencing local planning decisions and providing data for adding their stream to the list of impaired streams (section 303 d. in the *Clean Water Act*) (Nerbonne and Nelson, 2008). Conrad and Daoust (2008) found that 82 percent of Nova Scotia watershed group survey respondents had attempted to deliver CBWM data to decision-makers and yet were not able to identify evidence that it was used in decision-making. Despite this, Kebo and Bunch (2013) conducted a survey of

environmental NGOs from across Canada and found that one third of respondents had indicated influencing decision-making was the most meaningful way to engage volunteers in monitoring. When the CBWM information is not linked to management, volunteer monitors can fall into the trap of "monitoring for the sake of monitoring" which contributes to volunteer burnout (Conrad, 2006; Sharpe and Conrad, 2006). Despite the various obstacles, there continues to be much desire amongst community groups to integrate CBWM with governmental decision-making.

There is interest among government agencies with using CBWM data as well. EMAN, led by Environment Canada until its dismantling in 2010, provided much support and insight into ways to link CBWM and other ecological monitoring information with governmental decision-making (Wieler, 2007; Pollock and Whitelaw, 2005; Vaughan *et al*., 2003; Whitelaw *et al*., 2003). In the 2010 Nova Scotia Water Strategy, the provincial government provided explicit support for CBWM because one of their goals included "[building] capacity for community water monitoring in watersheds across the province" (NSE, 2010, p. 19). Provincial and federal governments continue to provide some funding to environmental stewardship groups engaged in CBWM including, for example, the Eco Action Program (Environment Canada), the Alberta Watershed Stewardship Grant, and the New Brunswick Environmental Trust Fund. Some government agencies have even started their own monitoring programs that engage citizens, including the Community Aquatic Monitoring Program (CAMP) run by the federal Department of Fisheries and Oceans in partnership with the Southern Gulf of St. Lawrence Coalition on Sustainability and the Canadian Aquatic Biomonitoring Network (CABIN) run by Environment Canada (nation-wide). The merits of engaging citizens in water monitoring are often recognised by government as well as by academic institutions (see Savan *et al*., 2003 and Sharpe and Conrad, 2006); however, challenges continue for making this type of monitoring information useful for governmental decision-making.

Several studies have examined the challenges for CBWM and have recommended ways to increase the capacity for integrating CBWM in watershed management (Conrad and

Hilchey, 2011; Pollock and Whitelaw, 2005; Conrad, 2006; Conrad and Daoust, 2008). These recommendations include training volunteers (Whitelaw *et al*., 2003), developing standardized sampling methods and quality control protocols (Sharpe and Conrad, 2006), establishing a data management system and sharing mechanism (Sharpe and Conrad, 2006), long-term financial support from government (Sharpe and Conrad, 2006), including government early in the process (Danielsen *et al*., 2005), and collaborative multi-stakeholder watershed partnerships (Whitelaw *et al*., 2003; Conrad and Daoust, 2008; Rankin, 2008). Frameworks have also been proposed for organizations engaged in CBWM (Pollock and Whitelaw, 2005; Conrad and Daoust, 2008). For example, Conrad and Daoust (2008) formulated a functional framework that provided practical steps for creating CBWM programs, including: 1) identify stakeholders, 2) identify available skills and resources, 3) create a communication plan, 4) develop a monitoring plan, and 5) implement monitoring and communication plans. Many of these recommendations have been based on representational studies of watershed groups that continue to experience challenges with CBWM (e.g. Conrad and Daoust, 2008; Sharpe and Conrad, 2006; Rankin, 2008). As well, there has been an absence of research involving government roles in supporting CBWM, including recommendations to government for overcoming obstacles. Challenges continue for integrating CBWM with governmental decision-making despite an abundance of research activity on the obstacles for watershed groups.

Conrad and Hilchey (2011) reviewed the literature on CBM and recommended future research on case studies of successful CBM integration with governmental decision-making to help further understand factors that influence CBM. Three non-peer reviewed studies have contributed to this research gap to date. In a report produced for EMAN, Wieler (2007) used five case study CBM organizations in Canada to inform recommendations for connecting ecological monitoring information with decision-makers (non-government as well). Wieler developed a framework for guiding CBM organizations in developing a monitoring focus, designing their program, connecting with decision-makers, communicating their results, and evaluating progress on implementation. Two Masters theses/projects have examined successful cases of

stewardship organizations that shared CBM (including CBWM) information with government (Hunsberger, 2004; Lefler, 2010). Lefler (2010) evaluated the validity of recommended best practices in the literature using case studies of successful CBM uptake. Meanwhile, Hunsberger (2004) conducted an in-depth analysis of factors contributing to successful integration of CBWM with government in three case study areas: Comox Valley (British Columbia), Hamilton (Ontario), and Muskoka (Ontario). The main influencing factors included political will, scientific rigour, and legitimacy of the organization (including funding and longevity). Hunsberger recommended further research on the impact of trust, power-sharing, and agenda setting on the use of CBWM in decision-making at the local level (Hunsberger, 2004). These studies have provided initial insight into the successful integration of CBWM with governmental decision-making. There has been less attention to more in-depth factors affecting relationships between groups and government, such as trust and credibility. In addition, more focus is needed on the factors that influence government's ability to use CBWM data. Taken together, these studies indicated that further research into case studies of successful CBWM integration with governmental decision-making was needed to enhance our understanding of CBWM and its role in enhancing watershed management.

1.3 Project Overview

1.3.1 General study design

The study herein sought to address the research gaps identified above by using a multiple case study approach to look at factors that influence the successful integration of CBWM with governmental decision-making. The case studies involved four watershed groups selected from a database of Canadian stewardship groups using set criteria. The case study groups include the Quamichan Watershed Stewardship Society (Duncan, British Columbia), Mid Vancouver Island Habitat Enhancement Society (Parksville, British Columbia), Bedeque Bay Environmental Management Association (Summerside, Prince Edward Island), and Shediac Bay Watershed Association (Shediac, New Brunswick).

These groups had either produced CBWM data that were used by various levels of government to inform decision-making processes, or the resulting information was used in a public process to influence decision-making. Interviews were conducted with watershed group coordinators and government representatives (as well as decision-makers) who were connected to the group. Factors such as trust, credibility, and power-sharing identified in the literature and through a theoretical framework (see section 1.4 p.23) were deductively coded and additional factors brought up by the participants were coded inductively. A focus on case studies of successful CBWM integration aims to deepen our understanding of the factors influencing CBWM integration and provide new insights into social factors such as trust and credibility. This research is intended to produce lessons learned for watershed groups, government agencies, and the CURA H2O project.

1.3.2 CURA H2O project

This research contributes to a larger Community-University Research Alliance project titled: *"Community-Based Integrated Water Monitoring and Management in Nova Scotia (CURA H2O)"*. CURA H2O is a 5-year project that is funded by the Social Sciences and Humanities Research Council and is based out of the Geography Department at Saint Mary's University in Halifax, Nova Scotia. The goal of the project is to increase the capacity and effectiveness of CBWM in Nova Scotia as well as nationally and internationally (see http://curah2o.com). It involves the development of a training module and toolkit called Wet-Pro™ that aims to address some of the identified barriers, especially the need for quality control. CURA H2O works with a broad array of partners, including community stewardship groups, environmental NGOs, academic institutions, government agencies, First Nations, public schools, and the private sector. Dr. Cathy Conrad (committee member) is the principal investigator and Dr. Heather Castleden (supervisor) is a co-investigator for the project. The CURA H2O team identified several priority research areas, and this study seeks to address one of them: linking CBWM with decision-making.

1.3.3 Research questions and objectives

My research is guided by two main questions:

1) *What are the dominant factors that contribute to the successful integration of CBWM information in governmental decision-making?*

2) *What recommendations can be drawn from the experiences of these watershed groups for government agencies, other watershed groups, and CURA H2O?*

To answer these questions, there are four main research objectives:

1) *Identify cases of successful CBWM integration with governmental decision-making from across Canada.*

2) *Gather information on key factors that facilitated the ability of watershed groups to engage in CBWM that informed and influenced governmental decision-making.*

3) *Provide insights and recommendations to CURA H2O collaborators and other relevant stakeholders on some of the most promising practices for integrating their CBWM in governmental water resource management.*

4) *Contribute to the body of literature on CBWM's application in IWRM and the fields of environmental and social geography.*

1.4 Theoretical Framework

A composite theoretical framework was employed in this study to guide the analysis of complex factors involved with the use of CBWM in decision-making. Four main theoretical frameworks were chosen to inform this research: 1) the theory of collaboration (Leach, 2011), 2) social capital framework (Putnam *et al*., 1993; Sabatier *et al*., 2005), 3) social exchange theory (Blau, 1964), and 4) extended resource-based view (Lavie, 2006; Arya and Lin, 2007). A composite of multiple theories was used in order to address multiple perspectives involved in the complex social phenomenon of CBWM (Cao and Zhang, 2013). These theoretical frameworks helped to increase understanding of

particular factors of interest (e.g. socio-political and economic) that have been raised in previous studies of CBWM and management, including trust, relationships/collaboration, financial resources, power-sharing, social networks, social capital, leadership, and knowledge generation.

Theory of collaboration

CBWM is often collaborative in nature, and several studies have determined that the multiparty form of CBWM is often the most likely to influence governmental decision-making (e.g. Milne *et al*., 2006; Conrad and Daoust, 2008; Whitelaw *et al*., 2003). Leach (2011) developed a theory of collaboration in the context of community-based collaboratives, which is applicable to CBWM. It was created "to help explain why, in study after study, scholars find certain factors play critical roles in shaping [community-based collaboratives] outcomes" (Leach, 2011, p.146). Leach's theory of collaboration draws on what he calls 'theoroids' derived from theories of human behaviour, cognition, psychology, and culture (Leach, 2011). Leach identifies ten theoroids, which he organized into categories of 'the essence of collaboration', 'the legitimacy of collaboration', and 'the economics of collaboration'. He argues that these categories help to clarify the basis for why people with multiple interests collaborate, how procedural fairness enables functioning of the collaborative, and what factors are involved when a person makes a decision regarding the costs and benefits of engaging in a collaborative. Several factors that aid in the process of collaboration are identified, including trust and respect (Leach, 2011, p.175). In an empirical analysis of trust, several requirements were found for collaborative partnerships: a small and stable group, the general membership has a predisposition for trust, processes are perceived to be fair, decision rules are clear, power-dynamics are perceived to be somewhat equal, shared beliefs involving policy exist, and a belief that there are few viable options for achieving outcomes outside of the collaborative (Leach, 2011; Leach and Sabatier, 2005). For the purpose of my study, Leach's theory of collaboration was useful for gaining an initial understanding of some of the factors involved with collaboration, which could be applied to the sharing of CBWM data.

Social capital framework

Increased social capital has been identified as a major benefit arising from citizen involvement in CBM (Bliss *et al.,* 2001; Becker *et al*., 2005). Social capital is "the good-will that is engendered by the fabric of social relations and that can be mobilized to facilitate action" (Adler and Kwon, 2002). The 'social capital framework', developed by Putnam, Leonardi, and Nanetti (1993) and Coleman (1988), explains a circuitous relationship between trust, norms of reciprocity, and horizontal social networks in creating civic engagement (Sabatier *et al*., 2005; Putnam, 2000). Trust can be interpreted both as general trust in the public at large and also specific trust in individuals to treat others fairly, keep promises, and show compassion (Sabatier *et al*., 2005). Reciprocity norms enable the sharing of factors such as trust by creating a desire to cooperate with others and return favors. Horizontal social networks indicate equal status relationships between members whereas vertical social networks imply power relationships between members. Horizontal social networks create opportunities for building trust, improving leadership and communications skills, and can enable smoother transitions when an organization requires change (Sabatier *et al*., 2005). Sabatier and colleagues (2005) use the social capital framework to help explain the successes of various policy-making institutions. They expand on Putnam and colleague's theory by interpreting 'civic engagement' as encompassing collective action, which makes the theory more applicable to collaborative partnerships (e.g. multiparty CBWM). They modified Putnam's theory in two ways: 1) 'collective action' goes beyond a focus on the general public to include policy-makers and stakeholder organization representatives, and 2) the outcome switches from civic engagement to reaching collaborative decisions and agreements. Thus, the factors of social networks, trust, and reciprocity have legitimate application to collaborative partnerships and CBWM.

Social exchange theory

Social exchanges, such as the exchange of knowledge and data, are central to collaborative partnerships. The 'social exchange theory', developed by Blau (1964; 1989), suggests that social exchanges develop trust and reciprocity between two

individuals over time, and an imbalance in the benefits and costs of the exchange can result in an imbalance of power in the relationship. Muthusamy and White (2005) used social exchange theory to inform their analysis of the relationship between trust/reciprocity and knowledge generation/learning in corporate partnerships and found a positive correlation. Berkes (2009) supports that knowledge generation is a key component of collaborative environmental management as it both enables more effective adaptation within the organization and is an outcome of collaboration. With CBWM, the sharing of knowledge through the transfer of monitoring data to government decision-makers is often a high organizational priority. In a study of barriers to CBWM integration, Rankin (2008) determined that the involvement of decision-makers in sharing knowledge of monitoring protocols at the beginning of the watershed study is important for establishing collaborative partnerships. However, as suggested by Muthusamy and White (2005) and Berkes (2009), social factors such as trust, social capital, and reciprocity are important precursors for successful knowledge exchange and can help to explain some of the barriers encountered by CBWM groups and decision-makers. Social exchange theory thus has the potential to inform the importance of collaboration and mutual-exchange factors such as trust on the success of sharing and using CBWM data.

Extended resource-based view

The concepts of 'resource-based view' and 'extended resource-based view' have typically been applied to the field of business in the literature, but Arya and Lin (2007) applied an extended resource-based view to not-for-profit organizations. This application of the theory was made in order to explain how partnerships and networks impact an organization's monetary and non-monetary resource base. Taking a resource-based view involves the idea that firms (or other organizations) derive competitive advantage from their internal resources, including financial, social, and physical (Cao and Zhang, 2013; Barney, 1991). Lavie (2006), however, challenged the assumption that a firm's competitiveness solely relies on their individual resources and offered the extended resource-based view, which accounts for resources that a firm derives from networks with other firms and integrates 'relational view' and 'social network' theories. The theory

provides a basis for examining the impact of extensive, intermittent, or lack of resources on the 'competitive advantage' (or success) of organizations engaged in CBWM. For example, Hunsberger (2004) identified that the lack of long-term funding can impact credibility and use of CBWM in decision-making. Thus, an extended resource-based view informs relationships between networks, funding, and organizational success, which can be applied to the capacity and organizational challenges of CBWM.

1.5 Case Study Contexts

This research involved four case study watershed groups that had experienced some degree of success in connecting CBWM information with governmental decision-making, namely: Quamichan Watershed Stewardship Society (Duncan, BC), Mid Vancouver Island Habitat Enhancement Society (Parksville, BC), Shediac Bay Watershed Association (Shediac, NB), and Bedeque Bay Environmental Management Association (Summerside, PEI). These groups had very different concerns in their watersheds, worked with different levels of government, and represented regional contexts from British Columbia to Prince Edward Island (see Figure 1.3). Below I provide some context for each organization, including their location, reasons for organizing, their organizational structure and size, and their diverse stewardship activities including key monitoring programs that were integrated with governmental processes.

Figure 1.3 Map of case study watershed group locations (modified from About.com (Geography (n. d.)).

1.5.1 Quamichan Watershed Stewardship Society (Duncan, BC)

The Quamichan Watershed Stewardship Society (or Quamichan Stewards) was established in 2006 by a group of local residents who were concerned with the declining health of Quamichan Lake. Quamichan Lake is a shallow, eutrophic lake located North East of the City of Duncan on Vancouver Island. It has a history of algae blooms, which had been worsening since the fifties along with increasing fish kills until the society began its remedial efforts. Initially, the society was constituted as a committee of the

Cowichan Land Trust, but incorporated under the *British Columbia Society Act* in November 2008 to allow it to receive Eco-Action funding from Environment Canada. They have a part-time project coordinator, which continues as part of a shared services agreement under the aegis of the Land Trust's Stewardship Centre. They also have a *de facto* executive of five to seven long-term volunteer directors who have dedicated their time since its inception. Over the past nine years, one director has withdrawn and four more have joined. They maintain a mailing list of some 300 volunteers who participate in their various stewardship activities. The Quamichan Stewards have taken a watershed approach to addressing the lake water quality, through education and awareness (e.g. fishing derbies), remediation (e.g. fine bubble aeration for fish habitat), and water quality monitoring. They initiated and received funding for a comprehensive watershed management plan for the Quamichan Lake watershed, which includes an advisory group representing the District of North Cowichan, Department of Fisheries and Oceans, Ministry of Environment, farmers, and other community members. They also have ongoing partnerships with the Cowichan Land Trust and the Cowichan Round Table. They started a long-term water quality monitoring program in 2006 with assistance from the Ministry of Environment, which became more regimented in 2009 (QWSS, n. d.). The monitoring data are stored in the British Columbia Lakes Stewardship Society database and is shared with the Ministry of the Environment. In 2010 they hosted an annual meeting for the Society where they presented their plan to watershed groups from across the province. The monitoring data have been used to inform their watershed management plan and provide feedback on the success of their remediation efforts. The District of North Cowichan implemented part of the plan by extending the central sewer system to lake residents who had previously been using septic fields. This was accomplished after the Quamichan Stewards had presented their findings to local residents and gathered support via petition for extending the sewer system.

1.5.2 Mid Vancouver Island Habitat Enhancement Society (Parksville, BC)

Mid Vancouver Island Habitat Enhancement Society (MVIHES) was formed in 1998 by a group of unemployed fishermen/fisherwomen to address concerns with the salmon fishery on the Englishman River on Vancouver Island. The Englishman River runs through the City of Parksville and Nanoose (Regional District of Nanaimo) and is a drinking water source for both. MVIHES has evolved to include broader interests in watershed protection, including public education and awareness, habitat conservation, restoration, and water quality monitoring. MVIHES currently has a part-time paid coordinator and a volunteer Board of Directors including eight people and representing 35 society members. MVIHES has been involved with the Englishman River watershed since the Watershed Recovery Plan was created in 2001 with funding from the Pacific Salmon Endowment Fund. The steering committee for the Plan included the Department of Fisheries and Oceans, Ministry of Environment, Regional District of Nanaimo, TimberWest, Island Timberlands LP, and various consultants, environmental NGOs, and community stakeholders. Although the funding for the Plan no longer exists, the steering committee continues to meet a few times a year. MVIHES is one of at least 14 watershed groups participating in a CBWM pilot project jointly initiated in 2010 by the Regional District of Nanaimo and the Ministry of Environment for watersheds in the Regional District. Regional District and Ministry staff members carry out a rigorous training program for volunteers, and the Regional District provides equipment. A fourth partner, Island Timberlands LP, provides safety equipment for monitoring on their lands and they assist with lab analysis fees. The data are input directly into the provincial database and the District intends to use the CBWM information in future land-use planning. Prior to the pilot project, MVIHES assisted the Ministry and Environment Canada with collecting water samples for their Water Quality Objectives Attainment Monitoring program, which informed municipal decisions involving the location of their drinking water intake pipes.

1.5.3 Shediac Bay Watershed Association (Shediac, NB)

The Shediac Bay Watershed Association (SBWA) was founded in 1999 by a group of local residents concerned about the impacts of forestry and residential activities on the health of Shediac Bay, which supports tourism and fisheries industries. The Shediac Bay watershed includes the Shediac and Scoudouc rivers, which run through the Town of Shediac on the eastern coast of New Brunswick. SBWA has a volunteer Board of Directors including 15 individuals with representation from the Town of Shediac and citizens of the different communities around the watershed. The Association usually has one to three paid staff during the year and up to eight positions seasonally. The board has remained stable over the years, although staff and volunteer numbers fluctuate with budgets. SBWA's activities include public education and awareness, stream restoration, and ecological monitoring including water quality. They have been involved in long-term water quality monitoring since 1999, which has been used to inform their restoration activities, identify hotspot issues, and use in their Status of the Bay reports, which were created in partnership with the Department of Fisheries and Oceans. They also contributed monitoring information to the New Brunswick Water Classification Program, which involved watershed groups from across the province in collecting baseline information for multiple provincial watersheds. The Water Classification Program was intended to inform the Water Classification Regulation created in 2002 under the *Clean Water Act,* which would provide a way to assess water quality goals. In 2014, it was announced that the Water Classification Regulation (specifically, the classification of waterways) has not been implemented to date due to limitations in provincial authority to enforce the Act (Office of the Ombudsman, 2014). SBWA is also involved in the Department of Fisheries and Ocean's Community Aquatic Monitoring Program (CAMP), which evaluates estuarine health using ecological indicator species and includes water sample collection. It is being contributed to a research partnership led by the Canadian Water Network called the Northumberland Strait Environmental Monitoring Partnership, which seeks to understand land-use impacts in the Northumberland Straight.

1.5.4 Bedeque Bay Environmental Management Association (Summerside, PEI)

The Bedeque Bay Environmental Management Association (BBEMA) was established in 1992 as part of the Atlantic Coastal Action Program (ACAP). ACAP groups were funded by Environment Canada as bottom-up, collaborative stewardship organizations for addressing priority areas of concern. BBEMA is concerned with land-use impacts, especially agriculture, on water quality in the Bedeque Bay watershed, which includes the Dunk, Wilmot, and Bradshaw Rivers. Since its initiation, BBEMA has transitioned to a not-for-profit, charitable model that is self-sustaining and has diversified its funding sources. BBEMA currently includes three full time staff positions (winter months) and nine full time staff positions (summer months), a paid Executive Director, and a Board of Directors with representation from agriculture, education, and fisheries with occasional involvement from other federal and provincial departments. BBEMA takes a broad ecosystem-based, watershed approach and addresses concerns including nutrient and sedimentation impacts from agriculture, climate change, and invasive species in Bedeque Bay. Their activities are diverse and include several ecological and water monitoring programs, tree planting, stream restoration, and environmental awareness and education. They have an established long-term water quality monitoring program which was transitioned to the Wet-Pro^{TM} toolkit and training program protocols (led by CURA H2O), which helps to inform their environmental stewardship activities. They are engaged in the Canadian Aquatic Biomonitoring Network (CABIN), which produces information that is housed in a database and accessible for use by government. They are involved in CAMP, which also feeds into government-housed database (mentioned earlier). Adopt-A-River is an education-based monitoring program that engages kids across the province in stewardship but government does not use the information.

1.6 Organization of Thesis

The thesis follows a paper-based format and includes five chapters, thus each chapter has its own reference section with all material cited across the five chapters appearing at the

end of the thesis. Chapter 2 provides a detailed account of the methodology used for the qualitative case study research. The subsequent two thesis chapters include two research papers that are based on the findings from the qualitative case study analysis. Chapter 3 includes findings from an analysis of key factors that influenced the integration of CBWM in decision-making (Research Question #1). Chapter 4 describes a theme that emerged from the interviews involving the alignment of three main CBWM program designs and goals that feed into IWRM decision-making. The concluding chapter, Chapter 5, summarizes the research papers' findings and includes some recommendations for future research as well as lessons learned from the case studies for watershed groups and government agencies seeking to link CBWM with governmental decision-making (Research Question #2).

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Chapter 2: Research Approach and Methods

2.1 Introduction

My approach to this study is qualitative in nature. Qualitative research is often concerned with human environments, individual experiences, and social processes (Hay, 2005) and case studies can help to assess complex factors associated with the social dimensions (Yin, 2003). A qualitative case study is "an approach to research that facilitates exploration of a phenomenon within its context using a variety of data sources" (Baxter and Jack, 2008). A qualitative case study approach was chosen for this study since the primary research objectives involved exploring the complex factors that influence the social process of watershed groups and government agencies sharing and using CBWM information. Four case study watershed groups were selected in order to identify cases where CBWM had been successfully integrated with governmental decision-making (contributing to Objective 1). Semi-structured interviews were conducted with watershed group coordinators and government counterparts to elicit information on key factors that influence the use of CBWM in governmental decision-making (contributing to Objective 2). Finally, recommendations for future research and lessons learned were assembled for CURA H2O partners, watershed groups, and government agencies (Chapter 5), and two research papers (Chapter 3 and 4) are targeted for scholarly journals to share study findings with the broader academic community (contributing to Objectives 3 and 4).

2.2 Study Design

2.2.1 Case studies

For this study, I chose to focus on instances of CBWM where watershed groups have found success with linking their monitoring information with governmental decision-making. The impetus for this focus was largely based on 1) a recommendation that arose from a paper by Conrad and Hilchey (2011) to look at successful cases of linking CBWM to decision-making, and 2) my observation that looking to examples outside of Nova

Scotia for new insights and models could help CURA H2O community partners overcome ongoing challenges to connecting CBWM and watershed management in Nova Scotia. To date, most recommendations for improving the effectiveness of CBWM have been made based on cases of the status quo involving ongoing barriers to CBWM use in management and representational studies (e.g. Legg and Nagy, 2006; Conrad and Daoust, 2008; Rankin, 2008). Cases of successful CBWM integration are rare (or atypical) in literature, and after extensive dialogue with the CURA H2O research team and partners, are found to be equally rare in practice. Meanwhile, Flyvbjerg (2006) suggests that atypical cases can provide richer and more in-depth information on a phenomenon than representational studies because there are often more actors and deeply rooted factors involved. Looking to successful cases for lessons learned is a commonly practiced research method, for example by the United Nations (UNIDO, 2011; UNDP, 1999) as well as in peer-reviewed literature (Granek *et al.*, 2007). By focusing on successful cases of CBWM data integration, this study adds to the knowledge of complex factors involved with CBWM and provides valuable learning opportunities for watershed groups and government agencies alike.

Case study selection was carried out across Canada in order to enable a wide scope for identifying atypical cases of varied contexts. The selection criteria for the case studies were devised based on the research questions and objectives and are as follows:

1) The group was well-established (6+ years) (Leach *et al.*, 2002);
2) The group was engaged in long-term water monitoring (2+ years);
3) The group's CBWM data had potentially been used in decision-making (e.g. land-use planning decisions);
4) The group had at least one leader who had experience-based knowledge of the watershed group's involvement in sharing monitoring information with government;
5) Both the watershed group coordinator(s) and government counterpart(s) were willing to participate in the study.

Potential case studies were identified using a Canada-wide database of community-based environmental monitoring groups produced in 2010 by Tristan Lefler; a graduate student whose supervisor is affiliated with CURA H2O (Appendix A: Potential Case Study Groups). The database included the organization's name, province, name of a primary contact (if available), website links, contact information (phone, email, and/or address), and a brief description of their activities. It was then updated to include additional organizations from each province and the contact information for existing organizations was double checked through online searches. A total of 36 potential case studies were identified through this updated database, representing 10 provinces and two territories. Initially, organizations as large as conservation districts were included; however, I realized during recruitment that selecting smaller, community-driven watershed groups would best enable me to address the second research question, which involved the production of lessons learned for watershed groups (documented in the CBM literature as experiencing challenges) and the CURA H2O research team which includes watershed group partners. Including watershed group case studies would provide examples with similar organizational contexts, making the findings more transferable. The goal of this study method was to select three to five case study watershed groups that met the case study criteria in order to present a variety of regions and case contexts for providing recommendations.

2.2.2 Semi-structured interviews

Each case study involved semi-structured interviews with key informants identified through the 'gatekeeper' method (Cloke *et al.*, 2004) and snowball sampling (Noy, 2008). 'Gatekeepers' are individuals in positions of authority or official organization communication who can assist researchers in contacting hard-to-reach individuals (Cloke *et al.*, 2004). Including watershed group coordinators as primary contacts or 'gatekeepers' enabled an efficient means of identifying potential participants as the study is focused on individual connections. Relying on gatekeepers can be risky as their judgment becomes central to recruitment (Cloke *et al.*, 2004); however, snowball

sampling was also employed to enable access to the social network of government counterparts and coordinators beyond the gatekeeper's initial contact list (Noy, 2008). Key informants for this study included 1) watershed group coordinators (project coordinators, executive directors, volunteer directors, etc.), and 2) government counterparts including staff, managers, regional directors, and elected officials connected with the group who were familiar with their water monitoring programs (municipal/local, regional, provincial, and/or federal levels). Watershed group coordinators were identified as most likely to engage in dialogue with government counterparts and sustain an up-to-date and in-depth knowledge of their water monitoring activities. Snowball sampling began at the stage of contact with one group coordinator, who helped to identify other coordinators/positions of leadership as well as their key government contacts. A goal of 15 to 25 interviews was established for this study, based on having 3 to 5 case study groups with a minimum of 5 participants each (including both watershed group coordinators and government counterparts).

Interviewing was chosen as the primary method of data collection for this study as its strengths lend to the examination of complex social phenomena such as opinions, experiences, and motivations (Hay, 2005). While there are various types of interviewing, semi-structured interviewing was selected in order to enable a combination of deductive and inductive qualitative analysis of the factors (Bryman and Teevan, 2005). A semi-structured interview guide was created using knowledge of potential factors gained from literature on CBM and a theoretical framework including the theory of collaboration (Leach, 2011), social capital framework (Sabatier *et al.*, 2005; Putnam *et al.*, 1993), social exchange theory (Blau, 1964), and extended resource-based view (Lavie, 2006; Arya and Lin, 2007) (see section 1.4 p. 23). Several potential factors were identified, including trust, reciprocity, power-sharing, perceptions of credibility, sharing of financial resources, social capital, and social networks. The interview questions were designed to provide opportunity for the participants to address these factors if they were relevant and also were open-ended enough for them to include additional factors not previously

explored in the literature (Dicicco-Bloom and Crabtree, 2006). The interviews were one hour on average and loosely followed the interview guide; incorporating spontaneous probing questions as necessary. This relaxed format allowed for in-depth interviewing as new themes emerged during the interviews that were based on the participants' interests and knowledge bases (Johnson, 2002). Semi-structured, in-depth interviews enabled the exploration of all potential factors involved with sharing CBWM data, whether previously included in the literature or not.

In-person interviewing (17 out of 29) was preferred over phone interviewing in this study; however, phone interviews (12 out of 29) were conducted when time and logistics did not permit the former. In-person interviewing was desirable as it helped to make the research more meaningful to me and was an important experiential component of the Masters program. Conducting interviews in person helps to establish rapport with participants (Cloke *et al.*, 2004), which is particularly important in sensitive cases but in this study the interviews were benign in nature and so using both in person and phone interviews was not an issue. Phone interviews present an economical alternative to in-person interviews, and this method has been shown to produce data of comparable quality (McCormick *et al.*, 1993; Sturges and Hanrahan, 2004). Sturges and Hanrahan noted that participants appreciated having the two options, as some may prefer the anonymity or convenience of the phone. For this study, the possibility of in-person interviews was explored when travel budget and field trips aligned but the participants always had the option of doing a phone interview if the timing was inconvenient for them or if it was their preference.

2.2.3 Overview of study timeline

Qualitative research is often an iterative process (Creswell, 2007), enabling concurrent phase development and adaptation of the study design to reflect learning experiences from subsequent phases. This study involved five main, overlapping research phases: research preparation, case study selection (and participant recruitment), data collection

(interviews and transcription), coding and analysis of interview transcripts, writing and revisions, and defense. The research phases can be broken into multiple tasks within a timeline (see Table 2.1).

Table 2.1: Timeline of tasks for the completion of the thesis.

Date	Tasks	Research Phase(s)
September '12- May '13	- Literature review - Development of research questions and thesis proposal - Defining methods - Preparing and submitting research ethics application	Research preparation
November '12- August '13	- Identifying potential case studies using a database	Case study selection
June- August '13	- Recruiting potential case study participants.	Case study selection
July '13	- *Fieldwork Phase 1 of 2:* Duncan and Parksville (Vancouver Island), BC (n=10)	Data collection
September '13- January '14	- Recruiting potential case study participants - Transcribing interviews from BC, PEI, and NB.	Case study selection Data collection
October- November '13	- Phone interviews with BC case studies (n=4)	Data collection
November '13	- *Fieldwork Phase 2 of 2:* Summerside, PEI and Shediac, NB (n=5) - NVivo9Training	Data collection Coding and analysis
November '13- February '14	- Phone interviews with PEI and NB case studies (n=10)	Data collection
December '13- August '14	- Writing of first thesis draft	Writing and Revisions
January '14- October '14	- Coding and analysis in NVivo9	Coding and Analysis

Date	Tasks	Research Phase(s)
May '14- February '15	- Thesis draft writing and revisions	Writing and Revisions
May '14- June '15	- Publication and dissemination of results via research papers, presentations, CURA H2O website, etc.	Writing and Revisions
March '15	- Thesis defense - Submit final thesis	Defense

2.3 Recruitment and Data Collection

2.3.1 Case study selection

The recruitment of potential case studies began on June 10th 2013 and was completed in October 2013. Prior to June 10th, watershed groups were pre-selected from the database using information available on their websites, background information included from the original database author, and based on their potential to fit the case study criteria (total of 36) (Appendix A: Potential Case Study Groups). When websites were not available, the groups were only contacted if it was already determined that they are involved in water quality monitoring. An initial information email was sent to the primary contact of the watershed group using contact information from the database (Appendix B: Email Recruitment Scripts), informing them of the study with an attached information sheet (Appendix C: Information Sheets). The email was followed-up with a phone call two to three business days later to gain more information on their watershed group and determine if they met the study criteria, determine their interest in participating, and provide the opportunity to ask questions (Appendix D: Telephone Recruitment Scripts). However, if they replied to the email promptly a phone call was sometimes not necessary.

When a phone number was not available a follow-up email was sent in its place. A final follow-up email was sent one week later when there was no success with the initial recruitment methods (Appendix B: Email Recruitment Scripts) (for recruitment once case study selected, see section 2.3.2 Participant Recruitment p. 56).

Selecting the potential watershed groups was an iterative process that was shaped by a self-imposed time constraint as well as funding constraints. An opportunity for conducting in-person interviews with groups as far west as British Columbia arose when I decided to travel to Alberta to attend a wedding on June 28th. This resulted in the creation of two case study selection phases: the first phase from June 10th to July 3rd and the second phase from June 24th to October 4th 2013; the timespan begins with the first email and ends with the last official notice of selection. For the first selection phase, I started recruitment from West to East and by the time I had left for Alberta I had contacted groups from British Columbia to Manitoba (22 of the 36 groups). From these groups, I selected my first two case studies on Vancouver Island, British Columbia; the Quamichan Watershed Stewardship Society (Duncan, BC) and the Mid Vancouver Island Habitat Enhancement Society (Parksville, BC). The second phase of recruitment began from East to West (Nova Scotia to Ontario) as I decided to prioritize Eastern groups in order to maximize the remaining travel funds for conducting in-person interviews. From these remaining 14 groups (of the 36 total) I selected the Bedeque Bay Environmental Management Association (Summerside, PEI) and Shediac Bay Watershed Association (Shediac, NB). The selection of case studies ended October 4th; however, recruitment of potential participants for these four groups continued until the final interview was scheduled in February 2014.

With logistical factors aside, the four case study groups were selected from a pool of potential case studies because of how well they fit the five case study criteria and presented interesting, contrasting examples of CBWM sharing arrangements (see Table 2.2). From the pool of 24 potential case studies that were reached successfully, 12 met the

majority of the case study criteria. Three declined to participate either because of their busy schedule or concerns with involving their government counterparts. Of the nine remaining groups, the four case study groups selected presented the clearest examples of CBWM use by government in decision-making. Since the two British Columbia case studies were selected in the first phase, I opted to select two more groups for a balanced study design. The New Brunswick and Prince Edward Island groups were selected because CBWM had been connected to a government process and had a high potential to influence decision-making. Including Maritime groups enabled me to conduct in-person interviews. An Ontario and Nova Scotia group presented clear examples of connecting CBWM with government as well; however, other members of the research team were already planning to compare Nova Scotia and Ontario cases and diversification of regional contexts would help to inform CURA H2O's overall research program. British Columbia and Ontario groups had also been analyzed together in a similar study of CBWM integration in decision-making (Hunsberger, 2004), and this study would be the first to include British Columbia, New Brunswick, and Prince Edward Island groups for this topic. Case study selection was limited to four because of financial and time constraints.

Table 2.2: The case study criteria and how they were fulfilled by the case studies.

Criteria	Quamichan Watershed Stewardship Society	Mid Vancouver Island Habitat Enhancement Society	Bedeque Bay Environmental Management Association	Shediac Bay Watershed Association
1) 6+ years	Since 2006	Since 1998	Since 1992	Since 1999
2) Long-term (2+ years) water quality monitoring programs (including past and current surface water and estuary monitoring).	1) Long-term water quality monitoring since 2009; 2) Assisted the Ministry in data collection for a 2-3 year study on phosphorous inflow to the lake (past).	1) Regional District of Nanaimo Pilot project since 2010; 2) Bi-weekly sampling for Environment Canada/Ministry of Environment; 3) Automotive stormwater outflow study (past).	1) CURA H2O for 8+ years; 2) Community Aquatic Monitoring Program (CAMP) for 6+ years; 3) Adopt-a-River for 5+ years; 4) Canadian Aquatic Biomonitoring Network (CABIN)	1) Long-term water quality monitoring since 1999; 2) CAMP 3) CABIN (past)
3) Use of CBWM data in decision-making	The results were used to inform residents and promote local government decision to extend centralized sewer system.	CBWM pilot project data are used by the province to identify risks and inform water quality objectives; District land-use planning; Ministry of Environment monitoring informed drinking water intake locations.	CABIN is housed in Environment Canada database; CAMP data are used by Department of Fisheries and Oceans to enhance decision-maker understanding of estuarine species and feeds into a regional study.	Data collected for the Water Classification Program was intended to inform legislation; CAMP data are used by Department of Fisheries and Oceans.
4) At least one coordinator with long-term experience	Yes	Yes	Yes	Yes

Criteria	Quamichan Watershed Stewardship Society	Mid Vancouver Island Habitat Enhancement Society	Bedeque Bay Environmental Management Association	Shediac Bay Watershed Association
5) Coordinators and government counterparts willing to participate	Yes	Yes	Yes	Yes

When selecting the cases, some flexibility was required for case study criterion #3: use of CBM in decision-making. Early in the recruitment process, it became clear that the idea of CBWM information 'impacting' decision-making (in the original criteria wording) was flawed and did not accurately reflect the experiences of watershed groups. Additionally, most watershed group coordinators (if not all) contacted initially did not know how government used the data or whether it influenced decision-making. I had to talk to government counterparts to determine how they used the data, but they were only contacted after the case study was selected (see section 5.3 Challenges and Limitations p.141). Criterion #3 was modified early in recruitment to include the *potential* for the data to be used in decision-making in order to more accurately reflect the reality of CBWM use by government as understood by the coordinators. The CBWM data had at least been sent to a government contact or it was made available to government in an accessible database.

2.3.2 Participant recruitment

Once a case study group was selected, the primary group contact was asked to provide a list of their watershed group coordinator and government contacts that met the case study criteria and their contact information (email and telephone number) (Appendix D: Telephone Recruitment Scripts). In most cases, the recruitment email was sent along with a follow-up phone call two to three days later (Appendix B: Email Recruitment Scripts; Appendix D: Telephone Recruitment Scripts). In some cases, the individual was

contacted by only email or phone depending on whether all of their contact information was made available and if the primary contact had already talked with them. At times it was more intuitive to call the participant first to gauge their interest and answer questions, then send an email with the information sheet and consent form attached. From this point onwards, recruitment was an iterative process, which included gaining new contacts from conversations or interviews and following up with requests for contact information. Once it was determined that the participant was interested, an interview was scheduled at a mutually agreeable time (and location if in person) and a consent form was sent to them by email for signing and completion prior to the interview (Appendix E: Informed Consent Forms). Most participants completed their consent forms prior to the interview; however, a couple had to complete them afterwards due to technological/time limitations in one case and miscommunication in the other case. For these participants, oral consent was achieved before the interview started and the consent forms were received after the interview. Compensation was not provided to participants except in one case, when a particularly stressful and inconvenienced interview (construction interruptions and relocation) resulted in my offer to cover lunch expenses. I had given them the option to continue the interview at another time but since I was there in person, and likely due to their busy schedule, they wanted to continue.

A total of 29 participants were recruited for this study, which surpassed the goal of 15 to 25 interviews (see Table 2.3). Recruitment was finalized for each group once a minimum of two watershed group coordinators and two government counterparts were included, the options for relevant watershed group coordinator and government contacts were exhausted. In addition, data saturation was evident through increased thematic repetition and infrequency of new themes arising (Guest *et al.*, 2006). 'Watershed group coordinators' included project coordinators, executive directors, and volunteer directors. 'Government counterparts' included staff, managers, regional directors, and elected officials from municipal/local, regional, provincial, and federal levels of government. In some cases, past watershed group coordinators or government contacts (total of three)

were included due to the limited involvement of current occupants of those roles. Three group coordinators had previous or current experience with government but were not counted as such, and four government counterparts could have been included in two case studies because of the type of CBWM program but were only counted for one case (see Table 3.1). The criteria for government counterparts became broader as I talked to them and realized it is nearly impossible to find a 'decision-maker' who both uses the monitoring information in decision-making and is connected to the watershed group. Government staff members were often more directly connected to the group, but often used the monitoring in a limited way (e.g. to produce a report or prioritize locations for government monitoring) and sometimes the decision-makers would use monitoring information indirectly to inform decisions but had limited connection with the groups. The criteria were broadened to include government counterparts who were connected with the watershed groups and were aware of their water monitoring programs or vice versa. It is estimated that roughly 50 percent of the government counterparts included in this study met the original criteria (i.e. connected with the watershed group and using their monitoring information in decision-making).

Table 2.3: Number of watershed group coordinator and government counterpart interviewees for each watershed group case study.

	Quamichan Watershed Stewardship Society	**Mid Vancouver Island Habitat Enhancement Society**	**Bedeque Bay Environmental Management Association**	**Shediac Bay Watershed Association**
Location	Duncan, BC	Parksville, BC	Summerside, PEI	Shediac, NB
Date Selected	July 3, 2013	July 3, 2013	Sept. 30, 2013	Oct. 4, 2013
Date Completed	July 22, 2013	Nov. 26, 2013	Dec. 16, 2013	Feb. 13, 2014
Watershed group coordinators	4	2	3	4
Government employees (staff and managers)	3	5	5	3

	Quamichan Watershed Stewardship Society	Mid Vancouver Island Habitat Enhancement Society	Bedeque Bay Environmental Management Association	Shediac Bay Watershed Association
Decision-makers (directors and elected officials)	1	1	0	1
Total # of interviewees	7	7	8	7

During the recruitment process, full anonymity of participants was often not possible due to the use of the snowball sampling method and occasional involvement of the primary contact in assisting with recruitment. For example, one group's primary contact insisted on contacting each of the potential contacts themselves in order to introduce the study after which I would proceed with recruitment. Government officials in the same department would often talk amongst themselves to determine the best representative(s) for the study, and they would often suggest possible contacts in other departments. The connectedness of study participants thus meant it was difficult to maintain anonymity. However, interviews were conducted individually, reducing any colleague's influence on the answers, and the content was not disclosed in order to maintain confidentiality. Codenames were assigned to all participants to maintain consistency and increase anonymity, although roughly half of the participants consented to using their real name with quotations/paraphrases.

2.3.3 Semi-structured interviews

A semi-structured, in-depth interview was conducted with each participant for a total of 29 interviews. Interview times ranged between 30 and 90 minutes (60 minutes on average) and approximately 60 percent of the interviews were conducted in-person. For these cases, the interviews were conducted at a mutually agreed upon location; most interviews were conducted at their offices but several were conducted at their homes or in coffee shops. Interviews were conducted in person during site visits and when the participant was located near my place of living (Halifax). Phone interviews were

conducted when the timing of the site visit or their location did not permit meeting in person and when it was the participant's preference. A site visit was included for each case study, providing the opportunity for in-person interviews for most participants.

At the beginning of the interview, participants were reminded of their right to take breaks, refuse to answer questions, strike comments, and to withdraw from the study. They were also provided the opportunity to ask questions for clarification. The interviews were audio-recorded with the participant's consent. The interviews were guided by two similar but separate sets of interview questions for watershed group coordinators and government counterparts (Appendix F: Interview Guides). These questions involved the broader themes of background information on their roles, involvement with the watershed group, factors that helped the groups to be successful, use of monitoring in decision-making, and perspectives on the future use of CBM. The interview questions evolved over the course of data collection as unsuccessful questions were dropped (e.g. trust building and feelings towards the group) or the wording was tweaked for clarification (e.g. instead of using the term "factors", asking the participant to describe "how" or "why" the group became successful). Question modification and evolution helps to make them more relevant to study participants (Hay, 2005), and assists in making the interviews more in-depth as they become tailored to each participant (Johnson, 2002). Probing questions were added on a case-by-case basis depending on the participant's background and knowledge base (Johnson, 2002). The same interview guide was used throughout data collection and the modifications were noted in order to maintain a level of consistency between interviews.

2.4 Data Analysis

The participant interview audio-recordings were transcribed verbatim and stored safely on a password-protected computer for the duration of the study. The analysis of transcripts involved thematic coding by a single coder (myself) with the assistance of NVivo9^{TM} qualitative data analysis software. Coding involves the process of defining the

essence of the data and includes assigning key terms/phrases (i.e. code) to sections of text (Liamputtong, 2009). A combination of an inductive and deductive approach to coding allowed for the observation of key factors determined in the literature in addition to the emergence of new themes (Fereday and Muir-Cochrane, 2006). The coding method reflected Fereday and Muir-Cochrane's method, which used a combination of an inductive approach by Boyatzis (1998) and a deductive approach by Crabtree and Miller (1999). For deductive analysis, a codebook of 19 codes including initial key factors was developed using the research questions, CBWM literature, and a theoretical framework (see Chapter 1: section 1.4 p. 23; Appendix G: Codebook). Inductive analysis involved coding of emergent themes brought up by the participants that were relevant to the research questions (Fereday and Muir-Cochrane, 2006). Simultaneous deductive and inductive analysis during the first round of coding allowed for the instantaneous recording of new codes as they became apparent. The first round of coding was followed by a phase of re-organizing, merging, revising, adding, and deleting codes according to methods described by Saldaña (2009). The initial number of 555 codes was thus reduced to 150 and organized into five 'parent nodes' or major categories. These categories include the following main themes: 1) key factors for CBWM integration with decision-making, 2) potential future roles of CBWM and its actors, 3) case study context information, 4) logistical information (e.g. for locating quotations/paraphrases), and 5) participant recommendations (see Appendix H: Final Coding Structure). The transcripts were then re-analyzed for a second round to check the consistency of coding, delete redundant codes, re-code using existing nodes, and add new codes if they were missed (none added). The consistency of coding for individual nodes was double-checked as needed during the interpretation of results.

My supervisor reviewed the coding method during the first round and it was deemed rigorous and suitable for this study. After analysis was completed, she examined the coding results in order to identify possible misinterpretations of the data, theme suppression, or evidence fabrication (Baxter and Eyles, 1997; Creswell and Miller, 2000; Crabtree and Miller, 1999). Emergent themes were presented to participants via a

webinar organized by the CURA H2O research team in May 2014; there was overall support for the preliminary findings by both participants and the research team and no concerns were brought to my attention. All participants were provided the opportunity to review the preliminary analysis as well as the use of their quotations/paraphrases in context through the consent form process. Member checking activities such as reviewing transcripts are common practice in qualitative research (Whiting, 2008) and were used in this study to ensure the opinions and voices of participants were both accurately represented and within their comfort level. An email was sent to those that indicated they wanted to review the preliminary results (22 of 29) and use of quotations/paraphrases (26 out of 29), and they were given up to two weeks to give feedback. Eight participants provided minor feedback and edits, which were incorporated into the text.

2.5 Ethical Considerations

2.5.1 Positionality

My position as a student researcher arriving at this topic was of a pragmatic origin. After my undergraduate degree in Environmental Science at Acadia University, I wanted to learn more about the role of communities in the protection of water resources and contribute to strengthening this role. 'Community-based water monitoring', for me, was a combination of ideals and values that I held with linking communities with nature, generating fact-based information on watershed health, and integrating the grassroots into typically hierarchical structures of watershed management. My involvement with the CURA H2O research team enabled me to pursue my desire to contribute to knowledge generation in a meaningful way; by conducting a study that provided recommendations and lessons learned for strengthening and improving this particular form of water quality monitoring. In addition, being from Antigonish (Nova Scotia) I had a personal connection to the project that involved informing CURA H2O on ways to support and integrate CBWM in Nova Scotia. My mother is an active member of a watershed group that is involved with water monitoring, and so I draw much inspiration from that connection as

well. I have strongly held beliefs and values tied to this project, which I must examine carefully as I understand that there are also assumptions linked with those beliefs.

When I started talking to people through recruitment, I realized almost immediately that I had a very incomplete understanding of the processes and purposes of CBWM. My direct involvement in CBWM has been very limited and so most of my base knowledge has been gleaned from my scientific background, conversations with my mother, and from the literature on CBWM. Going into the project, I held assumptions that CBWM was an ideal model that required improvement. However after talking to more people, I realized that it is not a perfect solution to the problem of declining government capacity for monitoring. There are social and political struggles that underlie the context for CBWM that must not be overshadowed or forgotten when producing recommendations. I also had an incomplete understanding of how CBWM (or other forms of monitoring) can be or is used by government decision-makers. The latter lack of knowledge is no surprise as that is a central question underlying this thesis. However, I realized I had to open my mind to the possibilities of potential limitations and not assume that the use of CBWM in governmental decision-making is ideal and should be replicated wherever possible.

Another dimension to my position is that I am pursuing a Masters degree in order to further my education and improve my chances of building a meaningful career. My personal interest in a career that involves watershed protection and management was another driving factor behind choosing this topic. And so, this is an important consideration when approaching potential participants for recruitment and involvement in this study. I have entered into a formal relationship with these individuals, which may or may not continue after the completion of my Masters. The relationship is built on the grounds that I am a student researcher, but I am also meeting many of these people in person, sharing tea or a meal, or being given a tour of their local waterway of concern. Part of my hope as a student is to build connections that could potentially be beneficial after the degree, whether as friendship, mentoring, or job connections. I found myself

juggling these roles, one with me wanting to build these connections and the other as a researcher who is professional and interested in collecting data. Therefore, the ongoing goal with this thesis will be to find a balance between producing useful information for my participants, other organizations, and the academic community while also building on personal and professional relationships that have potential to continue after the production of the thesis.

2.5.2 Research ethics

This research is in full compliance with the Dalhousie University Social Sciences and Humanities Research Ethics Board. An application for research ethics was submitted on May 7th 2013 and permission was granted to undertake the research on June 5th 2013. Due to affiliation with CURA H2O and Saint Mary's University funding, a second Research Ethics Application was also submitted to Saint Mary's University Research Ethics Board and approved on August 8th 2013; the fact of this requirement was only realized after data collection had begun.

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Chapter 3: A Call for Collaboration: Lessons Learned from an Exploration of Key Factors for Linking Citizen Science Data with Governmental Decision-Making.

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3.1 Statement of Student Contribution

I conducted all major phases of this study with substantial intellectual support from Dr. Castleden, including designing the study, conducting interviews and site visits, transcribing the audio-recorded interviews, and analyzing the transcripts. Dr. Conrad also provided regular intellectual guidance and Dr. Daborn's guidance was sought as needed. I was responsible for writing the first draft of this manuscript, Dr. Castleden actively contributed to the writing process, and I incorporated the comments and feedback of the other co-authors.

3.2 Abstract

Community-based water monitoring (CBWM), a form of citizen science, has been proliferating across Canada as government capacity for monitoring declines. As a result, there is growing interest across non-governmental organizations, government, and academia for identifying ways to bridge CBWM data with government processes for more participatory, adaptive, and ecosystem-based decision-making. While some organizations engaged in CBWM have seen meaningful uptake of their data, many have

continued to experience challenges with integrating CBWM with government processes. Our research was prompted by an identified gap in the literature: the limited understanding of the factors involved with successful integration of CBWM with governmental decision-making. Using a lessons learned approach, we have provided some best practices for governments and watershed groups that share this goal for CBWM. A comparative analysis of qualitative interview data was conducted with watershed group coordinators, government staff/managers, and elected officials associated with four Canadian watershed groups that experienced some degree of successful integration of CBWM with decision-making. Findings revealed three mutually reinforcing themes: 1) meeting government needs for data and decision-making was critical for CBWM uptake, 2) capacity building through diverse means helped to support long-term CBWM, and 3) collaborative approaches enabled CBWM to meet government needs. Collaboration was particularly complex; we found that leadership as well as reciprocity were necessary for building trust and capacity for collaboration. We add to the body of knowledge on collaborative long-term CBWM initiatives and we identify ways that government and watershed groups can facilitate CBWM that successfully informs watershed management decision-making.

3.3 Introduction

Increasingly, the general public has become more engaged in water quality monitoring and other types of environmental monitoring around the world (Conrad and Hilchey, 2011). Global volunteer environmental monitoring networks have been established; for example the Waterkeeper Alliance is a not-for-profit organization founded in 1999 with over 240 satellite organizations representing six continents (Waterkeeper Alliance, n. d.). The United States has seen great increases, with 517 volunteer *environmental* monitoring programs recorded in 1974 to over 400 volunteer monitoring programs involving *water quality* alone, representing over 1800 monitoring initiatives in 2013 (River Watch Network, 1994; National Water Resource Project, 2013). Here in Canada, we have seen

increasing involvement in volunteer monitoring as well (Pollock and Whitelaw, 2005); however, there is currently no national account of program numbers. This growth of public engagement in monitoring, known as citizen science, has been partly attributed to declining government capacity for monitoring linked to budget cutbacks (Au *et al*., 2000; Pollock and Whitelaw, 2005) and increasing public knowledge of environmental issues (Whitelaw *et al*., 2003; Conrad and Daoust, 2008). Citizen engagement in environmental monitoring or 'community-based monitoring' (CBM), has been reinventing the way that watershed management takes place.

CBM is defined as a process "where concerned citizens, government agencies, industry, academia, community groups and local institutions collaborate to monitor, track and respond to issues of common community concern" (Whitelaw *et al*., 2003, p.410). Community-based water monitoring (CBWM) includes the measurement of chemical water parameters (e.g., nitrates, dissolved oxygen), physical water parameters (e.g. pH, turbidity, total suspended solids), and observation or measurement of biological parameters (e.g. benthic macroinvertebrates, fecal coliform bacteria (*E.coli*)) (Sharpe and Conrad, 2006). CBWM is often conducted by volunteers or not-for-profit organization staff members, which are frequently organized at a watershed-scale (i.e. watershed groups). While professionals have traditionally conducted water monitoring, volunteers are able to collect equivalent monitoring data to professionals when they are properly trained (Fore *et al*., 2001; Shelton, 2013; Hoyer *et al.,* 2012). Thus, CBWM has the potential to complement government monitoring, allowing for environmental managers to be better equipped to adapt their programs and policies to environmental change.

The research reported herein was conducted as part of a broader five-year study on community-based integrated water monitoring and management in Canada. This research was undertaken in order to increase our understanding of the role and influence of CBWM in governmental decision-making in relation to its uptake of citizen science data and how watershed groups and governments can facilitate this integration of monitoring in management. The term decision-making in this paper refers to the process of

government staff or management making decisions that influence government planning and management (e.g. land-use planning decisions). Information produced through CBWM can take the form of raw numerical data as well as data summaries through reports and presentations; raw data-sharing was the original focus of this research but other types of information transmission were also included in our analysis. Through case studies of successful CBWM integration, the research team aimed to identify the dominant factors involved in facilitating the data-sharing and use processes and to identify promising practices for watershed groups and government agencies seeking to integrate CBWM with governmental decision-making.

3.1.1 Background

Watershed groups have engaged in CBWM for a variety of reasons, including understanding watershed issues, enhancing community awareness, and informing governmental decision-making regarding their streams, lakes, and rivers of concern (Kebo and Bunch, 2013). With diverse reasons for monitoring, Whitelaw and colleagues (2003) have identified a variety of types of CBM (and thus CBWM): 1) government-led, 2) educational/interpretive, 3) advocacy oriented, and 4) multiparty monitoring. Multiparty or collaborative monitoring has been recognized as the most influential in terms of contributing to governmental decision-making and increasing community participation (Whitelaw *et al*., 2003; Conrad and Hilchey, 2011). Success with citizen science initiatives, including CBM, can be defined differently based on the mission of the particularly program (Freitag and Pfeffer, 2013). In this study, we were most interested in CBWM programs that found success with informing and influencing government decision-making processes.

Linking CBWM to governmental decision-making has been identified as one of the more meaningful ways to engage volunteers in monitoring (Kebo and Bunch, 2013), and a goal for many groups involved in the activity. CBWM that is useful for government has the potential to increase the cost-effectiveness of environmental monitoring (Cuthill, 2000;

Stokes *et al.,* 1990) and increase public participation in environmental management (Whitelaw *et al.,* 2003; Conrad and Hilchey, 2011) as well as contribute to more informed management. For example, in a study of volunteer macroinvertebrate monitoring in the United States, researchers found that 19 percent of respondents included policy changes as a high priority goal for their program (Nerbonne and Nelson, 2008). In Canada, a study conducted in Nova Scotia found that 82 percent of respondents indicated they had attempted to deliver monitoring information to decision-makers but had limited evidence of impact (Conrad and Daoust, 2008). Challenges have continued to affect the usefulness of CBWM and CBM for environmental managers, including volunteer burnout (Conrad and Daoust, 2008), funding limitations (Whitelaw *et al*., 2003), inconsistent data records (Danielsen *et al*., 2005), and concerns with accuracy and objectivity of volunteer-collected data (Stokes *et al*., 1990; Legg and Nagy, 2006) which results in credibility issues with professionals (Sheppard and Terveen, 2011). Given these challenges, it becomes clear that when CBWM programs are not able to inform watershed management decisions, CBWM can become "monitoring for the sake of monitoring" (Conrad, 2006).

With increasing interest among watershed groups, government agencies, and academia to make a meaningful impact, a number of studies have identified recommendations for addressing the challenges to linking CBWM with governmental decision-making. These recommendations include, for example, adequate long-term funding, access to scientific expertise, and a program for communicating the data to diverse stakeholders (Conrad and Hilchey, 2011; Conrad and Daoust, 2008; Sharpe and Conrad, 2006; Rankin, 2008). However, these studies were based on groups that were experiencing obstacles for data integration; there has been limited research into the circumstances where CBM (including CBWM) has been successfully integrated with governmental decision-making for more informed environmental management (Conrad and Hilchey, 2011).

There are a handful of cases where CBWM programs have had a clear influence in regulatory, policy, or planning related decisions affecting water bodies of concern. For

example, in the United States, the Chocorua Lake Association and the University of New Hampshire's volunteer-collected phosphorus data contributed towards a water classification and nutrient loading study in order to address increasing sediment in the lake (Ely, 2002). This monitoring evidence enabled the State's Department of Transport to dedicate funds to restore the highway infrastructure, thereby reducing sediment transport into the lake (Ely, 2002). In Canada, the Lake Windermere Project contributed monitoring data to the British Columbia Ministry of Environment in order to re-evaluate the water quality objectives for the lake (Lefler, 2010). Also in Canada, the Ecological Monitoring and Assessment Network, established in 1994 by Environment Canada (and dismantled in 2010), laid preliminary groundwork for providing a framework of recommendations for linking CBM and decision-making (see Whitelaw *et al*., 2003; Vaughan *et al*., 2003; Pollock and Whitelaw, 2005; Wieler, 2007). Two graduate theses have also identified cases in Canada that have made links between CBM and decision-making, and have explored some of the factors for success (Lefler, 2010; Hunsberger, 2004). For example, Hunsberger (2004) found that political will, rigour, and legitimacy were key factors for CBWM and she recommended additional research on trust, power-sharing, and agenda setting. Such examples can provide great opportunities for learning but have rarely been explored in the academic literature on CBWM. Thus, further in-depth analysis of the factors associated with governmental uptake of CBWM data are required for a more comprehensive understanding of how CBWM can be integrated with governmental decision-making. This study reports the findings from four cases of successful integration, as understood by both watershed group coordinators and their government counterparts.

3.4 Research Methods

3.4.1 Case study selection

Four watershed groups were invited to participate in this study vis-à-vis a recruitment strategy drawn from a Canada-wide database of environmental stewardship organizations

originally compiled by Lefler (2010). The database was updated using internet searches to include additional organizations conducting CBWM for a total of 304 organizations representing 10 provinces and two territories. Based on the available online information, a list of screening criteria was used to narrow down the list to 36 potential case study organizations. Various types of organizations were included in this initial list of potential cases (including conservation districts and a municipality); however, after initial contact, we realised that watershed groups were the best fit because of the study's focus on providing lessons learned to the smaller, community-driven organizations that had documented challenges with CBWM (Sharpe and Conrad, 2006; Rankin, 2008).

The five criteria used for selecting watershed groups included:

1) The group was well-established (6+ years) (Leach *et al*., 2002);

2) The group was engaged in long-term water monitoring (2+ years);

3) The group's CBWM data had been used in governmental decision-making (e.g. land-use planning decisions);

4) The group had at least one leader who had experience-based knowledge of the group's involvement in sharing monitoring information with government;

5) Both the group coordinator(s) and their government counterpart(s) were willing to participate in the study.

These criteria helped the research team to strategically recruit watershed groups that were most likely to have influenced decision-making and that were willing to talk about their experiences. During the recruitment phase, it became clear that many group coordinators did not know precisely how their CBWM programs were influencing decision-making (Criterion #3). Moreover, each case was selected only after talking with group coordinators and before talking to government representatives, thus it was necessary for the researchers to assume that government used the data if the monitoring information was fed into a government process (e.g. internal database). Of the 24 organizations and watershed groups that were successfully reached by phone or email, approximately 12

watershed groups met the majority of the case study criteria. Three of these declined because of time constraints or concerns with involving their government partners. From the nine remaining watershed groups, four groups were selected: two groups from Vancouver Island, British Columbia, one from New Brunswick, and one from Prince Edward Island (Table 3.1). The two British Columbian groups were chosen because they represented the clearest examples of CBWM informing and influencing decision-making based on the available information. The New Brunswick and Prince Edward Island groups also engaged in CBWM that was intended to inform governmental decision-making and so were selected to provide greater regional diversity and a balanced study design. A group in Ontario and a group in Nova Scotia could have been suitable case studies as well, but were not included because the broader research team has extensively researched and compared watershed groups from Ontario and Nova Scotia and diversifying to new regions would strengthen the overall research program. Case studies were limited to four due to financial and time constraints. Moreover, analysis of cross-Canada case studies involving CBWM integration in governmental decision-making have thus far only included West Coast and Ontario groups (see Hunsberger, 2004) and West Coast and Maritime groups have not yet been included in the same analysis.

Table 3.1: Case study watershed group background information.

	Case Study Watershed Groups			
Background Information	**Quamichan Watershed Stewardship Society (QWSS)**	**Mid Vancouver Island Habitat Enhancement Society (MVIHES)**	**Shediac Bay Watershed Association (SBWA)**	**Bedeque Bay Environmental Management Association (BBEMA)**
Location	Duncan, BC	Parksville, BC	Shediac, NB	Summerside, PEI
Foundation Date	2006	1998	1999	1992
Reasons for initiation of the group	Concerned lake-side residents, with Cowichan Land Trust	Initially fishermen/fisherwomen concerned with salmon, evolved to ecosystem-based focus	Concerned residents, New Brunswick Environmental Trust Fund	Atlantic Coastal Action Program, multi-stakeholder representation

Background Information	Quamichan Watershed Stewardship Society (QWSS)	Mid Vancouver Island Habitat Enhancement Society (MVIHES)	Shediac Bay Watershed Association (SBWA)	Bedeque Bay Environmental Management Association (BBEMA)
Water quality concerns	Eutrophication, algae blooms, and fishkills in Quamichan Lake	Drinking water and salmon habitat in Englishman River	Impacts from residential, forestry in Shediac Bay watershed (Shediac and Scoudouc Rivers)	Nitrate, sedimentation, and fishkills in Bedeque Bay watershed (Dunk, Wilmot, and Bradshaw Rivers)

3.4.2 Data collection

Using the contact information available from the database, preliminary discussions with the main watershed group coordinator helped to determine if the group met most of the study criteria and if the group was interested in participating in the study. Once case groups were approached and consented to participate, individuals were recruited for interviews using a combination of gatekeeper (Cloke *et al*., 2004) and snowball sampling methods (Noy, 2008). Specifically, the group coordinators provided contact information for 1) additional program coordinators, directors, or executive directors and for 2) government staff, managers, directors, and elected officials at municipal/local, regional, provincial, and/or federal levels who had knowledge of or involvement with the CBWM programs.

Site visits for each group occurred in July 2013 (British Columbia) and November 2013 (New Brunswick and Prince Edward Island) for in-person interviews (total of 17). Phone interviews (total of 12) were conducted when in-person interviews were not possible, which have been shown to provide results that are comparable in quality to in-person interviews (McCormick *et al*., 1993; Sturges and Hanrahan, 2004). The interviews followed a semi-structured format, using research questions to loosely guide the conversation around key factors of interest while also enabling the participant to bring up

additional factors not yet addressed in the literature (Dicicco-Bloom and Crabtree, 2006). The interviews were between 30 and 90 minutes long, lasting 60 minutes on average.

Interviews were conducted for each group until data saturation was reached; a total of 29 individuals for four case studies (see Table 3.2). Themes became repetitive during the last interviews with government representatives and watershed group coordinators, indicating data saturation (Guest *et al*., 2006). Government counterparts included municipal/local, regional, provincial, and federal levels and government staff, managers, a regional director, and two municipal elected officials. Ethical approval to conduct this study was attained from the Dalhousie University Research Ethics Board and Saint Mary's University Research Ethics Board.

Table 3.2: Number of group coordinators and government representatives interviewed for each case study group.

	Case Study Watershed Groups			
Interviewees	**QWSS**	**MVIHES**	**SBWA**	**BBEMA**
Group coordinators	4	2	4	3
Government employees (staff and managers)	2	4	2	5
Government decision-makers (elected officials and regional directors)	1	1	1	-
Total interviews	7	7	7	8

3.4.3 Data analysis

All interviews were audio-recorded and transcribed verbatim. The interview transcripts were then coded using NVivo 9^{TM} qualitative analysis software by the first author using a combined deductive and inductive approach (Fereday and Muir-Cochrane, 2006). Deductive analysis involved the use of a codebook of terms that were synthesized from the research questions and relevant literature involving CBWM (e.g. Conrad and Hilchey, 2011; Whitelaw *et al.,* 2003). Inductive analysis was performed simultaneously with deductive analysis in order to facilitate the spontaneous emergence of codes as they

became apparent. The first round codes were organized and pared down using established methods (Saldaña, 2009) and the second round of coding in this category involved re-coding with existing codes, double-checking the consistency of the coding, and considering any important new codes (none were identified). A senior member of the research team (second author) reviewed the coding method to ensure rigor. Major emergent themes were presented to participants via a webinar forum during which time feedback was sought on the accuracy of the findings as a ground-truthing exercise. Overall, the themes resonated with the participants and research team and no concerns were brought to the team's attention. Participants were give the opportunity to review the preliminary analysis of their interview as well as use of their quotations/paraphrases in context, and all of the feedback was incorporated.

Study participants are identified below with a codename for each of their quotations/paraphrases (e.g. "1-WC1" = Watershed Group Case Study 1- Watershed Group Coordinator 1; "2- GR10" = Watershed Group Case Study 2- Government Representative 10) (see Table 3.3). Watershed group coordinators were assigned a number from 1 to 13. Government representatives (including staff, managers, and decision-makers) were assigned a number from 1 to 16. Although 50 percent of participants allowed for use of their real names, we have assigned codenames to all participants to maintain consistency.

Table 3.3: Codenames for watershed group case studies.

Watershed Group Case Study	Number
Quamichan Watershed Stewardship Society	1
Mid Vancouver Island Habitat Enhancement Society	2
Shediac Bay Watershed Association	3
Bedeque Bay Environmental Management Association	4

3.5 Findings

3.5.1 Use of CBWM in decision-making

The four watershed groups in this study engaged in multiple CBWM programs; however, there were three main long-term CBWM programs that had influenced governmental decision-making (two watershed groups engaged in the same CBWM program):

1. The Quamichan Watershed Stewardship Society (QWSS) developed a rigorous but simple long-term CBWM program with the assistance of British Columbia Ministry of Environment staff. The monitoring information is shared with the British Columbia Lakes Stewardship Society, which produces reports that are accessible to government. A multi-stakeholder watershed management planning process has guided the monitoring activities to specific goals in the watershed, including remediation. The CBWM information was used to inform landowners and build support via petition for the municipality to extend a centralized sewer system around the lake. They also assisted the Ministry of Environment with data collection for a three year nutrient loading study which helped to connect water quality with land-use impacts.
2. The Mid Vancouver Island Habitat Enhancement Society (MVIHES) is one of several watershed groups involved in a CBWM pilot project jointly run by the British Columbia Ministry of Environment and the Regional District of Nanaimo. The program involves regular training of volunteers, standardized sampling protocols, equipment funded by the District, and a private forestry company helps to fund lab analysis. The raw data are added directly to the Ministry's database and are used for long-term evaluation of trends, prioritizing areas for government monitoring, and comparisons to British Columbia water quality guidelines. The program helped to identify a septic leak issue, after which the District wrote letters to landowners to encourage sewer hook-up. The District intends to use the pilot project data to inform future land-use planning decisions. The Ministry also regularly engages volunteers in their own water quality monitoring, and in one

case a Ministry report helped to inform two municipalities in their decisions involving drinking water intake pipe locations in the river.

3. Shediac Bay Watershed Association (SBWA) is involved in a long-term CBWM program initiated as part of New Brunswick's Water Classification Program and Regulation in 1999, which sought to characterize baseline water quality information for watersheds across New Brunswick and produce enforceable standards for land-use impacts in watersheds. However, issues with implementation led to the announcement in 2014 that it is currently non-operational; soon after data analysis was completed for this study. They are also involved in the CAMP program outlined below.
4. The Bedeque Bay Environmental Management Association (BBEMA) in PEI is involved in the Department of Fisheries and Ocean's (DFO) Community Aquatic Monitoring Program, which involves sampling estuarine water quality and aquatic organisms. DFO provides funding to the Southern Gulf of St. Lawrence Coalition on Sustainability to hire students and assist DFO staff in training volunteers in a rigorous and standardized monitoring program. The data have been used to enhance decision-maker understanding of the distribution of species at risk and aquatic invasive species, and are being contributed to a multi-stakeholder research partnership involving land-use impacts called the Northumberland Strait Environmental Monitoring Partnership. They are also involved in the Canadian Aquatic Biomonitoring Network (CABIN) monitoring program run by Environment Canada, which feeds into a centralized database and has potential for use in risk-based management and guiding government research.

3.5.2 Key factors for CBWM uptake in decision-making

Three key factors were identified as being essential to the integration of CBWM with governmental decision-making in these cases: meeting government needs, capacity building, and collaboration (see Figure 3.1). These factors were mutually reinforcing and contributed to a broader process that facilitated the use of CBWM in governmental

decision-making. For clarity, these factors are presented separately below but in reality there is much overlap between them. Leadership and reciprocal relations between the organizations are presented below as secondary factors that helped to build the trust necessary for collaboration with CBWM.

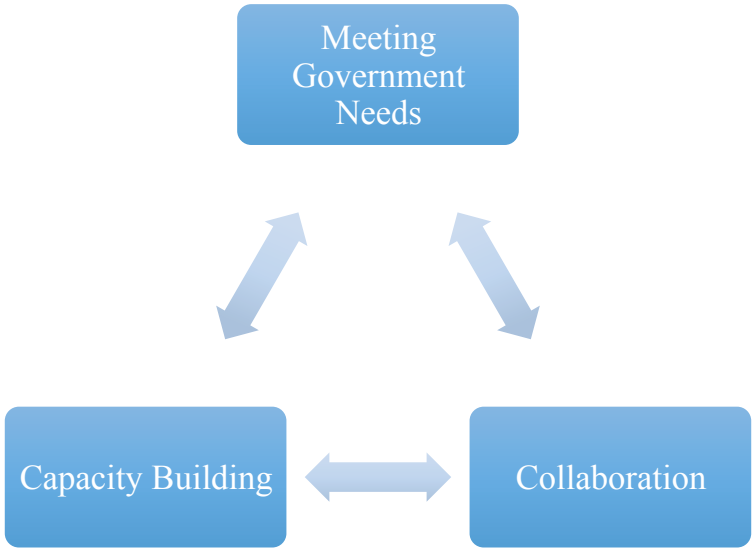

Figure 3.1: Three mutually reinforcing key factors that influenced the use of CBWM in governmental decision-making.

Key factor #1: Meeting government needs

In these case studies, CBWM programs were tailored to government information and decision-making needs in order for them to feed into governmental decision-making. Many government participants talked about data-related needs for monitoring in order for it to be directly used by government, for example, comparability of results with government data across both time and scale (4-GR8; 4-GR1), format of the data (2-GR 5), relevance to department mandate/ level of interest (1-GR6), and credibility of the monitoring information (2-GR5; 1-GR6). One former government employee noted that government involvement in the design phase of a multiparty monitoring program helped to ensure that their needs for rigor were met:

> "When it comes down to it, there are some really basic things that you can get. These people are scientists, and they are able to tell us what's possible and what's not. And one of the things they discovered is with the right equipment, and some basic training, and assuredness that people are following the protocols…You can really take away any….or most error" (2-GR10).

The program successfully engaged volunteers in monitoring and the data was integrated into a provincial database. One federal government employee involved with a government-led monitoring program explained that government involvement in the training enabled use of the data:

> "I would say it is necessary to have someone that has experience [emphatic] with the program, either myself or if it's someone else from [our department] who has experience with the program… or someone who has been trained [emphatic] by [our department staff] such as summer students, to be there and make sure the identification is correct" (3-GR7).

In this case, the monitoring information helped to enhance decision-maker understanding of species of concern but it did not inform specific legislation. The participant explained that if it were to inform legislation, those responsible for monitoring would have to be "really really tight on the protocol" (3-GR7). CBWM certification programs, such as CABIN or CURA H2O, also helped to establish confidence in the water quality data (3-GR5; 3-GR7); however, these certification programs also involved government in the design phase. One group that engaged in an independent CBWM program (with design assistance from the province) used another approach to linking CBWM with decision-making: CBWM results were used to inform the public and build community-wide support via a petition for a local government decision. A group coordinator emphasized the importance of public education for building public support for government policies and decisions, which is part of a functioning democracy:

> "What you have to do with the facts and the data is get it to the constituent group and get them to understand it. So when they are in turn talking to the decision-makers, they will support the action that's required. And if you think you can be successful by short-circuiting that and simply going to the decision-maker, you're going to fail" (1-WC6).

The watershed group's broad mandate, which included both monitoring evidence and public education and engagement, also helped to increase credibility with government contacts (1-WC8) and with the broader community (1-WC9). Using CBWM to build public support helped to meet governmental decision-making needs for undertaking a

positive action in the watershed, and government involvement in CBWM helped to meet government information needs when they directly used the data.

Key factor #2: Capacity building

The ability of watershed groups and government agencies to build their capacity affected the usefulness of long-term CBWM for influencing governmental decision-making. Group coordinators and government counterparts talked about a variety of resources that contributed to their capacity for CBWM, including funding, volunteers/ staff, expertise, and monitoring equipment. One federal government employee commented on the effect of limited volunteer capacity on the usefulness of monitoring data for government:

> "You can't be sampling one year and not doing it the next year…being sporadic like that. It is very difficult to actually have conclusive data if there [are] missing data in the database. So that was one of the [constant] challenges [emphatic] with the groups was to keep their interest, and have volunteers involved" (3-GR7).

The consistency of funding affected capacity for long-term CBWM as well, especially when staff was hired for monitoring. To illustrate this, one group coordinator commented on the challenges of relying on "volatile" government grants and how it affected the ability of groups to sustain long-term programs:

> "So as funding oscillates from one year to the next the amount of staff that would be on hand in any given community group obviously varies. The ability of communities to sustain programming is highly variable" (3-WC10).

With limited government capacity to support CBWM, a group coordinator highlighted the need for diversifying their partners and sources of funds for maintaining their capacity:

> "Like obviously [the federal government staff] don't have a lot of actual equipment and stuff they can give us. But at this point we've actually gone after funding from TD Bank and [other sources] to get our own. So most of what they do now is offer us advice" (4-WC5).

In that case, diversification of funding enabled the watershed group to be independent and government was still able to contribute expertise, including guidance with CBWM. A provincial government employee also supported this idea of funding diversity for watershed groups, and emphasized the importance of having multiple partnerships:

> "In order to help watershed groups continue to be successful in their endeavors, we do strongly encourage them to have multi-agency partnerships. So that they can facilitate or have more funding diversity" (3-GR2).

In these case studies, watershed group capacity for long-term CBWM was enhanced through diversification of funding and partnerships. The next section will further highlight how collaboration with multiple partners increased government capacity for facilitating CBWM initiatives that influenced governmental decision-making.

Key factor #3: Collaboration

Watershed groups and government agencies in this study collaborated with multiple partners, which helped to build their capacity for linking CBWM with governmental decision-making. All four groups had a Board of Directors or multi-stakeholder committee, which facilitated collaboration with multiple partners and increased their capacity. One group coordinator highlighted the importance of a strong Board of Directors:

> "It's hard, if they don't have a good Board and it relies all on one staff there's a real danger that the organization falls when that staff person leaves…. And then the other thing would be partnerships. If you develop a lot of partnerships it helps to be more resilient" (3-WC4).

Government agencies increased their capacity for supporting CBWM by partnering with regional-level stewardship organizations in multiple cases. A federal government employee commented that partnering with a regional-level organization was facilitated by the fact that they had a similar geographic coverage (3-GR7). One provincial government employee explained how a regional-level partner increased their capacity to support watershed groups:

> "Government can't be everywhere, and there's not enough funding, there's not enough staff… But there's a lot of people interested in their lakes and their water quality. So trying to help us prioritize where the Ministry needs to go…We can direct them to the BC Lake Stewardship Society" (1-GR13).

A provincial government employee commented on the necessity of having multiple partners for ensuring that the CBWM met their data needs:

> "I think for the long-term success of the program it needs to be [the province, regional government, and stewardship groups] as the core of the program because we're required to meet certain standards, and as soon as that requirement is gone we stop being able to trust the data" (3-GR11).

Several group coordinators and government employees also highlighted the role of watershed management plans in facilitating collaboration with multiple partners and linking CBWM to decision-making processes. One group coordinator explained the role of a management plan in bringing together partners and increasing the effectiveness of their organization:

> "[At the beginning] we had a working group that met monthly that included agriculture, forestry, and fisheries… We had so many players, we needed…to have an action plan that would provide the direction necessary to get this group working [emphatic]" (1-WC9).

The management plan was also useful for explaining their goals to funders (1-WC9), thus attracting funding and increasing their capacity. One federal decision-maker highlighted that watershed management plans were key to linking CBWM with decision-making because it helped to engage stakeholders that had the authority to make decisions related to land-use and it helped to tailor the design of CBWM to a governance structure (3-GR9). Another model used was a multi-stakeholder research partnership between multiple agencies and institutions for connecting long-term monitoring efforts at a regional scale to land-use impacts and decision-making (3-GR7). Collaboration involving multiple stakeholders was thus key for building government capacity to support CBWM and connecting the information to relevant decision-making processes.

Secondary factor #1: Leadership

Leadership in watershed groups and government helped to facilitate collaboration, which was necessary for linking CBWM to governmental decision-making. Group coordinators from three case study groups emphasized their intention to focus on collaboration and habitat stewardship rather than taking an advocacy role. One group coordinator, who was noted by others to have a strong leadership role, emphasized their broad-based, collaborative approach that included raising public awareness:

> "Getting help from some of the people in the [government] agencies…we would consult with them…and have meetings with them. So they're kind of used to working with us and I guess compared to most of the other kind of fish-centric groups…Our group has had a broader kind of mandate and we've done way more [emphatic] in terms of awareness…I guess it has given us credibility amongst government people that we are familiar with" (2-WC11).

A municipal elected official highlighted the importance of this watershed group leader's non-political approach and how it enabled them to trust the information for decision-making:

> "[What works is that] it's not a group that is coming at you with a political, specific political agenda. Then you can learn to trust their advice because it's, for lack of a better term, it's pure. It's basically them presenting information that should help you in shaping your decisions" (2-GR12).

When groups took a collaborative approach, it helped to reduce government concerns with information bias, which was a necessary consideration for decision-making. Leadership in government also facilitated collaboration with watershed groups for supporting long-term CBWM. A provincial government counterpart noted the role of their previous manager in facilitating a collaborative department culture:

> "It really was something that is core to the work we do in this office…Is everywhere he went [emphatic] on meetings… he would be talking to people to get connections… He knew there [were] always opportunities somewhere to work together, because he knew that we couldn't do it alone" (2-GR11).

Leadership was also a factor in a case where collaboration with CBWM had been absent and the information was not used by government. A provincial government employee noted that their department had been assisting watershed groups with monitoring but they had not sought collaborative monitoring partnerships. They recognized that they could take a more active leadership role in facilitating collaboration with CBWM if the monitoring goals were more aligned (4-GR1). Across the four case studies, leadership in watershed groups was identified as important for building credibility with government, and leadership in government facilitated collaboration with CBWM that was useful for decision-making

Secondary factor #2: Reciprocity

Reciprocity- or exchange of mutual benefits- was found to be an essential component of collaboration as it helped to build trust as well as capacity for CBWM that is useful for government. One provincial government employee noted that collaboration was helped by having mutual goals and thus benefits:

> "[When] the group's mandate mission and strategic goals align with that of the department's then there's a more clear opportunity for partnership" (3-GR2).

Relevance to government mandates was noted earlier as being necessary for meeting government information needs and, in this case, it also facilitated collaboration involving CBWM. For a provincial government employee, collaboration with community groups was seen as very beneficial and they helped to facilitate this collaboration through reciprocal, open communication:

> "So we have found in a lot of our projects, working with these locals, getting support from them, having them participating [emphatic] in collecting data so they understand what water quality is all about. What does the data mean. And supplying them the results [emphatic]. So feedback back and forth…[and] that's just been our standard. [W]e just sort of work with the locals from day one and it seems to really really [emphatic] work" (1-GR13)

In that case, two provincial government employees had noticed that they received less angry phone calls when they took a collaborative approach with watershed groups (1-GR13; 3-GR11), pointing towards increased trust in the community (another benefit for government). A former government employee also emphasized that recognizing volunteer efforts and providing assistance helped to ensure that government was not "using" watershed groups (2-GR10), making collaboration mutually beneficial. In another case, a group coordinator suggested that more reciprocity from provincial government could help to build trust with watershed groups as well as increase their capacity for conducting rigorous CBWM:

> "If you're looking at 14 dollars per sample by 20, he doesn't really have that funding to be able to send my samples off to the provincial lab. But if they were given a really good [emphatic] discount, 50 percent discount, for watershed groups. You'd really start getting access and building trust, and it would also give these watershed groups reliable data" (4-WC12).

Reciprocal exchange of benefits such as reduced lab costs had potential to build trust as well as increase watershed group capacity for CBWM that is rigorous. Another group coordinator commented on the lack of follow-up from provincial government with their monitoring program, indicating limited communication and reciprocity: "There was not a lot of follow-up [emphatic]. So while it engaged a lot of people in the beginning, it didn't really engage them in the long-term" (1-WC4). They observed that government efforts to engage communities in the program likely faded when it was no longer mandatory and there was less funding (1-WC4). One federal government employee mentioned that while

collaboration could be mutually beneficial, it also required a certain level of capacity and willingness to contribute:

> "I think that the benefit goes both ways, like I said…I'd like to see the collaboration continue, whether it's not enough and whether we need to do more? I'm not really sure because like I said it's a time and priorities kind of thing" (4-GR8).

Reciprocal actions such as reducing lab fees and providing volunteers recognition facilitated the exchange of mutual benefits, trust, and capacity for CBWM that informed governmental decision-making. However, it also required a base level of capacity, mutual benefits for government, and willingness on the part of government to engage in collaboration with CBWM over the long-term.

3.6 Discussion

There is a need for case studies of successful integration of CBWM with governmental decision-making (Conrad and Hilchey, 2011), and this study contributes to addressing this gap by identifying four watershed groups engaged in CBWM that fed into governmental decision-making. CBWM was directly used by provincial and federal government and linked with long-term decision-making processes in three of the case studies (two main programs) and, in another case, CBWM was used to build public support for a local government decision. Within these case studies, there were also instances of partial non-success (e.g. New Brunswick Water Classification Program), which provided a deeper and richer understanding of the complex factors involved. Inclusion of case studies of barriers to CBWM integration has also been recommended (Conrad and Hilchey, 2011). Key over-arching factors that influenced the use of CBWM in governmental decision-making included collaboration between watershed groups and government agencies, capacity building through diverse means, and meeting government information and decision-making needs. The secondary factors of leadership and reciprocity facilitated collaboration through building of trust as well as capacity for conducting high quality CBWM. Collaboration was a particularly complex factor as it also presented ongoing obstacles for CBWM in the same case studies. Collaboration has

been cited as important for CBWM (Conrad and Daoust, 2008; Whitelaw *et al*., 2003; Pollock and Whitelaw, 2005) and this study provides a deeper understanding of *why* it is key for linking CBWM with governmental decision-making. We present three mutually reinforcing factors that contributed to the process of enabling CBWM to influence decision-making, discuss new insights for collaboration with government, and summarize some best practices used by watershed groups and government in these case studies.

The over-arching factors of collaboration, capacity building, and meeting government needs directly support the recommendations in the literature (e.g. Whitelaw *et al.,* 2003; Conrad and Hilchey, 2011) for strengthening CBWM and linking it with governmental decision-making. Recommended practices that were consistently used across cases included standardized sampling protocols and programs (Whitelaw *et al*., 2003; Sharpe and Conrad, 2006), training of volunteers (Whitelaw *et al*., 2003; Conrad and Hilchey, 2011), securing adequate funding (Whitelaw *et al*., 2003; Weston and Conrad, 2015), and collaboration with organizations that are monitoring (Whitelaw *et al*., 2003; Conrad and Hilchey, 2011). Volunteer recognition and feedback on results was also observed in a couple cases and has been recommended in the literature (Whitelaw *et al*., 2003; Silvertown, 2009; Weston and Conrad, 2015).

These studies have tended to focus on providing recommendations to watershed groups rather than government, but this study shows that government has an essential role in facilitating CBWM that is useful for decision-making. Often the focus for government contributions has involved funding or inclusion in the design phase (e.g. Conrad and Hilchey, 2011; Conrad and Daoust, 2008), but government capacity to engage in supporting CBWM can be limited, including availability of staff (Wieler, 2007; Rankin, 2008). This study provides practical examples of how provincial and federal government agencies increased their capacity for CBWM by partnering with regional-level stewardship organizations and entering into multi-stakeholder research partnerships, and how government's reciprocal actions (including open communication) helped to both build watershed group capacity for long-term CBWM and trust in government. Good

communication is understood to be necessary for collaboration as well as successful public engagement and trust in management decisions (Addison *et al.,* 2013). Additional best practices for watershed groups included diversification of funding sources for increased independence, multi-stakeholder Boards for increasing capacity and facilitating partnerships, and watershed management planning for engaging local government stakeholders and aligning CBWM with a governance structure.

Studies have tended to focus on providing independent monitoring that is then 'delivered' in a timely and relevant fashion to governmental decision-makers (Whitelaw *et al*., 2003; Conrad, 2006; Pollock and Whitelaw, 2005) thus there has been limited attention to CBWM programs that are created within a governance structure. Multiparty monitoring programs have been promoted as most likely to influence decision-making (Whitelaw *et al*., 2003; Conrad and Daoust, 2008; Conrad and Hilchey, 2011) and this study shows that both government-led and multiparty monitoring programs are influential with decision-making. Two of the three main CBWM programs that influenced governmental decision-making in this study had a combined government-led and multiparty approach. Provincial and federal government involvement helped with training volunteers and ensured that government needs for timely and relevant data were incorporated into the design of the program. Government participants in this study also supported that standardized training programs and databases could help to facilitate the use of CBWM by government, which has been shown to have preliminary success in the case of the CURA H2O toolkit and training program (see Weston and Conrad, 2015).

An independent monitoring program was influential in one case where CBWM results were used to build public support for a local government decision, which has been recommended for CBWM in another study (Conrad, 2006). Advocacy monitoring has been seen as unlikely to influence decision-making (Conrad and Daoust, 2008); but in this case, a collaborative approach including public support combined with engagement of local government and neutral presentation of information helped to influence decision-making. Hunsberger (2004) found that organizational legitimacy was important for

CBWM influencing decision-making, including having adequate funding, and this study supports that public engagement helps to build credibility with both local government and communities. Two municipal elected officials were included in this study at Hunsberger's recommendation, and one indicated that a non-political approach was important for being able to trust information presented by these groups. Credibility has often only been considered in the context of data collection and analysis in the CBWM literature (Kebo and Bunch, 2013; Gouveia *et al.,* 2004; Conrad and Hilchey, 2011) and this study is the first to show that watershed group approaches affect decision-maker perceptions of CBWM credibility. Collaboration with provincial and federal government in the design phase as well as training was necessary for ensuring credibility of data that were directly used for long-term decision-making, and community support helped to link independent monitoring with short-term, local government decision-making.

Hunsberger (2004) identified political will and rigour, in addition to legitimacy, as important factors when looking at a range of advocacy, multiparty, and government-led CBWM monitoring programs and their use in governmental decision-making. Although collaborative partnerships were identified as one of many issues affecting governmental uptake, it was not analyzed as a factor. Political will was an alternative focus that included power-dynamics between watershed groups and government, and the influence of government priorities on the use of CBWM in decision-making. Political will has also been noted as a key challenge for collaboration with CBM:

> "Perhaps the greatest challenge facing CBM groups, in terms of community involvement and capacity, is the willingness and readiness of current decision makers and management institutions to work collaboratively with citizens and community stakeholders for stewardship and sustainability" (Conrad and Daoust, 2008, p.365).

While some participants talked about the role of government priorities and interest, political will was not emphasized as a key factor in this study. We speculate that this difference in findings could be due to a focus on long-term monitoring rather than short-term or advocacy monitoring. We provide an alternative focus to political will, one that includes meeting government needs for information, ensuring mutual benefits, and

building public support for decision-making. Focusing on collaborative approaches rather than the issue of political will helps to point towards solutions for linking CBWM with governmental decision-making; however, there are inherent challenges in collaborating with government that require further examination.

Cross-sector collaboration has become a global transformational trend in government (Huxham and Vangen, 2000) and is found to be an exceedingly complex factor that can 'make or break' the integration of CBWM with decision-making in this study. Successful collaboration requires organizations to recognize that there is a greater benefit to working with others rather than working on their own (Huxham, 1996; Bardach, 1998). There are many benefits associated with involving CBWM information in governmental decision-making, including reduced costs for data collection and analysis for government (Cuthill, 2000); however, these can be overshadowed by institutional challenges and risks. Tschirhart and colleagues (2005) describe a paradox between branding (involving independent missions) and collaboration (involving shared goals), which presents special challenges at the administrative level for government. Accountability is part of government's autonomous role (Huxham, 1996) and governmental control is often sought over the outcomes in non-formal partnerships in order to maintain accountability (Gazley, 2008). An understanding of government needs for accountability could help to explain study findings that government involvement in CBWM was necessary for enabling government to trust and use the data. Reciprocity and trust are necessary for collaboration (Ostrom, 1998) and it was observed that an exchange of benefits in two multiparty/government-led monitoring programs helped to build both trust and capacity for linking CBWM with governmental decision-making. In another case, a provincial government department would not reduce lab fees for groups conducting CBWM, which maintained limited trust in government. It is possible that the government staff either did not recognize the benefit of increased access to data or they had limited flexibility and capacity to do so. Institutional hierarchy and constrained missions are additional challenges that governments can experience, which limit the flexibility necessary for partnerships (Tschirhart *et al*., 2005; Thomsan and Perry, 2005). This was particularly

evident in New Brunswick, where the province had successfully engaged watershed groups in monitoring baseline conditions for their Water Classification Program but had failed to implement the classification system. This lag in implementation has been attributed to the province's limited authority to enforce the Act (Office of the Ombudsman, 2014). We found examples of successful collaboration between watershed groups and government agencies where mutual benefits were present and there was adequate capacity and trust; however, the perception of mutual benefits as well as institutional limitations continued to present challenges in other cases for linking CBWM with decision-making.

Leadership within government and watershed groups involved in this study was identified as important for facilitating collaboration. With a multiparty monitoring program involving provincial and regional government, individual staff and managers took a leadership role in seeking collaboration, which contributed to a collaborative provincial department culture. Pollock and Whitelaw (2005) also found that champions in municipal government were important for initiating environmental stewardship. Leadership is theorized to be an important element for collaboration, and a trusting attitude among individuals who seek collaboration can help to overcome the risks (Huxham, 2003). Shifting governmental attitudes towards collaboration has been seen as important in previous studies involving CBWM (Milne *et al*., 2006). Provincial governments in this study had very different approaches to working with watershed groups, which could be seen as differences in attitudes towards collaboration. Ministry of Environment staff on Vancouver Island actively sought partnerships and regularly engaged with watershed groups on Vancouver Island (providing in-kind assistance) while the New Brunswick department highly valued their partnerships with watershed groups and provided financial assistance for monitoring but their communications were limited. The Prince Edward Island department provided in-kind assistance to watershed groups for monitoring as needed in addition to financial assistance but did not actively seek collaboration. Overall, Canada's public sector has been found to lack a culture that is conducive to collaboration partly due to perceptions of risk (Morin, 2009). The ability of

leaders to see the advantages in collaborating and mitigating risks was thus key to facilitating the integration of CBWM in government processes.

3.7 Concluding Comments

Collaborative approaches to working with government as well as government involvement in the design phase helped to facilitate the usefulness of CBWM for governmental decision-making. Examples of advocacy monitoring were not present in the case studies and so we cannot speak to its effectiveness; however, this study does support that collaborative approaches to monitoring can be effective. There are inherent challenges in cross-sector partnerships involving government, and these include balancing the benefits of CBWM with institutional challenges. Further research is needed to identify different organizational structures or mechanisms for CBWM that can balance government needs for accountability with watershed group needs for flexibility and enhanced capacity. Research is also warranted on the roles of power-sharing and organizational leadership in cross-sector partnerships with CBWM.

A number of promising practices have been identified for watershed group coordinators and government agencies that seek to overcome these challenges to collaboration with CBWM and facilitate its uptake in decision-making. In these case studies, watershed groups and provincial/federal government departments increased their capacity for long-term CBWM through multi-stakeholder partnerships, such as Board of Directors (former) and regional-level stewardship organizations (latter). Watershed management planning and a multi-stakeholder research partnership also helped to align monitoring efforts with land-use impacts and municipal/federal governance structures. Involving provincial and federal government staff in the design phase of CBWM increased the confidence of those same staff in the data for their direct use. In the case of more independent monitoring, building public support along with neutral presentation of information helped to promote credibility with local government decision-makers. Leaders in both watershed groups and

government used collaborative approaches to working with other organizations, which helped to facilitate the reciprocal sharing of resources and building of trust.

CBWM contributes to enhancing public awareness of watershed issues and linking the information to decision-making presents an opportunity for enhanced public engagement in watershed management. However, government agencies currently share primary responsibility for watershed management in Canada. In order to balance these roles and avoid undue burden on the public, we recommend that government agencies (especially provincial and federal levels) become leaders in facilitating collaboration with watershed groups and other organizations for CBWM that informs decision-making.

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Chapter 4: Intensive, Balanced, and Basic: Aligning Three Community-based Monitoring Program Designs with Goals for Enhanced Water Management.

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4.1 Statement of Student Contribution

I conducted all major phases of this study with substantial intellectual support from Dr. Castleden, including designing the study, conducting interviews and site visits, transcribing the audio-recorded interviews, and analyzing the transcripts. Dr. Conrad also provided regular intellectual guidance and Dr. Daborn's guidance was sought as needed. I was responsible for writing the first draft of this manuscript, Dr. Castleden actively contributed to the writing process, and I incorporated the comments and feedback of the other co-authors.

4.2 Abstract

Community-based water monitoring (CBWM) is a form of citizen science that provides essential baseline information on watershed health and helps to flag emerging water quality issues. With decreasing capacity for government monitoring in Canada, CBWM also has the potential to increase access to rigorous information for government in

addition to enhancing community awareness and watershed stewardship. Citizens have engaged in CBWM for a variety of reasons, including informing decision-making, increasing understanding of watershed issues, and educating communities; however, ongoing challenges such as credibility issues and volunteer burnout result in difficulties with meeting these goals. This study involved qualitative interviews with watershed group coordinators (n=13) and government counterparts (n=16) from four case studies that sought to explore how CBWM could be used in governments' environmental decision-making. During interviews, participants discussed the suitability of CBWM program designs for two main, overlapping roles in integrated water resource management (IWRM): providing rigorous scientific information, and enhancing community awareness and involvement. The linkages between CBWM designs, goals, and roles in IWRM thus emerged as an important analytic issue that warranted further analysis. Data were thematically analyzed and findings revealed that basic monitoring was generally considered to involve: straightforward training and parameters, volunteer involvement, resource efficiency, and community education and engagement. Intensive monitoring was generally perceived to entail rigorous standards for long-term data, conducive to staff involvement, high resource intensity, and useful for informing governmental decision-making. Balanced monitoring was observed when CBWM programs were able to both engage volunteers over the long-term and maintain adequate standards of rigor, thus maximizing their contribution to both roles. This research intends to increase our understanding of CBWM design strengths and weaknesses and help watershed groups identify ways to link CBWM program designs to their goals for influencing multiple aspects of IWRM.

4.3 Introduction

IWRM is widely accepted as being necessary for tackling the complex water issues of our time (Jønch-Clausen and Fugl, 2001; Varis *et al*., 2014). IWRM is a process that seeks to integrate multiple sectors, government levels, ecosystem components, economic and

social needs, as well as water quality and quantity in the management of water resources (Jønch-Clausen and Fugl, 2001). The river-basin or watershed-scale has often been recommended as the most effective scale for integrating multiple stakeholder interests and water quality monitoring is an essential component of IWRM (Ramin, 2004). IWRM in Canada has been affected by government decentralization (Bakker and Cook, 2011) and reduced government capacity for monitoring (Pilon *et al*., 1996; Molot *et al.,* 2001; WCEL, 2004; Water Canada, 2010).

'Citizen scientists' have begun to contribute to filling this information gap by collecting community-based monitoring (CBM) data on their local environments (Wieler, 2007; Au *et al*., 2000; Conrad and Hilchey, 2011). CBM is a 'process where concerned citizens, government agencies, industry, academia, community groups and local institutions collaborate to monitor, track and respond to issues of common community concern' (Whitelaw *et al*., 2003, p.410). CBM is part of the broader citizen science movement, which has involved millions of volunteers and non-government organization (NGO) employees globally in scientific inquiry, including tracking and recording of ecological change (Bonney *et al.,* 2014; Dickinson *et al*., 2012). This study was concerned with community-based water monitoring (CBWM), where community groups partner with other organizations to measure water quality parameters of their watersheds, including, for example, dissolved oxygen, pH*,* coliforms, and total dissolved solids. Citizens engaged in CBWM often expect that their data will help to inform governmental decision-making concerning environmental management (Conrad and Daoust, 2008). However, many challenges make it difficult to realize the integration of CBWM into IWRM (Conrad and Hilchey, 2011), including, for example, inconsistent funding and data collection (Bliss *et al.,* 2001), volunteer burnout (Conrad, 2006), and concerns with data accuracy (Legg and Nagy, 2006).

CBWM that does not attain its goal—whether it is to do with engaging communities, validating restoration projects, or influencing decision-making —can turn into 'monitoring for the sake of monitoring', which can waste valuable resources and

contribute to volunteer burnout (Conrad, 2006). In the course of a study involving four CBWM organizations that sought to explore how and why their CBWM was 'successfully' linked with governmental decision-making, we identified an emergent theme about linking CBWM designs with goals and roles in IWRM, which warranted further analysis. As a result, in this article, we present the findings of a qualitative analysis of semi-structured interviews with watershed group coordinators and government decision-makers from four case study groups across Canada that help to distinguish between the three main CBWM design categories of intensive, balanced, and basic monitoring and their suitability for different roles in IWRM.

4.3.1 Background

Although IWRM has been widely promoted by government agencies in Canada (Environment Canada, 2010; Mitchell and Shrubsole, 1994), a combination of decentralized governance and fragmented jurisdictional divisions (Bakker and Cook, 2011; Hill *et al*., 2008; Robins, 2007) has contributed to obstacles in its implementation (Morin, 2009). The process of decentralization has also contributed to decreased government capacity for water quality monitoring; in the early 1990s, provincial/territorial and federal government departments experienced financial pressures due to federal deficit reductions, which contributed to the restructuring of existing water monitoring programs (Pilon *et al*., 1996; Perrone *et al*., 1998). More recently, Environment Canada's Ecological Monitoring and Assessment Network (EMAN), which had provided a base framework of recommendations for integrating CBWM in decision-making since 1994 (see Whitelaw *et al*., 2003; Vaughan *et al*., 2003; Pollock and Whitelaw, 2005; Wieler, 2007), was discontinued in 2010, again due to federal funding cuts. EMAN had been in the business of promoting continued capacity building for CBWM in response to decreased availability of government monitoring.

CBWM is part of a global movement of citizen science, which involves millions of volunteers and NGO staff engaged in the collection of scientific data for thousands of

projects (Bonney *et al.,* 2014). CBWM has enabled the tracking of long-term ecological trends at an unprecedented scale (Dickinson *et al.,* 2012). Many benefits have arisen from the engagement of citizens in CBWM, including increased access to information at a reduced cost (Cuthill, 2000; Conrad and Daoust, 2008), enhanced public participation in environmental management (Whitelaw *et al*., 2003; Au *et al*., 2000), democratization of science (Conrad and Hilchey, 2011; Ely, 2008), and increased social capital (Bliss *et al.,* 2001). At the same time, organizations engaged in CBWM often encounter capacity related challenges such as volunteer burnout (Whitelaw *et al*., 2003; Conrad, 2006), and researchers have expressed concerns with data accuracy (Legg and Nagy, 2006; Léopold *et al*., 2009) and participant objectivity (Stokes *et al*., 1990). But studies have shown that volunteers can collect good quality data when properly trained (Fore *et al*., 2001; Shelton, 2013). In summary, when adequate resources are invested, CBWM has the potential to enhance public participation and access to information, which have been highlighted as important components of IWRM (Jønch-Clausen and Fugl, 2001).

A diversity of types of CBWM programs exists, which reflects a variety of motivations for conducting CBWM. Reasons that citizens engage in CBWM have included, for example, responding to a perceived environmental threat, producing baseline information in its absence, and promoting community awareness about local conditions (Bliss *et al*., 2001). Government agencies have initiated CBWM programs to cover broader geographic areas for long-term baseline monitoring and to raise awareness of watershed health (Department of Fisheries and Oceans, 2014; Milne *et al*., 2006). The scholarly community has identified four main types of CBWM (modified from Whitelaw *et al*., 2003), which arise from these different reasons for monitoring:

1) Government-led monitoring, which is often directed by government and includes community members in data collection.
2) Multiparty monitoring, which involves collaboration between government agencies, NGOs, and/or other stakeholders in monitoring an issue of common concern.

3) Advocacy monitoring, which is directed and undertaken by communities for addressing a particular issue, often with the intent of inspiring action.
4) Interpretive or educational monitoring, which is focused on educating the community through public participation, including volunteer involvement.

There has been a focus in recent literature on CBWM that can be linked with governmental decision-making, with general agreement that multiparty monitoring is the most effective (Whitelaw *et al.,* 2003; Milne *et al*., 2006; Conrad and Daoust, 2008). Meanwhile, advocacy monitoring has been linked to localized success with influencing decision-making involving hotspot issues (Hunsberger, 2004) and educational aspects of monitoring have been promoted for enhancing community awareness (Cuthill, 2000; Firehock and West, 1995). Recommendations for success with citizen science have often been focused on scientific contributions alone, but success can be defined differently depending on the reasons for monitoring (Freitag and Pfeffer, 2013). Consequently, each type of CBWM can make meaningful contributions to management and achieve success when considering their slightly different goals.

The identification of monitoring goals, particularly through a collaborative process, has been suggested to be a key step in designing CBWM and other monitoring programs that can contribute to enhancing environmental management (Conrad and Daoust, 2008; Wieler, 2007). Meanwhile, several studies have shown instances where organizations engaged in CBWM have not properly identified goals or have mismatched monitoring designs and goals (Nerbonne and Nelson, 2008; Conrad and Daoust, 2008; Kebo and Bunch, 2013). For example, Conrad and Daoust (2008) found that 82 percent of Nova Scotia watershed group survey respondents had attempted to deliver their monitoring information to government decision-makers, but none could confirm whether their data had been used. Meanwhile, 72 percent of respondents said they did not use consistent monitoring methods or standards. In light of this finding, a functional framework was created to help guide community-based organizations in producing a comprehensive monitoring plan (Conrad and Daoust, 2008). However, as yet, there has been limited

guidance in the literature on the effectiveness of different monitoring designs for attaining desired goals. Connections between governmental and academic water research and water management have also been lacking (Dorcey, 1987; Pearse *et al*., 1985), pointing to the greater challenge of linking scientific information with environmental management (Sutherland *et al*., 2004; Vaughan *et al*., 2003). These ongoing challenges for citizen science as well as governmental monitoring indicate a need to understand the diverse roles of monitoring in IWRM.

4.4 Study Design

4.4.1 Case studies and interviews

The research reported here arises from a study that investigated the factors contributing to successful integration of CBWM in governmental decision-making. Similarly to Castleden and colleagues' (2010) study involving an unintended line of inquiry, we identified an emergent theme through inductive coding that warranted further analysis. As noted in the introduction, this paper explores the emergent theme of linkages between monitoring designs, goals, and roles in IWRM. We outline the overall study design below.

Four case study watershed groups were selected from across Canada using a database of environmental stewardship groups engaged in community-based environmental monitoring that was produced by Lefler (2010). The first author updated this database to include additional organizations engaged in CBWM using online information for a total of 304 organizations representing 10 provinces and two territories. Five main criteria were used to select case study groups from the database:

1) The group was well-established (6+ years) (Leach *et al*., 2002);
2) The group was engaged in long-term water monitoring (2+ years);
3) The group's CBWM data had potentially been used in decision-making;

4) The group had at least one leader who had experience-based knowledge of the group's involvement in sharing monitoring information with government;
5) Both the group coordinator(s) and their government counterpart(s) were willing to participate in the study.

These criteria allowed the research team to narrow down the list of 304 organizations to 36 potential case study groups using available online information. The 36 potential case study groups were contacted by email and phone and 24 were successfully reached. After initial contact, 12 of these groups were determined to fit the majority of the case study criteria. Three of these 12 groups declined the invitation to participate and some did not fully meet the criteria upon further examination through phone calls. Four case study groups were selected; two from British Columbia because of clear examples of CBWM being used by government and influencing decision-making. A New Brunswick and a Prince Edward Island case were chosen because CBWM fed into a government process and there was a high potential to influence decision-making (see Table 4.1). These four case studies provided an opportunity to present a wide geographical range of case studies as well as diversification from the research team's earlier focus on Ontario and Nova Scotia. West Coast and Ontario groups have been included in the same analysis in the past (Hunsberger, 2004), but not West Coast and Maritimes groups. Case studies were limited to four because of time and financial constraints.

Participants were recruited using 'gatekeeper' (Cloke *et al*., 2004) and 'snowball sampling' methods (Noy, 2008) and using contact information from the database. Semi-structured interviews were conducted between July 2013 and February 2014 with watershed group coordinators and government counterparts connected to the group for a total of 29 interviews (see Table 4.1). A semi-structured, in-depth style of interviewing enabled tailoring of the questions and prompts to the background and interests of the participants (Dicicco-Bloom and Crabtree, 2006; Johnson, 2002). Data saturation was reached when themes became repetitive during the final interviews (Guest *et al*., 2006).

Watershed group coordinators included executive directors, directors, and project coordinators (present and past). Government counterparts included staff, managers, regional directors, and elected officials from municipal/local, regional, provincial, and federal levels (present and past). Site visits were made for all watershed groups and in-person interviews were conducted when possible; phone interviews (total of 12) were also conducted in cases where scheduling necessitated doing so. The study protocol was reviewed and approved by Dalhousie University's Social Science and Humanities Research Ethics Board and Saint Mary's University Research Ethics Board.

Table 4.1: Characteristics of watershed groups involved in the study and number of participants.

	Watershed Groups			
Characteristics	**Quamichan Watershed Stewardship Society (QWSS)**	**Mid Vancouver Island Habitat Enhancement Society (MVIHES**	**Shediac Bay Watershed Association (SBWA)**	**Bedeque Bay Environmental Management Association (BBEMA)**
Location	Duncan, BC	Parksville, BC	Shediac, NB	Summerside, PEI
Foundation Date	2006	1998	1999	1992
Reasons for initiation of the group	Concerned lake-side residents, assisted by Cowichan Land Trust	Concerned salmon fishers, evolved to ecosystem-based focus	Concerned residents, NB Environmental Trust Fund	Environment Canada's Atlantic Coastal Action Program
Watershed water quality concerns	Eutrophication, algae blooms, and fishkills in Quamichan Lake	Drinking water and salmon habitat in the Englishman River and tributaries, estuary habitat	Impacts from residential, forestry in Shediac Bay and watershed (Shediac and Scoudouc Rivers)	Nitrate, sedimentation, and fishkills in Bedeque Bay watershed (Dunk, Wilmot, and Bradshaw Rivers)

Characteristics	Watershed Groups			
	Quamichan Watershed Stewardship Society (QWSS)	Mid Vancouver Island Habitat Enhancement Society (MVIHES	Shediac Bay Watershed Association (SBWA)	Bedeque Bay Environmental Management Association (BBEMA)
# Long-term (2+ years) water quality monitoring programs (past and current, surface water and estuaries)	2	3	3	4
Study Participants				
Watershed group coordinators	4	2	4	3
Government employees (staff and managers)	2	4	2	5
Government decision-makers (Elected officials and regional directors)	1	1	1	0
Total interviews	7	7	7	8

4.4.2 Analysis

Interviews were audio-recorded, transcribed verbatim, and analyzed following a simultaneous deductive-inductive coding method similar to a previous study (Fereday and Muir-Cochran, 2006). 'Coding' involves the assignment of codes (words or phrases) to sections of text to facilitate the organization of data within common themes for further analysis. The first author analyzed the interview transcripts using NVivo9^{TM} qualitative

analysis software. The results reported in this paper were identified through open, inductive coding of the transcripts, which allowed for the inclusion of new factors and themes identified by the participants during the interviews (Fereday and Muir-Cochrane, 2006). Codes produced during the first round of inductive coding were re-organized and condensed using established methods (Saldaña, 2009) and a second round was conducted to ensure consistency of existing codes and to identify new relevant codes (none were identified). The second author, a senior member of the research team, reviewed the inductive coding method prior to the second round of coding and deemed it to be appropriate. Preliminary findings for this paper were presented to participants and the research team through an online webinar and the findings resonated with those who attended, with no concerns brought to the team's attention. Participants were given the opportunity to review the preliminary analysis as well as quotations in context, and their feedback has been incorporated into the text.

Over 50 percent of participants indicated that they wanted to be anonymous and, to maintain consistency; all participant quotations and paraphrases are indicated by a codename (e.g. "1-WC2" = Watershed Group Case Study 2- Watershed Group Coordinator 2; "3-GR11" = Watershed Group Case Study 3- Government Representative 11) (See Table 4.2). Government representatives (including staff, managers, and decision-makers) were assigned a number from 1 to 16, and watershed group coordinators were assigned a number from 1 to 13.

Table 4.2: Codenames for watershed group case studies.

Watershed Group Case Study	Number
Quamichan Watershed Stewardship Society	1
Mid Vancouver Island Habitat Enhancement Society	2
Shediac Bay Watershed Association	3
Bedeque Bay Environmental Management Association	4

4.5 Findings

The findings presented in this paper were not the original focus of this study, nor were they intended as an analytic issue. However, during interviews with participants, it became evident that CBWM programs could be tailored to broader roles in IWRM and this had implications for organizations across Canada engaged in CBWM and warranted further analysis. Participants talked about two main roles for CBWM: 1) rigorous, scientific data collection that is useful for government, and 2) community awareness and engagement in stewardship. From discussions around monitoring design strengths and weaknesses for these two overlapping roles, three main categories were identified for monitoring program designs: 1) intensive monitoring that includes rigorous standards, is conducive to staff involvement, and is most useful for government, 2) balanced monitoring that can both engage community volunteers and include rigorous standards, and 3) basic monitoring that is ideal for broader community involvement and education. This categorization of CBWM designs, goals, and roles was derived from data associated with three key themes: 1) participant iterations of the differing roles, 2) the theme of matching monitoring design to the goals of the program, and 3) a summary of linkages between case study CBWM program designs and goals. The three categories for CBWM design reflected a potential gradient or spectrum of monitoring intensity. However, due to the study focus on the use of monitoring data in decision-making and subsequent over-representation of intensive and balanced study designs, our discussion is limited to these three categories and its application requires future validation.

4.5.1 Two overlapping roles for CBWM in IWRM

Several watershed group coordinators and government counterparts spoke of two overlapping roles for CBWM in IWRM. These roles included: 1) scientific data that can be useful for government (and watershed groups), and 2) community awareness and engagement in stewardship. One federal government employee explained how different program designs feed into these roles:

> '[The monitoring is] not done as a rigorous sampling but it's done…it's bringing the education of the public up to understand the importance of it. So you can do the monitoring at two levels. One is that rigorous data set that meets all the bells and whistles but there's also the educational monitoring…' (4-GR3).

A group coordinator supported the idea of both the technical, scientific role and educational role for monitoring when talking about a report that featured their CBWM results:

> "We kind of wanted to do the [Status of the Bay] project with [Department of Fisheries and Oceans], which is more of a technical report for their purpose. Of course it's going to be useful for us too, it's supposed to be a living document. But then we wanted to make a more simple format too that would be helpful for us to get exposure and share information with the public so that they know what we're doing. And then get involved a little more…there were kind of two lines to this project" (3-WC1).

A federal government decision-maker said that as you get further away from a focus on rigorous scientific monitoring and closer to educational, stewardship role for monitoring, the monitoring becomes less directly useful for management decision-making but it becomes important in broader, strategic objective setting by the public (3-GR9), indicating the roles may be more similar to a spectrum.

The two extremes of monitoring program roles identified by participants resulted in the below conceptualizations for three main categories of CBWM designs (Table 4.3). The role of "rigorous sampling" mentioned by the first participant is interpreted to require an intensive monitoring design, and an "educational monitoring" role is interpreted to require a basic monitoring design. The third "balanced" design represents a balance or overlap between these two main roles. Monitoring programs in this study were also used to provide baseline information, validating restoration activities, and flagging 'hotspot' issues (see Table 4.4), and so the broader role of understanding watershed health is included in the conceptualization of roles as well.

Table 4.3: Characterizing three categories of CBWM program designs, their matching goals and roles, and their strengths and weaknesses.

	Matching CBWM Program Designs, Goals, and Roles		
Monitoring Design	**Intensive**	**Balanced**	**Basic**
Monitoring Goals and Roles	**Inform governmental decision-making;** increase focused understanding of watershed health and establish baseline	**Inform governmental decision-making and engage communities**; increase understanding of watershed health and establish baseline	**Engage and educate communities**; increase general understanding of watershed health and establish baseline
Type of Monitoring (see Whitelaw et al., 2003)	Government-led	Multiparty or independent/advocacy	Educational
Characteristics	High quality standards and training; time consuming; conducive to staff involvement	Adequate rigor and training with some design flexibility; can range from collaborative to independent; staff or volunteer involvement	Very simple quality standards and training; easy; conducive to volunteer involvement
Strengths	Credibility more easily achieved; Can help to inform long-term governmental decision-making; some public participation	Can simultaneously engage communities and inform government, increasing influence on decision-making (short-term and/or long-term); high value for resources	Volunteers are more easily engaged; resource efficient; promotes broad community awareness and can produce short-term results e.g. public pressure
Weaknesses	Difficult to keep volunteer motivation; very resource intensive, especially over long-term	Moderate resources required; credibility issues with advocacy monitoring; inter-organizational collaboration can be challenging	Not able to be directly used by government due issues with rigor and credibility.

4.5.2 Matching CBWM programs designs to goals

CBWM programs in each watershed group case study demonstrated a range of intensive, balanced, and basic monitoring designs, and their effectiveness in matching to their goals can be observed through their outcomes (Table 3). Several participants mentioned the importance of tailoring the CBWM design to the goals of the program, and challenges when these were mismatched. One federal government decision-maker suggested that the credibility issues with CBWM arise when there is a mismatch between the monitoring design and program goals (3-GR9). One provincial government employee suggested that refining a monitoring program to a group's financial resources helped to ensure the goals were achieved (4-GR1). Including volunteers or staff in the monitoring program was another design choice that affected the goals, as one watershed group coordinator explained:

> 'I guess it would be what's the objective of the program? Is it just to gather data or do you want more community education and involvement? If it's more education-based maybe you should be using more volunteers, because just having staff gather data doesn't really involve or educate people in the communities' (3-WC4).

One participant from the same watershed group identified a trade-off between having a rigorous monitoring program and including volunteers:

> 'And that's the part we're struggling with. Trying to involve the public into what we're doing. But when you [involve volunteers in monitoring] you kind of lose a little bit of the robustness of results' (3-WC1).

The engagement of volunteers in monitoring had potential to strengthen educational goals beyond dissemination of findings to the public, but their engagement was seen to be in tension with collecting rigorous data. An intensive/balanced monitoring program engaged volunteers in rigorous sampling of estuarine species and water quality, but the government employee indicated "that was one of the [constant] challenges [emphatic] with the groups was to keep their interest, and have volunteers involved" (3-GR7). This indicated a potential mismatch between intensive monitoring and volunteer engagement. A basic monitoring program that included easier sampling protocols was more conducive to volunteer involvement than a more rigorous, intensive program, as one group coordinator explained:

> ‘Adopt-A-River is more useful in the fact that….we do [Canadian Aquatic Biomonitoring Network (CABIN)], it’s so regimented that you only have certain people that are trained in it. So your volunteer base is really small…Even though Adopt-A-River is a different level of sampling technique it’s far more widespread, and we have far more volunteers, and it’s far more intricate in the community’ (4-WC5).

CABIN, an Environment Canada program, engaged community volunteers and NGO staff in rigorous sampling and certification and created valuable baseline data for government, but the high cost of certification was prohibitive for the involvement of many community groups (4-WC5). A balanced monitoring program was able to both produce monitoring data that were useful for government and to enhance community awareness, but they had to adapt the training to volunteer needs and ensured that the monitoring equipment and parameters they selected were “simple, straightforward” (1-GR11). One government employee highlighted an inherent challenge of engaging volunteers in long-term monitoring, even when the design was quite balanced:

> “[W]hen you work with locals, they don’t understand that government is slow [emphatic]. No matter what government you deal with, whether its local, provincial, federal, things take time. Like you can’t sample in one year and expect changes to happen” (2-GR13).

This participant highlighted volunteer needs for short-term rewards, and helping to explain why engaging volunteers in long-term monitoring could be challenging. For another balanced monitoring program their group coordinator highlighted the importance of their monitoring program for supporting their broader goal: ‘The monitoring is to support the validity of the action we are taking which we believe [emphatic] is cleaning up the lake’ (1-WC6). Their monitoring program included volunteers, adequate standards of rigor, and they shared the results with landowners to build public support for influencing a local government decision. Aligning monitoring program designs to goals thus required careful consideration of the needs for rigor, volunteer engagement, and availability of resources as well as the role of CBWM in IWRM decision-making.

Table 4.4: Case study CBWM program examples with alignment between monitoring goals, design, and outcomes showing match/mismatch (as illustrative, not comprehensive examples).

Case Study CBWM Program Examples	Monitoring Goals (for both watershed group and program)	Monitoring Design (Intensive, Balanced or Basic)	Outcomes Indicating a Match/Mismatch with Goals and Design
Case study: Quamichan Watershed Stewardship Society **CBWM Program: Long-term lake water monitoring program**	Demonstrate the nutrient issues in the lake; involve and educate the community; inform the management plan for improving lake water quality; validate remediation activities.	**Balanced** The Ministry of Environment provided training, design assistance, and equipment (including calibration); 1-2 regular volunteers; quarterly monitoring (Secchi depth, oxygen, temperature, colour observation).	**Match** Engaged community around the lake through information sharing and presented a petition to local government, central sewer system was extended; lake remediation through air bubbling system.
Case study: Mid Vancouver Island Habitat Enhancement Society **CBWM Program: CBWM pilot project (Ministry of Environment/ Regional District of Nanaimo)**	Assess trends in watershed health and feed into provincial water quality monitoring; raise community awareness of watershed health issues; eventually assist Regional District in land-use planning	**Balanced** Province and regional district involved in design phase, training, and provide equipment; volunteers engaged weekly during summer low flow and fall rain periods measuring turbidity, conductivity, oxygen, and temperature; Island Timberlands LP contributes to lab fees.	**Match** Guides provincial monitoring and for evaluating long-term trends; Helped to identify water quality issue related to failing septic tanks and resulted in letters being written to landowners by Regional District; greater community understanding resulted in less angry phone calls.

Case Study CBWM Program Examples	Monitoring Goals (for both watershed groups and program)	Monitoring Design (Intensive, Balanced or Basic)	Outcomes Indicating a Match/Mismatch with Goals and Design
Case study: Mid Vancouver Island Habitat Enhancement Society **CBWM Program: Water quality objectives attainment monitoring (Environment Canada/Ministry of Environment)**	Assess provincial water quality objectives over the long-term	**Intensive** Province provides supervision and training and federal government provides funding; volunteers collect water and benthic invertebrate samples; 2 week periods every 5 years.	**Match** Water quality objectives continue to be assessed; Supported water quality issue identified related to failing septic tanks and resulted in letters being written by the Regional District to landowners to encourage them to hook-up to sewer system.
Case study: Mid Vancouver Island Habitat Enhancement Society **CBWM Program: Automotive Stewardship Sampling Program**	Reduce the impact of storm water pollution; provide a baseline for storm water near automotive businesses; increase awareness of automotive business owners; promote multi-stakeholder stewardship in the watershed.	**Balanced** Province helped with study design, provided equipment/lab analysis; volunteers collected sediment and water samples; re-measured water quality after visiting with automotive businesses to track changes.	**Match** Volunteers explained results to business owners and best management practices for remediating pollutants; newspaper article of companies that made changes to pollutants released and companies that didn't.

Case Study CBWM Program Examples	Monitoring Goals (for both watershed group and program)	Monitoring Design (Intensive, Balanced or Basic)	Outcomes Indicating a Match/Mismatch with Goals and Design
Case study: Shediac Bay Watershed Association **CBWM Program: Long-term water quality monitoring (New Brunswick Water Classification Program)**	Enhance community understanding and awareness of watershed health; validate watershed restoration efforts and pinpoint issue areas; long-term collection and storage of baseline information; inform the Water Classification Regulation.	**Intensive to balanced** Province provides funding, initial training, and sampling design; summer staff collect samples for 6 months annually; group owns a YSI probe for measuring physical and chemical parameters; send samples to lab for nitrates, phosphates, *E.coli,* and total coliforms.	**Match** Results included in a Status of the Bay report in 2006; Ongoing restoration activities and annual reports. **Mismatch** The Province continues to delay implementation of the Water Classification Regulation; Two coordinators indicated that including volunteers could enhance educational goals.
Case study: Shediac Bay Watershed Association **CBWM Program: Community Aquatic Monitoring Program**	Raise community awareness of estuarine ecology, collect baseline data on estuarine species, and assess species composition in estuaries.	**Intensive to balanced** Department of Fisheries and Oceans and Southern Gulf of Saint Lawrence Coalition on Sustainability jointly run the program for three months in the summer; volunteers help to assess estuarine species and collect water samples at six sites once a month.	**Match** Data increases decision-maker understanding of estuarine species; the data is contributed to a research partnership; involves volunteers at 35 sampling sites. **Mismatch** Government employee said volunteer engagement is a constant challenge.

Case Study CBWM Program Examples	Monitoring Goals (for both watershed group and program)	Monitoring Design (Intensive, Balanced or Basic)	Outcomes Indicating a Match/Mismatch with Goals and Design
Case study: Bedeque Bay Environmental Management Association **CBWM Program: Canadian Aquatic Biomonitoring Network (Environment Canada)**	Assess long-term watershed health status trends through interagency collaboration; supplement government water quality monitoring; identify issues and validate restoration activities	**Intensive to balanced** Environment Canada provides a biomonitoring certification program, rigorous training, a central database and analysis tools; in the fall, group staff collect benthic macroinvertebrates (identified to genus/species) and water quality samples that are sent to Environment Canada.	**Match** Information in national database is used for Environment Canada's annual reporting; BBEMA's restoration activities are ongoing. **Mismatch** Costs of macroinvertebrate ($250/site) and water sample analysis are prohibitive to many groups.
Case study: Bedeque Bay Environmental Management Association **CBWM Program: Wet-Pro™ training and toolkit (Saint Mary's University)**	Long-term baseline information on watershed health; validate restoration activities; raise awareness of surface and groundwater health issues through public engagement and education	**Balanced** University-based certification program (multi-stakeholder design input); peer-to-peer training model; summer staff use YSI probe to measure nitrates, pH, dissolved oxygen, and others; water samples sent to provincial lab.	**Match** Collection of long-term baseline data and storage in centralized database; government interest in long-term data; restoration activities ongoing; training of other groups in monitoring and water quality sampling service for well-owners.

Case study CBWM Program Examples	Monitoring Goals (for both watershed group and program)	Monitoring Design (Intensive, Balanced or Basic)	Outcomes Indicating a Match/Mismatch with Goals and Design
Case study: Bedeque Bay Environmental Management Association **Program: Adopt-A-River**	Children's science education and awareness of watershed issues; basic baseline information on watershed health; validate restoration activities.	**Basic** Provincial education department provides financial assistance for training teachers and equipment; Over 20 schools (kids ages 10-15) involved in collection of information on macroinvertebrates (identified to order), PH (colour indicator); dissolved oxygen, nitrates, turbidity, coliform bacteria.	**Match** Community outreach and education (2350 students since 2008); classes create a restoration and management plan and restore streams (e.g. tree planting); database of baseline water quality.

4.6 Discussion

This paper has presented a way of conceptualizing an alignment between CBWM program designs, goals and roles in Canadian IWRM through use of case study program examples and participant anecdotes. There have been issues in the past with groups expecting their CBWM information to be useful for government and becoming frustrated when it is not used (Conrad, 2006). The intent of this paper is to build a common understanding of potential CBWM program designs and help organizations engaged in CBWM to maximize the use of their limited resources, avoid credibility related issues, and achieve their monitoring goals. The focus is on goals that contribute to influencing IWRM decision-making process; however, we also acknowledge and promote the diverse uses of CBWM that include informing watershed group restoration activities and identifying hotspot issues. We argue that CBWM designs include three main categories: 1) intensive monitoring (for informing governmental decision-making), 2) balanced

monitoring (for informing both government and engaging communities), and 3) basic monitoring (for community education and engagement). All of these CBWM program designs can help to enhance public understanding and awareness of baseline watershed health and emerging issues, but tailoring CBWM programs to their strengths (and available resources) will help to maximize their effectiveness. CBWM programs that are aligned with their goals have the potential to strengthen IWRM by addressing both the evaluation of long-term trends by government and increased public engagement in watershed stewardship.

The importance of matching the monitoring design strengths to the goals of the program was emphasized by participants in this study and has also been highlighted in previous studies (Conrad and Daoust, 2008; Hunsberger, 2004; Whitelaw *et al*., 2003; Savan *et al*., 2003; Vos, 2000; Firehock and West, 1995). Conrad and Daoust's (2008) functional framework for CBM suggests that the identification of goals is a key first step of a monitoring program. Meanwhile, Nerbonne and Nelson (2008) found that the goals of volunteer macroinvertebrate monitoring were often poorly aligned with the monitoring design, with high quality data being collected for community awareness goals and low quality data being used for policy change goals. Burdensome time commitment is known to be a main challenge for engaging CBWM volunteers (Kebo and Bunch, 2013) and the need for short-term rewards for volunteers was an important consideration in this study, helping to explain why intensive long-term monitoring is not as conducive to volunteer engagement. Sheppard and Terveen (2013) discourage this idea of a tension between opposing goals of scientific rigor and education, and found that an educational monitoring program helped students to learn about the rigors of the scientific process while ensuring the data were useful for government, showing that these goals can be mutually reinforcing. However, they also indicated that the program was well funded and supported in the school system (Sheppard and Terveen, 2011). A balance between rigor and community participation has been found in other cases when the monitoring design was aligned to goals and adequate resources were available (Savan *et al.,* 2003), supporting our study findings. Many organizations engaged in CBWM face capacity-

related challenges (Danielsen *et al.,* 2005; Sharpe and Conrad, 2006), and so a primary function of conceptualizing CBWM designs is maximizing the use of available resources.

Standardized frameworks have been recommended for providing guidance to community groups that struggle to achieve their monitoring goals, such as influencing decision-making (Conrad and Hilchey, 2011; Conrad and Daoust, 2008; Pollock and Whitelaw, 2005) and watershed groups have favored functional over theoretical frameworks for monitoring (Conrad and Daoust, 2008). While Danielsen and colleagues (2009) provide a similar conceptualization for linking monitoring approaches to goals in the context of natural resource management in developing countries, this study is the first to provide a practical typology of monitoring designs and goals for CBWM in a Canadian context. In the developing countries context, Danielson and colleagues devised a spectrum of approaches and evaluated the strengths and weaknesses based on observations from other studies, suggesting that with increasing local participation in monitoring, rigor and expense decreased while the ability to build community capacity and influence local decisions increased (Danielsen *et al.,* 2009). The identification of three overlapping categories for CBWM supports the idea of a spectrum suggested by Danielsen and colleagues (2009), as local participation in monitoring is seen as conducive to community engagement and stewardship. This study adds to this work by characterizing CBWM design categories that are informed with empirical research, including case study examples of program alignment between designs and goals.

The monitoring program designs outlined in this study can be linked with the four CBM types described by Whitelaw and colleagues (2003); however, there are complexities that may make direct linkages more difficult in practice. The categories of intensive, balanced, and basic monitoring designs reflect decreasing government involvement in CBM types: government-led monitoring, multiparty monitoring, advocacy monitoring, and interpretative/educational monitoring. This sequence works while it assumes that rigor increases with intensity of sampling design and government involvement, which is supported by Danielsen and colleagues (2009); however, another study found that

scientific rigor increases with group autonomy, thus decreasing with the involvement of professionals (Nerbonne and Nelson, 2008). Nerbonne and Nelson's finding challenges the commonly held notion of a tension between volunteer involvement and rigor, which was reiterated by some participants in this study. Furthermore, Lawrence (2006) suggests that a top-down to bottom-up understanding of monitoring may disregard complexities inherent in the relationship between scientific data collection and community awareness and engagement. They emphasize that internal values (e.g. educational) and external values (e.g. rigorous data) of monitoring can be observed in the same program (Lawrence, 2006), much like the cases of balanced design in our study. Instead of suggesting that intensive monitoring cannot raise community awareness and basic monitoring cannot produce usable data; we propose that intensive, balanced, and basic monitoring have particular strengths that can be tailored to desired goals according to the availability of resources, including equipment, volunteers, funding, and partners.

Matching the strengths of monitoring program designs to goals was found to have implications for the credibility of CBWM as well as volunteer engagement in this study. Monitoring programs that were designed with an adequate standard of rigor (and including government in the process) were most likely to achieve goals of informing governmental decision-making. Meanwhile, a basic monitoring program was the most conducive to volunteer involvement and contributed to broader community awareness and education. The link between matching design to program goals and enhanced credibility has been suggested in previous research (Hunsberger, 2004) and volunteer burnout has been cited as a recurring challenge (Whitelaw *et al*., 2003; Conrad, 2006). Issues with credibility have been considered in the context of long-term, intensive monitoring (Conrad, 2006; Conrad and Daoust, 2008; Milne *et al*., 2006); however, there has been less attention to the implications of a mismatch between design and goals for volunteer engagement and educational roles of CBWM in the literature.

A focus on the integration of CBWM with governmental decision-making in the literature (e.g. Conrad and Hilchey, 2011; Whitelaw *et al*., 2003; Danielsen *et al*., 2005) and

interest from government in CBWM (e.g. Wieler, 2007; NSE, 2010) has coincided with an era of government decentralization and cutbacks for monitoring activities (Au *et al*., 2000). Subsequently, there has been less focus in the literature on the more educational role of CBWM involving basic designs that can have wider influences on community awareness and education (exceptions include Cuthill, 2000 and Bliss *et al*., 2001). While studies have found that many watershed groups seek to influence governmental decision-making through sharing of CBWM information (Conrad and Daoust, 2008; Milne *et al*., 2006), others have found that community education is considered by groups to be a main goal as well (Nerbonne and Nelson, 2008; Kebo and Bunch, 2013). Nerbonne and Nelson (2008) found that 73 percent of volunteer benthic invertebrate monitoring groups surveyed in the United States included public education as a main goal for their programs while only 19 percent included influencing government policies, indicating that many groups consider the educational role of monitoring to be more important than influencing government policies. Considering the motivations of volunteers for monitoring is important for engaging communities in environmental management over the long-term (Cuthill, 2000; Measham and Barnett, 2008) as well as choosing potential goals for monitoring. Firehock and West (1995) highlighted the importance of considering multiple types of CBWM:

> "As projects become more sophisticated by improving [quality assurance/quality control] and monitoring methods and by involving new partners, there is a danger that some groups may lose sight of one of the best reasons to conduct a volunteer monitoring project in the first place- increased public awareness" (p. 201).

The literature on citizen science has tended to focus on the scientific aspects rather than the process-oriented benefits, including the engagement of community members in science, indicating the need for a multi-faceted view of success (Freitag and Pfeffer, 2013). This study helps to facilitate a more holistic view of CBWM and its potential roles in IWRM by identifying the strengths of each category of CBWM program design, including the balanced and basic monitoring designs that support greater community awareness and engagement.

CBWM has the potential to feed into diverse aspects of IWRM decision-making when the strengths of different approaches are considered in the monitoring program design. Vos and colleagues (2000), as well as one of our study participants, emphasized the importance of identifying a decision-making system for tailoring the design of monitoring programs to specific goals. Intensive monitoring that includes rigorous standards can feed into the information gathering phase of decision-making, where scientific evidence is balanced with economic, social, and other considerations (Pollard *et al*., 2008). However, prior to information gathering, stakeholder concerns are identified for the prioritization of key issues (Pollard *et al*., 2008), and thus basic monitoring programs that include broad community engagement have potential to feed into this earlier phase of decision-making. A balanced monitoring design can help to both promote community education through inclusion of volunteers as well as provide rigorous scientific information, feeding into multiple aspects of IWRM decision-making.

It has become widely accepted in the CBM literature that multiparty monitoring is the most effective approach for influencing IWRM decision-making (Whitelaw *et al*., 2003; Conrad and Hilchey, 2011; Conrad and Daoust, 2008; Bliss *et al*., 2001), which included balanced monitoring designs in this study. Multiparty monitoring has not been associated with any 'cons' in the past (Conrad and Hilchey, 2011), but we suggest that inherent challenges associated with multi-stakeholder partnerships can be considered a weakness. Jønch-Clausen and Fugl (2001) suggest that public participation and awareness are vital to influencing decision-making with IWRM because of decreased government capacity and the need to prioritize. In this study, and others, increased local level participation was found to help influence local government decision-making (Danielsen *et al*., 2009). However, there are few studies that are able to make a direct link between public participation and improved decision-making (Ravenscroft *et al*., 2002). Decision-making is theorized to be a highly analytical process but is often strongly influenced by individual and societal concerns (Pollard *et al*., 2008) in addition to competing political forces, power relations, costs, and other factors (Colfer, 2008). Utilizing the differing strengths of CBWM program designs has the potential to influence multiple facets of

IWRM decision-making; however, political challenges such as costs and power relations will likely continue to present obstacles.

4.7 Conclusion

The rise of CBWM across Canada is indicative of growing public interest in understanding environmental issues and becoming involved in IWRM. There is also a desire amongst these groups to influence government decision-making and promote community awareness with CBWM; however, the best way to proceed has often been unclear. This study has attempted to clarify the strengths and weaknesses of three main CBWM program designs, including intensive monitoring that is most useful for informing government, balanced monitoring that can both engage communities and produce information useful for government, and basic monitoring that is more conducive to promoting community education and stewardship. There has been much less emphasis on basic, educational monitoring designs in the literature; however, engaging volunteers in monitoring can increase community awareness and concern for influencing the early prioritization phases of IWRM decision-making. Balanced monitoring shows the most potential for informing a holistic approach to influencing IWRM decision-making as it can achieve both adequate standards of rigor for informing government and engagement of community volunteers in hands-on learning about watershed issues, science, and environmental stewardship. All three CBWM program designs can help to inform baseline understanding of watershed health, flag emerging issues, and provide guidance to watershed stewardship activities. Further research is warranted on the links between multiple types of CBWM designs and their goals to validate these findings, particularly the link between basic monitoring program designs, their goals of community education, and influencing the early prioritization phase of IWRM decision-making. An examination of the assumption held by participants in this study and other studies (e.g. Danielsen *et al*., 2009) that data rigor increases with government and staff involvement would help to shed light on the role of government perceptions of credibility with CBWM (for contrast,

see Nerbonne and Nelson, 2008). This research has implications for assisting watershed groups in focusing CBWM efforts to areas of IWRM that will be most influential in their specific contexts and contribute to protecting the short-term and long-term health of Canadian watersheds.

4.8 References

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Chapter 5: Conclusion

5.1 Introduction

Citizen science is an emerging field as public desire to understand environmental issues grows and government agencies seek new ways to collect information. Around the globe, millions of individuals are collecting valuable scientific data on their surrounding ecosystems and yet this practice of citizen science is not yet widely accepted as valid in the scientific community (Bonney *et al*., 2014). Community-based water monitoring (CBWM), a form of citizen science, has great potential to increase the information available for watershed management. However, organizations engaged in this practice continue to face capacity related challenges (Conrad and Daoust, 2008) and concerns with the accuracy of volunteer-collected data (Legg and Nagy, 2006), which affects the credibility of these programs with professionals (Sheppard and Terveen, 2010). There is a gap in the broader community-based monitoring (CBM) literature regarding case studies of successful integration of CBM and CBWM in environmental management (Conrad and Hilchey, 2011).

Based on an established record of scholarship in this area, the Social Sciences and Humanities Research Council of Canada awarded Dr. Cathy Conrad a five-year, million dollar Community-University Research Alliance grant titled, *"Community-Based Integrated Water Monitoring and Management in Nova Scotia (CURA H2O)"*. As part of this program of research, my study sought to address the aforementioned gap in the literature by identifying case study watershed groups that have experienced some degree of success in sharing their water quality data with government and influencing decision-making. The broader aims of my study were to enhance scholarly understanding of factors involved in facilitating CBWM integration and to provide lessons learned to watershed groups and government agencies that wish to use CBWM to inform governmental decision-making.

Given these aims, my study was guided by two main questions:

1) *What are the dominant factors that contribute to the successful integration of CBWM information in governmental decision-making?*
2) *What recommendations can be drawn from the experiences of these watershed groups for government agencies, other watershed groups, and CURA H2O?*

To answer these questions, my study had four main objectives:

1) *Identify cases of successful CBWM integration with governmental decision-making from across Canada.*
2) *Gather information on key factors that facilitated the ability of watershed groups to engage in CBWM that informed and influenced governmental decision-making.*
3) *Provide insights and recommendations to CURA H2O collaborators and other relevant stakeholders on some of the most promising practices for integrating their CBWM in governmental water resource management.*
4) *Contribute to the body of literature on CBWM's application in integrated water resource management (IWRM) and the fields of environmental and social geography.*

Four case study watershed groups were identified for this study through use of a database of environmental stewardship groups and selection criteria: the Quamichan Watershed Stewardship Society (British Columbia), Mid Vancouver Island Habitat Enhancement Society (British Columbia), Shediac Bay Watershed Association (New Brunswick), and Bedeque Bay Environmental Management Association (Prince Edward Island). Semi-structured interviews were conducted with watershed group coordinators and government counterparts (total of 29). Data were qualitatively analyzed using a combined inductive-deductive coding method and the dominant themes were explored and discussed in two research papers, Chapter 3 and Chapter 4. The following section highlights key findings from these papers.

5.2 Key Findings

1. *Meeting government needs, capacity building, and collaboration are mutually reinforcing factors that facilitated the use of CBWM in decision-making.*

My findings indicated that CBWM influenced decision-making when provincial and federal government department staff were involved in the entire process, from design phase to analysis, or the information was shared with the public to influence local decisions. In the course of recruiting the case studies, I was not able to identify any examples where independent CBWM had been successfully "delivered" to local government with a marked influence on decision-making. Researchers and the former Ecological Monitoring and Assessment Network have promoted the method of delivering CBWM to government for influencing local government decision-making and they have provided frameworks for doing so (e.g. Wieler, 2007; Conrad and Daoust, 2008; Vaughan *et al.,* 2003); however, watershed groups using this general approach have experience limited success in the past (Conrad and Daoust, 2008) and there is little documentation of its success in the literature. This lack of documentation and inability to identify such cases in this study could be due to the difficulty in pinpointing influences that come from a decision-maker's enhanced understanding of watershed issues. I would also suggest that there are inherent challenges for government agencies with using independently collected information in decision-making, because of accountability and credibility issues. Below, I outline some key factors that enabled the successful linkage between CBWM data and decision-making in cases where provincial and federal levels of government were involved in multiparty/government-led CBM and where CBWM helped to build public support for local government decision-making, but not for the sharing of independent CBWM information with government agencies.

From the four case groups' data, I found CBWM helped to inform and influence governmental decision-making when it met their information and decision-making needs, capacity was built through diverse means, and collaborative approaches helped to build capacity and guide CBWM into decision-making processes. Government involvement in

the design phase and training helped to ensure that the data met their needs for rigor and standardization when they directly used the data, supporting others' assertions that volunteer training is required for accurate and credible CBWM (e.g. Fore *et al*., 2001). Government involvement in CBWM was facilitated through collaborative or multiparty monitoring, which has been cited as most likely to influence decision-making in other work as well (e.g., Whitelaw *et al*., 2003; Conrad and Hilchey, 2011; Conrad and Daoust, 2008), and government-led approaches were also found to be influential in my case groups. Independent CBWM was observed to be indirectly influential with local government decision-making in the case of the Quamichan Stewards when it was linked with public support, which has been recommended for CBWM in a previous study (i.e., Conrad, 2006). They engaged in watershed management planning that helped to guide the monitoring design and the information was used to build public support for a local government decision to extend the centralized sewer system. To increase capacity for supporting long-term CBWM that informed decision-making, watershed groups and government agencies in this study engaged in multi-stakeholder partnerships (e.g. Board of Directors or research partnerships), volunteer capacity was increased through short-term rewards like feedback on results, and watershed groups sought diverse funding sources. Volunteer burnout and funding constraints are known to present ongoing challenges for CBWM (Conrad and Daoust, 2008; Whitelaw *et al*., 2003) and my study helped to identify multiple ways (outlined above) that financial and volunteer capacity can be built for CBWM that informs and influences decision-making.

2. *Strong leadership and reciprocal activities helped watershed groups and government to build mutual trust and capacity for collaboration with CBWM.*

Contrasting instances of success and failure with sharing and using CBWM information in these case studies brought to light the roles of leadership and reciprocity in building capacity and trust for collaboration with CBWM. Reciprocal exchange of mutual benefits and trust are necessary for successful collaboration (Kolm, 2008) and this study found that reciprocal activities such as providing equipment and training to volunteers in two cases of government-led/multiparty monitoring helped to build watershed groups'

capacity for long-term CBWM, which contributed to increased trust. An instance of low trust and absence of collaboration with CBWM was observed in the Maritimes when a provincial government department did not recognize benefits to alleviating financial barriers such as lab testing fees for watershed groups. The ability of government to collaborate with NGOs can be hindered by institutional limitations (Thomsan and Perry, 2005), and a certain amount of government willingness and appreciation of the benefits was also observed to be required for collaboration with CBWM in this study. For my two case studies on Vancouver Island, provincial government leaders promoted a collaborative department culture and facilitated collaboration with CBWM, which supports previous observations that municipal champions have a key role in such processes (e.g. Pollock and Whitelaw, 2005). Leadership in watershed groups helped to facilitate collaboration as well. Group coordinators from three case studies emphasized their non-political and broad-based approaches, which were found to contribute to increased credibility with government decision-makers and public support for CBWM use in decision-making.

3. *Aligning intensive, balanced, and basic CBWM program designs with goals helped to maximize the contribution of CBWM to enhancing IWRM.*

An emergent theme from this research revealed that CBWM program designs have particular strengths and weaknesses that lend themselves to achieving different goals. When program designs and goals are aligned, CBWM can contribute to two main, overlapping roles in IWRM: providing useful scientific information on watershed health and building community awareness and engagement in stewardship. Aligning the monitoring design to program goals such as influencing decision-making has been recommended in the past (e.g., Conrad and Daoust, 2008; Hunsberger, 2004; Whitelaw *et al*., 2003; Savan *et al*., 2003), but to date there has been limited practical guidance on the suitability of monitoring program designs for particular goals (for an exception see Danielsen *et al*., 2009). My study provides practical guidance to watershed groups for tailoring CBWM designs to goals by identifying three main CBWM designs and their strengths and weaknesses—intensive, balanced, and basic monitoring. Intensive

monitoring involves rigorous standards, long-term focus, high resource use (including staff), and is more directly useful for government. Basic monitoring involves straightforward protocols, is less resource intensive, and is ideal for wide community inclusion and education goals for enhanced community awareness. Balanced monitoring maintains adequate quality standards but is also conducive to volunteer involvement. A balanced CBWM design can thus help to inform both watershed management decision-making and build community awareness for supporting action on watershed issues. This study supports others' findings that credibility issues arise when program designs and goals are misaligned (e.g. Hunsberger, 2004), and misalignment also contributed to volunteer burnout in my study. A quotation from Chapter 4 highlighted one federal government employee's ongoing challenges with volunteer involvement in an intensive/balanced program design:

> 'So that was one of the [constant] challenges [emphatic] with the groups was to keep their interest, and have volunteers involved" (3-GR7).'

Intensive and balanced monitoring designs have been the focus of recent CBM literature (see for example Conrad and Hilchey, 2011; Danielson *et al*., 2005); however, groups often include education as a main goal for monitoring (Nerbonne and Nelson, 2008; Kebo and Bunch, 2013). This study emphasized the importance of considering all three monitoring designs, with particular attention to balanced designs for achieving multiple goals.

4. *Limitations to long-term CBWM and use of citizen science in governmental decision-making require a multi-faceted approach to influencing decision-making.*

After many early conversations with watershed groups from across Canada during the recruitment phase and in-depth interviews with study participants, it became evident that there are limitations to the use of long-term water quality monitoring (in general) in short-term governmental decision-making. A federal government participant talked about how decision-making requires consideration of other factors besides scientific evidence, such as public interests, political interests, and costs (3-GR9), which echoed similar assertions about the complexity of decision-making in the literature (Colfer, 2008). Also,

the participant said that scientific uncertainty associated with water quality parameters makes it difficult to associate trends with a particular impact in the watershed, suggesting instead the use of macro-scale indicators such as width of riparian buffers (3-GR9). In combination with water quality indicators, macro-scale indicators can provide low-cost options for linking land-use impacts with water quality issues in decision-making. In the case studies, short-term influences of long-term CBWM on decision-making were only evident when a threat was identified, there was relevance to government mandates (e.g. existing water quality guidelines and legislation), and there was public support for taking action. Thus, it was found herein that connecting water quality indicators to land-use impacts through models such as watershed management planning as well as building public support are important activities for enabling CBWM to influence decision-making, especially in the short-term. Long-term CBWM that was directly used by government in this study was used along with provincial and federal government monitoring for long-term decision-making involving evaluating trends, assessing risks, and prioritizing government monitoring. Volunteers can experience burnout when there is little immediate reward for their efforts (Conrad, 2006; Conrad and Daoust, 2008), and my study highlights inherent tensions with volunteer involvement in long-term, rigorous CBWM. Intensive and balanced CBWM can have an important role in informing long-term governmental decision-making; however, this research shows that its limitations must be recognized and a breadth of activity including public education is required to support the scientific evidence and initiate watershed conservation actions.

5.3 Study Challenges and Limitations

During this study, I experienced five main challenges during recruitment and data collection, and below I detail how I overcame them. These challenges provide additional insights into the complexity of using monitoring information in decision-making. I also explore two broader study limitations with implications for interpreting the study findings and recommendations, including transferability of the results and researcher bias.

Challenge #1: Flawed initial focus on CBWM data 'impacting' decision-making.
When I undertook the study, my initial understanding was that CBWM could "impact" governmental decision-making, but through further conversations with watershed groups during recruitment I gained a more accurate understanding of the long-term nature of monitoring and its infrequent use in short-term decision-making. The wording of case study criterion #3 was modified from "impacting decision-making" to "potential to influence decision-making" part way through recruitment as a result of this deeper understanding. The use of "impact" early in the selection process could have deterred some watershed groups from participating that may have fit the modified criteria.

Challenge #2: Identifying watershed groups that had influenced governmental decision-making.
I recruited watershed groups for this study by emailing and phoning their coordinators to determine how they fit a list of selection criteria. Watershed group coordinators often did not know how government used their CBWM data when it was shared with government, and so I selected cases that had more obvious influences on decision-making but there was often a significant degree of uncertainty. This finding revealed that government agencies often do not actively seek out watershed groups to inform them of how their data are used. After the groups were selected, conversations with the government counterparts revealed the long-term nature of CBWM and its use (or lack thereof) in decision-making.

Challenge #3: Deciding on government representation for each case study.
Initially, I had intended to include government counterparts that personally knew the watershed group, had used their data, and were involved in the decision-making process. It became clear during participant recruitment that government staff members (e.g. science department) who knew the watershed groups and monitoring programs the best were not involved in upper-level management decision-making. Municipal elected officials from two case studies were familiar with the watershed groups but not their

CBWM programs, and a federal decision-maker was familiar with the government-led CBWM program but not with the case study groups. Thus it was nearly impossible to find government representatives who encompassed all of those attributes. The criteria for government counterparts were expanded to include decision-makers who were somewhat familiar with the watershed group and/or monitoring program, and government staff who were not directly connected with decision-making processes. In addition, representation of government staff, decision-makers, and government levels differed between case studies because of their different CBWM programs and contexts. I decided that heterogeneity in government representation was not a major concern because analysis did not involve direct comparisons between the case studies and it was focused on the broader factors that were in common between the cases.

Challenge #4: Modifications to case study "stories of success".

The intention of this study was to showcase examples of "success stories" where long-term CBWM had influenced decision-making. After selecting the case studies, I learned that each watershed group exhibited both challenges and successes in working with government, sharing CBWM, and influencing decision-making. In one case, a provincial government program that facilitated CBWM integration in government processes was announced to be non-operational after my data analysis was complete. I had to decide whether to include these examples of non-success in the study, which involved a certain degree of social and political sensitivity. Since multiple student and researcher colleagues had recommended that I look at instances of failure and Conrad and Hilchey (2011) also recommended inclusion of case studies of challenges, I decided to modify the study design to include these examples (including government counterparts) in the broader analysis of factors. Their inclusion enabled the role of social factors such as leadership and trust to become more apparent.

Challenge #5: Selecting four case studies

I selected the case studies using a phased approach rather than selecting them with full knowledge of all of the available watershed groups, which presented logistical challenges

associated with the resulting selection of four case studies. I used a phased approach to allow for site visits to occur in the western half of Canada at a time of personal convenience in the beginning of the field season. In the first phase of recruitment, I selected two very evident cases of influencing decision-making on Vancouver Island, which meant that I needed to select two more groups from the available options in other regions for a balanced study design. During the second phase, I selected the two Maritimes groups for a total of four groups. A multiplicity of case studies resulted in a very large number of interviews for achieving data saturation (29), which made analysis of a multitude of factors very complex. To make the best use of time and answer my research questions, I kept the analysis of results to a broader examination of factors across case studies rather than a nuanced analysis of context-related factors for each case. Alternatively, I could have opted to select fewer groups with full knowledge of all of the options, which would have made analysis more straightforward and enabled more nuanced analysis of each case study context. However, I would not have had the same opportunities to reduce travel costs and include site visits for conducting in-person interviews with two very fitting case study groups, in addition to the benefits of multi-site studies for the transferability and validity of the data (see below).

Limitation #1: Transferability of findings from case studies involving success with integrating long-term CBWM in governmental decision-making.

Transferability is often a consideration in qualitative research that involves the application of study findings outside of the context in which they were identified (Baxter and Eyles, 1997) and this has implications for the applicability of these findings for other watershed groups and government agencies engaged in CBWM. A multi-site study approach and purposeful participant sampling have both been suggested for enhancing transferability (LeCompte and Goetz, 1982; Baxter and Eyles, 1997) and both were used in this study. These findings were produced within the economic, social, environmental, and political contexts of these four case studies, which would have had an influence whether or not CBWM was used by government. For example, CBWM use was often related to the involvement of government mandates such as providing safe drinking water

or when there was a clear imposition to the public, such as algae blooms. Thus, watershed groups and government agencies operating within a wide diversity of contexts will likely have very different experiences with CBWM and working with their organizational counterparts, and so these findings may not fit with their particular context or interests. There are also a wide variety of types of organizations besides watershed groups engaged in CBWM, including schools (Sheppard and Terveen, 2013), universities (Savan *et al*., 2003), regional-level organizations (Lefler, 2010), and government agencies (Sharpe and Conrad, 2006), which would include a wide variety of organizational contexts as well as motivations for monitoring. These organizations may or may not share the same desire of many watershed groups for linking their CBWM information with government decision-making. It is also worth acknowledging that my study focus on integrating long-term CBWM in governmental decision-making could have been conducive to the selection of multiparty and government-led CBWM arrangements due to government interest in long-term monitoring. This would have resulted in less attention to advocacy or educational types of monitoring outlined by Whitelaw and colleagues (2003), which makes the findings less relevant to advocacy based groups or educational institutions engaged in CBWM. These findings will thus be most applicable to watershed groups and government agencies engaged in variations of the former types of CBWM, with a mutual desire to connect CBWM information with decision-making.

Limitation #2: Researcher bias and the interpretation of findings.

Personal motivations, interests, and values can influence how one interprets qualitative data, and requires careful consideration in qualitative research (Baxter and Eyles, 1997). I approached this study with a pragmatic, solution-oriented frame of mind and so the entire study has been designed around identifying lessons learned for integrating CBWM with governmental decision-making. The interpretation of findings has also been in this light; with a focus on factors that were facilitators for CBWM (e.g. collaboration) rather than obstacle-related factors (e.g. political willingness) or context-related factors (e.g. population size) that could still have an impact. However, all of the factors that participants indicated as important were analyzed and inductive coding enabled new

themes to emerge, resulting in Chapter 4. A single-coder (myself) was used for analysis in this study, which is common in qualitative research (Altheide and Johnson, 1994); however, employing two or more coders to verify consistency of the analysis, also known as 'inter-coder reliability' (Richards, 2005), could have provided greater assurance of validity. To ensure that my personal interests and biases did not affect the accuracy of the analysis, preliminary findings were presented via webinar to participants as well as the research team and no concerns were brought to my attention. Participants were also given the opportunity to verify the preliminary analysis and use of their quotations in context and all of the feedback was incorporated into the text.

5.4 Research Contributions

By looking at case studies of successful integration of CBWM in decision-making, this research made several contributions to theoretical and methodological areas of the literature as well as the literature on CBM and CBWM. I discuss the contributions of this study to these areas of the literature below.

Theoretical contributions

Theories of collaboration have been developed to help explain multi-sectoral processes and the situations that induce them (Leach, 2011; Huxham, 2003) and successful collaboration has been increasingly sought by a multitude of types of organizations, including public sector, private, and not-for-profit organizations (Thomsan and Perry, 2006). My study contributes to this literature by providing support for key factors that have been found to facilitate collaborative governance models, including multi-stakeholder watershed partnerships, including trust (Leach and Pelkey, 2001; Ansell and Gash, 2008), leadership (Leach and Pelkey, 2001; Ansell and Gash, 2008; Ospina and Saz-Carranza, 2010), and organizational frameworks (Leach and Pelkey, 2001). My findings provide additional insight into processes of trust building, which has been highlighted as a research need for understanding collaboration (see Ansell and Gash,

2008). Specifically, this study shows the importance of reciprocal activities such as ongoing communication, sharing of resources, and having mutual benefits for facilitating collaboration and building trust. Ostrom's (1998) theory of collective action involves reciprocity, reputation (or credibility), and trust as underpinning behavioral factors for collective action (including interdependent individuals), and these were found to be important secondary factors in my study, for facilitating collaboration between watershed groups and government for sharing and using CBWM.

My findings also build on social exchange theory by providing empirical support to Molm and colleagues' (2007) assertion that the instrumental values (i.e. resources) of reciprocal relations go hand-in-hand with the symbolic values such as trust in social exchanges. This study showed that when two organizations shared resources such as funding, staff, equipment, and knowledge, it contributed to increased trust over time and the resource-related capacity of each partner. This further contributes to social capital theories, as trust and reciprocity are inherent in building social capital (Putnam, 2000), and collaboration with CBWM was found to increase trust between individuals as well as in government and supported that CBWM contributes to enhanced social capital (Bliss *et al.* 2001). My research also contributes to emerging literature on the paradox of collaboration and branding (Ospina and Saz-Carranza, 2010; Tschirhart *et al.,* 2005) by introducing the idea of an inter-organizational collaboration paradox to the CBWM and CBM literature, including the role of institutional limitations for government with collaboration, and demonstrating practices for overcoming obstacles to collaboration in these settings.

Methodological contributions

This study provides a methodological example for theory building from case studies of successes, as key factors were identified in common across four case studies in order to help explain instances of successful CBWM integration in decision-making. These over-arching factors were combined with context-specific practices to provide lessons learned for other watershed groups and government agencies. Theory building from case studies has received support in recent literature (Tsang, 2013) but has been a source of

misunderstanding in the past as case studies are often thought to be best suited for generating hypotheses rather than theory development or testing (Flyvbjerg, 2006). By conducting semi-structured in-depth interviews with watershed group coordinators and their government counterparts, case study analysis enabled the development of an understanding of the watershed groups' networks from multiple perspectives and how those inter-organizational relationships affected the sharing and use of CBWM data. I present recommendations for overcoming challenges encountered with case study selection and data collection, contributing to the literature on case study methodology, especially for similar studies involving watershed groups and their government counterparts (see 5.5 Recommendations for Future Research).

Substantive contributions to CBM and CBWM literature

Key findings in this study (outlined earlier) presented several substantive and practical contributions to the body of knowledge on CBM and CBWM. In summary, my study provides empirical evidence for the roles of trust, reciprocity, and leadership in collaborative CBWM initiatives, and the relationships between CBWM credibility, non-political approaches, and trust with government. My findings revealed that government-led approaches to CBWM can be effective in influencing decision-making, but also supported previous studies' assertions that multiparty monitoring is effective (Conrad and Daoust, 2008; Whitelaw *et al.*, 2003). My study showed that multiparty monitoring enabled the sharing of resources for enhanced capacity, building of trust, and streamlining of CBWM designs with existing decision-making processes. Multi-stakeholder partnerships and diversified funding were identified as best practices that helped to increase both government and watershed group capacity to engage in long-term CBWM. Meanwhile, watershed management planning helped to bring together stakeholders that had a mandate for land-use impacts and aligning CBWM with decision-making processes. Finally, this study builds on previous research involving CBM frameworks (see Conrad and Daoust, 2008) by providing a practical typology of three main CBWM designs, their strengths and weaknesses, and suitable goals for influencing different aspects of IWRM decision-making. I supported that basic monitoring designs

involving educational goals is most conducive to volunteer involvement, while balanced CBWM designs can effectively engage volunteers while maintaining adequate standards of rigor for providing both high quality data and raising community awareness of watershed issues.

5.5 Recommendations for Future Research

1. For future research involving case studies of CBWM use by government, it is recommended that government representatives are included in the case study selection process by contacting them after talking with watershed groups and prior to official selection of the case study. Including regional-level stewardship organizations in the identification of watershed groups would also help to extend potential case studies beyond the information available online.
2. Further research into the attitudes in government environmental departments to working in partnership with watershed groups is warranted, and exploring the role of government department culture in limiting or facilitating a collaborative approach. The role of leadership in management with facilitating collaboration could also be further explored.
3. Research on the role of power-sharing with cross-sector partnerships and multiparty monitoring is sorely needed (see also Hunsberger, 2004). An examination of multiparty monitoring within consultative, collaborative, and transformative governance structures could help to shed light on the influence of power structures on CBWM.
4. Further research is needed to identify different organizational structures, mechanisms, and tools for balancing government needs for accountability and institutionalization and watershed group needs for flexibility and capacity building with CBWM.
5. An examination of program design and goals for multiple types of CBWM programs would help to validate study findings of three main CBWM design categories. Particular attention is needed to the link between basic monitoring, educational and

community awareness goals, and influencing the prioritization phase of IWRM decision-making. A quantitative study could help to cover a breadth of regions, monitoring program types, and diverse goals.

6. Further research is warranted into the assumption that data rigor increases with government and staff involvement in monitoring. Nerbonne and Nelson (2008) found, in contrast, that data quality increased with group autonomy and reduced professional involvement. Attention to the roles of government involvement and trust as well as data rigor in government perceptions of CBWM credibility is needed.

5.6 Lessons Learned for Watershed Groups and Government

Lessons learned were compiled from a combination of an understanding of key factors for CBWM influencing decision-making derived from the data and best practices used in the case studies. Participants mentioned recommendations for future CBWM activities during the interviews, which provide additional insights into lessons learned for connecting CBWM with decision-making.

Watershed groups

1. Developing multi-stakeholder partnerships through the use of a Board of Directors, working group, committee, or other arrangement can increase capacity and collaboration with long-term CBWM.
2. Adopting a collaborative, broad-based approach including relationship building with local decision-makers and building public support can help to build trust and credibility with both government and communities.
3. Diversifying funding sources beyond government grants to private sources of funds and including diverse ecosystem-based projects can enhance overall capacity.
4. Including government staff early in the design phase of long-term CBWM can increase the credibility of data that is aimed to directly inform that same government agency.

5. Watershed management planning can help to identify key government and non-government stakeholders and tailor CBWM to a governance structure.
6. Aligning the CBWM program design to program goals according to strengths has potential to increase resource efficiency while reducing credibility issues and volunteer burnout.

Municipal, Provincial, and Federal Governments

7. Developing multi-stakeholder partnerships, such as with regional-level stewardship organizations or research institutions (especially in provincial/federal context), can increase overall capacity for supporting long-term CBWM.
8. Adopting a collaborative approach to working with watershed groups in cases where monitoring goals align can help to create mutual benefits such as increased capacity.
9. Identifying leaders in government can facilitate collaborative approaches within the government environmental departments for working with watershed groups.
10. Engaging in reciprocal practices such as sharing expertise, lending equipment, reducing lab costs, recognizing volunteer efforts, and/or ongoing communication can help to build trust in government as well as capacity for collaboration.
11. Considering program design strengths and weaknesses has potential to help reduce volunteer burnout in multiparty and government-led CBWM programs.

Participant recommendations for CBWM that is useful for government:

12. Government could invest in automated long-term monitoring stations that involve volunteers in data collection. It would then rely on the equipment for data quality and make it easier for volunteers to stay involved, thus still having benefits of including locals in monitoring their watersheds.
13. Standardized sampling methods, quality assurance/quality control, and shared databases would make the sharing of monitoring information, including CBWM, easier across government departments and organizations.
14. Making CBWM protocols available and data publically accessible online would help to facilitate sharing water quality monitoring information with government.

15. Reducing provincial lab fees for watershed groups engaged in CBWM that helps to meet government monitoring goals could be mutually beneficial.
16. Open and ongoing communication between government and watershed groups about what monitoring information is needed would help to build trust and make CBWM more useful for government.
17. Using macro-scale indicators in conjunction with or in lieu of fine-scale water quality parameters would help to connect land-use impacts with risks for decision-making. For example, the number of stream crossings in a watershed could help to indicate habitat connectivity for fish, or the area of land covered by impervious surfaces would inform impacts of stormwater runoff. The Northumberland Strait Environmental Monitoring Partnership is one such initiative that is connecting a variety of environmental monitoring initiatives, including water quality and aquatic species, with macro-scale indicators for informing land-use impacts in the watershed.

5.7 Concluding Comments

Rapid human-induced changes are being experienced in our watersheds, and water quality monitoring is necessary for enabling communities to adapt to and mitigate these growing issues. The question is not whether we should monitor, but who should monitor and how should we do it so that it can inform watershed management? This study was conducted at a time of government decentralization in Canada, with increasing pressure on government environmental budgets as well as reduced political support for science and monitoring. Reduced government capacity for monitoring has created an opportunity for communities to take more ownership of protecting their watersheds, and for government agencies to consider different sources of information that result in greater public engagement. Community engagement in monitoring has many benefits; however, government continues to have primary responsibility for watershed management in Canada and thus should not transfer the costs of assessing watershed health onto communities.

Thus, in response to the question posed above, the findings from this study indicate that both government and the public have important roles in promoting watershed management, and linking CBWM to decision-making can help to both increase public engagement and provide useful information to government. These case studies have shown that, through collaboration between watershed groups, government, and other organizations, we can build capacity for long-term CBWM that informs and influences watershed management decision-making. Ultimately, water quality monitoring is but one small part of the process in decision-making that supports proactive management, and public education is essential for addressing the root cause of watershed health issues.

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Appendix A: Potential Case Study Groups

Province	Name	Date of first email sent	Reached successfully and gauged interest
British Columbia	Christina Lake Stewardship Society	June 10th	Yes, not able to gauge interest
British Columbia	Cusheon Lake Stewardship Committee	June 10th	Yes
British Columbia	Arrowsmith Watersheds Coalition Society	June 10th	Yes
British Columbia	Esquimalt Lagoon Stewardship Initiative	June 10th	Yes
British Columbia	Friends of French Creek Conservation Society	June 10th	Yes
British Columbia	Mid Vancouver Island Habitat Enhancement Society	June 10th	Yes
British Columbia	Nad'leh Bun Watershed Enhancement Society	No (incorrect emails)	No
British Columbia	Nile Creek Enhancement Society	June 10th	Yes, not able to gauge interest
British Columbia	Osoyoos Lake Water Quality Society	June 10th	Yes
British Columbia	Qualicum Beach Streamkeepers	June 10th	Yes
British Columbia	Quamichan Watershed Stewardship Society	June 10th	Yes
British Columbia	Salt Spring Island Water Preservation Society	June 10th	Yes
British Columbia	Slocan River Streamkeepers Society (CBMN member)	June 10th	No
Alberta	Clear Hills Watershed Initiative	June 11th	No
Alberta	Medicine River Watershed Society	June 11th	Yes
Alberta	Wizard Lake Watershed and Lake Stewardship Society	June 11th	No
Saskatchewan	Spirit Creek Watershed Monitoring Committee (Friends of Spirit Creek)	June 11th	No

Province	Name	Date of first email sent	Reached successfully and gauged interest
Saskatchewan	Last Mountain Lake Stewardship Group	June 11th	No
Saskatchewan	Turtle Lake Watershed Inc.	June 11th	Yes
Saskatchewan	Swift Current Creek Watershed Stewards	June 11th	Yes
Manitoba	East Interlake Conservation District	June 11th	Yes
Manitoba	Swan Lake Conservation District	June 11th	Yes
Ontario	Bonnechere River Watershed	June 25th	Yes
Ontario	Kawartha Lake Stewards Association	June 25th	Yes
Ontario	Lake of Bays Association	June 25th	No
New Brunswick	Eastern Charlotte Waterways	June 24th	Yes
New Brunswick	Kennebecasis Watershed Restoration Committee	June 24th	Yes
New Brunswick	Petitcodiac Watershed Alliance	June 24th	Yes
New Brunswick	Shediac Bay Watershed Association	June 24th	Yes
Nova Scotia	Bluenose Coastal Action Foundation	June 24th	Yes
Nova Scotia	Municipality of the County of Kings Volunteer Lake Water Quality Monitoring Program	June 24th	Yes
Nova Scotia	Mabou Harbour Watershed Stewardship Planning Process	June 24th	No
Nova Scotia	St. Mary's River Association	June 24th	Yes, not able to gauge interest
Nova Scotia	Tusket River Environmental Protection Association	June 24th	Yes
Prince Edward Island	Bedeque Bay Environmental Management Association	June 24th	Yes
Prince Edward Island	Desable River Enhancement and Activity Management Inc. (DREAM)	June 24th	No

Appendix B: Email Recruitment Scripts

Watershed Group Coordinator Introductory Email Script:

Hello _____ (watershed group coordinator):
My name is Amy Buckland-Nicks and I am a Master of Environmental Studies student at Dalhousie University in Halifax, Nova Scotia. I am conducting a study titled "*Keys to success: Looking at the socio-political and economic factors that impact the integration of community-based watershed monitoring in decision-making."* I am working with a team of researchers at Dalhousie University and Saint Mary's University on a five-year study about integrated community-based water monitoring and management (www.curah2o.ca). The goal of my project is to identify, document, and understand key factors that impact the sharing of community-based water monitoring data with governmental decision-makers. I hope to use this information to provide recommendations for strengthening community-based water monitoring programs.
I am particularly interested in studying these factors in watershed stewardship groups in Canada that have found success with impacting governmental decision-making. Would you describe your group in that way and if so, would your watershed group be interested in participating in an interview about your experience? (Direct impacts might include land-use planning decisions, changes in policy or regulations, and other management decisions).

If you answered 'yes' to both questions, I would be interested in following up with you about participating in this study. I will be calling you within three days to answer any questions that you may have and see if you are interested in participating in this study; in the meantime, I have attached a short information package about the study for your review.

If you have any questions or you would like more information, feel free to call me at (902) 219-2184 (cell) or reply to this email.

Thanks for your time. I look forward to hearing from you.

Sincerely,

Amy Buckland-Nicks.
Master of Environmental Studies (candidate)
School for Resource and Environmental Studies
Dalhousie University, Halifax, NS
Amy.Buckland-Nicks@dal.ca
(902) 219-2184

Watershed Group Coordinator Follow-Up Email Script:

Dear _____(watershed group coordinator):

Thank you for your interest in participating in the study "*Keys to success: Looking at the socio-political and economic factors that impact the integration of citizen-generated watershed monitoring in governmental decision-making*." I am delighted to report that your watershed group fits the study criteria and has been selected for inclusion in this case study and I would be grateful to have your involvement as a participant.

In my earlier email, I attached an information sheet to describe the study in detail and outline what is involved with your voluntary participation. As mentioned in our previous correspondence, interviews will be approximately one hour long and will involve questions that seek to explore how and why community-based data are used in governmental decision-making.

Attached, you will find a consent form that I would ask you to complete by [X date]. It can be scanned and sent to me by email or faxed to (902) 494-3728. Briefly, you will have the option of withdrawing from the study, including your data, any time prior to finalization of the quotations in the text without penalty. With your permission, the interview will be audio-recorded. Identifying information, including names, will not be included with quotations unless you request that I do so. The interview will be held at a time and in a location that is convenient for you.

If you have any questions about participating in this study or would like more information, please do not hesitate to call me at (902) 219-2184 or email me at Amy.Buckland-Nicks@dal.ca. You can also direct questions to the CURA H2O project co-investigator (and my graduate supervisor) Dr. Heather Castleden (Heather.Castleden@dal.ca).

I appreciate that you have taken the time to consider participating in this study as I understand the responsibilities of watershed group volunteers are immense and at times challenging. I am hopeful that the results of this study will be valuable for your watershed group and watershed groups in general.

I will call you on [date] to see if you have any further questions about the research, the consent form, and to schedule an interview.

Sincerely,
Amy Buckland-Nicks

Government Counterpart Introductory Email Script:

Hello _____ (governmental counterpart):

My name is Amy Buckland-Nicks and I am a Master of Environmental Studies student at Dalhousie University in Halifax, Nova Scotia. I am conducting a study titled "*Keys to success: Looking at the socio-political and economic factors that impact the integration of community-based watershed monitoring in decision-making."* I am working with a team of researchers at Dalhousie University and Saint Mary's University on a five-year study about integrated community-based water monitoring and management (www.curah2o.ca). The goal of my project is to identify, document, and understand key factors that impact the sharing of community-based water monitoring data with governmental decision-makers. I hope to use this information to provide recommendations for strengthening community-based water monitoring programs.

I have been in contact with [name of individual and group] watershed group; they have agreed to participate in an interview with me as they have met some key criteria for inclusion in this study:

1) Their watershed group been established for at least six years
2) Their watershed group been engaged in water monitoring for at least two years.
3) Their watershed group self-identifies as having success in sharing their data with government decision-makers and impacting decision-making.
4) Their watershed group has at least one leader who has experienced the events leading up to the inclusion of their data in decision-making.

For this study, I also need to connect with the government decision-makers that interact with [X watershed group] and so I am writing to see if you would be willing to participate in an interview with me about how and why you came to use [X watershed group's] data? I will be calling you within three days to answer any questions that you may have and see if you are interested in participating in this study; in the meantime, I have attached a short information package about the study for your review.

If you have any questions or you would like more information, feel free to call me at (902) 219-2184 (cell) or reply to this email.

Thanks for your time. I look forward to hearing from you.

Sincerely,

Amy Buckland-Nicks.
Master of Environmental Studies (candidate)
School for Resource and Environmental Studies
Dalhousie University, Halifax, NS
Amy.Buckland-Nicks@dal.ca
(902) 219-2184

Government Counterpart Follow-Up Email Script:

Dear _____(government counterpart),

Thank you for your interest in participating in the study "*Keys to success: Looking at the socio-political and economic factors that impact the integration of citizen-generated watershed monitoring in governmental decision-making.*" As you know, the [watershed

group] has expressed interest in participating in this study and with your similar expression of interest, it means that my eligibility criteria have been met for inclusion in this case study. Therefore, I am grateful that you have also expressed interest in participating as this was a key eligibility criteria.

Attached, you will find a consent form that I would ask you to complete by [X date]. It can be scanned and sent to me by email or faxed to (902) 494-3728. Briefly, you will have the option of withdrawing from the study, including your data, any time prior to finalization of the quotations in the text without penalty. With your permission, the interview will be audio-recorded. Identifying information, including names, will not be included with quotations unless you request that I do so. The interview will be held at a time and in a location that is convenient for you.

If you have any questions about participating in this study or would like more information, please do not hesitate to call me at (902) 219-2184 or email me at Amy.Buckland-Nicks@dal.ca. You can also direct questions to the CURA H2O project co-investigator Dr. Heather Castleden (Heather.Castleden@dal.ca).

I appreciate that you have taken the time to consider participating in this study as I understand the responsibilities of decision-makers are vast and time consuming. I am hopeful that the results of this study will benefit decision-makers and watershed groups by providing insight into how monitoring information can best be shared and utilized.

I will call you on [date] to see if you have any further questions about the research, the consent form, and to schedule an interview.

Sincerely,
Amy Buckland-Nicks

Appendix C: Information Sheets

Watershed Group Leader Information Sheet

Research project: "Keys to success: Looking at the socio-political and economic factors that impact the integration of citizen-generated watershed monitoring in governmental decision-making."

This study is being conducted by Amy Buckland-Nicks, a graduate student, as part of the Community University Research Alliance project titled "Community-Based Integrated Water Monitoring and Management in Nova Scotia (CURA H2O)". The study is jointly funded by the Social Sciences and Humanities Research Council (SSHRC), the Water Economics, Governance and Policy Network (WEPGN), and Clean Foundation.

Introduction: You have been identified as a watershed group leader and, therefore, you are being invited to participate in an interview for this study. Your participation is voluntary and you can withdraw at any time prior to the finalization of how I may use quotations from your interview in the text of my thesis. The study risks, benefits, and procedures associated with the interview are outlined below.

Purpose of the study: Community-based watershed monitoring (CBWM) is growing in Canada, however many watershed groups and decision-makers encounter barriers to integrating this type of monitoring data in decision-making. Some of these barriers have been identified through research to include funding, organizational structure, and data sharing strategies. The purpose of this study is to explore cases where CBWM has been successfully integrated with governmental decision-making – [name of watershed group] is one such case. Approximately 5 "success story" watershed groups are being recruited from across Canada to participate in interviews. Looking at cases of successful partnerships will help to provide insight into innovative strategies that help other watershed groups and decision-makers overcome the barriers to CBWM. This study will make recommendations to watershed groups and governments based on the findings.

Requirements to participate in the study: In order to participate in this study, it is required that you:

1) Identify yourself as watershed group leader (Director, Chair, Coordinator, or other leadership role).
2) Your watershed group has directly impacted governmental decision-making through the use of your community-based watershed monitoring data.
3) Your group has been in operation for at least six years.
4) Your group has been collecting water monitoring data for at least two years.
5) Your government contact also agrees to participate in this study.

Your participation: You are invited to voluntarily participate in a one-on-one interview either over the phone or at a location and time that is mutually convenient. If there is more than one leader in your group that wishes to participate, there will be an option for additional one-on-one interviews or a group interview. The interview will be approximately one hour long and it will be audio-recorded with your permission. You can choose to not answer certain questions or remove comments during the interview. You have the options of checking your interview transcript for accuracy, reviewing the preliminary analysis of your interview, and check the use of your quotations in the results text. These documents will be sent to you via email (or fax if you prefer). Your comments may be included in academic or public presentations and publications but you will not be identified by name.

How this research will be used: Direct quotations from the interview may be included in the text of the study results (my Masters thesis) and published in a peer-reviewed journal, used in presentations, or appear in public reports. The names of interviewees will not be identified; instead your name will be replaced with a codename such as "Watershed Group Leader 1"; however if you want your name included you can indicate that preference on the consent form.

Benefits of this study: There are no direct benefits for participants in this study. However, one of the objectives of this study is to provide recommendations to watershed groups and government decision-makers on ways to strengthen the process of sharing monitoring data. Thus, there is potential for watershed groups and decision-makers to use

the study results to inform and improve the sharing of community-based data. A summary report of the study results will be sent to participants who select that option on the informed consent form.

Risks of this study: There is a slight social risk for participants in this study. Publication of study results and release of public reports may result in increased public attention for the participating watershed groups that could contribute to added responsibilities and strain on the group (e.g. requests for information). Also, some people may find discussing topics such as trust and power-sharing uncomfortable. As the interviewer, I will do my best to make the situation as comfortable as possible. However if you experience discomfort, we can take a break, strike out comments that you do not want included, or change the time of the interview. You may also withdraw from the study.

Withdrawal from the study: You can withdraw yourself and your data from the study simply by telling me (Amy Buckland-Nicks) or by emailing me or my supervisor (Dr. Heather Castleden). You can withdraw before, during, or after the interview up until the analysis of the transcript is complete and the quotations from your interview are included in a preliminary draft of the text. There is no penalty for withdrawing from the study.

Confidentiality: Interview confidentiality will be strictly maintained. Identifying information will be stored in a separate location from the interview transcripts. Interview transcripts and tapes will be locked in a file cabinet in the School for Resource and Environmental Studies at Dalhousie University. Data stored on a computer will be password-protected. The raw data will only be available to the graduate student (Amy Buckland-Nicks), the CURA H2O project co-investigator (Dr. Heather Castleden). It will be destroyed 5 years following the completion of the study.

Consent: A signed consent form is required to participate in this study. Prior to the interview, I will go over the information sheet and consent form with you and answer any questions that you may have. Signing the consent form indicates that you have agreed to participate in the study as an interviewee.

Questions: If you have any complaints or concerns about this research that you feel you cannot discuss with the research team, you can contact Dr. Catherine Connors, Director of Dalhousie University's Human Research Ethics Office by phone at (902) 494-3423 or

by email at ethics@dal.ca. This study has been reviewed by the Social Sciences and Humanities Dalhousie University Research Ethics Board.

Graduate Student/Interviewer

Amy Buckland-Nicks

School for Resource and Environmental Studies

Dalhousie University

Email: Amy.Buckland-Nicks@dal.ca

Phone: (902) 219-2184

CURA H2O Co-Investigator

and Graduate Supervisor

Dr. Heather Castleden

School for Resource and Environmental Studies

Dalhousie University

Email: Heather.Castleden@dal.ca

Phone: (902) 494-2966

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Decision-Maker Information Sheet

Research project: "Keys to success: Looking at the socio-political and economic factors that impact the integration of citizen-generated watershed monitoring in governmental decision-making."

This study is being conducted by principal investigator Amy Buckland-Nicks as part of the Community University Research Alliance project titled "Community-Based Integrated Water Monitoring and Management in Nova Scotia (CURA H2O)". The study is jointly funded by the Social Sciences and Humanities Research Council (SSHRC), Water Economics, Governance and Policy Network (WEPGN), and Clean Foundation.

Introduction: You are invited to participate in this study as a decision-maker. Your participation is voluntary and you can withdraw at any time prior to the finalization of how I may use quotations from your interview in the text of my thesis. The study risks, benefits, and procedures associated with the interview are outlined below.

Purpose of the study: Community-based watershed monitoring (CBWM) is a growing phenomenon in Canada, however many watershed groups and decision-makers encounter barriers to integrating this type of monitoring data in decision-making. Some of these barriers include funding, organizational structure, and data sharing strategies. The barriers are well studied but the underlying factors to these barriers are less studied; the factors that impact relationships and perceptions of CBWM. The purpose of this study is to explore cases where CBWM has been successfully integrated with governmental decision-making – [name of watershed group] is one such case. Approximately 5 "success story" watershed groups are being recruited from across Canada to participate in interviews. Looking at cases of successful partnerships will help to provide insight into innovative strategies that help other watershed groups and decision-makers overcome the barriers to CBWM. This study will make recommendations to watershed groups and governments based on the findings.

Requirements to participate in the study: In order to participate in this study, it is required that you have had ongoing direct contact with the case study watershed group.
Your participation: You are invited to voluntarily participate in a one-on-one interview either over the phone or at a location and time that is mutually convenient. There will be an option for additional one-on-one interviews or a group interview if it is preferred. The interview will be approximately one hour long and it will be audio-recorded with your permission. You can choose to not answer certain questions or remove comments during the interview. You have the options of checking your interview transcript for accuracy, reviewing the preliminary analysis of your interview, and check the use of your quotations in the results text. These documents will be sent to you via email (or fax if you prefer). Your comments may be included in academic or public presentations and publications but you will not be identified by name.
How this research will be used: Direct quotations from the interview may be included in the text of the study results (my Masters thesis) and published in a peer-reviewed journal, used in presentations, or appear in public reports. The names of interviewees will not be identified; instead your name will be replaced with a codename such as "Decision-Maker1"; however if you want your name included you can indicate that preference on the consent form.
Benefits of this study: There are no direct benefits for participants in this study. However, one of the objectives of this study is to provide recommendations to watershed groups and decision-makers on ways to strengthen the process of sharing monitoring data. Thus, there is potential for watershed groups and decision-makers to use the study results to inform and improve the sharing of community-based data. A summary report of the study results will be sent to participants who select that option on the informed consent form.
Risks of this study: There is a slight social risk for decision-makers participating in this study. Some of the topics discussed in the interview may be politically sensitive (i.e. power-sharing) and complete anonymity will not be possible, as watershed groups will be identifying the decision-makers in this study. There is a small potential for politically sensitive comments to impact your career. To protect anonymity and mitigate this risk,

names will not be included with the quotations and quotations will not be associated with identifying information. Also, participants have the option to remove comments during the interview, not answer certain questions, and verify the transcript as well as the preliminary analysis. There is also the option to verify the use of quotations in the text. Some people may find discussing topics such trust and power-sharing uncomfortable. As the interviewer, I will do my best to make the situation as comfortable as possible. However if you experience discomfort it is perfectly fine. You will always have the options of taking a break, changing the time of the interview, or withdrawing from the study at any time.

Withdrawal from the study: You can withdraw yourself and your data from the study simply by telling the principal investigator/interviewer (Amy Buckland-Nicks) or my supervisor (Dr. Heather Castleden). You can withdraw before, during, or after the interview up until the analysis of the transcript is complete and the quotations from your interview are included in a preliminary draft of the text. There is no penalty for withdrawing from the study.

Confidentiality: Complete anonymity of the decision-makers in this study will not be possible. However, interview confidentiality will be strictly maintained. Identifying information will be stored in a separate location from the interview transcripts. Interview transcripts and tapes will be locked in a file cabinet in the School for Resource and Environmental Studies at Dalhousie University. Data stored on a computer will be password-protected. The raw data will only be available to the graduate student (Amy Buckland-Nicks) and the CURA H2O project co-investigator (Dr. Heather Castleden). It will be destroyed 5 years following the completion of the study.

Consent: A consent form is attached to this information sheet. Prior to the interview, the principal investigator/interviewer will go over the information sheet and consent form with you and answer any questions that you may have. Signing the consent form indicates that you have agreed to participate in the study as an interviewee.

Questions: If you have any complaints or concerns about this research that you feel you cannot discuss with the research team, you can contact Dr. Catherine Connors, Director of Dalhousie University's Human Research Ethics Office by phone at (902) 494-3423 or

by email at ethics@dal.ca. This study has been reviewed by the Social Sciences and Humanities Dalhousie University Research Ethics Board.

Graduate Student/Interviewer

Amy Buckland-Nicks
School for Resource and Environmental Studies
Dalhousie University
Email: Amy.Buckland-Nicks@dal.ca
Phone: (902) 219-2184

CURA H2O Project Co-Investigator

and Graduate Supervisor

Dr. Heather Castleden
School for Resource and Environmental Studies
Dalhousie University
Email: Heather.Castleden@dal.ca
Phone: (902) 494-2966

Appendix D: Telephone Recruitment Scripts

Watershed Group Leader Follow-up Telephone Script (Phase 1):

Hello _____ (watershed group leader):

My name is Amy Buckland-Nicks and I am a Master of Environmental Studies student at Dalhousie University in Halifax, Nova Scotia. I am conducting a research project titled "*Keys to success: Looking at the socio-political and economic factors that impact the integration of citizen-generated watershed monitoring in governmental decision-making*." I sent you an email about three days ago to see if you would be interested in participating in this study. Did you receive the email and were you able to download and review the attachment? I was wondering if you might be interested in participating in an interview about your watershed group but before I go any further, do you have any questions?

---

1) *If 'No' to the first question:*

Well, I can tell you a bit about the study now if you like. I am working with a team of researchers at Dalhousie University and Saint Mary's University on a five-year study about integrated community-based water monitoring and management (CURA H2O project).The goal of my project is to identify, document, and understand key factors that impact the sharing of community-based water monitoring data with governmental decision-makers. I hope to use this information to provide recommendations for strengthening community-based water monitoring programs.

I am particularly interested in studying these factors in watershed stewardship groups in Canada that have found success with impacting governmental decision-making. Would you describe your group in that way and if so, would your watershed group be interested in participating in an interview about your experience? (Direct impacts would include land-use planning decisions, changes in policy or regulations, and other management decisions).

---

2) *If 'Yes' to the first question and No to the second:*

That's great. I am interested in studying watershed stewardship groups that have found success with impacting governmental decision-making. Would you describe your group in that way and if so, would your watershed group be interested in participating in an interview about your experience? (Direct impacts might include land-use planning decisions, changes in policy or regulations, and other management decisions).

(If yes to the second question, I will take time to answer their questions before proceeding)

If 'yes' is answered to both questions posed in either scenario 1 or 2 above:

That is great. Thank you!

I will send you an information package about the study and a consent form but before we go much further, there are a few key criteria that I am using to determine watershed group eligibility to participate.

First, I need to confirm:

6) Has your watershed group been established for at least six years?
7) Has your watershed group been engaged in water monitoring for at least two years?
8) Does your group have at least one leader who was present for the events leading up to the use of your data in decision-making?

Finally, in addition to speaking with you and, other leaders in your watershed group if there are any, this research project also involves speaking with the governmental decision-makers that have integrated your water monitoring data. With your permission, I would contact them to invite them to participate in a similar interview. Are you comfortable with that? And if so, could I get their names and contact information now or in the next few days?

Thank you for offering that information. I will be finalizing the selection of case study groups once I have confirmation that the decision-makers are also interested in participating in the study and conduct interviews in the next couple of weeks. I will keep you informed by email and for now I will send you an information package. Do you have any questions at this time? Thanks for your time, bye for now and have a good day.

If 'no' to the first question and 'yes' to the second question:
At this time, my study is focused on groups that have already directly impacted decision-making because of my interest in factors that strengthen data sharing. If there are any changes to the study that would make these criteria more flexible, I will let you know. Thanks for your interest in the study and for your time. Have a good day.

If 'yes' to the first question and 'no' to the second question:
Ok, thanks for your time. If you change your mind, or if you know another watershed group potentially interested in this study, you can contact me at this number or by email at Amy.Buckland-Nicks@dal.ca. Have a good day.

If 'no' to both questions:
Alright, thanks for your time. Have a good day.

Decision-maker Follow-up Telephone Script (Phase 2):

Hello_____ (decision-maker):
My name is Amy Buckland-Nicks and I am a Master of Environmental Studies student at Dalhousie University in Halifax, Nova Scotia. I am conducting a research project titled "*Keys to success: Looking at the socio-political and economic factors that impact the integration of citizen-generated watershed monitoring in governmental decision-making*." I sent you an email about three days ago to see if you would be interested in participating in this study. Did you receive the email and were you able to download and review the attachment? I was wondering if you might be interested in participating in an

interview about your interaction with the watershed group but before I go any further, do you have any questions?

1) *If No to the first question:*

Well, I can tell you a bit about the study now if you like. I am working with a team of researchers at Dalhousie University and Saint Mary's University on a five-year study about integrated community-based water monitoring and management (CURA H2O project).The goal of my project is to identify, document, and understand key factors that impact the sharing of community-based water monitoring data with governmental decision-makers. I hope to use this information to provide recommendations for strengthening community-based water monitoring programs.

I have been in contact with [name of individual and group] watershed group; they have agreed to participate in an interview with me as they have met some key criteria for inclusion in this study:

1) Their watershed group been established for at least six years
2) Their watershed group been engaged in water monitoring for at least two years.
3) And their watershed group self-identifies as having success in sharing their water monitoring data with government decision-makers.

For this study, I also need to connect with the government decision-makers and so I am calling to see if you would be willing to participate in an interview with me about how and why you came to use [X watershed group's] data?

2) *If 'Yes' to the first question and No to the second:*

That's great. Would you be willing to participate in an interview with me about how and why you came to use [X watershed group's] data?

(If yes to the second question, I will take time to answer their questions before proceeding)

If 'yes' to the question posed in either scenario 1 or 2 above:

That is great. Thank you for your interest in this study! I am planning to conduct interviews with both the watershed group leaders and decision-makers that are connected

to the watershed group in the next couple of weeks. In the meantime, I will send you an email with an information package and a consent form and we can arrange a time for me to answer any of your questions and then book an interview. Do you have any questions at this point? Are there any other governmental decision-makers that I should be connecting with that you aware of who are working with [x watershed group]? Could I get their names/contact information? Thanks again and I look forward to talking more with you. Have a good day.

If 'no' to the question posed in either scenario 1 or 2 above:
That is alright. Thanks for your time, and if you change your mind you can contact me at this number or by email at Amy. Buckland-Nicks@dal.ca. Have a good day.

Appendix E: Informed Consent Forms

Watershed Group Leader Informed Consent Form

Research Project: "Keys to success: Looking at the socio-political and economic factors that impact the integration of community-based watershed monitoring in decision-making."

1. Do you understand that you have been asked to participate in a research study?

Yes No

2. Have you received and read a copy of the attached Information Sheet?

Yes No

3. Do you understand the benefits and risks involved in taking part in this research?

Yes No

4. Have you had an opportunity to ask questions about this study with a research team member?

Yes No

5. Do you understand that you can stop taking part in this study at any time?

Yes No

*You do not have to say why you have decided to withdraw.

6. Do you understand how the research team will strive for confidentiality of your data?

Yes No

7. Do you understand who will have access to your interview data?

Yes No

8. Do you understand that the research team will be contacting decision-makers that have previously been in contact with your watershed group to participate in data collection?

Yes No

9. Do you consent to being audio-recorded?

Yes No

10. Do you consent to quotations of comments from your interview being used in the study?

Yes No

11. Would you like your name to be included with quotations?

Yes No

12. Would you like to review a copy of your transcript to check for accuracy?

Yes No

13. Would you like to receive and comment on a summary of our preliminary analysis?

Yes No

14. Would you like to see how quotes from your interview are used before report(s) are finalized?

Yes No

15. Would you like an electronic copy of the final report?

Yes No

16. Would you like to participate in future studies undertaken by CURA H2O?

Yes No

I agree to participate in this research project.

_____

Date

_____

Printed Name

Interviewer (Amy Buckland-Nicks)

_____

Signature

_____

Date

Thank you for your participation.

DALHOUSIE UNIVERSITY
Inspiring Minds

Decision-Maker Informed Consent Form

Research Project: "Keys to success: Looking at the socio-political and economic factors that impact the integration of community-based watershed monitoring in decision-making."

1. Do you understand that you have been asked to participate in a research study?

Yes No

2. Have you received and read a copy of the attached Information Sheet?

Yes No

3. Do you understand the benefits and risks involved in taking part in this research?

Yes No

4. Have you had an opportunity to ask questions about this study with a research team member?

Yes No

5. Do you understand that you can stop taking part in this study at any time?

Yes No

*You do not have to say why you have decided to withdraw.

6. Do you understand how the research team will strive for confidentiality of your data?

Yes No

7. Do you understand who will have access to your interview data?

Yes No

8. Do you understand that the research team will be contacting a watershed group with whom you have contact to participate in data collection?

Yes No

9. Do you consent to being audio-recorded?

Yes No

10. Do you consent to quotations of comments from your interview being used in the study?

Yes No

11. Would you like your name to be included with quotations?

Yes No

12. Would you like to review a copy of your transcript to check for accuracy?

Yes No

13. Would you like to receive and comment on a summary of our preliminary analysis?

Yes No

14. Would you like to see how quotes from your interview are used before report(s) are finalized?

Yes No

15. Would you like an electronic copy of the final report?

Yes No

I agree to participate in this research project.	Interviewer (Amy Buckland-Nicks)
_____	_____
Date	Signature
_____	_____
Printed Name	Date

Thank you for your participation.

Appendix F: Interview Guides

Note: These interview questions were adapted to each participant and modified based on their experience and relevance of the questions. They provide an idea of what the researcher sought to find out from each participant. Interviews followed a semi-structured format that enabled participants to bring up additional topics to discuss.

Watershed Group Leader Interview Guide

Thank you for agreeing to participate in this study on factors that impact the use of community-based monitoring data in governmental decision-making. I will first tell you a little bit about how this interview will go and remind you of some options that you have during the process. I will be asking you questions that will guide our conversation around what is working well for your watershed group with respect to engaging government decision-makers. I am interested in your experience as a watershed group leader and so there are no right or wrong answers. The interview will be approximately one hour long and it will be audio-recorded (unless the participant did not consent).

At any time during the interview, you have the options of taking a break, removing comments from the record, not answering a certain question, or withdrawing from the study entirely. If you withdraw, none of your statements will be used in the study and there is no penalty for withdrawing. It is my priority to ensure that the interview is as comfortable for you as possible and so feel free to let me know when you need something changed. I want to remind you that your name will not be associated with any quotations taken from this interview and a codename will be used instead (unless specified that the participant wanted their name included). The only people who will have access to the interview records are my two university supervisors and myself. The transcripts, digital recordings, and identifying information will be stored securely at the School for Resources and Environmental Studies at Dalhousie University and will be destroyed 5 years after the study is completed.

Do you have any questions before we proceed?

Okay, I'm going to turn the recorder on. Let's get started!

General Questions:

1. I would like to first start off with getting to know your watershed group. Could you tell me a bit about how the group got started and your main activities?
    a. Why was the group initiated and when?
    b. What are the main priorities of the group (goals/ vision)?
    c. How many active members are in the group?
    d. What are the experiences of the members? (e.g. professional monitoring)
    e. How is the group funded?
    f. What monitoring activities does the group engage in? Other activities?
    g. How would you describe the quality of your data?
    h. How do you think other watershed groups and decision-makers perceive the quality of your data?
    i. What measures does your group take to ensure quality of the data? For example, monitoring protocols.
    j. How do you work with other groups, decision-makers, etc?

2. What is your role with the watershed group?
    a. How long have you been involved, and why did you become involved?
    b. How often do you interact with decision-makers on behalf of the group?
    c. Have you had prior experience working for government or collaborating with government employees in the past?

Impacting Decision-Making

3. Can you tell me about how and why your water monitoring data has been linked with governmental decision-makers?
    a. How did you connect with decision-makers? How were the data used?
    b. Do you think it has impacted decision-making? Why or why not?
    c. What level of government was involved? (municipal/provincial/federal)

d. Were there or are there any particular environmental or social issues of particular concern that prompted this sharing of data?
e. Can you describe any obstacles that your group has had to overcome.
f. Was your group involved in the decision-making process, or did you just provide the data?

Influencing Factors

4. What would you say were the 2 or 3 biggest factors that influenced your group's ability to connect your data with decision-makers?
    a. Prompts if needed: social, political, or financial?
    b. Of those 2 or 3, which is the biggest influencing factor, in your view?
5. Could you describe your (or your group's) relationship with the decision-maker(s) who ended up using the monitoring data?
    a. How long were they in contact with your group before they started turning to you for your water monitoring data?
    b. Who initiated the relationship? Your group or the government decision-maker? Can you describe that process?
        i. What kind of interactions did you have, and how many? (In-person individual meetings/phone calls/multi-stakeholder meetings)
    c. Does their department provide any guidance or funding support to your group?
    d. How would you describe your relationship with the decision-maker?
    e. Prompt if needed: partnership; one-way you to them; one-way them to you; bi-directional; etc.
    f. Do you think that the relationship is mutually beneficial?
6. What role do you think mutual trust plays in your relationship with decision-makers?
    a. How has your relationship evolved over time?
    b. Was or is lack-of-trust ever an issue on the decision-maker's side? On your side?

c. Do you think quality of the quality of the monitoring information is influential in building trust with decision-makers?
d. Do you think that your source and stability of funding has a role in enabling decision-makers to trust your group's data?

7. How did your group feel after learning that the government would use your data to inform decision-making?
    a. What benefits arose for those involved with the group, the community, the decision-makers?
    b. Did you or your group feel empowered by influencing decision-making? Why or why not?

Thank you very much for talking with me. I don't think there is anything left for me to ask you about but I wonder if there might be something that you wanted to say that I haven't asked you?

Ok, thank you. I just wanted to re-emphasize that everything you've shared today will remain confidential and a codename will be used in any publications, reports, or presentations. If you have any questions or concerns regarding today's interview please do not hesitate to contact me, any member of the research team, or the Dalhousie research ethics office. Before we wrap up, however, I wanted to ask if you have any suggestions for additional participants for this study from your watershed group or the government decision-makers you share your water monitoring data with?

If participant has checked off that he/she would like to see either transcript of preliminary analysis then say: That's all for now, I'll be in touch with a copy of your transcript for you to review and/or a copy of our preliminary analysis for your comment. Thanks so much, it was great to talk to you! [END].

Decision-maker Interview Guide

Thank you for agreeing to participate in this study on factors that impact the use of community-based monitoring data in decision-making. I will first tell you a little bit

about how this interview will go and remind you of some options that you have during the process. I will be asking you questions that will seek to guide our conversation around factors such as credibility and power-sharing that influence decision-making. I am interested in your experience as a decision-maker and so there are no right or wrong answers. The interview will be approximately one hour long and it will be audio-recorded (unless the participant did not consent).

At any time during the interview, you have the options of taking a break, removing comments from the record, not answering a certain question, or withdrawing from the study. If you withdraw, none of your statements will be used in the study and there is no penalty. It is my priority to ensure that the interview is as comfortable for you as possible and so feel free to let me know when you need something changed. I want to remind you that your name will not be associated with any quotations taken from this interview and a codename will be used instead (unless specified that the participant wanted their name included). The only people who will have access to the interview records are my two supervisors and myself. The transcripts, digital recordings, and identifying information will be stored securely at the School for Resources and Environmental Studies at Dalhousie University and will be destroyed 5 years after the study is completed.
Do you have any questions before we proceed?
Okay, let's get started!

General Questions:

1. I would like to start off by asking you to describe the mandate of your department and your role in the organizational structure of the department (who do they report to; what authority do they have to make decisions).
2. Great, thanks. Next could you describe how your department became involved with the [watershed group]?
    a. What is your level of involvement with the watershed group?
    b. What has your role been with their community-based monitoring activities? (guidance, expertise, analyzing data, using the data)

3. How would you describe the nature of your relationship with the watershed group (Probes: e.g. partnership, one-way from them to you, one-way from you to them, bi-directional, etc).
4. Do you think that the relationship is mutually beneficial?

Use of Monitoring Data in Decision-making

5. Can you tell me about your experience with integrating water quality data generated from this watershed group?
    a. Were their data useful for your department?
    b. How would you describe the quality of their data?
    c. How were the data incorporated into management decisions?
    d. Could describe any challenges with using the monitoring data, or obstacles that had to be overcome?
    e. Does using [watershed group's] monitoring data mean that you think that they are a credible source of water quality information? If so, what makes them credible?

Influencing Factors

6. Do you feel that community-based groups, in general, are a credible source of water quality monitoring data?
    a. Is [watershed group] a special case or can credibility be generalized?
    b. What factors might make some watershed groups more credible than others?
    c. Are there particular times or instances when it is appropriate to use community-based data in decision-making? Could you give me some examples?

       Are there any times or instances when it is not appropriate? Could you give me some examples?
    d. What can community-based groups do to enhance the likelihood of their data being useful for decision-making?

7. What are some of the risks that you associate with using community-based monitoring data in decision-making? What are some of the benefits (for decision-makers, for the community group)?
8. Do you think that collaboration with government early on in the process is important when community groups want to see their community-based data used in governmental decision-making?
9. What role do you think mutual trust plays when collaborating with watershed groups?
    a. Trust on the part of the community group?
    b. Trust on the part of the decision-maker?
10. Are there any other factors not yet mentioned that might influence your ability, as a decision-maker, to use community-based data?

Thank you very much for talking with me. I don't think there is anything left for me to ask you about but I wonder if there might be something that you wanted to say that I haven't asked you?

Ok, thank you. I just wanted to re-emphasize that everything you've shared today will remain confidential and a codename will be used in any publications, reports, or presentations. If you have any questions or concerns regarding today's interview please do not hesitate to contact me, any member of the research team, or the Dalhousie research ethics office. Before we wrap up, however, I wanted to ask if you have any suggestions for additional participants for this study from your department or others in government?

If participant has checked off that he/she would like to see either transcript of preliminary analysis then say: That's all for now, I'll be in touch with a copy of your transcript for you to review and/or a copy of our preliminary analysis for your comment. Thanks so much, it was great to talk to you! [END]

Appendix G: Codebook

Note: This list of codes was compiled for deductive analysis of the interviews after searching the CBWM literature and the theoretical framework for potential key factors that may facilitate the integration of CBWM in decision-making and other areas of interest to the research team.

Information source	Research interest	Deductive code
Background literature (theoretical frameworks, seminal CBWM papers)	Factor	Trust
	Factor	Perceptions of credibility
	Factor	Individual relationships
	Factor	Partnerships/social networks
	Factor	Organizational stability
	Factor	Financial resources
	Factor	Leadership
	Factor	Power-sharing
	Factor	Willingness
	Factor	Reciprocity
Thesis research questions and objectives/CURA H2O research questions	Research question	Examples of CBM uptake in decision-making
	Research question	Key factors that facilitate or constrain sharing CBM with decision-makers
	Objective	Recommendations for best practices with integrating CBM
	CURA H2O	Government values of CBM data
	CURA H2O	State of government and CBM programs
	CURA H2O	State of linkages between government employees/decision-makers and CBM groups

Information source	Research interest	Deductive code
Interview guide	Context/Research interest	Ideal or future scenario for role of CBM in monitoring network
	Context/Research interest	Perspective on usefulness or role of CBM (government)
	Context/Research interest	Government role in CBM

Appendix H: Final Coding Structure

Note: The original coding structure included, in addition to those below, the parent nodes: "Case Study and Participant Info", "Logistical codes" (including "quotations", paraphrases", and others), and "Recommendations" (containing a single child node). These codes helped to navigate the interviews, but were left out due to space. The "Key factors for sharing CBM and influence decision-making" and "Potential future roles of CBM and its actors" parent nodes are included below and are the basis for the findings.

Parent node 1: Key factors for sharing CBM and influencing decision-making

Child nodes				Sources	References
Level 1	**Level 2**	**Level 3**	**Level 4**		
Capacity				22	66
	Context-related factors			19	39
	Funding capacity*			28	175
		Financial resources for CBM		25	97
		Importance of even distribution of funding		9	22
		Pros and cons of funding types		13	42
		Role of diverse programs, partners, funding		21	62
		Vulnerability of groups to losing government funding		7	16
	Group independence			9	23
	Importance of continuity			23	67
	Importance of understanding each other's capacity			16	40
	Knowledge capacity			27	153
		Social networks		13	31
	Limited government capacity			24	83

Child Nodes				Sources	References
Level 1	**Level 2**	**Level 3**	**Level 4**		
		Role of increased reliance on watershed groups		12	38
	Link between capacity, coordination, and standardization of methods			2	9
	Link between funding, staffing, and capacity			13	30
	Link between partnerships and capacity			20	54
	Technological capacity			19	65
	Volunteer and staff capacity			26	127
		Comparison of paid staff versus volunteers in CBM		15	36
		Importance of immediate versus long-term reward		11	20
		Importance of well-functioning board		15	26
Meeting government needs				15	34
	Challenges with using CBM in decision-making			8	19
	Goals and focus			22	81
		Importance of a watershed management plan		10	20
	Importance of CBM program design and plan			16	52
	Importance of coordination			19	60
		Importance of government level of interest and use for data		18	54
		Importance of integrating CBM in framework		18	56

Child Nodes				Sources	References
Level 1	**Level 2**	**Level 3**	**Level 4**		
		Importance of non-duplication with monitoring		6	14
		Lack of coordination contributes to failed partnerships		3	4
	Importance of standardization and training			24	110
	Perceptions of credibility*			8	20
		Credibility with CBM		22	66
	Role of accessible database			15	52
	Role of quality results and positive feedback			12	30
Partnership*				25	132
	Attitude and approach			24	125
		Community involvement		23	70
			Importance of community perceptions	14	56
			Importance of community support and interest	19	47
			Importance of community values	8	16
			Role of education and awareness	21	49
			Role of ownership	9	13
		Importance of being inclusive		7	12
		Importance of neutral evidence and approach		7	14
		Importance of not politicizing		4	10

Child Nodes				Sources	References
Level 1	**Level 2**	**Level 3**	**Level 4**		
		Importance of seeking out opportunities		8	13
		Multi-stakeholder, watershed, ecosystem-based approach		16	42
		Role of mutual respect		7	15
		Role of open-mindedness		11	14
	Good communication			21	101
		Government changeover affects relationships		7	7
		Role of miscommunication and misunderstandings in failed partnership		5	13
	Government and group coordinator perceptions			22	77
	Government department culture			4	9
	Importance of commitment from watershed group			13	22
	Importance of government involvement			20	101
	Importance of government support			18	36
	Importance of recognition			12	22
	Importance of suitability			11	26
	Individual relationships*			29	235
	Individual relationships influence with CBM			21	91

Child Nodes				Sources	References
Level 1	**Level 2**	**Level 3**	**Level 4**		
	Leadership*			13	42
		Leadership with CBM		8	12
		Link between leadership and partnership		4	5
		Role of individual personalities		15	46
	Obstacles to partnerships with government			19	58
	Opportunities can arise from partnerships			11	22
	Partnerships with CBM			22	108
	Perspectives on role of regional umbrella group			10	26
	Power-sharing*			10	16
		Hierarchy and decision-making		15	28
	Reciprocity*			12	28
		Reciprocity with CBM		19	62
	Role of government priorities and traction			22	60
	Role of mutual benefit			19	37
	Role of mutual-understanding and knowledge-sharing			24	89
	Trust*			10	22
		Trust with CBM		10	24
	Willingness*			14	29
		Willingness with CBM		15	32
Understanding government processes and decision-making				14	52
	Understanding role of water monitoring in decision-making			22	74

Child Nodes				Sources	References
Level 1	**Level 2**	**Level 3**	**Level 4**		
		Limitations with using long-term data in decision-making		7	15

* Indicates a code selected deductively through literature and theoretical framework.

Parent node 2: Potential future roles of CBM and its actors

Child Nodes				Sources	References
Level 1	**Level 2**	**Level 3**	**Level 4**		
Bottom-up vs top-down approach with watershed groups and CBM				12	34
Government role in CBM				25	127
	Comparison of government levels with CBM			19	55
	Government responsibility with monitoring			15	42
	Government role with watershed management plan			14	36
Perspectives on role of watershed groups in governance				18	39
	'On the ground'			12	24
	Role of local knowledge in understanding issues			11	16
Perspectives on usefulness and role of CBM				28	215
	CBM as supplementing government monitoring			2	6

Child Nodes				Sources	References
Level 1	**Level 2**	**Level 3**	**Level 4**		
	Government values of CBM and community groups**			18	92
	'Ideal to have local people doing the monitoring'			14	23
	Not rocket science			7	7
	Perspective on potential for involvement of groups in analysis			7	14
	Responsibility of watershed groups vs. government to initiate			8	18
	Risk of adversarial or independent monitoring			5	9
	'Two fold benefit' or roles of CBM			15	34
State of government monitoring and CBM programs**				24	77
	Driver of CBM			16	39

* Indicates a code selected deductively through literature and theoretical framework.

** Indicates a code selected deductively because of CURA H2O research team interests.