COMMUNITY-BASED WATER MONITORING: A CASE STUDY OF THE OAK RIDGES MORaine, ONTARIO, CANADA

by

Erin Murphy-Mills

A thesis submitted to the Graduate Program in Environmental Studies

in conformity with the requirements for

the Degree of Master of Environmental Studies

Queen’s University

Kingston, Ontario, Canada

January, 2015

Copyright ©Erin Murphy-Mills, 2015
Abstract

The existence of community-based ecosystem monitoring activities is a relatively new concept that has been on the rise in past years for several reasons, including decreased governmental funding and capacity for monitoring, a growing awareness of environmental issues and a desire to participate in environmental planning and protection (Au et al., 2000; Bliss et al., 2001; Sharpe and Conrad, 2006; Sharpe et al., 2000). Water quality monitoring has become one of the most widespread types of community monitoring (Devlin, 2011). This research project is part of a larger initiative called the CURA H2O Project, based out of St. Mary’s University, Nova Scotia, Canada. CURA H2O looks at streamlining community-based water monitoring and resource management, with a focus on Nova Scotia. The province currently lacks a comprehensive policy water management framework (Sharpe and Conrad, 2006), but has very active community groups monitoring water resources to fill in the governance gap. This research project relates to one of CURA H2O’s objectives to review the state of CBM in Canada: the purpose of this research project is to investigate the state of community-based water monitoring in Southern Ontario, Canada, focusing on the Oak Ridges Moraine (ORM) landscape north of the Greater Toronto Area as a case study. The ORM was chosen for its ecological and hydrological significance, as well as the history of environmental activism and its water governance framework. The qualitative methods used to obtain this data included a literature review, in-depth interviews and a workshop with relevant stakeholders, as well as a document analysis of grey literature related to CBM. The main findings from the research project can be summarized as follows:

1. Water governance in Ontario involves multiple stakeholders.
2. CBM on the ORM takes the form of water quality and quantity, as well as policy monitoring.
3. Government agencies are involved in CBM initiatives, although it is not officially recognized.
4. CBM groups face many barriers which inhibit their ability to impact decision-making.
5. Participation in CBM is likely to increase in the future.
6. CBM programs in Nova Scotia and the ORM have some similarities and differences.
Acknowledgements

Completing this thesis would not have been possible without support from many corners! My family has been a very important part of this process—with four siblings, and a very supportive mom, I could always count on someone to be there when I needed them—I couldn’t have done it without any of them! I hope that I’ve made them proud with my hard work these past two years.

I was very lucky to have such a wonderful group of fellow MESers to spend two years with—we struggled together and celebrated together, and my Master’s experience wouldn’t have been the same without the wonderful friends that I’ve made over the past couple years. Working together in the MES office, going out to grad club, and commiserating over the thesis writing process, have all contributed to robust friendships that I hope to continue enjoying well into the future.

I would like to thank my fellow researchers out east with the CURA H2O Project—I’m so proud to contribute to such an important topic, and to have gotten the chance to know some great people as I’ve worked on this project. Thanks also go out to the MES department at Queen’s, and all the wonderful people I’ve gotten to known over the years, and who have helped me or encouraged me to strive for more and work harder. Everyone at the Cataraqui Region Conservation Authority deserves acknowledgement as well, for being patient as I have juggled working full-time and wrapping up my thesis, so I would like to thank them for all their encouragement.

And finally, I wouldn’t have gotten anywhere without my supervisor! I knew I wanted to work with Graham as soon as I took his environmental assessment course, and I was lucky enough that he accepted me as a grad student when I applied. Graham has proven to be a wonderful supervisor, with a mixed approach of hands-off to let me mould my own research project, and hands-on to guide me when I needed it. As Graham’s student, I’ve been given many opportunities to present my research project at conferences, explore the CURA H2O Project first-hand, and connect with some inspiring people across
the ORM and Nova Scotia. My deepest and heartfelt thanks go to Graham for taking a chance on me, and encouraging me to push myself so that I could achieve more than I thought I could.

Writing this thesis has been both challenging and rewarding—I’ve enjoyed the research process of exploring CBM as a concept and as a continually adapting and improving on-the-ground initiative. I hope that the findings from my thesis will have a positive impact on the practice of CBM on the ORM, Nova Scotia, and elsewhere in Canada, so that one day a graduate student can work on a project to explore community-based water monitoring as a known success story, rather than a work-in-progress. Once again, thanks go out to everyone who encouraged me and helped me—this thesis has been a labour of love that I couldn’t have done without a little help from my friends and family!
Table of Contents

Abstract .................................................................................................................................................. ii
Acknowledgements ................................................................................................................................. iii
List of Tables ........................................................................................................................................ viii
List of Figures ......................................................................................................................................... ix
List of Abbreviations ............................................................................................................................ x
Chapter 1 Introduction .......................................................................................................................... 1
Chapter 2 Literature Review ................................................................................................................... 8
  2.1 History of Community-Based Monitoring ......................................................................................... 8
    2.1.1 A Brief Overview of the Historical Development of Community-Based Monitoring .... 8
    2.1.2 Definition of Community-Based Monitoring ........................................................................... 9
    2.1.3 Recent Growth in CBM ........................................................................................................... 10
    2.1.4 Benefits Associated with CBM ............................................................................................... 12
    2.1.5 Challenges Associated with CBM ........................................................................................... 14
  2.2 Current Status of CBM ...................................................................................................................... 18
  2.3 Future of CBM ................................................................................................................................. 19
  2.4 Water Governance ............................................................................................................................ 20
    2.4.1 Watershed Planning in Ontario ............................................................................................... 24
    2.4.2 How can CBM influence water governance? .......................................................................... 26
    2.4.3 What is the Role of Government/Agencies in CBM? ............................................................... 28
Chapter 3 Methods ................................................................................................................................. 31
  3.1 Literature Review ............................................................................................................................ 32
  3.2 Interviews ......................................................................................................................................... 33
Table 2 ..................................................................................................................................................... 37
3.3 Document Analysis........................................................................................................38

Table 3 ................................................................................................................................38

3.4 Data Analysis................................................................................................................40

3.5 Knowledge Mobilization ...............................................................................................44

3.5.1 Confirmation of Methods..........................................................................................44

3.5.2 CURA H2O Workshop and Research Meeting .....................................................45

Chapter 4 Results and Discussion .....................................................................................47

4.1 Document Analysis: Results and Discussion ...............................................................47

4.1.1 What is the Current Status of Water Governance on the ORM? .........................48

4.1.2 What are the Types of CBM Initiatives that are Taking Place on the ORM with a Particular Focus on Water? .................................................................51

4.1.2.1 Becoming Involved in CBM on the ORM .........................................................54

4.1.2.2 Check Your Watershed Day .............................................................................58

4.1.2.3 Monitoring on the ORM .................................................................................69

4.1.3 What Role do Government Agencies Play in CBM on the ORM? .....................77

4.1.3.1 Coordinating CBM with Government Monitoring .........................................77

4.1.3.2 The Role of CAs within CBM ........................................................................81

4.1.4 What are the Challenges and Successes Associated with CBM on the ORM? ....86

4.1.4.1 CBM and Adaptive Management ..................................................................86

4.1.4.2 Communicating CBM Data .............................................................................91

4.1.4.3 CBM and Decision-making ..........................................................................94

4.1.4.4 Barriers to Establishing CBM .......................................................................98

4.1.4.5 Data Quality ...................................................................................................100

4.1.4.6 Funding ..........................................................................................................103

4.1.4.7 Government Cutbacks ..................................................................................105
4.1.5 What is the Future of CBM on the ORM? ................................................................. 108

4.2 Knowledge Mobilization ................................................................................................. 113

4.2.1 Collaboration ................................................................................................................ 113

4.2.2 The Use of CBM in Nova Scotia when Government-trained ...................................... 115

4.2.3 Working across Traditional Boundaries ................................................................. 116

4.2.4 Age of CBM Programs in Nova Scotia ....................................................................... 116

4.2.5 Role of CAs: Nova Scotia Perspective ....................................................................... 116

4.2.6 Policy Monitoring ......................................................................................................... 119

Chapter 5 Contributions to Theory and Practice ................................................................. 122

5.1 Contributions to Theory ................................................................................................. 122

5.2 Contributions to Practice: Conceptual Framework ....................................................... 128

5.3 Contribution to Practice: Recommendations .............................................................. 130

Bibliography ........................................................................................................................... 135

Appendix A Ethics Approval ................................................................................................. 154

Appendix B Interview Questions .......................................................................................... 155
List of Tables

Table 1. A list of keywords and search terms used to review the literature. Words were chosen based on their relevance to the research topic and research questions, and were confirmed based on input from the thesis committee. .................................................................32

Table 2. A summary of respondents who participated in an interview. Participants are only identified by their role in community-based monitoring/which organizations they worked for and a number to differentiate between multiple participants in a category. Participants came from a variety of backgrounds. ........................................................................................................37

Table 3. A summary of the documents included in the document analysis. Grey literature was included from multiple sources. ........................................................................................................................................38

Table 4. This table outlines the nodes and sub-nodes used to organize the results from the document analysis. The type of node/sub-node is identified as being either deductive (the theme was determined during data analysis) or inductive (the theme emerged during data analysis). The title of the node/sub-node is identified, and can be referenced during the chapter to understand which research question the node is answering. ........................................................................43

Table 5. A full list of all presentations (oral and poster) related to thesis research. The type of presentation, the location of the presentation, and the year of the presentation is provided. Each presentation represents an opportunity where the research methods were peer-reviewed to confirm their applicability for this type of research project........................................45

Table 6. This table names non-governmental organizations involved in community-based water monitoring on the Oak Ridges Moraine, and provides a brief summary of the non-governmental organization’s activities. This list may not be comprehensive, and is based on information provided during the interviews and a review of the grey literature. Some non-governmental organizations involved in community-based monitoring on the moraine are not named, to protect the privacy of some interviewees.................................................................53
List of Figures

Figure 1. This figure summarizes the conceptual framework developed based on results from the interviews and grey literature, as well as the literature review. Any relevant planning process should be informed by monitoring data on the implementation of the plan, in order to continuously improve the planning process and carry out AEM. It is important to recognize that monitoring (including CBM) is integral to the process of AEM. The width of the arrows indicates the relative importance of monitoring (including CBM) to the step of the adaptive management process. This figure suggests that monitoring is most important during the plan review stage of adaptive management, although it still feeds into the other steps of the process.
List of Abbreviations

ACAP – Atlantic Coastal Action Plan

AEM – Adaptive Environmental Management

CA – Conservation Authority

CAMC – Conservation Authorities Moraine Coalition

CARP – Clean Annapolis River Project

CEW – Citizen’s Environment Watch

CBEMN – Community-Based Environmental Monitoring Network

CBM – Community-based Monitoring

CLOCA – Central Lake Ontario Conservation Authority

CLLS – Canadian Lakes Loon Survey

CURA – Community University Research Alliance

CVC – Credit Valley Conservation

CYWD – Check Your Watershed Day

eNGO/NGO – Environmental Non-governmental Organization

EMAN – Ecological Monitoring and Assessment Network

GREB – General Research Ethics Board

GOV – Government staff

x
IWRM – Integrated Watershed Resources Management

LPP – Lake Partner Program

MOE – Ontario Ministry of Environment and Climate Change

MNR – Ontario Ministry of Natural Resources and Forestry

MTM – Monitoring the Moraine

NGO – Non-governmental Organization

ORM – Oak Ridges Moraine

ORMF – Oak Ridges Moraine Foundation

ORMCP – Oak Ridges Moraine Conservation Plan

OSAP – Ontario Stream Assessment Protocol

QA/QC – Quality Assurance/Quality Control

SRA – Sackville Rivers Association

STORM – Save the Oak Ridges Moraine Coalition

TRCA – Toronto and Region Conservation Authority

WRC – Watershed Report Card
Chapter 1

Introduction

Community-based monitoring (CBM) is a developing concept, referring to “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). Examples of CBM include citizen’s assisting with monitoring projects, including the collection of data, such as working with scientists to collect water quality data, visually assessing the health of an aquatic ecosystem, or monitoring the implementation of environmental policies. Community-based monitoring is part of a larger concept known as citizen science (Conrad and Hilchey, 2011). Miller-Rushing et al. (2012) identified citizen science as the “engagement of non-professionals in scientific investigations” (p. 285). Research over recent years has demonstrated that citizen science has become more accepted as a method to address scientific questions and increase public involvement in environmental management and sustainability (Au et al., 2000; Miller-Rushing et al., 2012). Although citizen science itself as a practice has existed for centuries (Miller-Rushing et al., 2012), there has been a documented increase in the presence of community groups carrying out monitoring activities, especially in Canada and the United States (Conrad and Daoust, 2008; Devlin, 2011; Lawrence, 2006; Savan et al. 2003; Whitelaw et al., 2003). This growth in CBM has been attributed to several factors: reduced governmental funding and capacity for monitoring (Au et al., 2000; Conrad and Daoust, 2008; Savan et al., 2003; Sharpe et al., 2000; Stokes et al., 1990); increased acknowledgement of the important role that stakeholders can play in the decision-making process (Cuthill, 2000); a growing awareness of environmental issues by civil society (Chicoine, 1996; Sharpe and Conrad, 2006) and a desire to participate in environmental management (Bliss et al., 2001); mistrust of the government’s care for the environment (Au et al., 2000); and to fill in existing gaps in monitoring programs from the government and professionals (Conrad and Hilchey, 2011; Freitag, 2008; Milne et al., 2006).
The benefits of involving community volunteers in monitoring programs are well-known and varied, and include: contributing to learning opportunities for community members, conservation objectives, and ecosystem management (Cuthill, 2000), as well as improved effectiveness and increased monitoring from using volunteers for monitoring activities (Stokes et al., 1990). Research has demonstrated that when community members are involved with monitoring groups and activities, they develop positive attitudes and behaviour towards the environment (Cuthill, 2000). Community-based monitoring can:

Increase citizen engagement in ecosystem management, contribute to participatory community development, and enhance community influence on policy directions. Citizen involvement in CBM represents an emerging contribution to environmental planning, decision making, and policy implementation (Pollock and Whitelaw, 2005, p.213).

Unfortunately, the ability of resource managers and decision-makers to integrate this data and use it in the decision-making process is often limited due to concerns about the quality of the data and the lack of standard methods for data collection (Sharpe and Conrad, 2006). The data that are collected through community-based monitoring programs, if it were integrated into the decision-making process, could promote sustainability and benefit both the community and the government (Sharpe and Conrad, 2006). Therefore, exploring the research and on-the-ground activities surrounding community-based ecosystem monitoring is important to understand the impacts that citizen participation can have on environmental planning and management, as well as the limitations which might prevent the use of monitoring data generated by these community groups.

This research project began at Saint Mary’s University in Nova Scotia, after a research team led by Dr. Cathy Conrad was awarded funding for a five-year Community-University Research Alliance (CURA) by the Social Sciences and Humanities Research Council of Canada. The purpose of the CURA
H2O project is to “generate new knowledge around issues of effective community-based management, improved accuracy of data collected by volunteers, and the successful integration of volunteer monitoring into resource management” (CURA H2O, 2014). The CURA H2O Project team is composed of multiple stakeholders, including government agencies, community stewardship groups, First Nations communities, environmental NGOs, academic researchers, and members of the private sector. As part of the CURA H2O Project, the Community-Based Environmental Monitoring Network (CBEMN) has worked with CURA H2O to “build capacity within stewardship organizations through a variety of resources and training” (CURA H2O, 2014). Research carried out through the CURA H2O Project is focused on four main themes: (1) community-based monitoring in Nova Scotia, nationally, and internationally; (2) CBM data collection; (3) linkages between government and CBM groups; (4) CBM and ecosystems. This research project contributes to research theme (1).

In Canada, Nova Scotia is one well-documented example where community-based water monitoring groups are abundant (Sharpe and Conrad, 2006). In response to the absence of comprehensive monitoring and management of water resources in the province, community groups have been extremely active in collecting water data throughout more than 10 of the province’s watersheds since the early 1990s (Sharpe and Conrad, 2006). The Oak Ridges Moraine (ORM) is another area that has an active citizen base for environmental protection and advocacy; this reputation was established in the late 1980s, when numerous local environmental organizations emerged to protest subdivision development on the ORM and eventually succeeded in bringing awareness to the importance of protecting the moraine landscape (Whitelaw et al., 2009). Despite approval of the ORM Conservation Act (2001) and the ORM Conservation Plan (2002), there has been no legislated provincial government monitoring to ensure that the associated policies have been implemented properly (Whitelaw et al., 2009). Similar to Nova Scotia, community volunteers have joined together to address this gap in monitoring and stewardship. Some similarities appear to exist between these two locations, although no comparative study exists to explore
the factors that contribute to these similarities, or explore the reasons for the differences between Nova Scotia and the ORM.

The purpose of this research project is to investigate the state of community-based monitoring of watersheds and water resources in Southern Ontario, Canada, focusing on the ORM landscape north of the Greater Toronto Area as a case study. The ORM was selected as a case study as part of research theme (1) from the CURA H2O Project (described above), which includes exploring the status of CBM in other areas of Canada, as well as to compare the results from Ontario with the current status of CBM in Nova Scotia. Located in Southern Ontario, the ORM covers roughly 190,000 hectares ranging 160 kilometers in distance from the Niagara Escarpment to the Trent River system (ORM Foundation, 2014). Twelve thousand years ago, the ORM was formed by the movement of glaciers, which deposited sediment and left deep channels on the landscape. Save the Oak Ridges Moraine Coalition (STORM) says that the moraine “is more than just a beautiful landform feature with its breathtaking vistas, rolling hills, wooded valleys and ‘kettle’ lakes. Its most precious feature lies hidden below the ground surface” (Save the Oak Ridges Moraine Coalition, n.d.). Save the Oak Ridges Moraine Coalition is referring to the ORM’s role as a water recharge/discharge area, which supplies drinking water to several municipalities and supports the ecosystem health of many watersheds whose headwaters originate in the moraine (Save the Oak Ridges Moraine Coalition, n.d.). The Oak Ridges Moraine Conservation Plan Technical Paper 9 – Watershed Plans says that:

The Oak Ridges Moraine (ORM) is one of Ontario’s most significant landforms. The Moraine has a unique concentration of environmental, geological, and hydrological features that makes its ecosystem vital to south-central Ontario, including: clean and abundant water resources, and health and diverse plant and animal habitat (Ontario Ministry of Municipal Affairs and Housing, n.d.).
In addition to its role as an important ecological feature and drinking water source, the ORM has other features which contributed to its selection as a case study for this research. Contrasting with Nova Scotia, which Sharpe and Conrad (2006) have previously established lacks a coordinated government approach to water monitoring and management, the ORM falls within the watershed boundaries of nine separate conservation authorities (CAs). These CAs have joined together to form a coalition called the Conservation Authorities Moraine Coalition (CAMC), which was “formed in response to the need for a comprehensive policy, planning and management approach geared to sustaining the health of the entire Oak Ridges Moraine” (Toronto and Region Conservation, n.d.). The important role that CAs might play in CBM on the ORM is unique, and thus critical to understand, especially when the case study is compared with Nova Scotia which lacks CAs but has a very active and dedicated community base that carries out water monitoring projects, due to a lack of comprehensive water management (Sharpe and Conrad, 2006).

After reviewing the literature, six research questions emerged: (1) what is the current status of water governance on the ORM; (2) what are the types of CBM initiatives that are taking place on the ORM, with a particular focus on water; (3) what role do government agencies play in CBM on the ORM; (4) what are the challenges and successes associated with CBM on the ORM; (5) what is the future of CBM on the ORM; (6) how does CBM on the ORM compare with CBM in Nova Scotia. In order to answer these questions, this thesis is set up as follows: Chapter 2 is a comprehensive review of the relevant literature surrounding water governance, CBM, conservation authorities, and government capacity for water monitoring. Following the literature review, Chapter 3 explores the theory behind the chosen research methods, as well as the actual methods themselves. After receiving approval from the General Research Ethics Board (GREB), interviews were carried out by the researcher. Using the snowball method (Berg, 2007), multiple stakeholders were interviewed, including staff from CAs, government agencies, and NGOS, as well as community members involved in CBM. Grey literature related to CBM on the ORM was also examined to understand how on-the-ground CBM activities
compared with how CBM was discussed in official reports and other communication materials. Research methods and individual results for this project were vetted throughout the research process. The research was presented at several academic conferences, as well as community workshops hosted by the CURA H2O Project, providing multiple opportunities for feedback and critique related to the research process, including data collection and analysis. Finally, once all other aspects of data collection and analysis were complete, the results from the ORM case study were presented at a CURA H2O workshop at Saint Mary’s University in Halifax, Canada, which was attended by both academic researchers and members of community groups. The purpose of this final workshop was to ensure knowledge transfer to the rest of the CURA H2O team and increase their understanding of the differences and similarities that exist between Nova Scotia and the ORM.

Following the methods section, Chapter 4 consists of a comprehensive exploration of the results, as well as a discussion of the potential implications of the project for the initial research questions. This chapter is extensive and detailed in order to fully answer the research questions and tell the story of water governance and CBM on the ORM, its challenges and successes, as well as to consider the results from the ORM in the context of CBM in Nova Scotia, as a partial contribution to the CURA H2O Project’s extensive research into CBM in Nova Scotia. Chapter 4 is organized by the themes and sub-themes that emerged from both the literature as well as the interviews and grey literature. Chapter 5 revisits the literature and the research objectives to more fully explore the implications of the results from this research project. The chapter expounds on the results and discussion, exploring the research’s contributions to the theory and practice of CBM, including the development of a conceptual framework for adaptive environmental management and suggestions for future research projects that could delve into the results from this research project. The roles of government agencies in CBM, as well as the ability of CBM to influence decision-making, were the main discussion points in Chapter 5, as they challenged previous frameworks for CBM in Canada, and appear to provide the basis for some understanding of the
differences that exist between CBM on the ORM versus CBM in Nova Scotia. This thesis also includes appendices with supporting documents: the ethics approval (Appendix A), as well as the interview questions (Appendix B).
Chapter 2

Literature Review

2.1 History of Community-Based Monitoring

2.1.1 A Brief Overview of the Historical Development of Community-Based Monitoring

In recent years, citizen science as a concept has become more accepted as a method to address scientific questions that could not be answered without a wide distribution and large number of professionals collecting data, as well as a way to educate and involve civil society with scientific research (Miller-Rushing et al., 2012). Even the United Nations Environment Programme emphasizes the importance of public participation in environmental management in order to achieve sustainability (Au et al., 2000). What makes citizen science unique is not the inclusion of scientists, but rather the community’s role in contributing to scientific research (Miller-Rushing et al., 2012) and informed decision-making (Sharpe and Conrad, 2006).

According to Miller-Rushing et al. (2012), citizen science has been around for centuries. Historical examples of volunteers collecting scientific data include: bird strike data collected by lighthouse keepers dating back to 1880, the annual Christmas Bird Count by the National Audubon Society initiated in 1900, and the National Weather Service Cooperative Observer Program which began in 1890 (Droege, 2007). In fact, community volunteers were collecting data concerning astronomy, bird distribution, and water quality throughout the 20th century; it is only within the last twenty years that citizen science has evolved “with its integration of explicit and tested protocols for collecting data, vetting of data by professional biologists, and inclusion of specific and measurable goals for public education” (Bonney et al., 2009, p. 978). The growing involvement of community members in scientific research has meant that “citizen science has influenced both the scale of ecological research that is being done and the relationship between ecologists and the public” (Dickinson et al., 2010, p.150). One such example is the Canadian Lakes Loon Survey (CLLS) which was founded in 1981 in order to monitor the reproductive success of
the Common Loon (*Gavia immer*). The CLLS program formed in response to the needs of researchers, who wanted to examine the impact of human disturbance and acid rain on loons. Between 1987 and 1993, volunteers collected 4236 records for loons on 1529 lakes in Ontario (McNicol et al., 1995). Researchers noted that the use of volunteers to collect information provided a “reliable, effective method of assessing the long-term health of large, acid-sensitive lakes across Canada” (McNicol et al., 1995, p.463). The CLLS program is just one example of collaborations between community groups and researchers, as will be seen in later sections of this literature review.

2.1.2 Definition of Community-Based Monitoring

Citizen science refers to “projects in which volunteers partner with scientists to answer real-world questions” (Cornell website, n.d.) and a process in which citizens are engaged as researchers themselves (Kruger and Shannon, 2000); it has also been referenced as community science (Carr, 2004). Citizen science can include community-based monitoring (CBM), which is defined as “a process where concerned citizens, government agencies, industry, academia, community groups, and local institutions collaborate to monitor, track and respond to [environmental] issues of common community concern” (Whitelaw et al., 2003, p.410). Although traditionally CBM has placed an emphasis on monitoring ecological changes, it is also beneficial to incorporate social and economic parameters into monitoring programs to “enhance the knowledge available for decisions about local sustainability” (Pollock and Whitelaw, 2005, p. 213). In fact, “local groups that undertake to monitor both ecological and socioeconomic parameters may find some unexpected relationships between the two” (Yarnell and Gayton, 2003, p.4), as community concerns related to human health and stability often lead to the development of ecological monitoring programs (Pollock and Whitelaw, 2005). According to Pollock and Whitelaw’s (2005) conceptual framework for community-based monitoring, CBM must be: (1) context-specific: “CBM should be appropriate to community context, respectful of local cultures, and supported by a suite of possible tools and techniques to meet the challenges of local diversity” (p. 217); (2) iterative: CBM should be versatile, as the
monitoring program may change over time, or repeat some components at different stages of monitoring; and (3) adaptive: CBM should implement responsive and proactive approaches to achieve local sustainability.

2.1.3 Recent Growth in CBM

Monitoring activities by community groups are on the rise in Canada and the USA (Lawrence, 2006; Whitelaw et al., 2003) and internationally (Nagendra et al., 2005; Pattengill-Semmens and Semmens, 2003; Sultana and Abeyasekera, 2008). Pretty and Ward (2001) observed that nearly 500,000 new local community groups have been established in countries worldwide since the 1990s. The growth in community-based monitoring activities in Canada and the USA has been especially pronounced (Lawrence, 2006), leading to an established body of literature concerning CBM in Canada (Conrad and Daoust, 2008; Devlin, 2011; Savan et al., 2003; Whitelaw et al., 2003). Water quality monitoring, in particular, has become one of the most widespread types of community monitoring (Devlin, 2011); between 1988 and 1992, there was almost a tripling of new water monitoring programs in the United States (Kerr et al., 1994). Despite the past growth in water monitoring, it has only been in the last few decades that the majority of existing watershed programs within the United States have been created (Hamaan and Drossman, 2006). From these inventories of community watershed groups, it is obvious that CBM is a steadily growing phenomenon, and this trend is likely to continue in coming years.

The government has traditionally been the primary source of scientific data collection, analysis and communication for ecological monitoring; academics and NGOs played a small role in one-time research studies or issue-specific monitoring, although it was usually local communities that promoted the development of monitoring programs (Milne et al., 2006). However, there has been a recent trend of government downsizing, despite the fact that environmental pollution continues due to growing urban development, economic activity and industrialization (Au et al., 2000). In Canada specifically, Provincial governments were previously the primary authorities responsible for environmental monitoring and
management. However, cutbacks like those observed in the Ontario Ministry of Environment and Climate Change budgets and staff “have affected the government’s ability to track and respond to environmental change to ensure the protection of both human and environmental health” (Savan et al., 2003, p. 561). Government cutbacks are not limited to the provinces and territories: Pollock and Whitelaw (2005) have noted that the ability of government to invest in monitoring at a national level is also limited due to a lack of resources. One illustrative example is the closing of the Ecological Monitoring and Assessment Network coordinating office located in Burlington, Ontario, Canada Centre for Inland Waters in 2010 (Environment Canada, 2012).

In response to these changing conditions, modern community-based monitoring programs with active citizens have developed for several reasons: decreased governmental funding and staffing for ecological monitoring (Au et al., 2000; Conrad and Daoust, 2008; Savan et al., 2003; Sharpe et al., 2000; Stokes et al., 1990); acknowledgement of the importance of stakeholder involvement in the decision-making process (Cuthill, 2000; Lawrence and Deagan, 2001); increased awareness of environmental issues (Conrad and Daoust, 2008; Sharpe and Conrad, 2006); a growing desire of citizens to participate in environmental planning and protection (Bliss et al., 2001); to fill in the gaps from government programs and professional scientists (Conrad and Hilchey, 2011; Freitag, 2008; Milne et al., 2006); and increasing mistrust of the government’s care of the environment (Au et al., 2000). Citizens become involved in community-based monitoring because they want to contribute to decision-making, share their data, and make a difference in their community (Pollock and Whitelaw, 2005). There is an important caveat that must be made as CBM activities continue to increase: community groups should not replace government monitoring, however “citizen-generated monitoring information [is] better than no information at all” (Sharpe et al., 2000, p.31).

As CBM activities continue to increase, the factors that contribute to a group’s success have been noted in the literature. CBM programs affiliated with institutions (e.g. a university or NGO partner) have
led to successful application of CBM. According to Pollock and Whitelaw (2005), partnerships between community groups and institutions are more likely to enhance the understanding of local governance processes, increase the size of monitoring networks, and increase influence within the local community. Savan et al. (2003) noted that universities in particular have the capacity to provide community groups with funding opportunities, as well as training and lab space. Partnerships between universities and community groups are progressively being developed, as they provide the opportunity for “interdisciplinary learning experiences and civic engagement” (Hamann and Drossman, 2006, p. 306). Some examples of CBM groups that have been associated with academic institutions include: the Community-Based Environment Monitoring Network run through the Department of Geography at Saint Mary’s University, Halifax, Nova Scotia; the Citizen’s Environmental Watch (now EcoSpark) in Toronto which was founded by academics; and the Nature Watch programs (including FrogWatch and IceWatch) currently managed by the University of Ottawa Laboratory for Integrated Environmental and Policy Change, in collaboration with Nature Canada (Conrad and Hilchey, 2011; NatureWatch website, 2014).

2.1.4 Benefits Associated with CBM

There are multiple benefits associated with citizen engagement in monitoring programs. Public involvement in environmental planning and management is encouraged for four reasons: (1) “if the public is involved, it is likely to take responsibility for the plan and support it” (Au et al., 2000, p. 225); (2) members of the public can provide valuable insights based on local knowledge and experience; (3) if done properly, public monitoring can complement monitoring activities by authorities; and (4) when the public and authorities cooperate, public trust in the authorities increases (Au et al., 2000; Pollock and Whitelaw, 2005). Sharpe and Conrad (2006) have also noted that CBM can benefit many different agencies who become involved in monitoring: (1) receptive government agencies can benefit from CBM as it can lead to expanded monitoring networks, reduced costs associated with using volunteers to collect data (also observed by McNicol et al., 1995), as well as the creation of “an early warning system of ecological
changes” (p. 396), and the assistance of civil society in the promotion and achievement of government goals; (2) non-governmental organizations (NGOs) benefit from CBM as citizens become more active in response to environmental issues; and (3) communities benefit from CBM due to greater participation in resource management, and increased social capital. According to Portes (1998), the literature suggests that social capital refers to the accrualment of benefits to actors through their participation in social systems or structures. Social capital increases through activities associated with volunteer engagement in CBM such as partnerships between agencies, leadership development and problem solving (Conrad and Hilchey, 2011; Whitelaw et al., 2009; Whitelaw et al., 2003). Greater social capital translates to stronger public support for environmental conservation (Schwartz, 2006) as well as the formation of a stewardship/conservation ethic (McNicol et al., 1995; Whitelaw et al., 2003). This is supported by Cuthill (2000), who argued that citizens participating in CBM programs experience positive attitudes and behaviours towards the environment. CBM activities are a relatively simple but powerful way to create place-based nature experiences for members of civil society (Dickinson et al., 2012). The benefits from CBM can also extend into other aspects of the community as well: communities that have CBM programs experience more engaged citizens in local issues and community development, and have more influence on decision-makers (Lynam et al., 2007; Pollock and Whitelaw, 2005).

CBM can also benefit researchers: Whitelaw et al. (2003) suggested that working with community volunteers allows data to be collected outside office hours, and over larger areas than a researcher or scientist could cover in a single project. Pollock and Whitelaw (2005) observed that community participation in monitoring initiatives can actually improve scientific understanding of environmental issues, as well as democratizing science. Democratization of scientific knowledge and the environment is a newly evolved concept which refers to the growing access to and understanding of scientific research by civil society, as well as the growing awareness that scientists have regarding the significance of local knowledge (Carolan, 2006).
As Sharpe et al. (2000) stated, “environmental monitoring is not simply busy work for enthusiastic volunteers. Monitoring and data collection help raise environmental awareness” (p.33). CBM programs can also carry out monitoring that professional scientists or academics would not take on, due to either the type of research or the location of the research. Professional scientists will have research questions that aim to enhance existing knowledge in their field of study, and will avoid research projects that are too narrow in scope; localized environmental issues are likely to be ignored by professional scientists, thus local citizens are more likely to investigate the issue themselves (Miller-Rushing et al., 2012). “The data they collect give[s] the community an indication of general watershed health and when anomalies arise, their monitoring experience can give them the confidence and understanding to take further action” (Sharpe et al., 2000, p.33) and lead to the development of plans or policies to resolve the issue (Miller-Rushing et al., 2012). In the United States, community volunteers are extremely active and respected members of water quality monitoring initiatives. According to Miller-Rushing et al. (2012), data collected by volunteers has “frequently been used by management agencies to define baseline conditions, identify problems, and determine what management actions” (p. 288) are needed, and in fact some states have provided guiding principles for using volunteer data in decision-making, “sometimes considering volunteer-collected data analogous to data collected by state agencies” (p. 288).

2.1.5 Challenges Associated with CBM

Although there are many proven benefits associated with CBM, and in fact Kenney (1999) argued that including CBM in resource management has been potentially the most significant advancement in this area since the environmental movement began, there are still many challenges that CBM must overcome. CBM programs can face challenges within their own organizations to retain volunteers and maintain long-term, consistent monitoring efforts. It is thus very important to understand what motivates community members to become involved, and remain involved, in monitoring programs (Cuthill and Warburton, 2005), and to allow community members to drive monitoring activities. The monitoring program should
appeal to local interests and concerns, and prevent the development of unrealistic expectations associated with monitoring, which could lead to volunteer dissatisfaction and potential withdrawal from the program completely (Pollock and Whitelaw, 2005). Volunteer recognition programs can keep community members engaged in monitoring, although monitoring program coordinators have stated that it is most important to “communicate monitoring results to the wider community to illustrate accomplishment, justify efforts, and build knowledge about environmental trends” (Pollock and Whitelaw, 2005, p. 220). Sharpe and Conrad (2006) also emphasize the importance of incorporating data collected by community groups into the decision-making process. Through their research with CBM groups in Nova Scotia, Sharpe and Conrad (2006) became aware of a collective struggle faced by volunteers which they termed “monitoring for the sake of monitoring” (p. 403). This refers to the fact that although volunteers understand the significance of monitoring ecosystems, they become frustrated when they cannot meaningfully impact decisions about resource management, and instead feel that they are simply monitoring “[…] an obvious decline in the system” (Sharpe and Conrad, 2006, p. 403).

In addition to the difficulties associated with keeping a strong volunteer base, Sharpe and Conrad (2006) explain that despite attempting to fill the gaps left in monitoring activities due to governmental cutbacks, community groups face multiple obstacles, including limited access to: funding sources, monitoring equipment/materials, scientific expertise, and robust data collection protocols. Another issue arises when community groups manage to overcome these obstacles and collect scientifically relevant data but there is no opportunity for the group to “participate in meaningful management of their watersheds” (Sharpe and Conrad, 2006, p. 395). For a CBM program to successfully engage in environmental management, Pollock and Whitelaw (2005) suggest that the group must not only analyze their data, but also translate their results into a format that is accessible and meaningful to decision-makers. However, many CBM groups have difficulty getting their data to the correct scientific journal or decision-maker, even if they do manage to overcome concerns about data quality (Conrad and Daoust, 2008; Milne et al.,
Sharpe and Conrad (2006) also discussed the challenges that community groups face with data management, within their own organizations to archive and analyze field data, as well as to compare separate datasets between monitoring groups. Improper or inadequate data management systems can lead to the corruption or loss of data (Sharpe and Conrad, 2006).

In order to overcome these challenges, Pollock and Whitelaw (2005) observed that monitoring protocols for community groups must be easy to acquire and comprehend, be appropriate for community use, and supplemented with training instructions and sources of support. However, it must be acknowledged that for aboriginal communities with an oral culture, the “double translation of protocols into traditional languages and translation of results into English remains a distinct” (p. 223) barrier to participation, despite a desire to contribute to monitoring objectives (Pollock and Whitelaw, 2005).

For community groups that do participate in monitoring activities, it is crucial for their success and ability to influence decision-making that the data are of sufficient quality. Standardized data collection protocols amongst CBM groups mean that the data collected in one area of a province can be compared to results from another location, which can create a more cohesive summary of environmental conditions across the province (Sharpe et al., 2000) and be more appealing to decision-makers. To determine if the data collected by volunteers were of sufficient quality, Cuthill (2000) conducted research to understand what types of protocol and training would be required to standardize data collection and enhance the ability of volunteers to collect the data. It was found that quality control skills, the competency to store data, as well as communication tools for sharing monitoring results, were the most significant capacity needs of CBM programs. Given accessibility to simple methodologies, citizens have been proven to provide “comparable patterns to the officially accepted most modern monitoring methods” (p. 224), and can thus “reliability [alert] the public and environmental authorities to sources of contamination” (Au et al., 2000, p.224). Sharpe and Conrad (2006) performed an analysis of the literature surrounding the issue of data quality concerns from CBM programs, and found that “…on the whole, water quality data
gathered by community groups can be comparable to that gathered by professionals […]” (p. 396). However, they did acknowledge that this statement depended on community groups using scientifically valid data collection protocols, as well as having the appropriate equipment and training resources available to both community volunteers and program staff for Quality Assurance/Quality Control (QA/QC) purposes (Sharpe and Conrad, 2006). Similarly, the Ecological Monitoring and Assessment Network (EMAN) experienced some controversy when they decided to include volunteers in the monitoring network, but eventually a consensus was reached that “with the proper consideration and guidance, volunteers […] could play a large role in ‘keeping watch’ over the Canadian environment” (Vaughan et al., 2001, p. 22).

In contrast, Sharpe et al. (2000) protested that volunteers “…are clearly unable to collect the same type and quality of data as government officials” (p.33) due to basic equipment, as well as poor quality control and minimal, informal training; therefore, CBM programs were no replacement for the withdrawal of government agencies from environmental monitoring. Conrad and Hilchey (2011) also described the challenges that CBM groups face when it comes to data quality, including poor environmental design and inappropriate sample sizes. Royle (2004) observed that many scientists believe that training of community volunteers is insufficient to prevent the occurrence of false positive or false negative data. Authorities have argued that non-professionals do not possess the materials or skills to collect scientifically valid and repeatable data (Au et al., 2000). Some researchers believe that data collected by community groups is disregarded by decision-makers because of concerns about the quality of the data (Bradshaw, 2003; Gouveia et al., 2004). The middle ground between these two conflicting viewpoints of the role that CBM plays in environmental monitoring might be the approach suggested by Whitelaw et al. (2003), where CBM is used to describe environmental trends and draw attention to issues that would require further research and exploration by scientific experts.
Sources of funding can also create challenges for community groups, as there is no core funding available to CBM programs, provincially or federally (Sharpe and Conrad, 2006). Research conducted by Pollock and Whitelaw (2005) found that coordinators of CBM programs were “[…] unable to accommodate the task of fundraising in addition to the wide range of other activities […]” (p. 222) within their program. Some of the interviewees in the study suggested that in order to resolve this issue, government support and financial assistance would be essential for at least three to five years initially, to allow community groups to develop a strong foundation on which to move forward (Pollock and Whitelaw, 2005). Inconsistent funding sources for community groups can eventually lead to data fragmentation (Bliss et al., 2001), reducing the usefulness of the data as it cannot be considered a long-term environmental dataset.

Although there are many challenges associated with CBM, Conrad and Hilchey (2011) says that these “challenges to effective CBM should not be used to de-value the significant of citizen-based initiatives, since the benefits [of CBM] far exceed the challenges that can be overcome” (p.282). If challenges primarily relate to concerns such as scientific rigor, but benefits include societal changes, the decision need not be to engage citizens or not” (p. 282). It is important to take into account the purpose of the monitoring program when evaluating the reliability of the data (O’Leary et al., 2004). Although CBM presents some challenges associated with integrating volunteer data into the decision-making process, there are undeniable social benefits as a result of these programs.

2.2 Current Status of CBM

Whitelaw et al. (2003) and Whitelaw et al. (2009) observed that four approaches to CBM have emerged: (1) CBM led by government agencies to detect early environmental changes that can then be more fully explored by experts, and to supplement existing professional monitoring; (2) monitoring programs that focus on the educational benefits associated with monitoring through the participation of community volunteers in data collection, and promote long-term commitments from volunteers; (3)
monitoring programs that are created when a community group becomes an advocate of a local environmental issue already of concern, and collect data in order to push the government to address planning/management issues and achieve “positive change in environmental quality” (Sharpe et al., 2000, p. 32); (4) multi-stakeholder monitoring that “influences decision-making through cooperation as opposed to advocacy” (Whitelaw et al., 2009, p. 78) and includes “all interested stakeholders- private landowners, individual citizens, representatives of civil society organizations, business, government and others committed to the community” (Whitelaw et al., 2003, p. 411). Of the CBM groups that were sampled by Pollock and Whitelaw (2005), the majority of groups were examining water quality, with only a few groups each monitoring birds, air quality, amphibians, fish, worms, plants or ice. Therefore, CBM programs vary not only in the composition of the monitoring group (i.e. including government, including multiple stakeholders, or activist monitoring) but also vary in the types of parameters being monitored.

2.3 Future of CBM

When considering the potential future direction of CBM, some interesting ideas may be found in the literature. Dickinson et al. (2012) noted that although community monitoring data are valuable, the volunteers are very rarely recognized for their efforts unless they have contributed more to the research project than simply collecting the data for the researcher. Instead, the paper suggests that it should become standard practice to officially acknowledge the contribution of the CBM group volunteers in a research paper (Dickinson et al., 2012). Pollock and Whitelaw (2005) also emphasized the importance of volunteer recognition programs.

Dickinson et al. (2012) recommended that CBM activities become more modern through the use of social media or other online tools. The paper brings attention to websites such as iNaturalist.org, which “combin[es] all-taxon monitoring with Facebook and other photo-upload tools, social data validation (corroboration), mapping tools and a smartphone application that is easy to use for novices of all ages” (Dickinson et al., 2012, p. 296). Other programs are using online resources to “increase participant
interest, data quality (using quiz scores as measures of observer variation or observer bias), participant interest, and learning impacts” (Dickinson et al., 2012, p. 296). CBM has many potential options, some of which will be explored later on in this research paper.

2.4 Water Governance

Between the 1960s and 1980s, governments became more aware of the management difficulties presented by complex environmental issues. Water, in particular, is one area where governments have acknowledged the importance of collaborative approaches; this move towards collaboration and away from “government command and control strategies” (Vaughan, 2011, p. 1) indicates a shift from only government to decision-making governance (de Loe, 2009). Bakker (2007) emphasizes that the challenges faced by water resource managers are three-fold: competition for water resources by multiple users; a need for coordination between the different scales at which water is managed; and resolving the separation that exists between hydrological and jurisdictional boundaries (this was also observed by Norman and Bakker, 2009). The complexity of current environmental challenges means that “[r]econciling the often conflicting needs, values and interests of various stakeholders without further compromising environmental quality […] is a challenge for governance rather than a challenge for science and technology” (de Loe and Kreutzwiser, 2007, p. 86).

The concept of environmental governance encompasses the mechanisms and regulatory processes through which multiple stakeholders can impact environmental policies and decision-making through a formally recognized process that integrates and respects various viewpoints and knowledge systems (Vaughan, 2011). According to Whitelaw et al. (2009), the governance concept includes actors who impact policy planning and implementation; actors come from civil society, the public sector, and the private sector. Whitelaw and McCarthy (2008) observed that the governance definition evolved to “recognize that the state is not solely responsible for societal development” (p. 124), and in fact Painter (2000) suggested that the majority of researchers believe that the state has actually become less important
than non-state actors (such as civil society) in the decision-making process. This can be observed in two ways, first as the government increases citizen involvement in water management decisions (such as the Alberta Water for Life strategy) or as community-led groups have emerged separate from the government (Hill et al., 2008). This is supported by Bakker and Cook (2011) who identified that environmental non-governmental organizations (eNGOs) in particular have played an increasingly important role in environmental and water governance, by keeping the public engaged in environmental issues and acting as an independent critic of government initiatives.

Top-down, traditional approaches to natural resources management have been criticized for several decades, and recent years have seen a push towards collaborative management of resources (Cervoni et al., 2008). This is supported by Norman et al. (2011), who observed that multiple water stakeholders are frustrated by current decision-making processes and have expressed a preference for a “more holistic approach to water governance that is comprehensive, action-oriented and user-friendly” (p.62). However, other studies have demonstrated that greater involvement of local actors does not always translate to greater influence within the water government system (Norman et al., 2011; Norman and Bakker, 2009). In fact, Norman et al. (2011) stated that water stakeholders face substantial challenges to meaningful participation in water governance. Bakker (2009) observed that local community groups have adopted a “vigilante-style approach” (p. 18) to the protection of water resources and have “set themselves a daunting task” (p. 18) to enforce water quality guidelines.

The Walkerton incident in 2000 is often highlighted as the catalyst that brought water governance into the spotlight in Ontario; however, there were several initiatives already in place across Canada, including Quebec’s Water Policy and Alberta’s Water for Life strategy (Hill et al., 2008). Justice Dennis O’Connor provided several recommendations following the Walkerton Inquiry, including the need for provincially approved, source protection systems for drinking water systems across the province that would be developed by conservation authorities and local municipalities and other stakeholders (O’Connor, 2002).
The recommended multi-barrier approach to protecting drinking water quality included other measures such as the continued provincial responsibility of setting legally binding drinking water quality standards and managing drinking water protection, the improvement of water treatment and distribution systems if necessary, the monitoring of drinking water quality, the role of municipal governments in drinking water protection, and the training of water treatment and distribution system operators, among others (O’Connor, 2002). Water governance has been addressed in different ways at different times throughout the provinces and territories. Therefore, although Walkerton can be credited with bringing greater attention to drinking water quality and the multi-barrier approach within Canada, as well as the gaps that were found in the existing water management structures (O’Connor, 2002; Winfield, 2002), there still exists a great deal of variation between provinces and territories regarding water legislation and policies (Hill et al., 2008), as well as enforcement of water quality guidelines. In fact, the Walkerton Inquiry concluded that the incident could have been fully prevented, had the Ministry of Environment (now the Ministry of Environment and Climate Change) successfully fulfilled their oversight and regulatory role in relation to the Walkerton water system (O’Connor, 2002).

Source water protection is part of the multi-barrier approach to drinking water protection that is experiencing growing interest from the provincial and territorial governments, and is just one example of an approach to Integrated Water Resources Management (IWRM) (Hill et al., 2008). IWRM is a “process which promotes the coordinated development and management of water, land and related resources” (Global Water Partnership, n.d). IWRM activities require multiple stakeholders and multiple scales to be incorporated into a top-down and bottom-up approach to participation and management (Cervoni et al., 2008). Provinces and territories across Canada are moving towards an IWRM approach to water governance, although there is still fragmentation between agencies (Hill et al., 2008).

IWRM is a part of a larger body of practice known as Adaptive Environmental Management (AEM). Holling (1978) defines AEM as a process wherein social, economic, and environmental factors are
integrated equally throughout policy development and implementation. Holling (1978) also recommends that newly discovered information be incorporated into management decisions, speaking to the process of continual monitoring and re-evaluation which creates feedback loops and can promote policies that are reflective and adaptive to complex and uncertain environmental systems (McLain and Lee, 1996; Allan and Stankey, 2009). Adaptive management is assisted by three fundamental practices: (1) the achievement of knowledge; (2) the dissemination of information; and (3) the creation of shared understandings (McLain and Lee, 1996). Interest in AEM and its implications for policy development began to grow in the 1970s, but the concept has expanded to include a wide range of natural and political settings due to an increasing understanding of the importance of collaboration and participation of multiple stakeholders (Allen and Stankey, 2009). The potential applicability of AEM on the ORM will contribute to the development of a conceptual framework that will emerge in Chapter 5, incorporating the results from the literature review and the other research results.

Within Canada, the majority of water-related activities are under the purview of the provincial and territorial governments, including “water supply (e.g. potability) and resource management (e.g. environmental protection and licensing) and governance (e.g. accountability)” (Hill et al., 2008, p. 317). Water supply management is often left to municipalities and is “more decentralized than other utility sectors” (Bakker and Cook, 2011, p. 277). The federal government is responsible for “federal lands, boundary and transboundary waters, and inland fisheries” (Hill et al., 2008, p.317), as well as wastewater and drinking water treatment systems on First Nation lands (Government of Canada, 2013). From this simple breakdown of the agencies responsible for water, it is easy to see that water management experiences jurisdictional, territorial and scalar fragmentation (Bakker and Cook, 2011; Hill et al., 2008). Government departments at both the provincial and federal level share responsibility for the management of water resources (Norman et al. 2011). In fact, Canada has one of the most decentralized approaches to environmental governance within the developed world (Bakker and Cook, 2011; Hill et al., 2008). Thus, if
other levels of government are taken into account, as well as the multiple, competing users of water resources, it is easy to see the difficulties presented by water governance in Canada.

2.4.1 Watershed Planning in Ontario

Watershed planning and governance in Ontario is delivered through many stakeholders, which is discussed in Sections 4.1.1 and 4.2.1 of this thesis. Ontario’s capacity to implement watershed-based management and link land use planning to water management has been extensively studied in the literature. In fact, the province of Ontario has one of the most comprehensive arrangements in Canada to use watersheds as resource management units (Cervoni et al., 2008), although this has also created concern related to the decentralization of power that is associated with watershed-based management (Hill et al., 2008). Conservation authorities were created in Ontario in 1946, after the Conservation Authorities Act was passed by Provincial Legislature in response to growing water problems related to flooding, water shortages and water pollution. The purpose of conservation authorities as described in the Act was to promote the “conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals” (Conservation Authorities Act, 1990) including watersheds and water resources. Conservation authorities were only formed in municipalities that supported them (Shrubsole, 1996). Thirty-six CAs have been created since 1946, with nine conservation authorities alone whose jurisdiction includes the ORM. According to the Ontario Select Committee on Conservation Authorities (1967), the creation of CAs was “one of the most advanced approaches to conservation anywhere” (p.16). There were three principles openly discussed during the development of the conservation authorities: the CA should manage the environment using the watershed as the unit of measurement, the CA should require involvement of local communities, and the CA as an organization should signify a municipal-provincial partnership (Shrubsole, 1996). Although the following principles were still addressed during the creation of CA, they were less explicitly discussed: linking the health of the economy to the environment, using a
comprehensive approach to environmental management, as well as the importance of cooperation and coordination amongst multiple stakeholders (Shrubsole, 1996).

Multiple stakeholders in Ontario are concerned about the ability of CAs to actually implement watershed-based management (Cervoni et al., 2008). These results are reflected in many other studies of water management in the province, which have discussed inadequate support for CAs and groundwater management (de Loe and Kreutzwiser, 2007; Shrubsole, 1996), especially regarding funding sources. According to Conservation Ontario (2004) and Conservation Ontario (2004), funding for CAs breaks down as follows: 11% from the provincial government, 40% from municipal governments, 47% generated independently (i.e. through land rental fees, gate fees, etc.), and 2% from the federal government. Conservation authority staff themselves have also noted that their ability to manage watersheds and water resources has in some ways been hindered post-Walkerton, because of the revised provincial focus on source water protection, which “CA interviewees said has forced them to mask broad watershed management initiatives under the guise of source water protection” and other interviewees supported this, suggesting that “provincial leadership in watershed management is lacking”, and in some cases “the province does more to obstruct watershed-based management than to facilitate it” (Cervoni et al., 2008, p.341).

On the Oak Ridges Moraine (ORM) itself, watersheds and water resources are managed and protected under the ORM Conservation Plan (ORMCP). During the initial stages of the development of ORM watershed planning structures, requirements to address issues such as stormwater management and water resource extractions were included, however it was acknowledged that a more comprehensive approach to water management was necessary (Bradford, 2008). In response, more sections to the ORMCP were added with the purpose of integrating an ecosystem approach within the ORMCP, with a special emphasis on acknowledging the important role that the water cycle plays in maintaining ecosystem linkages (Bradford, 2008). Bradford (2008) emphasizes that hydrological integrity is crucial to maintaining ecological
integrity, and given the ORMCP vision to “[…] protecting the ecological and hydrological features and functions that support the health and well-being of the region’s residents and systems” (Oak Ridges Moraine Conservation Plan, 2002, Introduction), the ORMCP includes both preventative and mitigation policies for water resources to protect groundwater sources and hydrological features, as well as water conservation measures.

Within the ORMCP are requirements for municipalities to prepare watershed plans, in which the municipality must characterize the watershed, set targets, develop a land and water use and management strategy as well as a water budget and a water conservation plan, implement the management strategy, and carry out environmental monitoring (Bradford, 2008). By requiring municipalities to develop a watershed plan, the ORMCP protects and manage water resources beyond the administrative boundary of the moraine, acknowledging that the hydrologic cycle is dynamic, and upstream/downstream activities are interconnected. The ORMCP also excludes “most development and site alterations within permanent and intermittent streams, wetlands, kettle lakes, seepage areas and springs, and the minimum vegetation buffers of these features” in order to protect hydrologically sensitive features (Bradford, 2008, p. 325). The ORMCP requires that municipalities are the government agencies responsible for its implementation, and that subsequent land use planning/official plans conform to the ORMCP. It was anticipated that conservation authorities on the moraine would be approached by municipalities to be the lead agency regarding watershed plans, given that the CAs were already watershed-based agencies with pre-existing governance arrangements and experience to implement the water resources management plans and policies required by the ORMCP. Overall, the ORMCP has created a unique environment for ecosystem management and water governance on the moraine through the Plan’s requirements for monitoring programs, watershed plans, and guidelines for land use planning (Bradford, 2008).

2.4.2 How can CBM influence water governance?
Environmental data from government sources are often not able to meet the growing demand for environmental monitoring information; academic institutions and non-governmental organizations (NGOs) are mobilizing to meet this need. However, although these organizations are contributing to the pool of information available for environmental management, the information is very rarely used to inform decision-making (Milne et al., 2006). The same issues are observed within community-based monitoring programs: local communities raise awareness of the need to monitor environmental issues and subsequently design monitoring programs which aim to collect information in order to influence decision-making. However, due to a lack of trust that exists in government agencies for community volunteers, they are often ignored in the design of monitoring programs, and the data that they do collect are usually not incorporated into decision-making (Milne et al., 2006). In contrast, Hamann and Drossman (2006) have noted that although in some cases community groups have emerged independently from authorities in order to respond to watershed issues, in Canada and the USA, management agencies at the “local, state, provincial, and federal levels are coming to rely on the service that community volunteers can provide to monitor and improve the health of watersheds” (p.306). The importance of community involvement has been discussed in the literature: citizen participation in decision-making has been linked with improved trust between citizens and institutions, and greater legitimacy for governing bodies (Pollock and Whitelaw, 2005). Pollock and Whitelaw (2005) suggest that collaboration between CBM groups and various government agencies can actually contribute to an improved, more democratic decision-making process with greater support from local communities.

In Collingwood, Ontario, community members became concerned after the Ontario Ministry of the Environment terminated water quality monitoring in the Harbour in 1994, at the same that “the harbour had been de-listed as an Area of Concern under the Canada-US Great Lakes Water Quality Agreement” (Savan et al., 2003, p. 562). In response to these cutbacks, a local environment group “monitored the harbour waters, and revealed high ammonia and abnormal pH levels. This focused attention on the
continuing need for local stewardship of the harbour” (p. 563), and the community group’s findings, “resulted in new partnerships between citizens and water resource managers and policies to increase testing and strive to improve the water quality of the Collingwood Harbour” (Savan et al., 2003, p. 563).

In Hamilton, Ontario, 1997, there was a well-documented case study at Red Hill Creek, where CBM was able to successfully monitor, identify and resolve an issue of water pollution. Lynda Lukasik, a Hamilton area woman, was working with high school students and community volunteers to measure pH levels at four different monitoring stations along Red Hill Creek as it flowed downstream from the Niagara Escarpment to Lake Ontario. The monitoring data identified that a broken sewer pipe was releasing nearly raw sewage into the Creek, which was then resolved by the City (Au et al., 2000). Volunteers from the same program also collected water quality data which indicated that a landfill site was leaking toxic effluents into the creek (Au et al., 2000); the volunteers monitoring efforts eventually led to a successful lawsuit against the City of Hamilton with assistance from the Environmental Bureau of Investigation as well as Sierra Legal Defence Fund (Sharpe et al., 2000). The City of Hamilton was fined $300,000 and was required to properly address the pollution from the landfill site (Au et al., 2000; Savan et al., 2003; Sharpe et al., 2000).

2.4.3 What is the Role of Government/Agencies in CBM?

In a study of 31 Canadian communities involved in a pilot CBM project, Pollock and Whitelaw (2005) observed that partnerships developed between agencies and CBM groups “contributes to the identification of champions, improves the effectiveness of consultations, and shapes organization structures for CBM” (p. 221). Partnerships can “benefit communities in at least three ways: a selection of technical protocols are made available, educational materials and program marketing is provided, and local CBM efforts gain credibility through national exposure” (Pollock and Whitelaw, 2005, p. 221). Partnerships can be formed with a wide range of groups, including all levels of government agencies, environmental organizations, the private sector, all levels of educational institutions, conservation authorities, field naturalist groups,
biosphere reserves, as well as other communities also participating in CBM programs (Pollock and Whitelaw, 2005).

One example of a successful partnership between a government agency and community groups is the Citizen’s Volunteer Monitoring Program, founded in Pennsylvania in 1996, which created a Volunteer Environmental Monitoring Panel to provide a setting that was conducive to the sharing of information between different groups involved in monitoring water quality (Sharpe et al., 2000). The Program has also assisted community groups through the provision of monitoring materials such as manuals for creating an environmental program, facilitating workshops to train community volunteers, and maintaining a national database for monitoring information (Sharpe et al., 2000). In Canada, a similar initiative known as the Ecological Monitoring and Assessment Network (EMAN) ran from 1994 to 2010. EMAN was an ecological monitoring network across Canada, coordinated by Environment Canada, and whose role was to monitor and report change in Canadian ecosystems, as well as establishing permanent monitoring sites across the country for long-term data collection (Sharpe et al., 2000; Vaughan et al., 2001).

However, although partnerships with government agencies can lead to expanded and supplemented governmental monitoring programs, Au et al. (2000) suggested that it is prudent to keep community monitoring groups independent of authorities, both in terms of sponsorship, as well as in the validation of community collected scientific data. Au et al. (2000) speculated that “monitoring by the public will very probably reveal embarrassing information for the authorities and/or powerful agents in the local community” (p. 226), which can create difficulties. This is corroborated by Sharpe et al. (2000), who found that NGOs were cautiously optimistic about the opportunities presented by the growing interest of governments in their monitoring programs. While NGOs acknowledged that government involvement created opportunities to access resources beyond their local scale, they were concerned that the community would no longer have control over their monitoring agenda or that government partnerships could prevent communities from “…taking public positions and commenting on government policies,
decisions and shortcomings” (Sharpe et al., 2000, p. 33) Ideally, communities and authorities should cooperate and respect each other’s scientific research, although there should still be a degree of separation between the two monitoring parties (Au et al., 2000).
Chapter 3

Methods

This research mainly examines CBM in Ontario, using the ORM as a case study. The case study approach allows the researcher to carry out an investigation that retains “the holistic and meaningful characteristics of real life events—such as individual life cycles, organizational and managerial processes, neighborhood change …” (Yin, 1994, p. 3). Case studies may be explanatory, descriptive, exploratory, or all of these investigating “a contemporary phenomenon within its real-life context…” (Yin, 1994, p. 12).

Qualitative methods were chosen over quantitative methods for this thesis due to the nature of the research (i.e. interviews and document analysis). In the past, qualitative methods have received criticism stemming from a perception that they are not scientific, while quantitative methods are often more respected due to an assumed precision and certainty in research results (Berg, 2007). However, Berg (2007) emphasizes that qualitative research methods can be extremely rigorous and provide significant contributions to the academic field of the social sciences. Three qualitative research methods were used to collect data for this research project: a literature review of scholarly articles on the ORM and monitoring, interviews and document analysis. Qualitative research techniques are used to “make sense out of an ongoing process that cannot be predicted...” (Babbie, 1986, p. 358). Qualitative research is focused on “meanings, concepts, definitions, characteristics, metaphors, symbols and description of things” (Berg, 2007, p. 3). Qualitative procedures allow the researcher to access “unquantifiable facts about the actual people researchers observe and talk to” (Berg, 2007, p. 8). Various perspectives must be tapped to gain a broad understanding of the social context and specific subject matter.

Three qualitative research methods were chosen for this research project in order to establish convergent validation of the research results, known widely in the literature as ‘triangulation’ (Jick, 1979). The importance of triangulation in research methods is that is improves the accuracy of and provides
validation for the results (Bouchard, 1976; Jick, 1979). Multiple research methods that reach a similar conclusion provide more certain results than a single measure of data (Jick, 1979). Therefore, results from the literature review, interviews, and document analysis were compared to each other to corroborate the results from the research.

3.1 Literature Review

The first step of the research process began with a review of scholarly articles which discussed the ORM, monitoring, CBM, and the role of communities in influencing the decision-making process. The purpose of the literature review was to explore the existing body of knowledge related to the research topic, and to help guide the development of the interview questions.

Scholarly databases were used to search for academic literature (GEOBASE, Environment Complete, and Web of Science). Google Scholar was also used to conduct an internet search to locate additional academic studies and other recognized reports and publications in the subject areas of CBM, the ORM, and water decision-making. A combination of keywords and search terms were used to explore the literature, chosen based on their relevance to the topic of the research project and the research questions. The keywords and search terms used during this literature review are given in Table 1.

Table 1. A list of keywords and search terms used to review the literature. Words were chosen based on their relevance to the research topic and research questions, and were confirmed based on input from the thesis committee.

<table>
<thead>
<tr>
<th>Keyword or Search Term Group 1</th>
<th>AND</th>
<th>Keyword or Search Term Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community-based monitoring</td>
<td>AND</td>
<td>Water</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oak Ridges Moraine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water governance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conservation authorities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decision-making</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ontario</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nova Scotia</td>
</tr>
<tr>
<td>Water governance</td>
<td>AND</td>
<td>Oak Ridges Moraine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ontario</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Canada</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>Individual keywords or search terms</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>-------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Community-based monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community-based water monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water governance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oak Ridges Moraine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conservation authorities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community-based monitoring on the Oak Ridges Moraine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Community-based water monitoring on the Oak Ridges Moraine</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As can be seen in Table 1, the database searches consisted of keywords or search terms from Group 1 combined with keywords or search terms from Group 2. As is indicated in the table, some keywords or search terms were used individually (as well as in a group) to capture a broad range of relevant scholarly articles.

After reviewing the literature, six research questions emerged:

1. What is the current status of water governance on the ORM?
2. What are the types of CBM initiatives that are taking place on the ORM, with a particular focus on water?
3. What role do government agencies play in CBM on the ORM?
4. What are the challenges and successes associated with CBM on the ORM?
5. What is the future of CBM on the ORM?
6. How does CBM on the ORM compare with CBM in Nova Scotia?

Once complete, the literature review results also informed the development of interview questions for the next stage of the research project, which will be discussed in Section 3.2.

3.2 Interviews

After receiving approval from the General Research Ethics Board (GREB) (Appendix A), interviews were conducted between August 27th and October 29th of 2013. An initial list of interviewees was created in discussion with the research committee and relevant experts familiar with both environmental organizations and government activities related to CBM on the ORM, as well as informed by the literature review and an extensive internet search. Once the initial contact list was created, potential
participants were emailed individually with a standard email introducing the research topic and asking if they would like to participate in an interview. If the initial email was not answered, a follow up email was sent; if the follow up email was not answered, the individual was not contacted again. Individuals who agreed to an interview were then sent a letter of information and consent form, to be read before the interview occurred. The signed consent forms were stored in a locked drawer in a locked office at all times in order to protect participants’ privacy.

McCracken’s (1988) long interview technique was selected for this research for the following reasons: the research team’s positive experience with the technique’s ability to discover and analyze complex concepts (Whitelaw, 2005); an emphasis on using the literature to develop and build on previous work while remaining open to new ideas, themes and patterns; as well as paying attention to the interview environment and interviewer behavior. Two factors often limit qualitative research: time limitations and concerns for privacy. The long interview technique is designed to overcome these limiting factors and allows the researcher to achieve “crucial qualitative objectives within a manageable methodological context” (McCracken, 1988, p. 11). The long interview technique allows for patterns and interrelationships between many issues to be examined so that complex processes can be analyzed, and intensive rather than extensive research carried out. The long interview technique consists of four successive steps (McCracken, 1988): (1) review of analytic categories; (2) review of cultural categories; (3) discovery of cultural categories; and (4) interview analysis.

The first step of the long interview process is to thoroughly review the literature (McCracken, 1988). Semi-structured interview questions were developed following a review of the literature related to CBM and water governance in Ontario, keeping in mind the goals of the research project: to determine what type of monitoring is occurring on the ORM, who is involved in CBM on the ORM, what the role of government is in CBM, whether or not CBM is contributing to adaptive management/decision-making, what are the barriers to CBM, and what the future of CBM will look like. The literature review can help
determine categories to organize the data (McCracken, 1988). The second step is meant for the researcher to both familiarize and defamiliarize themselves with the topic (which in this project was CBM) and to identify any underlying biases or beliefs held by the researcher. Familiarization promotes the listening skills required for data collection during the interview, and defamiliarization causes the researcher to establish distance between the information presented in the interview and any embedded assumptions (McCracken, 1988). For example, given the research topic of CBM, my cultural review consisted of reflecting on my own experiences in data collection as a non-expert. This reminded me how challenging it was to learn unfamiliar techniques/terminology, as well as the satisfaction that came from assisting with relevant and important research projects. Introspection made me more sensitive and cognizant of the point of view of CBM volunteers during my interviews.

Step three of the long interview is to discover cultural categories and create the interview questions (Appendix B). The interview was designed to be semi-structured/semi-standardized, meaning that although interview questions were developed prior to the actual interview, there was some flexibility built into the interview structure: interview questions could be re-ordered during the interview, the interviewer could answer questions and make clarifications if requested by the interviewee, and the wording/language of the interview questions could be adjusted throughout the interview (Berg, 2007). It is important that the researcher maintain a low profile during the interview; the main objective of the interview is to “allow respondents to tell their own story in their own terms” (McCracken, 1988, p. 35). Interview questions were designed to “move them [respondents], to move them to talk without overspecifying the substance or the perspective of this talk” (McCracken, 1988, p.35). The interview questions were designed to initiate testimony. For example, one of the interview questions was “Please explain how you became involved in community based monitoring activities”. This question is specific enough that the interviewee has an idea of the topic of their answer, but does not guide them to answer the question in any particular way. Thus, we avoided limiting the potential information that could be gathered through interviews by keeping the interview questions only as specific as they needed to be to explore the
research question appropriately. In the case of this research project, it was necessary at the beginning of
the interview to specify that the interview questions were only referring to CBM activities that the
interviewee was involved with on the ORM landscape, to stay within the scope of the project and avoid
extraneous information. If a participant gave a brief answer with very little detail, additional testimony
was obtained primarily through the use of prompts (i.e. repeating the last remark/term of the participant’s
answer) which usually stimulated more in-depth testimony on the subject.

The fourth step of the long interview is interview analysis, which is discussed in more detail in
Section 3.4. The interviews as well as the grey literature were analyzed using the same methods of data
analysis, in order to conduct an in depth comparison between the two data sets.

Interviews were conducted in-person, over the phone, or via webcam, depending on the location
of the participant as well as their personal preference for the interview. Each in-person interview began
with a description of the research project, after which the interviewee read the letter of information, and
signed the consent form. All phone or webcam interviewees received the letter of information and consent
form before the interview, and sent a scanned copy of the signed consent form to the researcher before the
interview began. Verbal consent was then obtained to record the interview. All interviews were recorded
to allow the interviewer to participate fully in the session without having to break eye contact or the flow
of the interview to take notes. The interview began informally with a few opening, biographical questions
to set the interviewee at ease and establish a rapport between interviewee and interviewer.

The snowball method was used to expand the initial list of participants into a much larger sample
size. According to Berg (2007), “[s]nowball sampling is sometimes the best way to locate subjects with
certain attributes or characteristics necessary in the study” (p. 44), which in this case included all
individuals/organizations involved in CBM on the ORM. At the end of each interview, the participant was
asked to recommend any individuals they knew or were associated with who were also involved in CBM
on the ORM. The recommended individuals were then contacted to determine if they would be interested in participating in the research project. Recommendations were noted at the end of each interview, and the interviews continued until the individuals being recommended for interviews reached a saturation point (no new individuals were being recommended by participants), which indicated that the key players in CBM on the ORM had been included in the research project.

As can be seen in Table 2, there were 27 interviews completed in total, with interviewees ranging from conservation authority staff, non-governmental organization staff, CBM volunteers, Ministry of Natural Resources staff, Ministry of Environment staff, as well as municipal decision-makers.

Table 2. A summary of respondents who participated in an interview. Participants are only identified by their role in community-based monitoring/which organizations they worked for and a number to differentiate between multiple participants in a category. Participants came from a variety of backgrounds.

<table>
<thead>
<tr>
<th>Type of Participant</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation Authority Staff (CA#)</td>
<td>CA1, CA2, CA3, CA4, CA5, CA6, CA7, CA8, CA9, CA10, CA11, CA12</td>
</tr>
<tr>
<td>Non-governmental Organization Staff (NGO#)</td>
<td>NGO1, NGO2, NGO3, NGO4, NGO5, NGO6, NGO7</td>
</tr>
<tr>
<td>CBM Volunteers (CBM#)</td>
<td>CBM1, CBM2, CBM3, CBM4</td>
</tr>
<tr>
<td>Members of Government (GOV#)</td>
<td>GOV1, GOV2, GOV3, GOV4</td>
</tr>
</tbody>
</table>

Participants’ personal information was removed from the interview file descriptions and changed to numbers, to create anonymity for the participants’. With the participants’ permission, interviews were recorded and then transcribed verbatim to ensure that information was accurately represented during data analysis. Completed interview transcripts were uploaded using the program Nvivo 10, which was then
used to code the interviews. Methods used to code and analyze interviews were the same for interviews and document analysis, and are described in more detail in Section 3.4.

3.3 Document Analysis

A document analysis was performed concerning water monitoring with a focus on community-based approaches on the ORM to further explore the role of water monitoring and its role in decision-making and adaptive management. Documents collected for analysis included grey literature from both government and civil society. Grey literature refers to written materials which are available to all levels (i.e. to industry, academics, government, and business) and not formally published (Hopewell et al., 2007). The types of documents that were analyzed included: watershed report cards and yearly reports from conservation authorities; literature from CBM groups such as field manuals, annual reports, data collection protocols and newsletters; government documents including the ORM Conservation Act and ORM Conservation Plan (Table 3). A total of 43 documents from various sources were analyzed for this research project.

Table 3. A summary of the documents included in the document analysis. Grey literature was included from multiple sources.

<table>
<thead>
<tr>
<th>Type of Document</th>
<th>Name of Document</th>
</tr>
</thead>
</table>
• Oak Ridges Moraine Act (Government of Ontario, 2001)  
• Oak Ridges Moraine Conservation Plan (Government of Ontario, 2002) |
| Conservation Authorities | • Conservation Authority Moraine Coalition (CAMC) Strategic Plan 2011 (Conservation Authority Moraine Coalition, 2011)  
• A Proposal to Develop an Ontario Stream Monitoring Network (Southern Ontario Stream Monitoring and Research Team, 2008)  
• CAMC 2012 Accomplishments (Conservation Authorities Moraine Coalition, 2012)  
• Nottawasaga Water Health Check 2013 (Nottawasaga Valley Conservation Authority, 2013)  
• Lake Simcoe Watershed 2013 Environmental Monitoring Report (Lake Simcoe Region Conservation Authority, 2013)  
• Ganaraska Region Conservation Authority 2012 Annual Report Card (Ganaraska Region Conservation Authority, 2012)  
• Credit Valley Conservation Water Report (Credit Valley Conservation Authority,
<table>
<thead>
<tr>
<th>Year</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Central Lake Ontario Conservation 2012 Year in Review (Central Lake Ontario Conservation Authority, 2012)</td>
</tr>
</tbody>
</table>

**NGO**

- Oak Ridges Moraine Foundation (ORMF) Watershed Health Assessment on the ORM (Oak Ridges Moraine Foundation, 2011)
- Citizen Scientists Spring 2009 Newsletter (Citizen Scientists, 2009)
- Save the Oak Ridges Moraine (STORM) 2012 Status Report (Save the Oak Ridges Moraine Coalition, 2012)
- Monitoring the Moraine (MTM) Citizen’s Guide to the ORM (Monitoring the Moraine, 2010)
- STORM Measuring Success (Oak Ridges Moraine Foundation, 2011)

**Other**

- Citizen Science as a Catalyst Bridging Science and Decision-makers (Vaughan, 2007)
- Ecological Monitoring and Assessment Network (EMAN) and Biosphere Reserves: Cooperating in Providing Information for Ecozone and Local Ecosystem Management (Craig and Vaughan, 2001)
- Citizen Scientists: What Type of Monitoring Do We Do? (Citizen Scientists, n.d.)
- Citizen Scientists: Channel Morphology (Citizen Scientists, n.d.)

**Protocols**

- 2013 Ontario Stream Assessment Protocol (OSAP) (Stanfield, 2013)
- Lake Partner Program (LPP) Interpreting TP and Secchi Results (Government of Ontario, 2013)
- LPP Spring Sampling Instructions 2012 (Government of Ontario, 2012)
- Citizen Scientists Fish Sampling (Citizen Scientists, n.d.)
- Citizen Scientists: Temperature Monitoring (Citizen Scientists, n.d.)
- Citizen Scientists: Aquatic Invasive Species Monitoring (Citizen Scientists, n.d.)
- Citizen Scientists: Invertebrate Sampling (Citizen Scientists, n.d.)
- MTM Action Guide (Monitoring the Moraine, 2011)
- EcoSpark Changing Currents Field Manual (Ecospark, 2013)
- Going with the Flow: An Analysis of Check Your Watershed Day Data, 2006 to 2010 (Ecospark, 2012)
- STORM: Moraine Watch Manual (Monitoring the Moraine, 2007)
Documents were collected from government and NGO websites, and then uploaded into the program Nvivo 10. Documents were coded and sorted into categories similar to the categories established during interview coding and analysis, in order to allow for comparison between what the literature describes, and what is actually happening on the ORM. The grey literature and the interviews were analyzed using the same methods of data analysis, to allow for in depth comparison between the two data sets. More detailed methods of data analysis are described in Section 3.4.

3.4 Data Analysis

The interviews conducted during data collection were transcribed verbatim into written texts, and thus can be analyzed using the same approach that is applied to documents. Therefore, for the remainder of this section, “document analysis” refers to both interviews as well as grey literature. Document analysis is “any technique for making inferences by systematically and objectively identifying special characteristics of messages” (Holsti, 1968, p.608). According to Berg (2007, p.326), the first step of a document analysis is to identify the research question and the overall goal of the document analysis. In the case of this research project, the research question was determined to be identifying and analyzing the
current status of CBM on the ORM, as well as exploring the impacts of CBM to decision-making, the barriers that exist to CBM, and potential future directions that CBM might take (Section 3.1).

Nvivo 10 was used to organize and sort the data. Once the interviews were transcribed, the transcripts and the grey literature were uploaded into Nvivo 10. The researcher entered the document analysis with the knowledge previously gained from the literature review, as well as “a glancing sense of what took place in the interview itself” (McCracken, 1988, p.42). Categories and subcategories relevant to the research question were developed through an initial analysis of the interviews and documents called “open coding” (Berg, 2007, p.317), related to patterns that become apparent in the data (Berg, 2007).

Stage one of the analysis treated each data point in the document as an individual observation, ignoring its connection to other aspects of the document. Stage two then took these individual observations and examined them according to evidence from the whole transcript as well as the literature review. Stage three linked together the observations from a single document, and stage four compared the results from all the documents (McCracken, 1988). Data analysis was an iterative process. *In vivo* codes “are the literal terms used by individuals under investigation, in effect, the terms used by the various actors themselves” (Berg, 2007, p.309). Using Nvivo 10, *in vivo* codes were sorted into the categories (aka “nodes”) as appropriate. The literature review was used to guide the development of categories, outlining the current status of CBM and its role in decision-making, as well as exploring barriers, benefits and future directions of CBM. Categories were created by the researcher (ex: “the role of conservation authorities in CBM”) based on the researcher’s knowledge of the literature (Berg, 2009) as well as the contents of the documents (interviews and grey literature). The methods used to create the categories were a combination of inductive and deductive methods. An inductive method requires the researcher to engross themselves in the documents “in order to identify the dimensions or themes that seem meaningful to the producers of each message” (Berg, 2007, p. 311). A deductive method, in contrast, means that the researcher has already developed categories based on previous research, and the purpose of the document analysis is to
assess these assumptions. A combination of these methods was chosen. Berg (2007) advocates that although inductive methods are most suitable to present the opinions of others (i.e. participants), content analysis is most effective when inductive and deductive methods are combined. In the context of this research project, when creating categories for document analysis, the researcher’s experience from the literature review (deduction) influenced the establishment of several categories (ex: the role of government in CBM); however, the researcher was sensitive to emerging themes from the documents throughout the analysis process (induction).

Once the various categories have been established in the final stage, the documents can be fully analyzed and the data can be sorted by themes into the appropriate category to bring together conclusions “about the general properties of thought and action within the community or group under study” (McCracken, 1988, p.42). In the context of this research project, themes refer to “…a more useful unit to count. In its simplest form, a theme is a simple sentence, a string of words with a subject and a predicate” (Berg, 2007, p.312). These themes are referred to as sub-nodes in Nvivo 10, and are listed in Table 4. The literature was again consulted after the categories were developed in order to help explain the results of document analysis. According to Berg (2007), it is necessary to consider the results in relation to previous research to establish if the findings confirm or challenge the current literature.

Table 4 outlines the themes from the document analysis, identifying if the node or sub-node was inductive or deductive. If the node/sub-node was deductive, the theme was determined before data analysis. If the node/sub-node was inductive, the theme emerged during data analysis. The majority of the nodes/sub-nodes reflect the research questions that underlay this research project. For example, one of the research questions was to determine the current status of CBM on the ORM, and thus the node “current status of CBM on the ORM” is deductive. Deductive sub-nodes such as “becoming involved in CBM on the ORM” or “skills training to volunteers in CBM” were the result of an interview question, as these topics had emerged from the literature. Others, such as “Check Your Watershed day (CYWD)” are
inductive because when interviewees were discussing how they became involved in CBM, they brought up CYWD without any prompting from the researcher, and thus a sub-node was created to reflect the results of the interviews. Some of the nodes were inductive, as a larger theme emerged from specific interview questions such as “how does CBM contribute to adaptive management”. For the node related to the future of CBM, no specific sub-nodes were created, as the interview question was intended to capture all of the themes of the research questions looking forward for CBM; thus, the results from this interview question are organized under a single node. Research questions are also included in the table to demonstrate how the document analysis nodes provided answers to the research questions. Note that research question six (how does the CBM on the ORM compare with CBM in Nova Scotia?) is not answered in the main analysis, as this question was posed during the CURA H2O Workshop with researchers and community members. The topic is discussed under the section Knowledge Mobilization (Section 3.5).

Table 4. This table outlines the nodes and sub-nodes used to organize the results from the document analysis. The type of node/sub-node is identified as being either deductive (the theme was determined during data analysis) or inductive (the theme emerged during data analysis). The title of the node/sub-node is identified, and can be referenced during the chapter to understand which research question the node is answering.

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Title and Type of Node</th>
<th>Title and Type of Sub-node</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) What is the current status of water governance on the Oak Ridges Moraine (ORM)?</td>
<td>What is the current status of community-based monitoring (CBM) on the ORM? <em>deductive</em></td>
<td>Becoming involved in CBM on the ORM <em>deductive</em></td>
</tr>
<tr>
<td>(2) What are the types of CBM initiatives that are taking place on the ORM with a particular focus on water?</td>
<td></td>
<td>Check Your Watershed Day (CYWD) <em>inductive</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Skills training to volunteers in CBM <em>deductive</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitoring on the ORM <em>deductive</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Policy monitoring on the ORM <em>deductive</em></td>
</tr>
<tr>
<td>(4) What are the challenges and successes associated with CBM on the ORM?</td>
<td>What influence does CBM have on the ORM? <em>inductive</em></td>
<td>CBM and adaptive management <em>deductive</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CBM and decision-making <em>deductive</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Communicating CBM data <em>deductive</em></td>
</tr>
</tbody>
</table>
What are the barriers to CBM on the ORM? (inductive)  
Barriers to CBM (inductive)  
Data quality issues (inductive)  
Funding for CBM on the ORM (deductive)  
Government cutbacks and CBM (deductive)

| (1) What is the current status of water governance on the ORM?  
(3) What role do government agencies play in CBM on the ORM?  
(5) What is the future of CBM on the ORM? | What is the role of government in CBM on the ORM? (inductive)  
What is the future of CBM on the ORM? (deductive) | Coordinating CBM with government on the ORM (deductive)  
Role of CA within CBM on the ORM (deductive)  
No specific sub-nodes determined for this node |

3.5 Knowledge Mobilization

During the completion of the research project, the researcher presented at academic conferences and during workshops with the CURA H2O team. These presentations provided an opportunity to confirm the research methods, and to disseminate knowledge to the CURA H2O Project researchers and participants. The methods of knowledge mobilization will be discussed in Sections 3.5.1 and 3.5.2.

3.5.1 Confirmation of Methods

Throughout the completion of the interviews and document analysis, as well as throughout the data analysis process, the researcher presented at several academic conferences as well as community workshops hosted by the CURA H2O Project. The purpose of these presentations was to give the researcher an opportunity to receive feedback on the validity of the research methods, the types of participants interviewed, the types of documents analyzed, as well as the data analysis process. Presenting the research to a wide range of academic researchers, graduate students and members of the conservation field (including multiple Conservation Authority staff) resulted in extensive knowledge mobilization, as well as validation of the research project methods, findings and conclusions. The full list of presentations can be found in Table 5.
Table 5. A full list of all presentations (oral and poster) related to thesis research. The type of presentation, the location of the presentation, and the year of the presentation is provided. Each presentation represents an opportunity where the research methods were peer-reviewed to confirm their applicability for this type of research project.

<table>
<thead>
<tr>
<th>Year</th>
<th>Type of Presentation</th>
<th>Title of Presentation</th>
<th>Location of Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>Poster</td>
<td>Local water governance, conservation authorities and community-based monitoring groups; a case study of the Oak Ridges Moraine, Ontario, Canada.</td>
<td>Canada Water Quality Association Symposium</td>
</tr>
<tr>
<td>2013</td>
<td>Oral</td>
<td>Community-based water monitoring and management: Examining community-based water monitoring programs and activities in Nova Scotia and southern Ontario.</td>
<td>Queen’s University School of Environmental Studies Research Day 2013</td>
</tr>
<tr>
<td>2013</td>
<td>Poster</td>
<td>Local water governance, conservation authorities and community-based monitoring groups; a case study of the Oak Ridges Moraine, Ontario, Canada.</td>
<td>A.D. Latornell Conservation Symposium</td>
</tr>
<tr>
<td>2014</td>
<td>Oral</td>
<td>Local water governance and community-based monitoring groups; a case study of the Oak Ridges Moraine, Ontario, Canada.</td>
<td>Water Initiative for the Future (WatIF) Graduate Student Conference</td>
</tr>
<tr>
<td>2014</td>
<td>Poster</td>
<td>Local water governance, conservation authorities and community-based monitoring groups; a case study of the Oak Ridges Moraine, Ontario, Canada.</td>
<td>Queen’s University School of Environmental Studies Research Day 2014</td>
</tr>
<tr>
<td>2014</td>
<td>Oral</td>
<td>Local water governance, conservation authorities and community-based monitoring groups; a case study of the Oak Ridges Moraine, Ontario, Canada.</td>
<td>CURA H2O Community Workshop and Research Meeting</td>
</tr>
<tr>
<td>2014</td>
<td>Oral</td>
<td>Water governance, conservation authorities and community-based monitoring groups; a case study of the Oak Ridges Moraine, Ontario, Canada.</td>
<td>Conference of the Environmental Studies Association of Canada (ESAC)</td>
</tr>
</tbody>
</table>

3.5.2 CURA H2O Workshop and Research Meeting

One of the research questions for this project related to understanding how the current situation regarding CBM on the ORM compared with CBM in Nova Scotia. The limited time associated with the
MES degree made a two case study thesis of the depth required for comparison impossible. Other researchers from the CURA H2O Project research team were exploring the Nova Scotia case. In order to explore this facet of the research, the initial results of the research (from both the interviews and the grey literature) were presented to both the academic and community members of the CURA H2O Project. The purpose of this presentation was to outline the research findings to the group, as well as to gain their perspective on the differences that existed between the ORM, and Nova Scotia. Both academics and community members were interested in the differences that exist between the two provinces, and provided helpful insights and points of discussion. The purpose of this workshop was to answer research question six: how does the CBM on the ORM compare with CBM in Nova Scotia? The outcomes of this knowledge mobilization will be included in Chapter 4.
Chapter 4

Results and Discussion

4.1 Document Analysis: Results and Discussion

In this section, the results from the scholarly literature review on ORM monitoring, grey literature, and interviews are presented and discussed, weaving together a narrative through all of the aspects of CBM that were explored in this research project (see research questions, discussed later in Section 4.1). It will be clearly stated in this chapter whether a statement is from an interview, the grey literature, scholarly literature on ORM monitoring, or is a discussion item presented by the researcher. The interviews were designed to explore the opinions of people actively working with CBM on the ORM, while the grey literature was examined to determine if or how CBM was being discussed in official documents. Scholarly literature assisted with triangulation, to provide validation of the research results, and with discussion of the results. It must be recognized that there are few direct references to the review of the grey literature, as there is very little mention of CBM within government documents. However, this finding is telling on its own, in that CBM is not a concept that is generally acknowledged by these agencies, but is discussed in grey literature produced by NGOs and community groups. This will be discussed later on in this chapter.

Furthermore, it is important to recognize that a large portion of the data came from interviews with staff members of various government, non-government and community organizations. During the interview process, participants’ identities were protected through the removal of identifying information from their files, as well as the use of codes to classify the interviews (i.e. CA1, see Section 3.2). As part of the confidentiality agreement signed by participants and included within the ethics approval for this research (Appendix A), identities of the participants are not disclosed within this thesis. Therefore, although as much information and detail as possible is discussed in the results section to provide the appropriate context within which to consider the results, the identities of the interviewees were not compromised and therefore some identifying context or details had to be excluded.
The results and discussion chapter is organized based on the research questions, all of which are presented below:

1. What is the current status of water governance on the ORM?
2. What are the types of CBM initiatives that are taking place on the ORM with a particular focus on water?
3. What role do government agencies play in CBM on the ORM?
4. What are the challenges and successes associated with CBM on the ORM?
5. What is the future of CBM on the ORM?

In order to answer these questions, it is important for the purposes of this thesis to understand the type of programs that are already in place to protect water resources, how individuals or organizations become involved in CBM; the mechanisms for incorporating volunteers into monitoring programs; how/if CBM data influences decision-making or adaptive management; the role that government agencies play in CBM; the barriers to CBM; as well as the future direction of CBM on the ORM and structure of CBM in both Nova Scotia and the ORM.

4.1.1 What is the Current Status of Water Governance on the ORM?

This research question explores the water legislation that exists in Ontario to protect and manage water resources, as well as other tools that are used to govern water. The answer to this research question emerged as part of the initial review of literature surrounding water governance in Ontario. Table 5 provides a list of Acts that are administered by the province of Ontario to govern water resources, as well as summarizing the purpose of each piece of legislation. The table only includes legislation and regulation that directly manages water resources in the province of Ontario, excluding legislation that indirectly affects water management or federal legislation related to water, due to the focus of this research project on water resources in Ontario.

Table 5. This table names and provides a summary of pieces of legislation in Ontario that directly regulate water resources in the province. This list is adapted from a Conservation Ontario brochure for drinking water source protection (Conservation Ontario, 2009) and a water legislation fact sheet produced by the Canadian Environmental Law Association (2012), as well as the Ontario e-laws website.

<table>
<thead>
<tr>
<th>Legislation</th>
<th>Purpose of Legislation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation Authorities Act, 1990</td>
<td>To establish and undertake programs for the conservation,</td>
</tr>
<tr>
<td>(Government of Ontario, 1990)</td>
<td>restoration, development, and management of natural resources in Ontario other than gas, oil, coal and minerals, including drinking water and other resources.</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Environmental Protection Act, 1990 (Government of Ontario, 1990)</td>
<td>To protect water resources in Ontario from contamination, including prohibition of the discharge of pollutants into the natural environment.</td>
</tr>
<tr>
<td>Clean Water Act, 2006 (Government of Ontario, 2006)</td>
<td>To protect the quality and quantity of current and future sources of municipal drinking water by managing or prohibiting activities or land uses in vulnerable areas.</td>
</tr>
<tr>
<td>Safeguarding and Sustaining Ontario’s Water Act, 2007 (Government of Ontario, 2007)</td>
<td>To protect water in Hudson Bay Basins, St. Lawrence River, and the Great Lakes by regulating or prohibiting water consumption and/or diversions from these water sources. Amending the Ontario Water Resources Act, 1990.</td>
</tr>
<tr>
<td>Oak Ridges Moraine Conservation Act, 2001 (Government of Ontario, 2001)</td>
<td>To protect, maintain and restore the ecological and hydrological integrity and function of the Oak Ridges Moraine, to maintain the Oak Ridges Moraine as a continuous natural landscape for current and future generations, to support land uses and development that are compatible with the objectives of the Plan, to support continued development and recreation on the moraine.</td>
</tr>
<tr>
<td>Water Opportunities Act, 2010 (Government of Ontario, 2010)</td>
<td>To promote innovation in water, wastewater and stormwater operations, as well as conserve and maintain water resources in Ontario for current and future generations, and create economic opportunities and clean-technology jobs.</td>
</tr>
<tr>
<td>Greenbelt Act, 2005 (Government of Ontario, 2005)</td>
<td>To create a network of countryside and open spaces to support and create connections between the Niagara Escarpment and the Oak Ridges Moraine, promote sustainable resources use, to sustain the communities that agricultural operations in place, as well as the ecological and hydrological functions of the greenbelt area.</td>
</tr>
<tr>
<td>Lakes and Rivers Improvement Act, 1990 (Government of Ontario, 1990)</td>
<td>To manage, protect, preserve and use the lakes and rivers in Ontario for the benefit of public rights and interests in water, the natural environment including fish and wildlife, and the properties of those living near water bodies.</td>
</tr>
<tr>
<td>Environmental Assessment Act, 1990 (Government of Ontario, 1990)</td>
<td>To protect, conserve, and manage the natural environment in Ontario by regulating development in the province that could have an ecological, social, cultural, and/or economic impact.</td>
</tr>
<tr>
<td>Municipal Water and Sewage Transfer Act, 1997 (Government of Ontario, 1997)</td>
<td>To transfer the ownership of water and wastewater systems from the province to municipalities.</td>
</tr>
<tr>
<td>Safe Drinking Water Act, 2002</td>
<td>To protect drinking water quality by regulating drinking water</td>
</tr>
</tbody>
</table>
As can be seen from Table 5, there are many different pieces of legislation in Ontario that address water resources. The legislation ranges from broad spectrum legislation such as the *Lakes and Rivers Improvement Act, 1990*, which includes a range of applicable powers, from the natural environment, to recreational activities, to protecting properties from flooding, to the *Clean Water Act, 2006* which is focused on protecting municipal drinking water sources from land uses and activities in vulnerable areas. Water legislation in Ontario addresses both water quality and water quantity issues through land use planning (e.g. the *Clean Water Act, 2006*), processing development applications (e.g. the *Environmental Assessment Act, 1990*), the regulation of drinking water and wastewater systems (e.g. *Municipal Water and Sewage Transfer Act, 1997; Safe Drinking Water Act, 2002; Water Opportunities Act, 2010*), and the establishment of agencies to promote water resource management (e.g. the *Conservation Authorities Act, 1990*). Conservation authorities play a unique role in the province; according to the *Conservation Authorities Act, 1990*, “the objects of an authority are to establish and undertake, in the area over which it has jurisdiction, a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals” (Government of Ontario, 1990, 20(1)). Conservation authorities are therefore given the objective of promoting and undertaking projects that could be related to any and all aspects of water quality and quantity within their jurisdiction, all across Ontario. A clear example of this is the development of Source Protection Plans under the *Clean Water Act, 2006* to protect current and future drinking water sources. Under the Act, conservation authorities are influencing land use planning, prohibiting and managing activities that are taking place in vulnerable areas near drinking water sources, and educating local municipalities and residents on the importance of protecting source water.
In addition to these many provincial Acts in Ontario that govern water resources, there is also a layer of water governance that is being administered by communities across the province. This additional water governance mechanism has been observed in the literature, and was confirmed during the interview process. Community-level water governance will be discussed in Section 4.1.2.

4.1.2 What are the Types of CBM Initiatives that are Taking Place on the ORM with a Particular Focus on Water?

One area of Canada in particular that has inspired citizens to become more active in their local ecosystem is the Oak Ridges Moraine (ORM) in southern Ontario. Community groups have been active on the moraine for several decades. Between 1989 and 2002, dedicated local citizens campaigned for stronger environmental protection, biodiversity conservation (Whitelaw and McCarthy, 2008) and improved land use planning, eventually leading to the development of the ORM Conservation Act in 2001 and the ORM Conservation Plan (ORMCP) in 2002 (Oak Ridges Moraine Act, 2001; Oak Ridges Moraine Conservation Plan, 2002; Whitelaw et al., 2009).

Shortly thereafter, three NGOs came together to produce the Monitoring the Moraine Project (MTM) in 2005, which includes community volunteers in monitoring and stewardship on the moraine (Whitelaw et al., 2009). The three organizations which organized MTM are: Save the Oak Ridges Moraine (STORM), Citizens Environment Watch (CEW), and the Centre for Community Monitoring.

Save the Oak Ridges Moraine (STORM) Coalition is an environmental organization that was founded by citizens concerned about urbanization and resource extraction in the City of Toronto during the 1980s. STORM’s goal has been to encourage and participate in sound land use planning, environmental management and policies, as well as to protect the moraine from harmful developments now and in the future (STORM, n.d.). STORM has partnered with Citizen’s Environment Watch (CEW) to protect and monitor the ORM. CEW was founded in 1997 by concerned academics and community
members, in response to cutbacks by the provincial government, as well as public interest in environmental monitoring (Sharpe et al., 2000). The creation of CEW is just one example of when citizen science has evolved from scientists using community volunteers to collect data, to citizens as scientists themselves (Lakshminarayanan et al., 2007). CEW’s original mandate was to protect and enhance Ontario’s ecosystems by assisting community members in the establishment of connections between “science, policy and action to improve environmental conditions” (Savan et al., 2003, p. 564) and including both school and community groups in environmental monitoring initiatives (Savan et al., 2003). Since its inception, CEW has worked with communities to monitor the health of local water systems through multiple parameters.

STORM and CEW created the Monitoring the Moraine program (MTM) in 2005, and although the program officially ended in 2012, the monitoring activities included within the program are still carried out by the founding organizations. The project’s goals were to: design and implement CBM activities across the ORM for both ecological and policy monitoring that would be relevant to all communities and monitoring initiatives on the ORM; to influence decision-making through the communication of CBM data to relevant authorities for both smaller policies as well as the upcoming review of the Greenbelt, which includes the ORM Conservation Plan (Greenbelt Council, 2013; Whitelaw and McCarthy, 2008).

Table 6 lists some of the organizations across the Oak Ridges Moraine that are involved in aspects of community-based water monitoring and water management. Table 6 also includes a brief description of the type of CBM that is carried out by the organization. This is not a comprehensive list of CBM initiatives on the ORM, and is instead based on information from interviewees and select grey literature. For some CBM programs, such as those that are integrated with CA programs, the specific CA is not named to protect the privacy of the CA staff involved in these initiatives.
Table 6. This table names non-governmental organizations involved in community-based water monitoring on the Oak Ridges Moraine, and provides a brief summary of the non-governmental organization’s activities. This list may not be comprehensive, and is based on information provided during the interviews and a review of the grey literature. Some non-governmental organizations involved in community-based monitoring on the moraine are not named, to protect the privacy of some interviewees.

<table>
<thead>
<tr>
<th>Name of Organization</th>
<th>Type of CBM</th>
</tr>
</thead>
<tbody>
<tr>
<td>EcoSpark</td>
<td>Examines water quality using benthic macroinvertebrates. Works with youth in schools.</td>
</tr>
<tr>
<td>(<a href="http://www.ecospark.ca/">http://www.ecospark.ca/</a>)</td>
<td></td>
</tr>
<tr>
<td>Citizen Scientists</td>
<td>Volunteers carry out ecological monitoring to assess stream health.</td>
</tr>
<tr>
<td>(<a href="http://www.citizenscientists.ca/Citizen_Scientists.html">http://www.citizenscientists.ca/Citizen_Scientists.html</a>)</td>
<td></td>
</tr>
<tr>
<td>Save the Oak Ridges Moraine (STORM)</td>
<td>Works at the local and provincial level to protect the Oak Ridges Moraine and encourage good land use planning. Provide policy advice on ORM matters to the Provincial government based on policy monitoring activities.</td>
</tr>
<tr>
<td>(<a href="http://www.stormcoalition.org/">http://www.stormcoalition.org/</a>)</td>
<td></td>
</tr>
<tr>
<td>Adopt-A-Stream</td>
<td>Involves community members in ecological stewardship and restoration projects.</td>
</tr>
<tr>
<td>(<a href="http://www.ontariostreams.on.ca/adopt_a_stream.html">http://www.ontariostreams.on.ca/adopt_a_stream.html</a>)</td>
<td></td>
</tr>
<tr>
<td>Lake Partner Program</td>
<td>Community volunteers collect water samples and test water clarity in lakes as part of a program from the Ministry of the Environment.</td>
</tr>
<tr>
<td>(<a href="http://desc.ca/programs/lpp">http://desc.ca/programs/lpp</a>)</td>
<td></td>
</tr>
<tr>
<td>Trout Unlimited Canada</td>
<td>Aquatic ecosystem monitoring and stream restoration.</td>
</tr>
<tr>
<td>(<a href="http://www.tucanada.org/">http://www.tucanada.org/</a>)</td>
<td></td>
</tr>
<tr>
<td>Lake Ontario Waterkeepers</td>
<td>Encourages community involvement in ensuring swimmable, drinkable, fishable waters.</td>
</tr>
<tr>
<td>(<a href="http://www.waterkeeper.ca/">http://www.waterkeeper.ca/</a>)</td>
<td></td>
</tr>
<tr>
<td>Freshwater Future Canada</td>
<td>Supports community groups involved in protecting water resources.</td>
</tr>
<tr>
<td>(<a href="http://freshwaterfuturecanada.ca/">http://freshwaterfuturecanada.ca/</a>)</td>
<td></td>
</tr>
<tr>
<td>Conservation Authority Programs</td>
<td>Restoration projects, CYWD, aquatic ecosystem health, water monitoring, policy support.</td>
</tr>
</tbody>
</table>

There are several non-profit organizations involved in community-based water monitoring across the ORM, but also some programs that are associated with government agencies and departments. This list of groups carrying out monitoring across the moraine provides an interesting snapshot of existing CBM.
initiatives. Based on the results of the interview and document analysis, multiple facets of water resources are being monitored and managed across the ORM, including aquatic ecosystem health and land use planning. However, simply knowing what types of CBM programs exist are not enough; to fully understand CBM on the ORM, more in-depth analysis must be completed.

4.1.2.1 Becoming Involved in CBM on the ORM

Part of understanding the current status of CBM on the ORM, with a particular focus on water, is learning how individuals currently involved in CBM became involved in it initially. Knowledge of the motives that lead to engagement in water monitoring activities, as well as first experiences with CBM, provide insight into the complexities that underpin involvement in water resource issues. Interviewees’ experiences with CBM on the ORM were extremely variable, which will be explored further in this section.

According to one CA staff member (CA9), “I help out with on the ground monitoring and working with stakeholders through open houses and that type of thing so it’s almost a natural progression to put the two together [CBM and CA involvement]”. CA9 was referring to their personal experience working with community volunteers at the CA for programs such as CYWD and lake management planning, which emphasizes the ease with which stakeholders can become involved in CBM activities with the help of the CA. Other CA staff confirmed this: CA1 said that in the past, their work “[…] had a strong focus on community-based work, so some of that obviously translates to our work here with respect to monitoring programs […]” for CA staff, and ones that involved volunteers. CA2 added that their CA provided support to community groups through a technical support role, answering questions from community members involved in water monitoring programs. According to CA3, CBM has “been happening in the [CA] for a number of years [referring to annual aquatic ecosystem assessment], and we’ve looked at, we’ve also had them do some other programs like CYWD as well more recently”, and CA3 emphasized that the CA is a stewardship organization, so “we get a lot of input from the public,
we’re directly connected with the public...we’ve always had people in our watershed that have been interested in bird-watching, those types of things [...]” although community involvement can be very informal. CA4 emphasized that CAs are community based, so they have been involved in lots of community participation over the years, although their first experience with CBM occurred when “[...] community members were invited to participate with technicians on sampling programs, so it wouldn’t be totally community, but it would be a blend of community and the trained technicians [...]” working together to collect monitoring data.

Conservation authorities can also become involved in CBM when their own programs have insufficient capacity for their own monitoring programs: one CA has had its own community monitoring group since the early 2000s, which was originally [...] basically filling a gap, a monitoring gap, that we, that this area had. There weren’t that many people active on the ground, we wanted to get community involvement in the program and increase the profile of our organization and increase the profile of citizen scientists just in general [...] (CA9).

CA5, from the same CA, added that “[...] we were also short on cash as an organization; we didn’t really have a lot of disposable income so volunteers were seen as the mechanism to get some information in our watersheds”. These comments indicate that CA staff can become involved in CBM through a variety of mechanisms, although it is usually related to their position at the conservation authority.

Staff members of NGOs can also become involved in CBM due to the nature of their position. According to one staff person, they became familiar with CBM because their organization is based on community monitoring: “the community basically acts as our eyes and ears for the water”, and “it was about identifying a problem or hearing from a community group that was identifying a problem in their community” (NGO5). For NGO1, their organization had “always had some involvement in community-
based monitoring since the very beginning, so when I joined the organization, it was continuing those activities [associated with CBM]”. NGO8’s experience with CBM also developed through their organization: the interactions with community were variable, sometimes requesting information from government agencies or writing articles in newspapers to draw attention to an environmental issue, for example the dumping of commercial fill near vulnerable water bodies. NGO8 added that although they have assisted communities and do partner with other groups involved in environmental monitoring, their organization has not truly been “part of the community monitoring framework”. NGO2 had been working at their NGO before they became aware of CBM as a concept, where they took CBM “to mean more of a broadened governance structure involving different parts of the community and that builds a kind of resilience […] more importantly it’s there to be more reflective of all the different stakeholders”. These findings suggest that staff from NGOs often have a different approach to CBM than CA staff, which was strictly centered on the scientific aspects of monitoring.

These differences between CA and NGO experiences with CBM on the ORM are emphasized in other interviews with NGO staff. For one interviewee, the pathway to CBM was much more personal: they were “raising [their] three children and I would look out the window and evidently I could [see] by the green carpet of duckweed that was out there that there was a problem” (NGO6). NGO6 was active in their own community’s environmental issues before becoming actively involved on the moraine. According to NGO6, “I started looking out my kitchen window and saw my river was really sick, I learned my river was a watershed and then I learned my river came from the ORM and it was backing it up that you grasp the whole picture” referencing the fact that issues in their backyard were local, but the larger environmental problem was at the moraine level, which stimulated their interest in addressing water quality on a broader geographical scale.

One NGO staff person said “I did do my master’s in ecology, and then when I finished my master’s I sort of had in mind that I would do more science related, and I did a few contracts of strictly
monitoring based contracts, and sort of missed that interaction with the community and found my way into positions that had more stewardship, more community involvement” (NGO3). In contrast, NGO4 began working with community groups after years of experience in government agencies. Their work with CBM emerged in response to a perceived lack of government resources. The interviewee said “one of the reasons that myself and others got involved in monitoring was because government was no longer doing so. As government budgets diminished over the last 10, 15, 16 years, there was a real concern from a lot of people in the public and private sector as well as the not for profit sector that without good information how the heck could you manage?” (NGO4). NGO4 also had prior experience working with professional monitoring programs, which contributed to their interest in CBM: “on one level […] I was trying to pull together professional, scientific techniques and approaches for monitoring, measurement and management, on the other I was constantly thinking of the fact that at some point communities would be taking more responsibility because government was slowly walking away from monitoring the natural resources of the province [Ontario]” (government cutbacks were also observed by Savan et al., 2003). NGO4 went on to say that they were “doing it from a professional standpoint, at the same time I was also trying to figure out how we can take some of these ideas and translate them into a more basic and more straightforward methodology that the average person could use to try and make sure their watershed was healthy”, and eventually decided that temperature was a simple, effective parameter for volunteers to monitor. Some of the partnership programs discussed above included Monitoring the Moraine (MTM) activities (Monitoring the Moraine, 2007), including Check Your Watershed Day (CYWD) and Save the Oak Ridges Moraine Coalition’s policy monitoring (STORM) (Monitoring the Moraine, 2006).

GOV1 has had extended involvement in CBM, although they first began to get involved in CBM programs after observing that communities did not have opportunities to become engaged in their own watersheds. GOV1 supports CBM because they believe that “you don’t need to do a million dollar study to figure out when there’s a real problem, so you can get away with rapid assessment tools, and those
rapid tools [such as the Ontario Stream Assessment Protocol] were perfectly amenable to any citizen doing those surveys”. GOV1 continues to be involved in water monitoring protocols including the Ontario Stream Assessment Protocol (OSAP) (Stanfield, 2013). GOV3 indicated limited involvement in CBM; although their branch of the government included citizen scientist and community volunteers, their role in CBM was strictly establishing standardized protocols because “most of the [community] organizations that I’m aware of are using [water monitoring] method, and so I [helped with] those methods, provide training […] I will often have trained some of these folks [CBM volunteers]”. The comments from both GOV1 and GOV3 suggest that government agencies tend to have minimal involvement in CBM except for the development of monitoring protocols, with the exception of a government-run program for community volunteers, known as the Lake Partner Program. CBM2 has been a volunteer for this government-based monitoring program for several years; they became involved in the program after retiring. According to CBM2, they became aware of water issues in their community when the municipality “had a meeting about the quality of the lake water and stuff and told everybody that they should be naturalizing their shoreline”. When CBM2 looked for information related to shoreline naturalization, they became involved in a watershed group and were eventually asked to do water monitoring on their lake.

CBM1 had previously been involved in stream monitoring as a full time career, which is how they became aware of a standardized stream monitoring protocol, which “[…] everyone told me […] was designed for local groups to do standardized stream monitoring”, although “as we went through [the protocol] and asked around more and more […] there was almost no one doing [stream monitoring] that was a local NGO though, and that’s who it was designed for, so there was kind of a gap that emerged to me that I thought our group could fill so that’s how we started […]” (CBM1). CBM1 was the only interviewee that referred specifically to a community run monitoring program, suggesting that there are very few groups like it on the moraine.

4.1.2.2 Check Your Watershed Day
The topic of Check Your Watershed Day (CYWD) came up many times in the research process, and is one of the most common CBM programs that were referenced by interviewees. CYWD is a one-day event where communities can go out and measure water temperature and take photo of culverts in order to understand the health of their watershed. It was created by Monitoring the Moraine (MTM), specifically EcoSpark, in 2006, in partnership with a government staff volunteer. With assistance from the Ontario Ministry of Natural Resources, CYWD examined small streams, which were ecologically relevant as well as easy to access and monitor, to determine if barriers existed to fish passage or if restoration work was necessary in the stream (Whitelaw et al., 2009). Community volunteers used the Ontario Stream Assessment Protocol (OSAP) (Stanfield, 2013), which was “provincially recognized by the Ontario Ministry of Natural Resources and federally recognized by the Department of Fisheries and Oceans” (Whitelaw et al., 2009, p. 83). CYWD’s goal was to have community volunteers assist conservation authority staff to monitor the flow of water in a watershed and observe if fish passage has been obstructed in the watershed due to perched culverts (EcoSpark, 2014).

According to GOV1, CYWD was originally designed so that any community group could lead the monitoring program, due to the relatively simple methods of going out one day a year to measure certain attributes of a stream at each road crossing. However, GOV1 says that CYWD has failed at getting citizens to take ownership of monitoring projects, and instead the CAs have taken control over the program, rather than the community. It should be acknowledged that other interviewees did not see the role of CAs in CYWD as a negative development, as the initial goal of the program itself was to have volunteers work with conservation authorities in a joint effort (EcoSpark and Credit Valley Conservation, 2012).

Staff from CAs had varying opinions on CYWD. CA10 said that their CA had participated in CYWD once, because of the educational benefits associated with volunteer involvement. However, the CA dropped out of the CYWD program after the first year because it cost them money for their staff to be
out in the field, and the data collected through CYWD had no value for the organization, as it could not be used in any decision-making processes. CA10 said that there were issues associated with the program: volunteers required training before they could conduct any monitoring, and since working with volunteers required that the date for CYWD was set months in advance, the data was collected even if the conditions on the actual day of the event were not appropriate for the monitoring protocol. CA10 went on to say that “the data was not something that they [the CAs] would want to rely on to make really science-based objective conclusions”, which contributed to their decision to back out of the program. NGO1 agreed, acknowledging that while CYWD was a good way to get community members with limited time to do something hopefully useful in their watershed, the data to date had not been of sufficient quality for data analysis, and could not currently be used to impact any level of decision-making.

CA3 expressed similar concerns about the value of the data generated by CYWD, which eventually led them to stop collecting water flow data as part of the program. According to CA3, the CA’s solution to the challenges associated with CYWD was to create a modified monitoring protocol which has been successfully run for a few years, although it is not part of their formal monitoring activities. CA4 had a similar experience with CYWD. CA4 augmented the original CYWD methodology by sending out one of their technicians with the volunteers to do more rigorous sampling on their own, and make sure that the data collected by volunteers was accurate. However, the CA’s involvement in CYWD is winding down due to the fact the data from CYWD is not as scientifically robust as it could be, and because the CA is now carrying out its own base flow monitoring rather than relying on volunteers (CA4). However, these comments from CA4 suggest that having quality control measures in place during data collection (in the form of a staff member) could contribute to a more positive perception of the quality of data collected by volunteers. Although their CA had participated in CYWD for several years, CA5 and CA9 indicated that their CA is no longer involved in the program. CA6 said that their CA is also no longer involved in CYWD due to limited resources to support the program, although community members have expressed a
strong interest in participating in water monitoring. The comments from interviewees regarding CYWD indicate that although the concept was very promising, there have been serious challenges and concerns associated with the program and the quality of the data that could be collected.

4.1.2.3 Skills Training of CBM Volunteers

When working with community volunteers, CA3 provided training to community volunteers on health and safety, as well as general information on the purposes of the monitoring program:

It’s more health and safety information […] so we do an orientation where we talk about how the[equipment] works, things to watch out for, things to do, things not to do, a little bit of background on why we’re collecting the data, what the data gets used for and then a little bit of species information at the end of the day, a little bit of show and tell on what we caught and what each species’ habitat preference is, or pollution tolerances or whatever it might be.

For their other CBM programs, it was:

[… the same thing although to a lesser extent with CYWD, there’s health and safety orientation, protocols on how to collect the temperature data, what sort of information we’re looking for on the culverts they’re assessing as well and then a little bit of information on how it gets used, what it gets used for, restoration projects, dam mitigation, that sort of thing. So it’s not really done, there’s nothing provided beforehand, it’s all sort of done the day of, when they show up (CA3).

CA3 also talks to the volunteers about the importance of collecting the data properly:

We calibrate the thermometers beforehand, we talk to them a little bit about that, we talk to them about the consistency and the importance of collecting data accurately, recording data accurately, recording things neatly, completely filling out data forms because we certainly get a whole mix [of volunteers].

61
The CA had different approaches to training depending on the program:

[…] with [aquatic ecosystem assessment] we’re in charge, right, so we’re the ones that are present the whole time, whereas with CYWD we send people off in groups, so it’s a group of two or three people, and they go to five or six sites, there’s no [CA] person to sort of oversee them when they’re collecting the data and then they come back and then after the event we go through the data sheets so there’s, it’s much more important for that that they record the data properly, because there’s no one to check it when they’re there other than themselves. So we need to make sure that what we want is clear, that they understand, and that it’s done correctly when they’re in the field (CA3).

When working with community volunteers, CA4 said that they always provide skill training, using a similar approach to CA3 (discussed above):

[…] and that skill is two parts, there’s a health and safety portion, they do what we call a task hazard analysis, and they look through their tasks to understand their safety and the requirements for them being safe and doing it, and then there’s another part where we train on the actual technique for whatever they’re doing.

The volunteers are trained “[…] how to gather chemistry so that you’re not contaminating the samples, those types of things. If they’re sampling metals or particular acids involved, so be safe with that and those types of things as well” (CA4) although that kind of activity would be part of a special project where the volunteer works closely with CA staff. There are some difficulties with training volunteers as CA4 noted:

[…] in every group you have some people that you can train quite a bit and they won’t necessarily get there, um, particularly with teenagers, um but we had groups of 35 people in CYWD that we
were training, and we would do a couple hours of training for them, because the methods are relatively simple, we also sent them information beforehand to study up on.

CA5 said that when it comes to training community volunteers “yep, [you] need to, because repeatability is important, and the reliability amongst different volunteers, which is sort of a wild card, is important”. Eventually the CA ended up:

Simplifying the [water monitoring] program, and that’s where we started taking the grab samples again, it was beneficial because it removed some of that, the bias, of reading the information so now we just have to train on how to collect the sample, as opposed to how to collect the sample and read the test. So it made it a lot easier and the training, yeah you have to provide the training for repeatability and removing, or trying to remove some bias, anyway (CA5).

For their community volunteers, CA9 said that “[…] we bring them in and show them, you know, we go out in the field with them and show them how to take measurements, what the proper protocol is, that type of thing […] we show them how to work the equipment, how to take the samples […]”. These comments from multiple interviews indicate that CAs provide training to community volunteers wherever they help out CA staff with monitoring projects, for health and safety purposes as well as to ensure the quality of monitoring data. However, there was no information in any of the grey literature to suggest that community volunteers can be trained to assist CA staff with water monitoring programs. When it comes to training community volunteers, NGO1 said “yes, that’s basically what we do as an organization, so we don’t actually do the monitoring ourselves, we provide people with the skills, resources and training so that they can do it”. According to NGO1:

We teach them about how to do the monitoring and what’s involved with that, and then we provide them with the knowledge and information, and then we also provide them with a protocol. The protocol’s usually something that’s already existing, and has been created by scientists,
academics, government, it’s usually a version of something like that that has been modified so it’s suitable for citizen science. And then we supply them also with the equipment and the support system if they need help choosing where to do it [the monitoring] or how to do it, just planning that out.

Similarly, STORM’s 2012 (and 2007) Status Report section on MTM provided citizens with the information, tools and support system to monitor the moraine at the local level, as well as identifying the important role that community volunteers play in protecting the ORM when government agencies are not doing any monitoring (STORM, 2012; STORM, 2007). The Action Guide to MTM (MTM, 2011) guided community groups through the process of designing their own monitoring programs, with set goals and projects. The MTM Citizen’s Guide to the Moraine (MTM, 2010) discussed the importance of local management and the role of the community in protecting the ORM. The Moraine Watch program (MTM, 2007) emphasized the importance of CBM, and provides volunteers with instructions on how to fill out monitoring data sheets correctly, as well as how to interpret the results. EcoSpark’s Changing Currents field manual (EcoSpark, 2013) also explained in detail the water monitoring protocol, as well as providing a guide to volunteers for analyzing the data. Likewise, the Lake Partner Program (LPP) Spring Sampling Instructions (Government of Ontario, 2013) provides the volunteers with step-by-step instructions on how to collect their sample of water. The LPP Interpreting Results document (Government of Ontario, 2013) provides its volunteers with a guide on how to interpret their monitoring data.

For interested volunteers, NGO3 provided training:

At the [monitoring] site as well as annually to host a stream stewardship training workshop that sort of gives them more detailed information, more of a classroom setting um, that not all of the volunteers participate in but we usually get a few out to do the training over a couple of days [for the volunteers that are interested].
The organization has also created a manual:

[...] which we give to all participating groups, so that talks about types of monitoring to do, it
doesn’t give them the details on how to do it in that particular manual, but we also have a
monitoring protocol which we give out to groups as well. So the stream rehabilitation manual is
more of an overall, you know [...] those are the things you want to consider, and then we have our
protocol that sort of specifically lays out how to do this work (NGO3).

NGO4 is involved with a volunteer training program:

Which includes at least one and a half days of just talking about monitoring and assessment: how
to set up a monitoring program, why you set it up, what parameters you collect in a rational,
reasonable way, how you interpret the basic information and how you develop a basic idea of
what the problems are and develop a strategic plan to address them.

According to NGO4, the organization came up with the idea of a training program when:

[...] we began to realize that there would never be enough staff at [the organization] to do all the
work [...] maybe the better thing to do would be to train the people on how to do it themselves
and we can just mentor them through the process and provide information or technical expertise
when most appropriate or where they [the volunteers] didn’t have it.

NGO4 went on to say that although community based monitoring is a great concept:

[...] it’s difficult to maintain in the medium to longer term without some level of training or
support by some organization or agency to help the community make sure that they’re collecting it
in a reliable, reasonable fashion that can be interpreted and used properly.
NGO4 said “when it comes to the community groups we’ll usually walk them through how to launch
[data] loggers and how to collect the data but we still maintain control of calibration”. The volunteers are
responsible for launching the data loggers into streams with the help of a training manual which:

[…] includes the standardized templates for recording the location you put it in, taking pictures
upstream and downstream at the location you do put them in, get the GPS coordinates, all that, we
do that short little training for all of them, and we’ve been very successful at getting our loggers
back in good condition and collecting the data from them.

Comments from NGO4 suggested that a strong volunteer training program with support from professional
staff can lead to improvements in equipment return and data quality.

Another organization similarly trains community members:

[…] when we have organizations sign on to be a [water quality partner] for example, we’ve
developed a very comprehensive training manual showing people basically how the system works,
what they should be monitoring for […]. In terms of going out in the field and monitoring water
quality and taking their own samples, we’re right now finalizing a tool kit which starts people off
at like the I see something wrong with my community and it walks people through step by step
how to investigate, how to do your monitoring and the next steps in how to solve that problem, so
a lot of the work that we do is in the legal realm so we use legal tools and so monitoring is part of
that very initial investigation stage […] (NGO5).

This organization supports greater involvement by communities in their local water issues by making
citizens more aware of the role that they can play in ensuring good water quality and empowering them to
take action when issues arise through these educational activities.

GOV2 runs a training course related to water management and wetland restoration, although the
majority of attendees are professionals. The course is:
Available to whoever wants to sign up for it and pay the dollars for it, um, we focus on resource agencies and resource professionals […] but we’ve had individuals attend, we’ve had landowners attend, we’ve had interested public attend, and so if, it’s a first come first serve basis so certainly others [like community members] can attend.

Similarly, GOV3 runs a training program that is designed mostly for professionals, although volunteers have participated: “non-professionals, like non student, the people who are neither student nor professionals in some way related to water management, we only, we have very few of them that actually take the courses, but we do get some”. Another government monitoring protocol, the Ontario Stream Assessment Protocol (OSAP), recognizes that people using the OSAP manual will have varying levels of skill, and it provides several mechanisms for analyzing monitoring data (including sending samples to experts for analysis) (Stanfield, 2013). The equipment listed in the protocol is very basic, and are things that volunteers could take from their house (e.g. teaspoon). The OSAP mentions that volunteers collecting data do not need to include their personal contact information to distribute their data (Stanfield, 2013), thereby acknowledging that both professionals and community volunteers are meant to be using the OSAP. One example of this is Citizen Scientists, a CBM program that relies on the OSAP for all of their monitoring initiatives, as was demonstrated in several of their documents related to water monitoring (http://www.citizenscientists.ca/Citizen_Scientists.html). For example, in their fact sheet “What Type of Monitoring Do We Do” (Citizen Scientists, n.d.), it said:

Citizen Scientists uses the Ontario Stream Assessment Protocol (OSAP), to collect data in a defined and standardized manner. The Ontario Ministry of Natural Resources (MNR) has developed this standardized method for collecting information about rivers and streams in Southern Ontario. This collection method allows for information to be directly compared between sites and between years in wadable streams within the province. Citizen Scientists uses crew leaders that have been trained and certified by MNR in the collection of OSAP information.
Using experienced volunteers as crew leaders builds in a mechanism for the community group to establish a track record for volunteer performance and reliability. It could also establish a record of good quality data, and therefore confer greater legitimacy for CBM groups.

At CBM1’s organization “[…] we do some workshops, we do some in the field stuff, in the class stuff, so they can learn not just how to do it, but again why to do it, how to apply it, things you want to think about before you undertake it, that kind of stuff”. Training continues in the field:

[…] we have team leaders that always lead the untrained people, I mean they did some background training with us to get back up to speed with us, there’s always an experienced leader that’s leading them out in the field, keeping an eye on things so they don’t go off track and they do the protocols the way they’re supposed to be done, if there’s anything that they need help with or answer questions or whatever else (CBM1).

In contrast, training for CBM2 is much more hands off than volunteer training at CBM1’s organization: they receive training information “every spring when they [the provincial agency] send us the sampling kits and stuff there are instructions as to how to do it. It doesn’t change much from year to year. A bit. But they tell you how to use the Secchi disk [used to measure water transparency] and so on and so forth” (CBM2).

From all of the above comments from interviewees, as well as the evidence from the grey literature, the results indicate that every single group and agency, government or otherwise, provides training to community volunteers in order to control the quality of the data that are being collected, as well as to educate volunteers about the importance of monitoring, and the associated benefits to the environment. However, it is interesting to note that although CA staff do provide training to their volunteers, there is no mention of this in any of the examined literature. This suggests that CBM programs associated with CAs are not formally acknowledged in their reports and other official documents. In
contrast, documents from NGOs clearly outline the monitoring protocols and other training that is provided to community volunteers, as do the documents from the Lake Partner Program based with the Ministry of the Environment.

4.1.2.3 Monitoring on the ORM

Results from the interviews suggested that some CAs were not involved in CBM at all. For example, CA10 said that, to their knowledge, the CA had an active environmental monitoring network where citizens monitored the forest, wetland areas, and vegetation plots in the CA’s jurisdiction. However, when the researcher followed up on this information and contacted the individual in charge of the program (according to the CA website), they said that the CA did not include volunteers in monitoring activities. From this information, it can be concluded that the CA is not involved in any CBM activities. CA7 and CA8 staff acknowledged over email that the CA does not participate in any CBM activities. CA6 said that the CA had previously been involved in CYWD for a few years, but stopped participating in the program due to a lack of resources to support it.

CA2 had previously been involved in CBM but:

I guess one of the things that we found was that unless you have the ability to continue providing that support to your citizen scientists, it’s tricky for them to continue. And so we have, we do have volunteers come participate in our restoration programs, but not like, we don’t have a volunteer monitoring program.

CA2 went on to add that sometimes they do get assistance from “[a] community member working with us on a monitoring visit […]”, and that the CA staff “need extra hands for those visits” so the community members are a welcome addition to existing CA monitoring programs carried out by CA staff members. For the most part, the CA includes community volunteers in stewardship and restoration projects rather than water monitoring initiatives.
In contrast, CA3 is extensively involved in volunteer engagement in monitoring activities. For example:

We have about 15 or 20 sites that we sample annually and we need about 20 people to out as part of those events, for [the CA] to provide 20 staff is costly, so the volunteers are a great way of getting people out to cut our costs and get people who are interested in that sort of thing or want to find out more about [aquatic ecosystem assessment], or interested in the health of the river in their backyard, um, it’s great to get them out, and they help with catching the fish, helping record the data, and it’s just a good experience for them to see some of the fish that they might not normally see (CA3).

CA3 also relies on landowners to give their permission for the CA to access their property and collect data; CA3 considered this to be another form of CBM, because:

Even though the landowners aren’t out there doing the work, we are very reliant on them volunteering permission for us to go and access their properties and collect all kinds of data in their backyards […] permission from landowners is so important to us.

The CA has also established a conservation program for youths, where the CA provides a formal crew leader, and high school students volunteer for a week of eco-work, where they will sometimes assist with [aquatic ecosystem assessment] and benthic sampling. CA3 said that they will also have volunteers assist with trout spawning surveys, where the group is accompanied by an experienced leader:

They walk half a kilometer beside the stream in locations where the trout are spawning, as well, and that isn’t sort of formal monitoring, it’s more surveys, we haven’t done any analysis of trends over time, for example, but they do help collect with some of that data.
Volunteers are also highly engaged with another CA on the moraine. CA5 and CA9, both from the same organization, said that the CA has developed their own monitoring program to engage interested citizens, although the CA is also “filling in gaps [from the volunteer program] with our more routine monitoring sites, like our actual [monitoring] stations” (CA9). CA5 said the volunteers “look at water quality across creeks and lakes in our watershed, that’s been going on for the better part of 10 or 15 years” with sampling generally occurring every month. The CA had originally supplied volunteers with kits which contained a colour chart where the volunteers identified the concentration of a chemical based on the observed colour, but eventually the CA wanted a greater level of detail from the water samples. The current design of the monitoring program requires volunteers to:

Take the [water] sample and then put it into one of the bottles that are from the laboratory [where the water is tested] and sometimes they have a fixing agent so we [the CA] put that in, then they’re refrigerated and they all come to the office and then we ship it off to the lab after [for sample analysis] (CA5).

Previously, the CA had also used volunteers to collect benthic data, but “there’s a different frame of reference for the OBBN now [Ontario Benthic Biomonitoring Network monitoring protocol] and a higher level of resolution required so we don’t use volunteers for that at this point in time” (CA5).

CA4 was involved in CYWD, but that is “winding down a little bit”, and instead CA4 said that volunteers are now included in some monitoring projects run by CA staff, “where people are interested and we say, okay, come on along with us and we’ll show you what we do and all those types of things”. Although it’s not a formal monitoring program:

We just head right into the watershed and do as many points as possible under base flow conditions, we usually have probably half the crews are volunteers […] people will phone us up and say, ‘I’m interested in water’ (CA4).
However, CA4 said that the monitoring is almost secondary to other benefits associated with engaging community volunteers. “When you engage a community in monitoring activities, there’s a double purpose to it. There’s science but there’s also community relations, and the community relations pieces are as big as anything”. In some ways, the science is less important because “[the sampling] really makes a difference in the buy-in of the community, so that piece is extremely important to us” (CA4).

Despite the apparent ubiquitous nature of CBM in many CAs across the moraine as was reported in the interviews, these results are not supported in the grey literature. Central Lake Ontario Conservation Authority (CLOCA) recognized in their Year in Review report that community members are an important part of environmental protection, although there was no mention of CBM (Central Lake Ontario Conservation, 2012); neither did the CLOCA Watershed Report Card (WRC) (Central Lake Ontario Conservation, 2013). The Kawartha Conservation Watershed Report Card (Kawartha Conservation, 2013) also had no reference to CBM. In Credit Valley Conservation’s (CVC) Water Report (Credit Valley Conservation, 2013), they define the authority as a community-based organization, and encourage citizens to get involved with CVC, whether it is being a funder or a volunteer for the agency; despite this apparent interest in community engagement, no mention is made of CBM.

The annual report for Ganaraska Region CA (Ganaraska Region Conservation Authority, 2012) mentioned their stewardship activities and their partnership with local municipalities for CA staff to sample streams, but there was no mention of CBM. Lake Simcoe Region’s Watershed report (Lake Simcoe Region Conservation Authority, 2013) also discussed stewardship, and their multiple monitoring projects, but made no mention of CBM. Lower Trent Region WRC (Lower Trent Conservation, 2013) said that the CA monitors several watershed indicators, but the report did not mention CBM aside from suggesting that volunteers can assist the CA with stewardship activities. Nottawasaga Valley WRC 2013 (and Watershed Health Assessment) did not discuss CBM either, although it did say that community members are welcome to join the CA in stewardship projects (Nottawasaga Valley Conservation
Authority, 2013; Nottawasaga Valley Conservation Authority, 2013). Otonabee CA WRC (Otonabee Conservation, 2013) said that the CA provides classroom sessions and public workshops in addition to their own monitoring programs, but there was no mention of CBM. Toronto and Region Conservation Authority (TRCA) WRC (Toronto and Region Conservation, 2013), also did not mention CBM, although the report card discussed stewardship roles, such as tree planting and educational activities.

In this section there appear to be some inconsistencies between the results from the interviews and results from the grey literature. Although interviews with CA staff indicated that many of the CAs had some involvement in CBM, with a few CAs having extensive interactions with community members to monitor water resources, there was no mention of CBM in any of the documents from CAs. However, many of the CA documents encouraged community members to become involved in stewardship activities at the conservation authority. These results are illustrative of the contradiction that exists between the CAs actual interactions with community volunteers, and what is being published in official documents. The CA staff interviewed for this research project listed several examples where they had worked with volunteers to monitor water, however these efforts were not officially acknowledged. This could create difficulties for CBM initiatives, if they are not being officially acknowledged by the agencies that are involved in CBM programs. In contrast, documents from NGOs explicitly stated that community members volunteer at the organization for water monitoring. This could potentially create a misconception that CBM is something that only NGOs, rather than both NGOs and CAs, are incorporating into their own programs. The role of NGOs in CBM will be discussed more in the following paragraphs.

NGO1 actively involves community members in water quality monitoring (i.e. physical and chemical testing of water quality, as well as benthic monitoring) and water quantity monitoring:

We start off immediately with the physical and chemical testing of water quality, and then we focus on benthic monitoring, which is a biological indicator and so now we’re trying to bring it
back so we have a holistic view of water quality, with physical, chemical and biological aspects of water quality.

NGO1 also works with school students to educate them about benthic invertebrate sampling and generate interest in water resources.

NGO3 works with several community groups that are active on the moraine. These groups collect monitoring data approximately once every three years to measure the impacts of stream restoration projects, with the option for more frequent monitoring if the community members are interested. To understand the current conditions of the stream the community groups look at:

Things like what the substrate’s like, what the bank conditions are like, how much habitat is available for fish, um, how much vegetation there is surrounding the stream, um, and then we do a benthic survey and we do a fisheries community sampling (NGO3).

The community groups “look at the invertebrates that are there [at the site] and calculate stream quality from that, and we do a fisheries community assessment […]” (NGO3). The volunteers carry out baseline monitoring before any restoration work happens, and then they go back to the site every three years to monitor the changes in the ecosystem over time. Monitoring is limited to every three years because “to get out with that many groups every year would not be possible” partly due to the large number of volunteer groups that NGO3 works with, but also because the NGO wants to observe changes over time related to the stream restoration project. Volunteer groups are extremely varied in composition with different levels of accomplishments for each stream restoration project depending on the skills of each volunteer group (e.g. a conservation club versus a grade three class).

Similar to NGO3, CBM1 works with volunteers to sample fish, aquatic insects, freshwater mussels, and observe underwater fish behavior. Their volunteers are trained through a standardized protocol for fish identification and bug identification (i.e. OSAP). According to CBM1:
We like to call it aquatic ecosystem monitoring, it’s more about linking it back to actual processes in the landscape as opposed to just looking at fish or bugs on their own, so we do a range of sampling from fish to aquatic bugs or freshwater mussels, we do some underwater fish behavior, some filming.

CBM1 said that “a lot of times our volunteers are pretty skilled in the first place because that’s kind of who’s attracted to us, there’s a lot of graduate students or the odd MNR staff person, there’s the odd DFO staff person, an MOE staff person”, which is why they are able to carry out such complex monitoring projects.

NGO4 had community volunteers collect water temperature data, because it was information that “people can collect in a rational straightforward way with a modest amount of data collection”; the organization provides the volunteers “with tools so that they could in a reasonable way monitor their watershed, at least the temperature, and get some inkling of where the problems were from a temperature standpoint”. The NGO works with community volunteers to identify what their watershed interests are, and then:

We take the responsibility to try to raise money to purchase the data loggers and they help us deploy them and they collect them for us at the end of the year, we analyze the data and at the end of the year provide them with reports and recommendations and they take those recommendations as they see fit and implement them (NGO4).

NGO4 saw this approach to CBM as a way to engage community members in water resource management as the capacity of government and non-government agencies to monitor water decreases, while also keeping the data collection methods simple enough for community volunteers.

NGO2 was involved with a volunteer policy-monitoring program which included a manual that volunteers followed to determine if the ORMCP was being implemented properly. The program officially
ended in 2012, although the data that was collected will still be used during the 2015 review of the ORMCP: “at one point it was a program, at one point it was a manual that people used to determine if the ORMCP was being implemented as it should be, now it is a dataset of points and information that we will now look at and develop new themes related to 2015” (NGO2). NGO8 was involved in a similar type of CBM where volunteers monitor land use, and inform the NGO if they see people behaving illegally, for example dumping fill where it is not permitted. NGO5 also had a different way of working with community groups, where volunteers monitor water quality for recreation and drinking using visual indicators (i.e. colour of the water, presence/absence of dead fish), smells, and tests for *E.coli*. During the time of the interview, the NGO was in the process of developing a toolkit “which starts people off at like I see something wrong with my community and it walks people through step by step how to investigate, how to do your monitoring and the next steps in how to solve that problem”, often through a legal case with the assistance of the NGO.

CBM2 volunteered for a government-led CBM program known as the Lake Partner Program. Monthly, from May to October, they go and “do Secchi disk clarity testing and take three water samples and water temperature, and then we fire that off to the ministry and what they’re basically looking for in the samples is phosphorous”. When collecting the water quality data, they filled out a formal data sheet and mailed it off to the ministry at the end of the season as a confirmation of what CBM2 had already sent them; the water samples themselves were sent out monthly, with information about the temperature of the lake, the Secchi measurement, the date and the time of day the sample was taken. Therefore, there appears to be some level of direct government involvement in CBM programs, although this was the only government-led and entirely CBM program on the ORM that came up during the research process.

GOV3 said that their group will sometimes get community members that “will come out, register for our training courses, get trained and go out and do sampling and contribute data, but again, they’re usually acting independently” and so GOV3 did not actively engage with the volunteers beyond the actual
training. GOV3 had noticed that “non-professional volunteers are typically looking at the benthic community as a whole so they’re looking at taxonomic composition of the community, perhaps functional composition, and their taxonomic level is usually fairly coarse” compared with benthic data collected by professionals.

These findings from the interviews and grey literature indicate that CBM on the ORM is taking several forms, including water quality/quantity (i.e. water chemistry, water temperature), aquatic ecosystem health (i.e. benthic invertebrates, fish populations), as well as policy implementation (i.e. land use planning and implementation of the ORMCP). The role of government agencies appears to be variable, ranging from direct involvement through monitoring programs to the attendance of community members at government-designed training modules. However, the participation of various agencies in CBM is not always explicitly stated in official documents or reports. These results are very interesting when they are contrasted with the ORMCP Technical Paper 9, which stated that there is a need to involve the public in determining watershed study objectives, as well as identifying the ORMCP’s aim to create local ambassadors that can act as watchdogs in their municipality; this seems to be a type of CBM, although it is less structured than other types of monitoring. The technical paper also said that the watershed plan should encourage stakeholders “[…] to take responsibility for monitoring and watershed stewardship, for example by promoting community-based monitoring programs with schools, special interest groups, and neighbourhood associations” (Ontario Ministry of Municipal Affairs and Housing, n.d., p. 18). Despite this explicit mention in the ORMCP’s technical documents of CBM programs being an integral part of the ORMCP, there appear to be only a few government organizations on the moraine that are directly and overtly involved in CBM, with the majority only peripherally involved and choosing to downplay the involvement in their grey literature.

4.1.3 What Role do Government Agencies Play in CBM on the ORM?

4.1.3.1 Coordinating CBM with Government Monitoring
CA5 said that their CBM program augments the Ontario Ministry of the Environment and Climate Change Lake Partner Program (http://desc.ca/programs/lpp): “[…] there’s the Lake Partner Program that’s going on, so that’s on a monthly basis and we were on a monthly basis so we’d try and stagger them a bit and get good information or we would stay away from the sites if there wasn’t enough information to try and augment it”. CA9 added that a lot of their coordination with the government is associated with the use of shared protocols: all of their monitoring programs, CBM or otherwise, used protocols that are recognized or accepted by government institutions. The way that NGO1’s organization works with the government is similar to CA5 and CA9: “[…] a lot of the protocols we use are literally protocols that other professionals use or versions of them”; NGO1 had worked with government agencies to develop water quality monitoring protocols, as well as utilizing existing government databases. Therefore, NGO1 said that the organization “[…] do[es] a lot of coordinating with the government for our activities”. The NGO had also partnered with several CAs to run CBM programs, which is another form of collaboration with a government agency (CA10).

NGO2’s organization was not currently collaborating with any government agencies, although they:

[…] will hopefully align ourselves at 2015 when we are there before the hearing officer telling our story [at the ORMCP 2015 Review]. And there is an alignment of objectives, but we are collecting data at a different scale than they are, and that’s the beauty of where we are with this, that we are recognized by the government as having a story to tell and […] their framework recognizes that there’s data other than pure science data that will have value (NGO2).

Although this is a less direct form of collaboration with a government agency, this comment demonstrated that government can play various roles in CBM initiatives across the moraine, even if it is as simple as recognizing the validity of a group’s collected information.
NGO3 worked with government agencies because:

[…] the sites that the volunteers are working on, a lot of them are on either CA land or municipal property […] so we have the permission of either the municipality or the CA or the province depending on where it is, so we definitely have permission from them and we definitely keep them in the loop of all the activity that we’re doing there, and sometimes they come to us and say we’d really like to see this done, and can you consider looking at this, so it goes both ways.

In a similar fashion, NGO4 had worked with CAs and other agencies to share data in order to solve an environmental issue; when working with CAs, NGO4 said:

[…] we will contact them and say where are your sites and then we’ll make sure that we don’t have a site at the same location, so we will do that. If we’re in a watershed where we know the local agencies are collecting data, we will not replicate that data, we will say where are you collecting that data and we will then try to fill the holes for them. So we do that occasionally (NGO4).

The NGO had a good relationship with some CAs, where:

[…] we summarize our information and we provide it to them for their purposes, for example the [CA] are good partners, we work with them quite a bit […] so we collect information and data, we will share the results with them and they share their results with us because we’re all trying to work towards the same goals. I guess the kind of question there depends on whether or not they have the same goals that you have. If they do, then we definitely work with them, if they don’t then we work on our own (NGO4).

CBM1 had a comparable approach when working with the CA:
[…] so we don’t overlap sites, so we want to fill any gaps there, per number of sites an area, so we’re hoping to add data to the datasets so we’re not replicating anything, we’re just adding to it and hopefully adding some more powerful data that might be available down the road.

Some of the organization’s data had been submitted to MOE, but aside from that branch of the provincial government, “there’s really no one left that does any work […] there’s really not many government agencies around outdoors anymore” (CBM1). CBM2, in contrast, worked directly with the provincial government through their water monitoring program, but they also work with their local municipality “[…] to make sure that we were not duplicating the testing that they were doing […]”. NGO5 said that their organization did not:

[…] necessarily coordinate with the government monitoring, we collect the information and we take the information that the government provides so we do use that information and we do use their specific results but for the most part if a community group […] are out doing monitoring, it’s because there’s not already a government program in place […] we might be doing it in tandem but we haven’t recently done any coordinating with government.

Similarly, GOV1 said “I’m not aware of any programs [that] were integrated within what our ministry does […]. MOE is much better at that. There must be some….wow. I can’t think of any [collaboration examples between the department and CBM groups]”.

There appear to be a few trends in the data. Some CAs used CBM to augment their own monitoring sites and other provincial programs; similarly, some NGOs coordinated with government agencies to avoid overlap on monitoring sites, or to receive permission to carry out monitoring on government-owned land. Other NGOs had very little coordination with government agencies, as they only became involved with CBM activities to fill a gap when there was no pre-existing government monitoring program. For most NGOs, and all CAs, the majority of coordination with other government agencies is based on the use of the similar and accepted monitoring protocols (e.g. OSAP).
4.1.3.2 The Role of CAs within CBM

According to CA1, “I think we’re a good link for on the ground activities like I guess a local group with relatively good networks in our local communities, I think CAs are positioned really well to engage local community members”. CA2 cautioned that the role of CA staff in community initiatives depended on the capacity of the CA, because “[…] once you establish a community-based monitoring approach you have to have the bodies in place [and the capacity] to be able to deal with that”. A proposal published by Toronto and Region Conservation Authority (2008) suggested the development of a coordinated water monitoring network in Ontario, in order to create collaboration opportunities between government agencies and NGOs. The proposal acknowledged the difficulty that ‘ad hoc’ networks faced without the endorsement of established agencies; although it does not specifically mention CBM monitoring programs as part of the monitoring network, the support of agencies for CBM had been acknowledged as an important factor for success (CA2).

When asked to explain the role of CAs within CBM, CA4 said that:

 […] one of these things that we always remember as a conservation authority, we’re very place based. We are community based, and part of it may be as much community building as well and we want to make sure people understand what watershed they’re in, that they’re a community within the watershed.

CA10 added that when it came to the CAs role in CBM:

I guess I would have to say to provide advice and assistance to them where we can, that’s probably the key role, providing what advice and assistance we can to them, you know, within the confines of everybody’s budget restrictions that everybody has, because it costs money […].

CBM1 believed that CAs should play “[…] some sort of supportive role and they have the ability to enhance local groups and their ability to do the work without interfering too much with the CAs own
activities […] I think they should be kind of a fostering role for NGOs”. NGO4 also hoped that CAs would support CBM activities, since:

[…] the biggest problem with any type of monitoring is having at least somebody professionally who can help the community groups sort out what they can’t easily sort out, things like calibration, standardized methodologies […] most community groups don’t have the expertise, the time or the capability of doing that aspect, that’s where I see CAs being a really big partner […].

CBM2 agreed that CBM groups and CAs should work together, although their reasoning presented a different perspective on the relationship between CAs and community groups: CAs “[…] do not have the resources to do as much monitoring as they want, as they would like to do, but they have the expertise, so if they can communicate the expertise and have people trained enough […] it would make sense” for community groups and CAs to collaborate. NGO3 also believed that CBM can also benefit CAs:

I know a few CAs that have CBM programs, and I think that they make a good use of the data that’s collected, so I think overall the CBM is a great resource and I think that there’s a large place for that among CA research, so obviously CAs just like any other organization are limited by time and manpower and funding to some extent, so I think that having CAs offer those CBM programs can have a huge benefit for them in gathering good information.

CA3 had a different opinion on the CA-CBM relationship:

[…] CAs are organized on a watershed basis, we’re very community oriented, community focused, we rely heavily on the community to implement a lot of our projects […] so I guess as watershed managers, the community can play a role in supporting issues, obviously provide support to us for actual monitoring […].
The reasoning behind this statement was that “[…] you get into questions about training and again the accuracy of data and all that aspect, so you can’t get away from the agency being involved and the expertise needed within a conservation authority or MNR or MOE or whatever […]” (CA3). CA11 believed that the CA’s role in CBM involved providing protocols and standards, educating the community, as well as encouraging the recognition of the importance of monitoring watersheds. CA12 had a similar opinion: CAs should provide “[…] QA/QC, making sure [the data are] usable and making sure that it’s collecting information in the right place for a reason […]”. CA9 added that CAs can help the community “[…] realiz[e] their potential and really bridg[e] the gap between technical science monitoring jargon and on the ground stewardship […]”. This perspective of CA-CBM relationships suggests that the CA should take a leading role and have CBM as a supplement to their own monitoring, contrasting with the previous paragraph, which had instead envisioned CBM programs receiving support from CAs.

NGO2 agreed that CAs play a very important role in CBM: “[…] they’re kind of the ones that bridge the scale distance between the province, municipalities and local. So in my mind they’re absolutely key to this whole thing”. In their experience working with CAs:

[…] I think that they are the most amazing organization in the sense that […] if you can come up with some funds and a plan, we can work with CA to collect data and to partner with groups, so they are there, they have the technical advice, they have gobs of data and information and so they can probably be tapped more effectively than they are to provide that back and to partner with [CBM] stuff (NGO2).

NGO5 agreed:

I think conservation authorities are in a really interesting position because they’re kind of like a non-profit but they’re also a government agency so I think that there’s an opportunity for them to
play a really awesome hub between the non-profit communities and the proper government bodies that oversee them.

However, NGO5 added that:

Conservation authorities, they kind of think of themselves as non-profits […] but non-profits think of them like government because they get all the funding from the government, so there’s this weird like, not like we can’t trust each other, but it’s kind of like, we don’t really know how to be friends necessarily, all the time, so I think that it would be really great for non-profits and conservation authorities to be friends because we totally have the same goals, like we want clean environments, we want to conserve these areas.

CA5 believed that “[…] we’re probably in the best position to do something from the standpoint of we’re a government organization so we have […] access and partnerships to some of the provincial ministries”. Due to their local office and their constant presence on the landscape, the CAs are accessible to municipalities, so “[…] we consider ourselves the environmental branch a lot of times for municipalities […] we have the potential to influence the community quite a bit from that community-based monitoring perspective” (CA5). CA6 had a similar opinion: “[…] we are community based, we are out there monitoring, we do have education and outreach programs, so [CBM] sort of fits well with what we’re doing and our mandates and our community focus”. GOV3 pointed out that CAs are “[…] more well-known and kind of part of the community locally in watersheds than the provincial government is, they’re a more logical point of contact for volunteers […]”, which makes the CA an ideal contact point for community groups interested in water monitoring.

However, the grey literature did not support the results from the interviews with CA staff. For example, the Conservation Authority Moraine Coalition (CAMC) Strategic Plan recognized the importance of involving the local community in CA programs, as environmental health is linked to the
understanding and commitment of the local community to the conservation of the ORM (Conservation Authorities Moraine Coalition, 2011). The Plan promoted the existence of educational programs at CAs to provide environmental-based educational opportunities. The CAMC 2012 Accomplishments document mentioned that the CAs would work with stakeholders to monitor the ORMCP (Conservation Authorities Moraine Coalition, 2012), and the CAMC 2011 Strategic Plan emphasized the importance of a balance between competing interests and values of stakeholders (Conservation Authorities Moraine Coalition, 2011), although there was no mention of CBM in either document. Results from the grey literature emphasized once again the disconnect that exists between on-the-ground CA operations, and the information that the CA presents in its official reports.

According to NGO1, “I think the CA can have a really strong role because their jurisdiction is based on a watershed, and that’s a really good context for CBM” although NGO1 also expressed some concern about the sources of CA funding: “[…] If the funding comes from the municipality, they’re not going to want to do something that will go against the hand that feeds them” (NGO1), so other organizations and stakeholders should also be engaged in CBM to mitigate a potential conflict of interest. Although NGO1 wanted CAs to be involved in CBM, they added that “I don’t think they should be leading it, because if it’s community driven then the community should be able to have a voice and a say in how that data’s being used, and if it’s being run by the CA that might prevent that freedom of conversation from being used”. NGO8 added that CAs lack real authority; despite their knowledge and skills:

[…] they have to remain politically neutral sometimes, so they could help facilitate monitoring, but they’re not able to really, or they don’t, how do I say this right? Their monitoring, their role in the whole monitoring process doesn’t really, can’t really affect or lead to a policy change, or lead to more kind of long term change that you’d like to see.
GOV1 had been disappointed by the role that some CAs have taken in CBM. Using the example of CYWD, GOV1 said that the CAs:

[...] took on the idea of the watershed report card and CYWD as their own initiatives, that they would lead, they would do to meet one of their mandates, and they would engage citizens to the extent that they needed to get the information out and check the box and say we’ve engaged the citizens in their activity as opposed to a community taking on the project, having ownership of the project and leading it.

GOV1 added that there is variation in how CAs interact with CBM groups, where “[...] some CAs that have more resources feel that it is not worth their effort to engage citizens in monitoring because the quality of data is not there, or it takes too much time, or whatever”. GOV1 said that some CAs use CBM as an outreach activity only, while other CAs use volunteers to help them with their monitoring programs.

The comments from GOV1 emphasized a trend which has emerged from the data: the role that CAs play in CBM is extremely variable, although it is still unclear what approach is most effective. There appear to be two opposing viewpoints: some interviewees believed that CBM supported by the CA is an ideal way to supplement existing CA monitoring programs with limited resources, while others said that CBM is most effective when it is supporting CA staff, rather than existing as a separate program. Concerns existed that without CA involvement, data quality issues would continue to be an issue, while too much CA involvement could limit the ability of CBM to criticize government agencies and affect policy change.

4.1.4 What are the Challenges and Successes Associated with CBM on the ORM?

4.1.4.1 CBM and Adaptive Management

In the literature, Fernandez-Gimenez et al. (2008) have noted that community-based organizations and collaborative monitoring can contribute to the advancement of adaptive management. To explore this
concept, one of the interview questions explored whether or not CBM has contributed to adaptive management on the ORM. According to GOV1:

This adaptive management process has been around for a long time. But it’s all about the fundamentals of the adaptive management process, which basically says, you monitor, you analyze, you act, and monitor and analyze and act, you go in a circle, and the core components of that is that monitoring is core because you have to have quality data that everyone has access to, and it keeps the circle going. That’s why there’s so much buzz around community monitoring and all the rest.

CA10 said that although adaptive management is likely a goal for both CAs and NGOs, they were unsure if either type of organization had actually been able to achieve it. It can be very difficult for CBM data to have any impact. This can be attributed to:

[…] the turnaround time, to collect the data to document the changes is a long time and then there’s a huge advocacy period after that to say, you know, here’s what we’ve done […] and you’re always going to get arguments to say […] that it was something else, a combination of other things, and once the damage is done here you have to put in new rules and you have to get them approved and you have to get that ready for the next development that happens upstream, so (CA10).

NGO4 agreed:

[…] in some circumstances it has [led to adaptive management], where we’ve gone through the full cycle of assessment and monitoring, determination of a problem, identification of potential solutions, a decision on doing something, organizing it, getting it done and monitoring again to determine if you did the right job […].

87
However, the cycle of adaptive management “[…] is still in its early stages, in most of the projects we’re dealing with, our monitoring takes three to four years before you can figure out what the hell’s going on” (NGO4). Although the NGO did support the adaptive management concept, “[…] the challenge is that it takes a while for that cycle to work its way through” (NGO4).

CA3 said that adaptive management is the reason that they “[…] have monitoring stations that we can monitor every single year and go back to, write reports and then make reports based on those changes in the watershed, and it directly informs how we manage our watershed”. CA4 had the same approach: the CA used “[…] the adaptive management model in our sampling, it’s part of our sampling protocol and our watershed plan updating”, meaning that “[…] we use the adaptive management loop where what we learn changes what we do. And what we plan for”. CA5 said that adaptive management is something that their CA is working towards as they slowly build up their capacity for it: “[…] we’ve been building back [from past funding cutbacks], but we really had to take care of the meat and potatoes, as opposed to the gravy, and the gravy is adaptive management”. Funding cuts have negatively impacted the CAs ability to conduct adaptive management, and CA5 said “[…] we’re just getting to the point now where you could call [it] adaptive management […]”. However, although the CA staff discussed the concept as it applied to their own operations, there was no mention of whether or not CBM could impact adaptive management.

NGO9 works with many CBM organizations, and said that “[…] I think that’s our primary goal, is to be able to use that kind of data during the process to make sure that the work that’s being done is going in the right direction and to course correct if it’s not”. For NGO5’s organization, adaptive management was also one of their underlying principles:

Anytime a decision-making process is available and it relates to water quality […] you can almost be certain that [the organization] is involved, and we’re always using our monitoring data and information and expertise to try and make better decisions, give people the tools they need to make those better decisions, and build communities of people who will also push for those better
decision-making and decisions, so I think yeah, we’re definitely doing that [adaptive management].

NGO6, whose organization is involved in policy monitoring, had observed their own success with adaptive management:

I think that we do [contribute to adaptive management]. Um, I would say a lot of our municipal leaders come to our workshops, interestingly enough, and I think when they come and they truly understand the impact of what’s happening that will affect water quality and water quantity, I think that it does temper what they do.

Not all organizations experienced success with adaptive management, however. NGO1 indicated that their organization was not currently contributing to adaptive management: “[…] I think the scale at which we monitor is too small to have any impact besides local or community based, I can’t really see it having a greater impact beyond that scale”. NGO1 said that “[…] we haven’t done a good job of it, and that’s due to our capacity and our resources […].” If the NGO had the capacity to analyze their data over shorter periods of time, it would allow them to choose their monitoring sites based on strategy (and thus contribute to adaptive management), rather than the convenience of the location (NGO1). NGO3 said their CBM activities were also not contributing to adaptive management, although the organization’s overall projects did. The CBM initiatives were “[…] things that we have already tested out on our other sites, so I think most of the influences on management is stuff that we’re doing at other sites and less those sites [the CBM sites]” (NGO3).

When asked if their organization contributes to adaptive management, NGO8 said they would “[…] like to think so, but I think some of these things will take a little bit longer to be able to effectively, clearly see, at the risk of sounding vague”. Although their work in the past with the provincial government regarding water issues had not resulted in any changes “[…] in what the government’s doing in terms of adaptive management […]”, NGO8 said “I don’t want to sound jaded and say no definitively, I
don’t think it’s fair for me to say no”. In contrast, GOV3 was skeptical that anyone was contributing to adaptive management:

I think on paper a lot of us talk about adaptive management, but I’m not convinced that anyone’s really doing it. We may be doing trial and error management and monitoring and trying to get this adaptive cycle where we do monitor, modify it, re-monitor it, etc. but I’m not convinced that in many cases that’s really all that adaptive.

GOV3 added that “[…] there’s tonnes of watershed plans and subwatershed plans and environmental monitoring programs that talk about how monitoring is used in this adaptive process, but in practice whether or not that’s really going on I’m skeptical about that”.

CBM1 said “we would like to think [that we are contributing to adaptive management], but again there’s no real mechanism for that to occur […].” CBM1 cited the example of their organization monitoring two separate chemical spills where monitoring data had indicated that there were impacts to water from the spills “[…] but the knowledge hasn’t really changed any behavior […]. We talk a lot about it when we do workshops or whatever else, there needs to be adaptive management done all the time, not after impact […].” CBM1 added that it’s a big question at this point, whether or not adaptive management can actually be achieved, “[…] because everyone speaks to it and says that it’s a good thing to strive for, we’re going to do it, and then when it comes down to it no one actually seems to do it”. CBM2 agreed: although they hoped that they were contributing to adaptive management, “[…] we don’t know for sure apart from posting it on the [government program’s] website, exactly what they do with the website […],” so “the potential is there, but whether that is in fact happening we couldn’t confirm that”.

These findings are illustrative of the challenges and uncertainties associated with adaptive management. Although both NGOs and government staff (CA or other) understand and support the importance of adaptive management to protect water resources, there appears to be difficulty incorporating monitoring data into the adaptive management process. Some of the challenge is attributed
to the time frame of collecting and interpreting monitoring data versus the review of policies, although some interviewees expressed some doubt that adaptive management was being achieved in any sense, regardless of time limitations. However, some interviewees maintained that adaptive management was one of their core mandates, and was an underlying principle of their monitoring projects.

4.1.4.2 Communicating CBM Data

It is important to understand how CBM data are communicated in order to provide insights into the audiences that CBM is reaching and potentially impacting, as well as the challenges associated with mobilizing CBM data. CA3 communicated CBM data in a number of ways, although “[…] we don’t really specifically get back to Todd Smith [note: not a real name] that came out and say this is what we got on this specific day, we don’t do that. We do try and provide landowners that have given us access [with] the data that we collected on their properties”. The CA also wrote up annual reports and a watershed report card to the public that “[…] don’t really at all speak to the community side of the data, it’s just, this is the data that was collected in a specific year…but we don’t break it down between community monitoring and other sites” (CA3). All CAs on the ORM published watershed report cards; the review of the grey literature included these documents. The CA also communicated their data for other purposes as well, such as fisheries management or planning issues, “[…] but again we’re not breaking up the community monitoring data as part of that, it’s just, this is our monitoring data, and a portion of that ends up being from the volunteers” (CA3), although it is important to note that the CBM data in this case had been collected under the direct supervision of CA staff as part of their regular monitoring programs, rather than a CBM program designed specifically for community volunteers. Similarly, CA4 said that whether or not they communicate data “[…] depends on how good the data is, whether it’s sort of passed the test of actually being supportable, you know, we don’t just use data, like anybody else we go through it and make sure it’s usable”.

91
According to CA5, the CA used to publish long documents related to watershed monitoring, “[...] but now it’s very simple, bit of a cover page, just tells the volunteers a little bit about the tributary and what’s around it, who sampled, we have a picture of the sampling site, a map and then we have the actual results of the sampling that we’re doing, so we do sample a few things like pH, turbidity, alkalinity, just for the sake of characterizing the water [...] we show max, mins and averages, and then a [yearly] average [...]” (CA5). The CA also has a long term goal “to provide kind of the raw water quality results on the watershed report card side of things [...] and it would all be there for people to look at and use in whichever way they want. But we’re not quite there yet” (CA5). CA9 added that the CA sends out an email alert to everyone on their subscription list, which includes reports that have integrated data from both CBM volunteers and CA staff.

NGO1 said that their CBM data are distributed through several channels: it is “[...] posted on our website, and then we also have our newsletter that we send to our subscribers to keep them up to date”. Citizen Scientists also produces newsletters to keep their volunteers informed; a summary of the results from their monitoring activities for the year are included in the newsletter (Citizen Scientists, 2009). NGO1 added that some of their information “[...] for our benthic data, we have a Google-based map that has where the sites are and in what watersheds, and our photos and data associated with it”. Therefore, anyone who is interested is able to access the data collected by NGO1 and its volunteers. NGO3 and NGO4 had a similar approach to communicating their data. NGO3 said:

[…] the fisheries monitoring data all goes into the MOE, um and beyond that, it’s, we share data with anybody who may be interested […] but I guess the only one that’s regularly shared is the fisheries data, the rest is in our database and certainly welcome to anyone who wants to see it.

NGO4 said that the “[...] first step is a technical report with recommendations and that information is sent back to the local chapter and is also then posted for download by anybody on our website”. NGO4 added:
Our technical report is primarily for hard data, if we do have a field report of observations and recommendations, it’s more observational, that goes directly back to the organization or chapter that asked for that information, it’s not posted for public use, it’s directly for their consideration….but if it’s data we analyze it and post it.

These results suggest that for some NGOs, the collected CBM data might be shared directly with a specific audience, although the data could also be available to the general public via the organization’s website.

NGO2 had a slightly different perspective on communicating CBM data:

[...] when possible we tried to do hard data but I think as we got more comfortable in our skin we realized that we could come off our pedestal of this hard data and use this as a platform to tell the story of the need for continued environmental protection, and protection of the moraine.

NGO6 pointed out:

[...] I think we’ve all become very reliant on everything being online or email. The majority of people I deal with on the ORM don’t have internet, a lot of them are farmers, they don’t have the time and they don’t have broadband and they don’t have high speed [...].

NGO6 also emphasized that “[...] the people who are on the land using it are the ones that are impacting it the most, and we’ve got to figure out a way that they have access to this data in a way that’s meaningful, they’re not being preached at, and it’s consistent [...]”. For example, CBM1 had a different approach to communicating data, rather than simply providing summaries of hard data:

[We] tried to lead some narratives for people, they go on educational workshops or hikes when we talk about the understanding of the systems…we did some newsletters… but we try to again, weave it into other, more narrative talks to tell a story that allows people to see the linkages and
how it relates to other things [more than just knowing that the water quality is poor, it is important to understand why the water quality is poor].

These comments indicate that people are most receptive to CBM data when it is presented in a way that is tailored to their local needs and in a language that they can understand; large summaries of quantitative data are less well-received, and could be hard to understand for some community members.

These results suggest that some CBM-related data is being communicated, ranging from formal reports including hard data to informal nature walks or story-telling. It is unclear if one method of communication is more effective than another, although there are some concerns about the value of using newsletters or similar methods, which can limit the communication between the organization and the receiver of the newsletter. According to GOV1, the majority of CBM data are currently communicated through tools such as newsletters. However GOV1 points out that it can be a huge effort for community groups to write a newsletter, to summarize the data, write it up, and have all stakeholders agree on it. The disadvantage to this type of communications is that “all the newsletters to date are general updates, they’re one-way communication and that’s the issue” (GOV1), which limits the impact of CBM data.

4.1.4.3 CBM and Decision-making

Some interviewees from CAs were pessimistic that CBM could impact decision-making. Referencing their work with NGOs, CA10 said that CBM activities were:

[…] really meant to be an educational experience and I think part of it is to hopefully engage some of the students into doing advocacy but currently there’s no capacity….to take the data that [the volunteers] find and move up the chain or talk to people who might be in the position to take action on it, so that’s sort of the missing action I think, is that there’s no capacity to do that [impact decision-making].
CA3 indicated that “the CYWD stuff, we don’t use it too much for the planning aspect, it certainly could be used, but it’s really, the nature of that data doesn’t really feed into the planning process too much” because:

It’s temperature data, so, and it’s a spot temperature, so it’s useful when comparing sites…or at a site to get a picture of the watershed at a single point in time or an afternoon, but from a planning perspective people really aren’t interested in what the water temperature is or whether the culvert is perched or not (CA3).

However, some of the CA’s staff monitoring programs (which include some community volunteers) such as the spawning survey, “[…] gets rolled into the planning process fairly often…so that data we often get asked for, and we would use community data, we would send it in as part of that planning review, so that would certainly get used in the process” (CA3). CA3 went on to say that this discrepancy existed because the data that gets used in the planning process or fisheries management decisions:

[…] needs to be accurate and there’s a whole different level associated with that data collection compared to just getting a group out and let’s go and learn about a type of bug, and again not to say that the information…isn’t valuable, because it is, but there’s a different level of importance attached to that [decision-making data] (CA3).

This suggests that when the CA had control over the data collection, and thus data quality, they were more likely to include it in planning decisions. CA4 also said that their CA has contributed to decision-making in many ways, and gives the example of official plans, where the information regarding natural heritage systems comes from the CA’s watershed plans and monitoring data. CA4 says that “yep, for sure” CBM data are also included in this process. According to CA5, “I would say [CBM is]
influencing decision making […] from my perspective anyway… we’re starting to go in that direction […]” but the CA was only in the beginning stages of having CBM impact decision-making.

NGO1 said that their impact on decision-making occurred on a small scale: “[…] there have been existing datasets that have helped other researchers and academics prioritize certain areas over others in terms of where to start their research. We act as a baseline for other kinds of research […]”, however there has been little impact on broader projects or decisions. Similarly, CBM1 said that they have contributed to decision-making “[…] maybe mildly, again some of our ideas have been used for you know, some research papers and some planning documents, but again I don’t know that they’ve really amounted to any real changes in any behaviours, policies or laws, it’s just been incorporated into a document… the documents themselves haven’t really done much of anything, so it’s kind of hard to say that anything has changed as a result”. Their CBM data was included in two reports “[…] to help inform the characterization and the condition of the stream health and whatever else, but again, that doesn’t seem to translate into any real policy changes or laws or anything tangible” (CBM1). “In terms of hard data, the findings being able to influence policy, that hasn’t happened” (NGO1). CBM2 agreed, saying that they were unaware of any impacts that their data had on decision-making: “I don’t know if we can answer that, um, yeah all the information goes to the ministry… what the ministry does with it as far as making decisions we really can’t say”. NGO1 attributed this difficulty influencing decision-making to the following factors:

[…] there’s a) skepticism around citizen scientist data and b) because the nature of that data is monitoring, monitoring is a long-term process, so it’s not often you have enough data to show long term trends and the periods for reviews of policies are about ten years…so it’s not even a long enough time frame to show long term trends.

NGO1 added that “there’s a disconnect between the amount of time it takes to collect monitoring data and the timeframe it takes to make amendments to policy”, so if there is a “[…] need to update
policy, there just hasn’t been enough time in that period to collect enough data to tell you how to change
the policy that needs to be changed”.

Policy monitoring appears to have had a greater impact on decision-making than community-based water monitoring, although the overall scale of the impact was still small. NGO2 said that it is hard to find concrete examples of situations where CBM has directly impacted decision-making although:

The activities to collect the data have had an impact on decision-making in the sense that it shows
local councils that there are people out there keeping an eye on them and that’s kind of convoluted
because it's not very cut and dry at this point. So I would say that our presence and our reporting
has kept them on their toes which in effect affects decision-making.

NGO8 agreed, saying that their impact on decision-making “[…] comes in incremental steps, you don’t see the sweeping policy changing overnight, but we have, for sure. Not to the effect that we want to though, in all honesty”.

Although their organization in general had contributed to decision-making, NGO3 admitted that
“[…] I would say no from the community based side of it […]”. NGO4 suggested that the challenge with
CBM data was that:

[…] it’s easy for managers in government to discount information collected by volunteers because
it’s collected by volunteers, and they feel that they can dismiss it because they don’t think it’s
rigorous enough to a certain standard that government can use, so that’s a challenge.

However, NGO9 disagreed: “[…] I think there are all levels of decision-making that [CBM] can
impact if it’s well thought out from the beginning”. To support that theory, NGO5’s organization related a
major victory influencing decision-making: their core mandate had recently been incorporated into a water
protection strategy created by the provincial government. NGO5 said “[…] we wouldn’t have been able to
push that information and we wouldn’t have been able to provide the government with the background that was necessary for them to adapt that [strategy] without our monitoring programs”.

GOV1 said that the solution which could allow CBM programs to influence decision-making depends on “[…] engaging the public, allowing them to understand the implications of the decisions they make, um. Lack of access to information enables bad decisions because you know, people can basically say, I made the best decision I could with the information I had” (GOV1). Having volunteers collect monitoring data increases the amount of information available, which decision-makers should be using to create scientifically accurate policy.

The ability of CBM to influence decision-making appears to be variable, and is affected by several factors. Some NGOs have been able to successfully influence decision-making, while others have found that the data collected through their CBM programs is easily dismissed by decision-makers, due to concerns associated with the data quality. Some groups have been able to contribute to academic research, despite a lack of influence on overall water resources management; others have influenced policy, usually associated with conservation authorities when the data from volunteers and staff were incorporated into one larger dataset (and when data quality was controlled by CA staff). Some of the interviewees emphasized that although the impact of CBM on decision-making has been minimal so far, CBM programs are still important for educational purposes.

4.1.4.4 Barriers to Establishing CBM

During the interviews, there was a wide and varied discussion related to the barriers associated with CBM, not only in developing CBM programs, but also in collecting and communicating the data from community volunteers. This section includes the barriers to establishing CBM programs that were discussed in the interviews; the following sections discuss barriers to maintaining CBM programs, including data quality and funding for CBM programs.
According to CA5, health and safety regulations could be a barrier to establishing CBM: there is “[…] huge liability that we’re talking about when we start looking at [CBM], so I know we have those discussions internally all the time […] just because the liability could be so great with so many volunteers […]”. CA5 gave the example that “[…] if someone drowns while they’re collecting water samples, then there is a huge possibility that they could actually charge the authority in that regard”, which is a deterrent for the CA to take responsibility for community volunteers. CBM1 had also noticed that it is becoming more difficult over time to conduct CBM activities due to the cost of insurance and other legal processes:

[…] it’s going to be increasingly more difficult for an NGO to do any work because again you need legal access to land, you have liability insurance that covers you […] you need all kinds of equipment […] you have to ask permission to do stuff[...].

Strict health and safety regulations, and their associated liabilities, could prevent community monitoring groups from becoming established in the first place.

Another barrier to establishing CBM is general uncertainty regarding the effectiveness of CBM to affect changes to water resource management. For example, NGO6 was unsure that CBM is the best mechanism to achieve environmental protection. Although CBM is effective at the local scale, NGO6 pointed out that CBM does not scale up effectively from local to regional, which creates difficulties for having a larger impact than at the local level. NGO6 was:

[…] concerned with community-based monitoring, I have serious reservations with it. I think it’s a feel good thing to get people involved, but is it going to replace CAs and the MOE going in and doing proper scientific study? That’s my concern that you’re actually going to be letting them off the hook […].
NGO6 added: “I want the science to stay with the scientists, I guess is what I’m saying”, referencing the difficulties that community members can face when attempting to address water issues based on data that has not been collected by a professional.

Working with volunteers appears to be a challenge due to the health and safety regulations, as well as the liability that is assumed when working with community members. Interviewees were also concerned that the growing popularity of CBM lets the government off the hook when government monitoring programs are cut, and that CBM cannot effectively scale up from the local to the broader scale.

4.1.4.5 Data Quality

CA10 referenced CYWD when asked about barriers to CBM. CA10 pointed out that there was data quality issues associated with the monitoring program:

[…] from talking to the technical people that I know at different CAs, the data was not something that they would want to rely on to make really science-based objective conclusions, but they said from an educational and experiential point of view it was a really great program […]

CA10 went on to add that “[…] if you’re looking for hard scientific data to make a point and advocate for a certain point of view, it maybe doesn’t quite provide that level of scientific objectivity and accuracy that the monitoring through the CA can do, quite frankly”. NGO4 said that CBM programs like CYWD are “[…] a really nice way of getting people with limited time to do something hopefully useful in a relatively finite time […]”. However, NGO4 indicated that for CYWD:

[…] the data was not collected to sufficient data quality standards that [CAs] could actually interpret and then they felt very embarrassed because […] they’d taken a whole day of people’s time to collect all this information with great hope and expectation only to discover that it wasn’t good enough to use […].

CA3 had also experienced data quality issues associated with CBM activities:
[...] some of the issues [were] people not filling out data forms correctly, or not filling in, we ask them to take photos of culverts for example, and what happened, some of the issues from this year [...] when [the camera] comes back and you’ve got fifteen photos, they’re not labelled as photo one on the camera, right [which made it very difficult to properly identify the monitoring site]. CA3 said “[...] sometimes I shake my head a little bit at how badly they get things wrong”. CA11 had observed:

[...] the challenge with you know citizen engagement and community monitoring is the variances in the way data’s collected [...] what protocols do you use, and there could be a lot of variances depending on the area, depending on the type of group, depending on who the leader might be or the initiative project that’s putting this forward [...].

When writing a report that made reference to CBM on the ORM, the data that were actually included in the report had been collected by CA staff because there was a “[...] fear of, was the data collected consistently, were there appropriate protocols put in place [...] there’s still a hesitancy with respect to what’s the quality assurance around that data” (CA11). CA12 indicated that there is concern that the data collected by volunteers will not stand up to scrutiny, “[...] so if you’re going up to Ontario Municipal Board hearing, and you’re relying on data collected by Farmer Joe for the last ten years, probably easy for a lawyer to say, look, it’s Farmer Joe, we can’t trust this data, so that kind of thing probably floats in people’s heads and so on”, which can discourage investments in CBM. CA4 said that “[...] you have to be really careful with data that you use from volunteer programs. Um, and it really depends in some ways how good the methods that you’ve given them are”. Despite the fact that many of the CAs interviewed had participated in some form of CBM, and provided training to the community volunteers, these results suggest that there is an inherent distrust in the data collected by volunteers, regardless of the training and support that is being provided.
These findings are supported by more comments from the interviewees: “[…] We find with a lot of people who do voluntary monitoring of their watersheds is that they neglect the fact that they have to calibrate their instruments or else you may be getting false information” (NGO4). NGO4 has also admitted that:

So the challenge I always find with community-based monitoring is that it’s a brilliant idea, it’s difficult to maintain in the medium to longer term without some level of training and support by some organization or agency to help the community make sure that they’re collecting it in a reliable, reasonable fashion that can be interpreted and used properly.

It’s too easy for “[…] managers in government to discount information collected by volunteers because it’s collected by volunteers, and they feel that they can dismiss it because they don’t think it’s rigorous enough to a certain standard that government can use, so that’s a challenge”. In response to this dismissal of CBM data, NGO9 has observed that citizens “[…] become so afraid of collecting data because it’s not considered accepted by a municipality or a province or that sort of thing”. NGO4 said that the challenge for CBM programs has become figuring out what community volunteers can monitor reliability given their resources (i.e. what variables to examine), what are the ways to collect that data (i.e. methodologies and equipment), in order to ensure that the collected data are useful to agencies to involved in decision-making.

In contrast, GOV1 said that they have seen “[…] no difference in data quality between volunteers and professionals. In fact, I’ve had lots of problems with professionals, whole datasets we’ve had to throw out”. According to GOV1, it is more important that a person understands the monitoring protocol and is engaging in the monitoring process than whether they are a volunteer or a professional. GOV1 said that “[…] volunteers can easily collect high quality monitoring data with minimal expense and provided you have the appropriate training, their data will be no different than a professional’s”. However, this opinion
is in the minority; results from the interviews indicate that there are still serious concerns about the quality and validity of data collected by community volunteers. Interviewees maintained that CBM programs still struggle to collect data that is useful to CAs or other agencies without the support of professionals or organizations to provide volunteers with training and quality control. Even when community members are trained appropriately and use approved monitoring protocols, the data are still dismissed by decision-makers because of the stigma that is attached to data collected by community volunteers.

4.1.4.6 Funding

Funding has been referenced in the literature as a barrier to CBM (Sharpe and Conrad, 2006), and this observation was supported by comments from interviewees. CAs received the majority of their funding from their local municipalities (CA2, CA3, CA5). Although there was no money explicitly set aside for CBM activities, the community aspect is integrated into the monitoring budget by some CAs (CA3). According to CA5, they often receive in-kind donations since “[…] people don’t like to give out cash but labour’s okay […] people would rather volunteer their time than give probably a hundred bucks to some things, so that’s primarily where we see a lot of funding”.

NGO1 said that their funding varies yearly, but a large amount of their money comes from foundations and government agencies. NGO1 indicated that finding funding sources is always a challenge, especially recently since “[…] the kind of money to support this type of work, at least with the government funding, it’s based on what [the government will] want to fund and it’s not always consistent, like the focus will change after a couple years […]”, making it difficult to access funding over longer timeframes. NGO4 and NGO5 agreed:

[…] it’s been a tough time for not-for-profits the last three or four years since the 2008 financial crisis, fewer people are giving to conservation and environmental organizations and as such we’ve had to just tighten up what we do […] (NGO4).
NGO6 added that “[…] foundations are changing their focus; the economy has really changed a lot of the focus away from environment to economics […]”. NGO7 noted that “[…] with all of the different cutbacks it seems to be the environment [that’s impacted] and you know the ORM, you can certainly see that funding has been cut for preserving the ORM”.

According to NGO8, the majority of their funding comes from private donors, either the general public or charitable foundations, which has been achieved through door-to-door canvassing, phone calls, etc. NGO4’s organization also receives the majority of funding from the private sector or through foundations, with approximately five percent of funding coming from the government. NGO3, in contrast, said “[…] the highest proportion of our funding probably comes through various government grants, a combination of federal, provincial, and municipal […]”, equally split between the three levels of government, with some private funding sources as well. These results suggest that funding opportunities for NGOs are extremely variable.

CBM1’s organization receives very little funding from the government or other sources, and attributes this to the fact that:

[…] no one wants to fund monitoring research, education for the most part, they want to fund tree planning for implementation […] they want to fund tangible deliverables or ideas; increasing your understanding of how a stream operates is not valued the same way as putting a hundred trees in the ground.

In contrast, CBM2 is part of a program which is completely funded by the government. This suggests that community groups, similar to NGOs, can have very different funding portfolios, depending on their associations with government and other organizations.

GOV1 pointed out that “monitoring is really, really hard to get funding for. Almost impossible, in fact”, and adds “it’s the last thing on the agenda, and it’s the first thing to get slashed”; this could
potentially create difficulties for community groups attempting to engage in long-term monitoring. The interviews suggested that while CA’s have a slightly more stable base of funding from municipalities and other levels of government, NGOs and community groups have difficulties accessing consistent funding. Challenges with receiving funding are attributed to both a slower economy since the 2008 financial crisis, as well as the altered focus of foundations as their funding priorities change over time.

4.1.4.7 Government Cutbacks

Government cutbacks to monitoring programs have been discussed in the literature (Whitelaw et al., 2003), and it is a topic that emerged during the interviews. For some CAs, the organizations limited capacity means that they “[…] certainly do need volunteers to help with those [monitoring] programs […]” (CA2). CA3 agreed: as their funding decreases, so does the number of sites that the CA has the capacity to monitor. The CA can’t afford to send out enough staff to cover all of the monitoring sites, “so the continued support of the volunteers allows us to sample sites that we would likely not be able to sample annually or maybe even ever without the use of volunteers […]” (CA3). Although their CBM program has not been affected much by government cutbacks, NGO3 has also developed a:

[…] heavier reliance on having volunteers out there doing, collecting data for us and getting work done […] if we can get a group of volunteers out to you know a day of work that three employees could spend a day out doing, it’s better to have one employee out with the volunteers to help our budget a little bit.

The Trout Unlimited Annual Report identified their existing monitoring programs for community groups that monitor water resources and develop plans to address the identified issues, emphasizing that reduced governmental monitoring means that it is even more important that NGOs collect water data properly if government programs are lacking (Trout Unlimited, 2012). NGO1 had noticed that a reduction in government monitoring programs led to more activity community groups; GOV1 added that cutbacks have contributed to an increase in the engagement of community stakeholders. In fact, GOV1 suggested
that more monitoring may be occurring than there was prior to government cutbacks. NGO5 cautioned that “having communities step in [to do monitoring] are then putting onus back onto the community to look after their own monitoring […]”, which can lead to serious financial burdens for municipalities. NGO5 indicated that they had observed a pushback from communities in response to government cutbacks, where citizens pursued the government to reinstate monitoring programs.

However, CA3 believed that relying on CBM would not work for more complicated programs such as fish monitoring, where CA staff would still need to be included in the monitoring process to ensure good data quality. CA4 had a similar opinion: CBM is extremely useful and “[…] there is a place for community based monitoring, but it is not going to replace the requirement that there are professionals out there, monitoring”.

CA5 said that government cutbacks have had a huge impact on the CAs water monitoring programs: “[…] that’s why we got into it [CBM], we had no money to work with […] and we didn’t have enough time, we didn’t have enough staff to run around […]” and so they turned to community volunteers to fill the monitoring gap. CA5 also said that although government cutbacks have played a strong role in the past in stimulating the development of CBM programs, it is currently a more engaged and concerned environmental community which is the main driver for monitoring. According to CA12:

[…] I can’t think of anything recently that I could say you know, a bunch of cuts is a problem and as a result we should have more community based, you know I think the level of monitoring and the level of data management has been poor for a long time, and it was poor before budget cuts, it’s poor after budget cuts […].

To date, CBM2 has not been affected by government cutbacks either, although they were “[…] worried that the program could eventually be cut back or cut out because of all the various cutbacks that have taken place” in other organizations.
NGO1 said “I think the kinds of cutbacks that have been made are sort of, it’s a signal that there isn’t a priority for community-based monitoring […]” in the government, citing the example of the loss of the Ecological Monitoring and Assessment Network (EMAN) due to massive funding cuts. Funding cuts create a gap in the coordination and capacity of organizations to carry out CBM activities (NGO1). NGO2 has observed that there has been a “[…] refocusing of attention away from collecting data to basically hanging on, yep”, and NGO8 added that these cutbacks have not been a singular occurrence, and instead have been a gradual, consistent reduction of funding resources. NGO4 believed:

[…] the government has completely walked away from the vast majority of monitoring and as such there is no current information on the status of our watershed […] other than that which is being collected either through conservation authorities, not-for-profits like us and/or our partners and volunteers.

“Monitoring’s not sexy […] and most governments and most foundations for that matter don’t really want to spend a lot of money on assessment and monitoring, they just want to spend money on doing […]” (NGO4). These comments suggest that some interviewees believe that government agencies are not supportive of carrying out their own monitoring programs, which has created gaps in monitoring initiatives across the ORM.

The general trends from these results suggest that government cutbacks can be perceived as both negative and positive developments. In some ways, government cutbacks have pushed CAs to work more with communities to fill monitoring gaps left by reduced capacity and staff, and communities have become more active in the environment as they observe the government pulling back from monitoring programs. However, there are also concerns that these government cutbacks indicate a lack of interest in monitoring in general, and download the responsibility for monitoring onto the community, creating strain on already-struggling NGOs and community groups.
4.1.5 What is the Future of CBM on the ORM?

The challenges and successes of CBM, as well as the changing role of government in CBM initiatives, will have an impact on how CBM is carried out in the future on the ORM. The comments from interviewees provided insight into the potential opportunities presented by CBM, as well as the issues that will need to be addressed before CBM can move forward.

CA2 has observed a growing interest from the public to become involved in environmental activities, as the CA has received more inquiries for both monitoring and stewardship programs. In contrast, CBM1 has seen a declining interest in CBM, with volunteers more interested in short-term volunteer engagements than long-term, intensive programs. “[…] Everyone tends towards tree planting as it’s a very short duration and you stick a couple of trees in the ground and you can drive to the site, drive home, have a hamburger, you’ve done your job […]”, and so community members are less interested in activities such as water monitoring (CBM1). The level of interest in CBM in the future appears to still be uncertain, based on comments from interviewees.

Although the level of interest in CBM may be variable in the future, environmental issues exist on the ORM that CAs lack the mandate to address, creating a unique space on the landscape for CBM to fill (CA10). “One of the big issues that’s out there right now is the green energy projects that are being approved through Ontario and especially on the ORM […]” (CA10): the general land use planning monitoring for these projects is not currently being carried out, an issue that needs to be addressed in the future (CA10). Citizens can play a unique role in green energy projects, as well as other issues on the ORM, according to a unique comment from one of the interviewees:

[…] citizens have more leeway to go out there than the CA because we don’t want to be out there criticizing the people who give us money kind of thing, so we have to be real careful in how we frame our discussion and our debate, whereas citizens, they can go out there and tell it like it is (CA10).
GOV1 said that the key to the success of CBM in the future lies in engaging volunteers: “[…] it’s the younger people, we have to engage them because right now there’s a real feeling of apathy out there, there’s nothing they can do about it, right? We have to reverse that apathy, and say, no there is something you can do […]” and show them how they can get involved in activities such as CBM. One way to generate interest in younger individuals about CBM is to make it easier and more accessible using technology. For example, CA3 suggested that CBM can be very useful for issues such as invasive species detection, as there are more people out exploring the woods than the CA could ever achieve with their staff. Using technological features such as apps make it easy for people to submit information and become engaged in environmental monitoring. NGO1 agreed, saying that CBM should start to adopt new trends to engage new CBM volunteers:

I think with the whole new trends in crowd-funding and crowd-sourcing, I think that is the new community-based monitoring, it’s really easy to get involved because you know, people are willingly contributing information and it benefits them directly in return immediately […] the whole traditional community-based monitoring could take note of that, and there could be ways to use crowd-sourced data in a way that’s um built on that trend.

The comments from NGO1 and CA3 emphasize the importance of providing positive short-term feedback to the people participating in CBM so that their interest in CBM is rewarded and encouraged. CA2 suggested that “[…] community based monitoring agencies really need to kind of keep up with the times to ensure that it’s easy for people to be engaged and to report the things they see”. Interviewees believed that incorporating technology could make CBM more accessible and interesting to the younger generation.

CA2 suggested that there is potential in a growing population of retirees, since “[…] there may be pretty good interest in people getting involved in those types of programs [CBM], that’s sort of a generation that has been involved with you know, field naturalist groups and those types of programs that do include that sort of community focus [similar to CBM]”. CA4 has also paid attention to the retired
community, since that is where the CA finds more long-term committed volunteers with a full career’s worth of knowledge to contribute to the CBM program. Regardless of their age, however, CA4 believed that community volunteers could augment CA water monitoring through activities such as reading water gauges after rain events, which the CA would not be able to collect otherwise due to their limited resources. CA11 agreed that there is an opportunity for CBM to grow as resources become tighter for government agencies; however, they cautioned that concerns regarding the quality of data collected by volunteers will need to be addressed in the future (CA11).

NGO8 hoped that the future of CBM would move towards a more comprehensive approach, where it is acknowledged that CBM “[…] information isn’t anecdotal data, it’s something that’s taken seriously and actually […] have an integrated comprehensive approach to all this, and actually it being used by different levels of government”. GOV3 agreed that the future of CBM will likely include further integration of CBM into comprehensive monitoring programs, especially as more standardized protocols are established to bring together volunteers and professionals. CA4 also agreed:

I think there’s lots of future, I don’t think we should ever do monitoring without engaging the public, conservation authorities have to be community based, they have to be place based, and without support of the public we don’t have anything, so and one of the biggest ways we can educate, it’s sort of like the purpose of our conservation areas, the purpose of a conservation area is so you can experience nature and get some sort of appreciation for it. I see watershed monitoring having the same purpose, that people can experience the values of the watershed, and really get to understand how important a piece of stream is and how beautiful it is, and put value to it, and that is as much a part and an end result as the data we gather”.

In NGO9’s experience, CBM was:
[...] growing just because there are so many things in society communities are picking up because governments are letting go of, and so I do think at least in the short form of a decade, we’re probably going to see more community monitoring, and I guess I see that as a positive [...].

Despite the growth in CBM that is likely to occur, NGO9 “[...] would like to see optimally that CBM is just a supplement to broad based monitoring by government so that we still have that baseline data we really need across the board”. NGO4 had a similar view, in that the ideal future of CBM would include “[...] strongly committed people who understand what the importance of monitoring is and they have the support of professionals to help to ensure that they keep a good quality of how they collect the information [...]”, since “[...] it’s the people that live there’s greatest responsibility to look after their own bloody environment, it’s the role of government and other agencies to provide the best support possible for them to manage it well”. NGO4 suggested that in the future, CBM “[...] may be the only way we’re going to get information in the future about the state of our environment [...]”. As CBM grows, NGO7 would like to see the establishment of a CBM program in each municipality:

[…] I think with water becoming such a huge resource and people realizing how precious the ORM is as a water resource, I think it’s only a matter of time whether it’s provincially funded or federally funded, but I think it’s only a matter of time till it [CBM] does happen.

EMAN’s presentation on citizen scientists suggested that citizen science could bridge the gap between policy and ecology: citizen science can act as a sentinel, identifying early changes in the ecosystem so that policy-makers can make timely decisions (Vaughan, 2007). CBM could be used to screen water quality (and other environmental issues) to determine if any changes occur to the natural state; once an anomaly in the baseline monitoring has been identified, expert scientists could then begin more detailed monitoring and analysis to determine the reason for the change in water/environmental quality. EMAN’s paper on biosphere reserves noted the growth of environmental NGOs, which was indicative of a growing concern for the environment (Craig and Vaughan, 2001). NGO3 agreed that CBM
will continue to grow in the future, regardless of whether or not there are budget cutbacks. In contrast, CBM2 was concerned that the current economy will eventually lead to the decrease of CBM programs, as limited resources will be distributed to skilled professionals rather than volunteers.

A comment from NGO5 captured the complex nature of CBM’s future, especially as citizens become more aware of environmental issues and more empowered to address them:

[…] I think we’re at a very interesting time right now in Ontario, Canada generally but especially in Ontario I think that the environmental movement, which would include conservation authorities in my eyes, is poised to emerge as a cohesive group and I think that we’re poised to emerge as really great thought leaders […].

There are so many new projects occurring, including pipelines and plants, that citizens are beginning to voice their concerns: “[…] for the first time in a long time we’re starting to say, hold up, this isn’t okay, and it’s across the board, so that’s why I think we’re kind of poised in a really interesting position [for the future]” (NGO5).

These results seem to suggest that there is an overall belief that CBM will likely increase in the future as multiple factors combine to support the growth of CBM programs: a growing retiring population with pre-established skills and dedicated time available for volunteering, an increasing awareness and interest in environmental issues, as well as an expanding monitoring gap due to government cutbacks that community groups are attempting to fill. An interesting comment from one of the interviewees suggests that there is a belief that eventually CBM will be the only mechanism for monitoring to occur, due to extensive government cutbacks. Although uncertainties still exist regarding the relative role of CAs and community volunteers in these monitoring programs, the interviews seemed to indicate that a cooperative approach between these two groups would be best, where the community works with the government agencies such as CAs to carry out monitoring.
4.2 Knowledge Mobilization

This research project contributed to research theme (1) of the CURA H2O Project (i.e. CBM in Nova Scotia, nationally and internationally) (discussed in more detail in Chapter 1). A workshop was held on May 13, 2014 at Saint Mary’s University, Halifax, Canada to discuss the findings of the research project. The results of the interviews and document analysis were presented to community members and researchers present at the CURA H2O workshop and research meeting. A number of comments were noted regarding the similarities and differences that exist when comparing the status of CBM on the ORM to Nova Scotia. The names of organizations, as well as other identifying information, relevant to other CURA-related projects will not be discussed in this research project, both to maintain the confidentiality of individuals and community organizations, as well as their unpublished research papers. As much information as is possible will be given in this section to provide the proper context for analysis and comparison.

4.2.1 Collaboration

A well-documented example of where community-based monitoring groups have proliferated is the province of Nova Scotia, Canada, which lacks “a comprehensive policy framework for the management of watersheds and water resources” (Sharpe and Conrad, 2006, p. 397); in response to this absence, community monitoring groups have become abundant (Sharpe and Conrad, 2006). Community water monitoring groups have been active in more than 10 of the province’s watersheds since the early 1990s, collecting biological, physical and chemical water quality data in streams, rivers and lakes, estuaries and nearshore marine settings (Sharpe and Conrad, 2006). Watershed groups “have gathered in excess of 55 monitoring-years of water quality data at over 200 sampling sites in Nova Scotia watersheds” (Sharpe and Conrad, 2006, p. 399).

The Community-Based Environmental Monitoring Network (CBEMN) was established at Saint Mary’s University campus by Dr. Cathy Conrad, in response to the needs of community groups for
monitoring methods and equipment, as well as to improve current relationships with community groups and establish new ones (Conrad and Hilchey, 2011; Sharpe and Conrad, 2006). Through the CBEMN, a Community-University Liaison Officer acts as an information resource to community groups to answer queries ranging from “how to monitor/measure the environmental quality of the ecosystems in their community; how to “access” scientific and social data related to the environment; and how to use this data and utilize technology as a tool to further their understanding of their communities” (Sharpe and Conrad, 2006, p. 400).

Several community groups in Nova Scotia have successfully developed and maintained long-term monitoring projects and records, two of which are the Sackville Rivers Association (SRA) and the Clean Annapolis River Project (CARP). The SRA initially began working strictly on restoration projects and educational initiatives, but has since expanded their projects in response to a lack of information concerning the physical health of their watershed. The SRA works on a variety of projects both independently and in conjunction with government agencies such as the Department of Fisheries and Oceans and Environment Canada, as well as universities. The SRA combines their restoration projects with water monitoring, collecting data on benthic macroinvertebrates and water quality. CARP organizes a volunteer water quality monitoring program called the Annapolis River Guardians, which has been running since 1992 with more than 90 volunteers. The longevity of the program is attributed to its minimal operation costs due to “its administration by a community-based organization and the use of volunteers” (Sharpe and Conrad, 2006, p. 401). The proliferation of community-based water programs to fill in existing water governance gaps provides an interesting opportunity to understand the role that a lack of government involvement can play in community initiatives.

Although past research has demonstrated that community groups in Nova Scotia have worked separately from government agencies, collaboration with government agencies was an interesting area of comparison between the ORM and Nova Scotia that emerged during the workshop. During discussion
with CURA researchers, it was discovered that community groups in Nova Scotia had experienced variable success working with government agencies, depending on their approach to the collaboration. When community groups and government used positive language, emphasizing the mutual benefits associated with a partnership and sharing information, CBM groups were more likely to successfully partner with the government. Working with the government had other benefits as well: volunteers using highly standardized and rigorous methods with training provided by government staff were more likely to influence decision-making than community groups working alone and/or using less vigorous methods. In contrast, community groups that used negative language and pursued the government to resolve an environmental issue were less likely to successfully work with government and impact decision-making.

On the ORM, there was no mention in the interviews or grey literature regarding the success of various approaches when community volunteers want to become involved in water monitoring programs; in general, it appeared that volunteers simply contacted CAs and volunteered to assist with water monitoring programs.

4.2.2 The Use of CBM in Nova Scotia when Government-trained

The role of government agencies in CBM was emphasized during the workshop when discussing the ability of CBM on the ORM or in Nova Scotia to influence decision-making. In Nova Scotia, the majority of CBM is carried out solely by volunteers, as it has been previously noted in the literature that the government currently lacks the policy structure to comprehensively manage and protect the province’s natural resources, unlike Ontario’s conservation authorities (Conrad and Daoust, 2008). In Nova Scotia it appears that government agencies will use CBM data when volunteers are trained by government staff; on the ORM, CAs only seemed to incorporate CBM data into their own databases when CA staff were able to directly control the quality of data that was being collected (e.g. when volunteers were assisting CA staff with monitoring). CA staff were concerned about data quality issues when volunteers collected data independent of CA staff, and thus the monitoring data goes unused. This contrast suggests that
government agencies in Nova Scotia trust data collected by CBM groups more than government agencies on the ORM, since they appear to require less control over the data collection as long as they have trained the volunteers initially.

4.2.3 Working across Traditional Boundaries

Other discussions during the workshop suggested that CBM in Nova Scotia is occurring across traditional boundaries (including watershed boundaries, jurisdictional, and institutional boundaries). In this sense, CBM on the ORM seems to be similar: when community members or NGOs assist CAs with water monitoring programs, they are working with an organization that exists across an entire watershed; they are also crossing jurisdictional boundaries (as there are many municipalities in a single conservation region) and institutional boundaries (as CAs contribute to both municipal and provincial levels of government).

4.2.4 Age of CBM Programs in Nova Scotia

In Nova Scotia, initial research has indicated that the lifetime of CBM groups is limited by the volunteers; because the volunteers are often retirees, there is concern amongst some of these groups that the group will eventually fade away as the volunteer base diminishes over time. In contrast, interviewees on the ORM saw the growing number of retirees as a positive development for CBM, as they have often been involved in environmental organizations in the past, and bring a full career’s worth of experience to the program. On the ORM, the volunteer pool is expected to face an influx of volunteers with both retirees and younger volunteers participating in water monitoring projects.

4.2.5 Role of CAs: Nova Scotia Perspective

The province of Ontario has a very different approach to water governance than the province of Nova Scotia due to the presence of conservation authorities (CAs), which do not exist in Nova Scotia (Sharpe and Conrad, 2006). According to the literature, Nova Scotia lacks an integrated approach to water management, which has led to negative impacts on both socio-economic and ecological health (Sharpe
and Conrad, 2006; Timmer et al., 2007). However there has been little research to determine what capacity exists for water resources management, and in 2005, Wilcox-Musselman indicated a need for information regarding water management strategies across Canada that could be incorporated into Nova Scotia’s own provincial planning legislation. The province has been working towards a comprehensive approach to water resources management, beginning in 2002 with the creation of the Drinking Water Strategy by Nova Scotia Environment. The purpose of the strategy was to provide incentive for municipalities and water agencies to create source water protection plans in partnerships with multiple stakeholders (including Nova Scotia Environment) (Cervoni et al., 2008). However, there is some concern that this model of water management is limited because of the main focus on drinking water resources rather than a more inclusive management of all water resources (Cervoni et al., 2008). In other areas of water legislation, Nova Scotia is a leader: along with New Brunswick, the two provinces are the only ones within Canada to “regulate specific activities in entire watersheds. For example, Nova Scotia has 11 protected watersheds and prohibits activities such as fishing and manure stockpiling in some cases” (Hill et al., 2008, p.325).

To improve water governance in the province, Environment Canada created the Atlantic Coastal Action Program (ACAP), a community-based program which is often considered to be “a best practice for water resources management at the local level” (p. 337), with a focus on the restoration of watersheds in Atlantic Provinces (Cervoni et al., 2008). According to Ellsworth et al. (1997) ACAP challenges traditional governmental roles in water management because of the leadership role that communities have assumed to develop water policy priorities, with government acting as a partner to meet the communities identified needs. Hawboldt (2004) suggested that these types of water management initiatives have increased the commitment of local communities to these projects. This approach is especially suitable to Nova Scotia, where a significant number of environmental stewardship groups are actively involved in local water issues in their communities (Sharpe and Conrad, 2006).
Despite these advances in water governance, watershed community groups in Nova Scotia both in the workshop and in the literature (Cervoni et al., 2008) have repeatedly stated a preference for the creation of government agencies in the province that would have a similar role to CAs in Ontario: to facilitate and coordinate water resources management on a watershed basis. The unique role that CAs play in water monitoring and management across the province of Ontario (Sharpe and Conrad, 2006) was a topic that emerged during the CURA workshop as an important difference between CBM in Nova Scotia and on the ORM. Rather than relying on citizens to fill the existing water monitoring gap, community groups in Nova Scotia would like to see government agencies take responsibility for managing the province’s water resources.

This topic has been much debated in the province; some researchers argue that it may not be wise to copy another province’s legislation for water management, especially since “[i]n Ontario, CAs were established under particular political circumstances and their responsibilities gradually evolved” (p.342), whereas in Nova Scotia there are concerns about adding another level of government to the province, as well as the financial ability of the provincial government to support CAs (Cervoni et al., 2008). A government organization such as a CA, which is also part of the local community, appears to change the dynamics between higher levels of government and civil society when compared to Nova Scotia. On the ORM, NGO staff and members of government agencies have indicated that CAs are responsible for a majority of the water monitoring while community volunteers support CA staff in these programs. In contrast, Nova Scotia has no designated government agency which is responsible for monitoring water resources across the province, and thus community groups carry out water monitoring in response to this lack of government coordination.

Cervoni et al. (2008) suggested that the provincial and municipal governments should “formalize relationships with community groups […] without having to impose an entirely new structure, such as CAs” (p. 345). Although research has suggested that a CA style of water governance would not work in
Nova Scotia since the organizations were designed in Ontario under a specific set of circumstances (Cervoni et al., 2008), the desires of community members who are currently undertaking water monitoring in the province should be acknowledged and respected. The results from this research project indicated that there is a need for an extensive exploration of what a CA model might look like in the Nova Scotia context. Research would need to explore how the CA model would fit into the province’s current environmental management framework, as well as the funding sources to support another level of government. Consideration would also need to be given to the future role of CBM groups if agencies similar to CAs were established in Nova Scotia (i.e. how would community groups continue to participate in water monitoring across the province?).

4.2.6 Policy Monitoring

Some similarities exist between CBM on the ORM and in Nova Scotia: community groups from both provinces are involved in monitoring water quality (Conrad and Daoust, 2008; interviews; CURA H2O workshop). However, there was no equivalent in Nova Scotia to the policy monitoring that was taking place on the ORM. On the ORM, the presence of community groups that monitor land use planning and environmental policy is well-documented in the literature (Whitelaw et al., 2009); policy monitoring was also discussed during several interviews. As part of the MTM program, policy monitoring on the ORM began in response to the approval of the ORMCP and a failure of the Provincial government to establish its own implementation monitoring program. STORM and CEW (now EcoSpark) worked with community volunteers to monitor the implementation of ORMCP policies, and other NGO staff discussed during the interviews their experiences monitoring land use planning and compliance on the ORM.

In 2006, MTM published its first status report on the ORMCP implementation. The report’s findings were generally positive, although the group did express concern related to well head protection implementation, fill by-law development, and the province of Ontario’s lack of initiative related to the publication of technical papers to support the implementation of the Plan (Monitoring the Moraine, 2006).
The policy monitoring conducted by community volunteers was significant because the group was able to successfully influence decision-making, as seen when the government actively addressed policy deficiencies which had been identified through CBM activities (Whitelaw et al., 2009). As well, the creation of the MTM Project led to active participation of the government on the MTM Advisory Committee, and integrating the Project’s monitoring with their own monitoring programs which covered the entire Ontario Greenbelt (Ontario Ministry of Municipal Affairs: Greenbelt Protection, n.d.). The Moraine Watch aspect of the MTM Project indicated that community volunteers can successfully participate in land use planning, monitoring and environmental stewardship, and in some cases community volunteers have been identified as planning experts (Whitelaw et al., 2009).

Some interviewees saw more potential in policy monitoring than water monitoring on the ORM: CAs in Ontario are already monitoring water resources to ensure a healthy ecosystem and therefore CBM groups are not really necessary, but monitoring compliance with land use planning policies such as the establishment of green energy projects across the ORM is a gap that could be effectively filled by community groups. Policy monitoring is particularly suited to CBM groups, as they are not usually limited by a need to be politically neutral.

Comparing the practice of CBM on the ORM to CBM in Nova Scotia presents a unique opportunity to understand how differing water governance approaches have influenced the activities of community groups in these two different case study locations. In Nova Scotia, it has been clearly demonstrated both in the literature (Sharpe and Conrad, 2006) and during the CURA H2O workshop that CBM in the province emerged in response to an absence of a comprehensive governance framework to manage water resources. CBM initiatives in the province appear to be filling that monitoring gap through volunteer-run programs, some of which have been established for many years. Although some CBM programs in Nova Scotia are involved in baseline water monitoring or aquatic ecosystem restoration projects, results from the workshop suggest that the majority of programs are used to guide government
monitoring efforts, identify environmental risks that the government can respond to, and focus on specific water issues rather than general routine monitoring programs. The province of Ontario, in contrast, has a comprehensive water policy framework, with several pieces of legislation and conservation authorities mandated to protect water resources across the province. Several long-running NGOs also carry out water monitoring and aquatic ecosystem restoration projects. In the face of strong, established water resources management programs, CBM across the ORM generally appears to have taken the form of community volunteers assisting with water monitoring programs or restoration projects that exist through conservation authorities or environmental NGOs. However, there are also organizations on the ORM that are filling a gap left by government monitoring programs, or monitoring land use planning/environmental policy implementation, for which are no comparative programs in Nova Scotia. Based on these results, it appears that the existing water governance framework can influence the development and structure of community-based water monitoring initiatives, although it is recommended that further research be carried out to explore this potential relationship.
Chapter 5
Contributions to Theory and Practice

The conclusions from this research are discussed in the context of their contributions to the theory of CBM as it is discussed in the literature (Section 5.1) and its contributions to the practice of CBM, including recommendations for future research and exploration (Section 5.2). The purpose of the conclusion is to tell the story of CBM that has emerged from several levels of analyses, including a review of the existing literature on CBM, comprehensive interviews/an interactive workshop with representatives from government staff, academic researchers, conservation authority staff, non-governmental organization staff, CBM program staff and CBM volunteers, as well as an examination of the grey literature to determine how CBM is discussed in reports and monitoring protocols from CAs, NGOs, and CBM programs.

5.1 Contributions to Theory

The results from this research project have clearly indicated that community-based water monitoring is present and active on the ORM, although the particulars of each monitoring program appear to be variable. CBM on the ORM can range from quantitative to qualitative: physical and chemical testing of water quality, aquatic ecosystem health assessments, to visual checks of water quality and monitoring land use planning decisions for legislation compliance or illegal activities. On the ORM, interviewees involved in CBM included staff from CAs, NGOs, community volunteers for government- or NGO-run monitoring programs, as well as members of community groups that were running their own monitoring programs separate from other agencies.

Despite the large variation in the types and member composition of CBM programs that have been observed on the ORM, they generally fall within the four approaches to CBM observed by Whitelaw et al. (2003): (1) CBM led by government agencies, which was observed in the interviews when CA staff were
assisted by community volunteers during regular water monitoring projects; (2) monitoring programs focused on the educational benefits of CBM, which was acknowledged by CA staff as an important component of working with community members, and was observed at some NGOs, where staff were trying to educate citizens about the health of their local environment; (3) advocacy monitoring in response to an environmental issue, which was a topic that emerged in conversation with some NGOs when discussing how people became involved in CBM, or when community members reported illegal land uses to NGO staff; (4) multi-stakeholder monitoring which influences decision-making through collaborative projects. Examples of multi-stakeholder monitoring were given during interviews where CA or other government agency staff and community members were working together to monitor water, or to coordinate monitoring sites to avoid data redundancy.

Sources of funding for CBM programs are another area where the literature and the results from this research were in agreement. In regards to the future of CBM, the literature recommended that CBM activities should become more modern through the use of online tools or social media (Dickinson et al., 2012). This was supported by the results, where it was suggested by several interviewees that social media could be used to engage the younger generation in environmental issues, and to make monitoring more immediately rewarding. Examples of this update to traditional monitoring were given in the literature, including websites such as iNaturalist.org (Dickinson et al., 2012). Interviewees went on to emphasize that incorporating technology makes CBM more interesting and accessible to the younger generation, which could help overcome the general apathy that appears to exist in youth towards the environment.

Interviewees also had several other ideas about how CBM would likely evolve in the future, including a growing volunteer base as the number of skilled retirees increases, as well as a more comprehensive approach to CBM where data collected by volunteers is taken seriously by professionals and there is increased collaboration between volunteers and professionals.
A common theme in the literature centred on the discussion of the benefits and challenges associated with CBM initiatives. In the interviews, many CA and NGO staff acknowledged the benefits associated with including volunteers in their monitoring programs, which have previously been discussed in the literature, such as: an increased awareness of environmental issues, reduced costs associated with using volunteers instead of compensating for staff time, an expanded number of monitoring sites, and an improved relationship with, and trust in, CAs, as well as the formation of a stewardship ethic in volunteers (Au et al., 2000; Pollock and Whitelaw, 2005; Sharpe and Conrad, 2006; Whitelaw et al., 2003). However, several challenges to CBM were also discussed in the interviews, reinforcing previous results from the literature. For example, funding was acknowledged in both the literature and the interview results as a barrier to CBM. Sharpe and Conrad (2006) noted that no core funding is available to CBM programs provincially (in Nova Scotia) or federally; this was supported in the interviews, where several interviewees cited inconsistent sources of funding on the ORM. Although CAs as an organization received core funding from government agencies for their own monitoring programs, there was no specific support to carry out CBM for any group, government or otherwise. For NGOs and CBM groups, sources of funding ranged from foundations to government departments; however, funding was extremely variable as the focus of agencies changed over time and funding in general diminished in response to the 2008 financial crisis. Variability in funding sources was cited in several interviews as an obstacle to CBM activities; this agrees with previous research by Pollock and Whitelaw (2005), who suggested that it is more important for the success of CBM programs that funding for CBM be delivered over the long term, rather than providing short-term support. Other barriers to CBM also emerged in the results, including the liability that is assumed when working with volunteers and the risk of using CBM to justify a reduction in government monitoring programs.

Although past research has identified the numerous benefits associated with collaboration between stakeholders in resource management and has cited multiple stakeholders working together as the key
factor necessary for CBM success (Pollock and Whitelaw, 2005), on the ground there was no real influence of decision-making associated with CBM. Sharpe and Conrad (2006) observed that community volunteers become frustrated when they are unable to impact water resource management decisions. No interviewees explicitly discussed frustration with the lack of influence over decision-making, but admitted that there have been very few instances where CBM has been able to successfully influence policy. Although policy monitoring has had some impact in the sense that municipal decision-makers are aware that the community is watching, most of the water monitoring projects discussed in the interviews had not observed any success influencing water resources management, aside from a few cases where academic research projects had been informed by CBM data. Norman et al. (2011) has also observed the same problem, noting that stakeholders face considerable difficulties influencing decision-making.

Results from the interviews and literature suggest that concerns over data quality may be the main reason that CBM has not yet successfully been used to influence decision-making. Interviewees often did not believe that community volunteers were capable of collecting water quality monitoring data that was scientifically robust enough to be used in the decision-making process. Although interviewees maintained that the simple act of collecting data was valuable in and of itself, when it came to using monitoring data to make water resource management decisions, staff from both NGOs and CAs preferred to leave the data collection to the experts. A review of CBM literature by Conrad and Hilchey (2011) found that challenges to CBM often centred on data quality: data inaccuracy, lack of volunteer objectivity, lack of appropriate experimental design, a lack of monitoring expertise/quality control, as well as the utility of CBM data for decision-making and environmental management. Although Pollock and Whitelaw (2005) suggested that accessible, standardized monitoring protocols that were appropriate for community members to use could overcome the challenges associated with data quality, the evidence suggests that this is not always the case. Despite the fact that NGOs and community organizations were using government approved monitoring methods including the OSAP protocol (which is explicitly meant to include community
volunteers in the modules), interviewees were still not able to meaningfully participate in or impact decision-making. Although research in other locations has successfully observed CBM influencing environmental management (Miller-Rushing et al., 2012), these observations were not supported in the results from the interviews or grey literature review. In contrast, CBM in Nova Scotia has experienced some success influencing water management decisions. Part of this success can be attributed to the trust that the provincial government has for community monitoring groups, as well as the open, collaborative approach that some communities take when working with government; other factors that might contribute to this success story in Nova Scotia is the training of volunteers by government staff to assure quality control measures are in place.

Organizational frameworks are a useful tool that can used to improve approaches to CBM across Canada (Conrad and Hilchey, 2011; Milne et al., 2006). Conrad and Hilchey (2011) suggested that a standardized framework for CBM could resolve many of the challenges faced by CBM groups. The following CBM framework, originally developed by Pollock and Whitelaw (2005), and reviewed by Conrad and Daoust (2008) in the context of Nova Scotia, is used to examine the impact of the current on-the-ground practice of CBM on CBM theory. The conceptual framework developed by Pollock and Whitelaw (2005) consisted of the following four dynamic themes based on the theory that CBM should be context-specific, iterative, and adaptive: (1) community mapping: governance analysis, community visioning, citizen engagement; (2) participation assessment: consultation and outreach, skills assessment, champion identification; (3) capacity building: partnership development, organizational structure, resource support; and (4) information delivery: ecological monitoring, communication, achieving influence.

According to Conrad and Daoust (2008), a CBM framework presents an opportunity for community groups to move towards stewardship and sustainability based on collaborations between decision-makers and community stakeholders. While the conceptual CBM framework proposed by Pollock and Whitelaw (2005) provided a strong foundation, Conrad and Daoust (2008) simplified the CBM framework
processes: (1) identify stakeholders, (2) identify skills and resources available to the CBM program, (3) create a communication plan to influence decision-makers, and (4) create a monitoring plan, including communication of the monitoring results. Steps (4) from both CBM frameworks address how CBM can influence decision-making. One of the final steps of a monitoring program is to communicate the results to the intended audience. Based on Conrad and Daoust’s (2008) research, once the data has been collected and analyzed, the next step is communicating “the results of monitoring to not only the stakeholders but to the general public […]” (p. 364). This recommendation is very general, and based on this description, is being achieved by the CBM initiatives analyzed in this project. As was observed in the interviews, grey literature, and workshop, CBM programs have little trouble communicating their monitoring results in some format or another. For some community groups, communications have taken the form of newsletters or storytelling; some NGO programs send email updates to their stakeholders. Volunteers working with some CAs have contributed to the CAs official reports, although their contribution to these reports is not officially acknowledged by the organization.

Results have indicated that influencing decision-making is perhaps the greatest challenge for CBM initiatives. Step (4) from Pollock and Whitelaw (2005) is more specific than Conrad and Daoust (2008): once the first three steps of the framework are complete, and community groups have completed their community mapping, participation assessment, and improved their capacity through initiatives such as partnership building and collaboration, “raw data should be translated into meaningful information so that monitoring results can inform decisions in an adaptive fashion” (Pollock and Whitelaw, 2005, p. 224) and be used by decision makers to manage environmental resources. Pollock and Whitelaw (2005) recommended that further research is needed to determine if their proposed framework increases the influence that CBM initiatives have on decision-making. The results from this research project indicate that this conceptual framework for CBM is somewhat flawed, in that regardless of the engagement of volunteers, the structure of the program, the partnerships that have been established to carry out the
monitoring, or the communication of monitoring results, data collected by community volunteers is still not being used by decision makers to manage environmental resources. Therefore, further research is recommended to fully understand the mechanisms that underpin the inability of CBM to overcome the barriers to influence environmental decision-making, which could inform the revision of Pollock and Whitelaw’s conceptual framework to more accurately reflect CBM. Potentially, future research projects could focus on decision-makers at the local, provincial, and federal level, to explore their understanding of CBM both as a theory and as a practice, and to analyze their receptiveness to incorporate CBM data into decision-making. This research project was directed to explore CBM programs on the ORM from an on-the-ground perspective using community volunteers, NGO and CA staff; it would be beneficial to explore CBM from the perspective of government officials through future research initiatives.

5.2 Contributions to Practice: Conceptual Framework

Based on the results of the literature review, interviews, document analysis, and workshop, a conceptual framework was developed to explore the role that CBM can play in any relevant, adaptive planning process (i.e. watershed plan, community plan, etc.).
Figure 1. This figure summarizes the conceptual framework developed based on results from the interviews and grey literature, as well as the literature review. Any relevant planning process should be informed by monitoring data on the implementation of the plan, in order to continuously improve the planning process and carry out AEM. It is important to recognize that monitoring (including CBM) is integral to the process of AEM. The width of the arrows indicates the relative importance of monitoring (including CBM) to the step of the adaptive management process. This figure suggests that monitoring is most important during the plan review stage of adaptive management, although it still feeds into the other steps of the process.

The development of the conceptual framework as shown in Figure 1 was influenced by an analysis of Pollock and Whitelaw’s (2005) conceptual framework for CBM. Three general characteristics are incorporated into the conceptual planning framework developed in this section, as recommended by Pollock and Whitelaw (2005): (1) CBM programs should be appropriate to local conditions; (2) CBM should be an iterative, fluid process; and (3) CBM should be adaptive to achieve sustainability.

As was discussed in Section 5.1, the CBM framework developed by Pollock and Whitelaw (2005), and reviewed by Conrad and Daoust (2008), included the communication of monitoring data to influence decision-making. However, the results from this research project demonstrated that CBM
frameworks in the literature were not reflective of CBM as it occurs on-the-ground. A revised version of the Pollock and Whitelaw (2005) conceptual CBM framework as recommended in the previous section (5.1) could lead to an improved approach to CBM. The developed conceptual framework in this section includes CBM and other monitoring initiatives as a central concept which feeds into all steps of the adaptive management planning process, demonstrating the ease with which monitoring (including CBM) can be incorporated into plan development to inform decision-making.

In the adapted conceptual framework, the planning process proceeds as follows: the identification of objectives must occur before the management process can move forward to develop a plan. Using the objectives as a guide, a resource inventory is carried out to establish the capacity and resources available to the planning process; this is similar to the community mapping, participation assessment, and capacity building discussed in Whitelaw et al. (2009) to understand the values, concerns, and skills of individuals involved in monitoring programs. Then a plan is developed and approved, after which CBM as well as other assessment and monitoring measures can inform the review of the watershed plan to assess its efficacy and ability to manage the area of interest. Once the plan has been reviewed, the process begins again, with new objectives and resources established to improve the plan as necessary. The establishment of new objectives following plan review ensures that the planning process is truly adaptive. The design of the conceptual framework indicates that monitoring (including CBM) is integral during plan review, although it also feeds into the other steps of the adaptive planning process.

5.3 Contribution to Practice: Recommendations

Although some groups carried out monitoring programs without assistance or support from government agencies, there remains an underlying expectation that it is the government’s responsibility to monitor water resources. Government cutbacks were often associated with the positive development or growth of CBM programs; however, interviewees also voiced concerns that cutbacks to programs indicated a lack of in monitoring (and the environment) in general. In the interviews, when asked about
the future of CBM, the overall results indicated that ideally water monitoring on the moraine should still be carried out by government agencies such as CAs, although communities would still be involved in the programs in some way. Although interviewees acknowledged the benefits associated with CBM, it was generally agreed that government agencies should be involved in water monitoring to avoid placing the burden on communities to carry out monitoring. At the very minimum, government agencies should provide training and advice to community volunteers for water monitoring programs. For some interviewees, the growth in CBM programs is seen as a positive development following government cutbacks, as CBM can contribute to expanded monitoring efforts; however, this growth in CBM should not be used to justify continued cutbacks to government monitoring programs.

Another interesting trend that emerged from the research was the dichotomy that existed between the interviews and the grey literature on the discussion of CBM. Although interviewees from CAs, NGOs, and community groups spoke extensively regarding their involvement in multiple water monitoring programs with community volunteers, corroborating evidence was not always found in the grey literature. For NGOs and community groups, newsletters, reports and data protocols acknowledged the role that community volunteers played in their programs, and supported the evidence from the interviews. In contrast, not a single document from a CA that was analyzed mentioned CBM, despite verbal assertions from CA staff that community volunteers assisted with multiple projects across the watershed. This disconnect between on-the-ground actions versus what is actually being communicated to stakeholders could potentially create difficulties for several reasons: government agencies or other groups may not be aware of how widespread CBM actually is amongst CAs, which could contribute to a reluctance for others to participate in CBM; a lack of acknowledgement by CAs of the important role played by volunteers in their monitoring programs could also add to the uncertainty that exists regarding the usefulness of CBM for collecting valid data. Some CAs have integrated CBM data into their own datasets because they trust the quality of the data collected by their volunteers; however, since this contribution from volunteers is not
acknowledged in the CAs formal reports, other groups cannot see that CBM is being successfully used by a government agency to make decisions about water resources. The perception that data collected by community volunteer is sub-par will likely continue to exist if the agencies actively using that data refuse to disabuse the notion that CBM is only an accessory activity, rather than truly useful to the CA. Pollock and Whitelaw (2005) and Dickinson et al. (2012) have both discussed the importance of recognizing the contributions of community volunteers. Therefore agencies (government or otherwise) that actively engage community volunteers within their water monitoring programs must recognize role that citizens play in their organization’s ability to properly monitor and manage water resources. Without a formal acknowledgement, the status of CBM is unlikely to change in the future. The nature of the acknowledgement will need to be determined based on the characteristics of each individual monitoring program, and the nature of the community’s contribution to the monitoring initiative.

To increase the visibility of CBM program on the ORM, a program such as the Oak Ridges Moraine Foundation (ORMF) or EMAN should be established to take the lead on an ORM strategy. This new program should be funded by the Provincial government to bring monitoring partners together across the ORM to: promote the use of CBM; establish standard, trusted monitoring protocols and certification processes; manage CBM data and establish a track record for CBM programs; organize a conference to discuss CBM experiences and develop new strategies to improve the practice of CBM; promote AEM; discuss CBM in formal documents and officially recognize the contribution of community groups to the protection and management of water and other resources. These efforts to improve CBM across the ORM are especially relevant given the upcoming review of the ORMCP in 2015 (Greenbelt Council, 2013). These recommendations for the ORM should also be extended to other areas of Canada. This research project suggests that the CURA H2O should be supported to become a national group working with CBM initiatives across Canada, including the ORM. Given the CURA H2O Project’s extensive work with CBM
as a concept and a practice, the group is ideally placed to share its expertise and expand its knowledge base to other areas of Canada to improve CBM practices across the country.

5.3 Concluding thoughts

This research project represents a study of CBM on the ORM which explores the current status of water governance and CBM on the moraine, the role that government agencies can play in CBM, the challenges and successes of CBM, and the future of CBM, as well as how CBM on the ORM compares to CBM in Nova Scotia. Multiple methods were used to confirm and validate the research results, including a review of scholarly literature, interviews and a workshop with relevant stakeholders, as well as a document analysis of the grey literature published in official government and NGO reports and publications.

Results from this research project provided insight into the theory and practice of CBM on the ORM, and contributed to the CURA H2O Project’s research objectives to further its understanding of CBM in Nova Scotia, and across Canada. Several recommendations emerged from this research project to contribute to and improve the field of CBM research and practice. The recommendations are summarized below:

1. Research on CBM from the perspective of government staff and decision-makers should be carried out be to determine what measures are required to generate enough trust in CBM data to use it in decision-making. The potential for CBM to act as a screening tool which identifies changes in environmental conditions should be explored.

2. The contributions of community volunteers to government monitoring programs should be recognized officially in reports or other documents. The nature of the recognition will need to be tailored to each specific monitoring program.
3. Investigate the influence that water governance structures can have on the prevalence or mandate of CBM programs, as well as the complex relationships that exist between government agencies and community monitoring groups.

4. Further explore the role that CAs play in water governance and CBM in Ontario, as well as the potential for the CA model to be extended to apply to Nova Scotia, or other provinces. Establish a clear understanding of the future role of CBM in the province(s) in the event that a water governance agency and comprehensive framework is established.

5. Refine existing CBM conceptual frameworks to guide community groups to effectively impact decision-making. Framework should be tested using case studies to confirm accuracy.

6. Test the conceptual framework developed in this research project to explore the efficacy of CBM incorporated into the adaptive planning process.

7. Establish an organization (similar to the ORMF or EMAN) to act as a central body to coordinate and direct CBM activities on the ORM. Consider the role of the organization in the establishment of standardized training, certification and monitoring protocols, and the maintenance of a track record of community volunteer performance to demonstrate reliability and QA/QC in CBM programs.

8. Encourage the CURA H2O Project to expand to a national scale and continue its research on CBM and influencing decision-making. Connect the expanded CURA H2O Project with CBM organizations across Canada (including the central organizing body for CBM on the ORM) to streamline and improve the practice of CBM in Canada.
Bibliography


150


Appendix A
Ethics Approval

October 29, 2012

Dr. Graham Whiteley
Assistant Professor
School of Environmental Studies
Queen’s University
Biociences Complex
Kingston, ON K7L 3N6

GRED Ref #: GENSC-052-12, Romee # 600749
Title: “GENSC-052-12 Community-based Water Monitoring and Management: Comparing Community-based Water Monitoring Programs and Activities in Nova Scotia and Southern Ontario”

Dear Dr. Whiteley:

The General Research Ethics Board (GRED), by means of a delegated board review, has cleared your proposal entitled “GENSC-052-12 Community-based Water Monitoring and Management: Comparing Community-based Water Monitoring Programs and Activities in Nova Scotia and Southern Ontario” for ethical compliance with the Tri-Council Guidelines (TCPS) and Queen’s ethics policies. In accordance with the Tri-Council Guidelines (article D.1.6) and Senate Terms of Reference (article G), your project has been cleared for one year. At the end of each year, the GRED will ask if your project has been completed and if not, what changes have occurred or will occur in the next year.

You are reminded of your obligation to advise the GRED, with a copy to your unit REB, of any adverse event(s) that occur during this one year period (access this form at https://services.queens.ca/romee_researcher/ and click Events - GRED Adverse Event Report). An adverse event includes, but is not limited to, a complaint, a change or unexpected event that alters the level of risk for the research or participants or situation that requires a substantial change in approach to a participant(s). You are also advised that all adverse events must be reported to the GRED within 48 hours.

You are also reminded that all changes that might affect human participants must be cleared by the GRED. For example you must report changes to the level of risk, applicant characteristics, and implementation of new procedures. To make an amendment, access the application at https://services.queens.ca/romee_researcher/ and click Events - GRED Amendment to Approved Study Form. These changes will automatically be sent to the Ethics Coordinator, Gail Irving, at the Office of Research Services or romee@queens.ca for further review and clearance by the GRED or GRED Chair.

On behalf of the General Research Ethics Board, I wish you continued success in your research.

Yours sincerely,

[Signature]

John Stevenson, Ph.D.
Professor and Chair
General Research Ethics Board

cc: Ms. Erin Murphy-Mills and Dr. John Devin, Co-investigators
Appendix B
Interview Questions

1. Please explain how you became involved in community based monitoring activities.
   a. What monitoring activities were you initially involved in, and how has that led to the monitoring that you are involved in now?

2. Please explain when and how your organization became involved in community based monitoring?

3. Describe the types of community based monitoring you carry out.

4. Is your monitoring educational, activist, comprehensive? (definitions to be provided)
   a. Educational monitoring: promotes the educational aspects of monitoring through participating to contribute to conservation objectives, and promote commitment from volunteers.
   b. Activist monitoring: Monitoring that focuses on local issues which are already of concern in order to achieve positive change in environmental quality though action and advocacy
   c. Comprehensive monitoring: All interested stakeholders (citizens, businesses, government, etc.) participate in monitoring, influence decision-making through cooperation rather than advocacy.
   d. There might be spillover from one to another, which is fine

5. What are your views on each kind of monitoring?

6. Do you provide skills training to the community volunteers carrying out the monitoring?

7. Do you coordinate your community based monitoring activities with government monitoring programs?
   a. Let me know if you’re talking from government perspective or the group that you’re working with

8. What do you think is the role of Conservation Authorities within community-based monitoring activities?
9. How much funding do you receive from government, the private sector, foundations etc.?

10. How do you communicate your community based monitoring activities? And who is receiving this information?
   
   a. Can you distinguish between communicating hard data vs. what you’re doing in general

11. How have government constraints/cutbacks influenced the need for your monitoring activities?

12. Has your monitoring data influenced decision-making?

13. Are you contributing to adaptive management? (definition provided)
   
   a. Adaptive management: a process that aims to reduce uncertainty in the decision-making process through the continual search for information needed to improve future management, where monitoring is used to determine if current management is meeting the initial objectives as well as gaining further knowledge

14. Who else can you recommend to talk to?

15. What do you think is the future of community-based monitoring activities, and what would you like it to be? How can this future be achieved?

16. Is there anything I’ve missed that you would like to add?