Watershed Indicators: Contributions of the public to customize a generic index to local needs

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

The purpose of this research is to examine the ways in which public contributions, as part of a larger public participation program, can shape the use of the Canadian Water Sustainability Index (CWSI) and increase its relevance to the communities for which it is used. A case study in the Clear Lake watershed in Riding Mountain National Park (RMNP), in Manitoba, was undertaken in which stakeholder and partner perceptions, knowledge, concerns and priorities were gathered through a questionnaire and interviews from August to November 2009. This information provided a lens through which the CWSI could be viewed regarding its social relevancy. Public consultation highlighted four main areas of interest upon which indicators can be focused: bottled water use; well water reliance; water conservation and efficiency; and communications. While the identification and development of indicators will be led primarily by RMNP, the indicators will be used in monitoring, reporting, and communicating within the watershed community. Socially relevant indicators are intended to complement scientific indicators concurrently being developed for the Clear Lake watershed. Public participation increased the relevancy of the CWSI to suit local needs, although the participative process was limited by time, complexity of the information, and a necessarily broad survey.

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Dedication

To my family

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Chapter 1 Introduction

Watershed-based management associated with Canada's national parks has the potential to demonstrate innovative, cross-boundary integration of resource management strategies that highlight public involvement, knowledge and information sharing, and watershed-based decision making. Successful watershed management requires effective communication of ecological information to decision makers and stakeholders, thereby empowering groups and individuals to participate meaningfully. Communication can be enhanced through the participatory development and use of socially-relevant assessment tools, such as indicator systems. The dissemination of data and information through such resource management tools has been shown to promote the success of ecosystem management (Fraser et al. 2006).

At a time when increasing scarcity of and concern over freshwater and related resources have arisen on the international agenda, it is increasingly appreciated that water resources are a human necessity (Gleick 1996; 1999) as well as inextricably linked to other environmental necessities and human well being (Falkenmark 2001; Global Water Partnership; UN-WWDR2 2006; Gleick 2008). The Global Water Partnership (2000) outlines the main challenges facing freshwater resources: pressure arising from population growth and increased resource consumption; populations falling into water-stressed situations; pollution impacts on resource quality; and inadequate water governance. While these are global concerns, regional ecosystem variability, coupled with diversity of human activities and governance of water resources, have inspired various locally-focused resource management actions, often at the watershed scale.

In recognition of ecosystem boundaries, Canada's parks and protected areas often require integrated water resource management strategies that reach beyond park boundaries. Integration can be enhanced through use of management tools that reflect watershed management units as complex socio-environmental systems and for which critical linkages between society and the environment are identified and measured (Bowen and Riley 2003; Hooper and Lant 2007). Indicator-driven assessment can detect and provide information in an accurate and timely manner regarding the ecological integrity of protected aquatic ecosystems, while also fostering integration of stakeholders' interests and goals (Bowen and Riley 2003).

This investigation aims to contribute to the development and effective use of interdisciplinary indicator systems as a tool for assessing change, fostering integration in water resources management, enhancing communication with stakeholders, and improving decision making. Towards this, I chose to study the Canadian Water Sustainability Index (CWSI) with regard to the local context of the Clear Lake watershed in Manitoba with the intent to demonstrate the ways in which public engagement can contribute to the design and application of indicator-style reporting. Watershed management is currently led primarily by Riding Mountain National Park (RMNP). RMNP is currently seeking to measure and report aspects of ecological integrity to the local community in a way that highlights issues of social relevance.

1.1 Indices and Indicators

Indices and indicators have gained popularity as natural resource management tools for monitoring and reporting. They are particularly lauded for simplifying complex information into a user-friendly, and often cost-effective, format (Hammond et al. 1995). However, it remains a challenge to select the most suitable indicators for different resource management needs, particularly when they will be used to communicate with the public. To achieve effective communication, the public must be engaged in the process of identifying topics of interest and concern for which indicators can be selected, and this reality may have a profound impact on indicator and index design.

Various indices and indicators are in use worldwide and in Canada for monitoring freshwater resources. Their purposes vary among the social and biophysical aspects of water resources. The Water Poverty Index (WPI), developed by Sullivan et al. (2003), has been applied in various regions of the world to rate the 'water well being' of communities. In Canada, the Water Quality Index (WQI) is widely used to measure various parameters of water quality. The Canadian Water Sustainability Index (CWSI), recently developed by the Policy Research Initiative, reflects the broad range of considerations required to manage freshwater resources for both human and ecological needs (Canada 2007).

A challenge in the development and application of indices and indicators is to make them relevant for the intended audience(s). Certain aspects must be considered for indicator-style reporting to a specific local community. Public input into the design and selection of indicators

can help to ensure that the final product is meaningful for that audience (Stanghellini 2010). However, because there can be multiple audiences in a community, challenges are often encountered in selecting indicators that are meaningful to all the potential audiences.

The CWSI had just been released when I began my research in the area of watershed indicators and indices in 2007. I was looking for indicator-style tools, like the CWSI, that were apparently designed to measure both human and biophysical aspects of water resources; were intended to be suitable for application in varying situations; and were to allow comparisons between management units, such as watersheds. The most progressive work in this field seemed to be that of Sullivan et al. (2003, 2006) on the Water Poverty Index and, in Canada, where many watershed reporting tools are in use, the CWSI stood out as being intended to be useful in any of Canada's contexts. Ultimately, I decided to focus on the CWSI, in part because it was current and suited generally to the Canadian context. In the case of Canada, watersheds can vary widely and I was curious about what could be learned about its use in a local context, through a case study and input from the public.

The intent of this research is to better understand the ways in which public participation may guide the content and application of the CWSI in the context of a specific watershed. The Clear Lake watershed, in Manitoba, was chosen as a case study because of its unique situation as well as the interest that resource managers had in using indicators for monitoring and reporting. Clear Lake is within the boundaries of Riding Mountain National Park (RMNP), but its watershed lies mainly outside of the park boundary. As the watershed is home to a small permanent and seasonal community, the public had been invited by the RMNP to participate in an advisory role in watershed management and, thus, opportunity arose to investigate important social aspects of the watershed.

1.2 Introduction to Case Study Area

Resource managers working in the Clear Lake watershed recognized the need for indicator-style monitoring and reporting in order to effectively manage the watershed resources and communicate with the watershed community. In 2005, efforts began to establish biophysical indicators of ecological integrity for Clear Lake. In 2008, the project was expanded to reflect the

entire watershed and also to include the local community in watershed planning. Ongoing community involvement requires that information be shared among stakeholders and partners, so resource managers in the Clear Lake watershed proposed additional research to increase the social relevance of ecological indicators.

The Clear Lake watershed, Manitoba, straddles the border of Riding Mountain National Park of Canada (RMNP), the lands of the Keeseekoowenin Ojibway First Nation (KOFN) and publically and privately owned lands within the Rural Municipality (RM) of Park. It also falls within the jurisdiction of the Province of Manitoba and the provincially overseen Little Saskatchewan River Conservation District. The main feature of this watershed is Clear Lake, a deep, clear and cold body of water that attracts thousands of visitors and recreationists every year, and supports a unique ecosystem. While there are no significant negative environmental impacts from so many visitors, the efforts by resource managers to build socio-ecological understanding and support for cross-boundary, watershed-wide integrated resource management indicate that collaborative efforts are critical to maintaining the ecological integrity of the Clear Lake watershed.

Using public consultation, the CWSI can be customized to form a suite of indicators that measure, evaluate, and communicate selected criteria of ecological integrity in a manner that emphasizes the social relevance of this information. One of the foremost interests of the RMNP staff is to develop indicators to assess and communicate data and information regarding Clear Lake's ecological integrity, to resource managers, partners, and stakeholders, in a way that will inform decision making and project support. It is imperative that the final indicators are both meaningful and feasible. The focus in this thesis is to explore how understanding of local issues can contribute to the content and application of the CWSI.

1.3 Introduction to the Literature

The literature reviewed in Chapter Two provides an overview of indicators, IWRM, and public participation in resource management. This literature forms the foundation for my research by demonstrating that, while it is possible to identify indicators in the absence of public input, lessons from IWRM (Mitchell (1990; 2005), Fitzgibbon et al. (2006), and Mitchell and Shrubsole (2007)) suggest that uptake and support for environmental goals will be enhanced

through community engagement and locally-relevant reporting (Bowen and Riley 2003, Hooper and Lant 2007, and Berkes 2009). As such, public participation in the identification or customization of watershed indicators contributes to the relevancy of the reporting tool to local interests.

First, the desired characteristics of indicators and the roles of indicators in resource management are discussed in general. This section highlights the most widely accepted characteristics of good indicators by selected agencies. The discussion then turns to how socioecological understanding can inform indicator development and the ways in which, by looking beyond biophysical elements, water-related indicators can reflect social aspects of a specific watershed.

Examples of indicator use in water resources management are provided and followed by a discussion on how the principles of IWRM can guide further development of watershed indicators. This includes considering the degree to which integration may take place, and how ecosystem-based management and IWRM can assist parks and protected areas in reaching beyond parks boundaries.

To conclude the literature review, public participation, as well as its benefits and limitations, are discussed. Literature focused on public participation in the development and identification of indicators, methods, and challenges, is outlined, in addition to the usefulness of these indicators to adaptive capacity. Finally, I discuss limitations and considerations on the development and use of indicator systems.

1.4 Ecological Integrity in the Clear Lake Watershed

Ecosystems have **ecological integrity** when their native components (plants, animals, and other organisms) and processes (such as growth and reproduction) are intact. Parks Canada (2000 n.p.) defines ecological integrity as "a condition that is determined to be characteristic of a natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes". This definition follows generally accepted aspects of ecological integrity (Karr and Dudley 1981; Parrish et al. 2003), wherein an ecosystem, composed of genetic, species, and community diversity and interactions, can support a functional organization supported by natural

processes and abiotic components in the face of change. In addition, Woodley et al. (1993) noted that such integrity evolves in the virtual absence of human intervention.

The problem with managing resources according to such a definition is that the social components and interactions with biophysical integrity are not considered explicitly. Ecological 'health', on the other hand, is a complementary term that encompasses the role and impacts of humans in ecosystem sustainability (Rapport 2010). Rapport and Singh (2006, 417) define ecological health such that "in human-dominated ecosystems, there can be considerable changes in the capacity of ecosystems to maintain their organization, resilience, and vitality (productivity) measured in terms of ecological, socio-economic, cultural, and human health aspects." The reality in almost all ecosystems is that there are human interactions of various kinds and scope. In recognition of this reality, in 2005 Riding Mountain National Park, in collaboration with stakeholders and partners, created a vision statement for ecological integrity that acknowledged the complementary relationship of human activities and ecological integrity in the Clear Lake watershed:

Keeping the "Clear in Clear Lake" is the fundamental management goal for ecological integrity.

The clear, blue water must be maintained. Clear Lake must be safe for public swimming and boating. Native fish must be sustained for their respective ecological functions and recreational angling opportunities. Boating and shoreline use must continue to benefit from the natural forest cover, shoreline, and scenic qualities.

Ecological Integrity Statement¹ (Parks Canada 2005, 1)

Effective management of the watershed requires facilitating human use and enjoyment of the watershed resources, especially the lake, while respecting the requirements of ecological integrity. In this regard, the 2005 vision statement by Parks Canada for Clear Lake is impressive, given its explicit recognition that ecological integrity must incorporate both biophysical and social dimensions.

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¹ A new vision statement is being developed by the newly formed 'Lake Group', a voluntary stakeholder and partner advisory committee, which will reflect current perspectives and knowledge regarding the watershed.

1.5 Study Purpose and Scope

The purpose of this research is to examine the ways in which public participation shapes the use of the Canadian Water Sustainability Index (CWSI) and increases its relevance to the communities for which it is used. Through a case study of the Clear Lake watershed, stakeholder and partner perceptions, knowledge, concerns, and priorities were obtained through a questionnaire and interviews from August to November 2009. This information will guide modification of the CWSI to achieve monitoring, reporting, and communication within the watershed community. The socially relevant indicators that emerge are intended to complement the scientific indicators concurrently being developed for the Clear Lake watershed.

This research has four main goals with the following associated objectives:

Goal 1: To gather baseline information from stakeholders and partners in the watershed community regarding their interests, concerns, priorities, and knowledge.

Objective: Understand the human aspects of the Clear Lake watershed: concerns, priorities, activities, knowledge, and values of stakeholders and partners.

- a. Review literature to understand past and current local context.
- b. Conduct a community survey focused on water supply and demand, watershed activities, ecological integrity, and information sharing.
- c. Conduct interviews with community members to augment the information gathered in the questionnaire survey.

Goal 2: To recommend measurable indicators which reflect baseline stakeholder information with regard to ecological integrity – both human and biophysical dimensions – of the Clear Lake watershed.

Objective: Integrate information collected by social and ecological research, as well as from literature on public participation.

a. Identify key elements, issues, concerns, interests, and goals.

Goal 3: To examine how stakeholder and partner involvement may enhance or disrupt the development and use of indicators for monitoring, reporting, and communication.

Objective: To observe current stakeholder and partner involvement and to recommend future directions for further involvement based on study results.

Goal 4: Identify and recommend ways in which the CWSI may be used to enhance monitoring, reporting, and communication within this watershed.

Objective: To provide criteria for the selection of desirable and feasible indicators that meet local needs.

1.6 Thesis Overview

The rest of the thesis is organized in the following way. Chapter 2 provides a review of published literature on the use and development of ecological indicators, and in involvement of the public in this process. Chapter 3 describes the social and ecological elements of the case study area, and establishes the context to appreciate the research methodology outlined in Chapter 4. The methods were designed to gather information from the watershed community that might be useful in the selection of indicators. Chapter 5 presents results in two parts – first, I address the results of the community questionnaire and, second, I describe how this information can be incorporated into the indicator selection process. Finally, in Chapter 6, I highlight the key findings and recommendations and discuss the implications related to literature on the role of public participation in developing and selecting indicators.

Chapter 2 Literature Review

Indicator-driven monitoring and assessment have gained worldwide attention from resource managers as a method to provide measurable and standardized baseline information upon which decisions and policies can be based, monitored and assessed (Sullivan et al. 2003; UN-WWDR2 2006). "One of the critical success factors for effective water resource [...] management is the appropriate assessment of the diverse, interacting components of catchment processes, and the resource management actions that impact the water resources in a catchment" (Walmsley 2002, 198). Assessment initially was focused on obvious environmental stressors, but research shows that many environmental threats and problems are the result of subtle or multiple sources of stress occurring in a complex socio-ecological environment (Jackson et al. 2000). The literature presented here suggests that public participation can play a significant role in identifying and developing indicators, helping to detect and understand social aspects of resource management, and ensuring that the final product is suited to the target audience(s).

This chapter explains how indicators are being used in water resources management and how participatory-style research can enhance the process to select indicators. As well, the limitations to indicator development are discussed, with a particular focus on the limits of public participation.

2.1 Indicators

The use of indicators is a concept now being widely explored in resource management and how 'indicator' is defined varies widely, according to the situation (Heink and Kowarik 2010). Feitelson and Chenoweth (2002, 264) provide a general definition of indicators relevant to resource management: "Indicators are instruments that are used for communicating key information about key systems in a simplified form to policy makers and the general public". Indicators are designed to signal or represent ecological, economic or social conditions or status by identifying and measuring changes in variables as they relate to a given system or process.

They are chosen in a deliberate way to simplify messages about complex systems. Indicators can also be used to communicate information regarding progress towards goals and targets (Hammond et al, 1995).

2.1.1 Characteristics of indicators

Adriaanse (1993) identified three basic functions of indicators: *simplification*, *quantification*, and *communication*. Expanding on those concepts, several well known scientific and data management organizations, such as Statistics Canada, Eurostat, and UN-Water, have outlined basic quality assessment criteria for statistics employed as indicators (Figure 2.1 shows the progression from primary data to indices). Table 2.1 summarizes the agreement among these agencies regarding characteristics of good indicators. Several key characteristics emerge for which there is consensus by four or more of these agencies:

- Accessibility of data for users,
- Ease of interpretation,
- Relevance to users' needs,

- Accuracy, and
- Coherence within/across datasets; over time; and across boundaries.

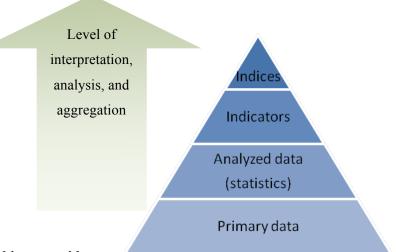


Figure 2.1 Information relationship pyramid.

Adapted from FAO, 1998. 'Issues, Perspectives, Policy And Planning Processes For Integrated Coastal Area Management'. http://www.fao.org/docrep/W8440e/W8440e03.htm

Table 2.1 Summary of data quality assessment criteria for statistics and indicators by					
select organizations.					
Statistic or Indicator Characteristic	UN-Water (2006)	Eurostat (2003)	OECD (2003a)	IMF (Carson 2001)	Statistics Canada (2002)
Measurability	✓				(= * * =)
Responsiveness	✓				
Methodological soundness				✓	
Analytical soundness	✓				
Cost effectiveness	✓		✓		
Accessibility of data for users	✓	✓	✓	✓	✓
Ease of interpretation (clarity for users)	√	✓	✓		✓
Policy relevance	✓				
Relevance to users' needs		✓	✓	✓	✓
Accuracy		✓	✓	✓	✓
Timeliness		✓	✓		✓
Comparability in space and/or time		✓		✓	
Coherence - within/across datasets		√	√	√	✓
- over time					
- across boundaries					
Reliability				✓	
Credibility or integrity			✓	✓	

These characteristics can be used to guide the development and selection of indicators. While it would be difficult to meet completely all of the suggested criteria, consideration should be given to which among these best apply in a specific situation. The key characteristics that are most agreed upon should be strongly considered in developing indicator-style reporting; however, incorporation of all of these is also challenging (Issues and challenges regarding indicator

of statistical data

selection are discussed in section 2.6). Other entries, such as 'cost effectiveness', 'measurability' and 'responsiveness', identified by OECD (2003a) and UN-Water (2006), are also noteworthy because these inform essential components of functional statistics and indicators to be considered in indicator development.

2.2 Indicators in the Socio-Environmental Context

2.2.1 Complex human and environmental interactions

There is now a common understanding that 'sustainability' of a system depends on multiple dimensions – most often identified as environmental, social, and economic (WCED 1987, Berkes and Folke 2000, Holling 2001). While this characterization may be considered too general – and other categories are sometimes substituted; for example, *institutional, political* or *cultural* systems – such framing facilitates the recognition of the characteristics of these systems and the ways in which they interact. This understanding is also relevant as it relates to water resources, as recognized in the Dublin Statement (International Conference on Water and the Environment 1992) and in the Bonn Recommendations (International Conference on Freshwater 2001), outcomes of major international conferences on freshwater. Figure 2.2 provides a general representation of these interacting systems.

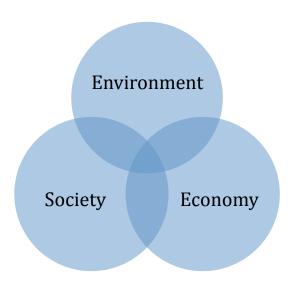


Figure 2.2 The interaction of environmental, social, and economic systems.

Figure 2.2 also reminds us that ecological units are linked to human systems in many ways, creating what is described as *socio-ecological systems* (www.nesh.ca; Holling 1978; 1998; 2001; Waltner-Toews 2004). In general, ecosystems feature hierarchical nesting of subsystems whose components and parts are joined by linkages to other systems that may be internally or externally situated. They are also subject to time and space variables, and may feature cyclic interactions. These characteristics imply that, through interactions, human activities can have impacts (positive or negative) on ecosystems. This reality also means that when we manage our interactions with the environment in a way that enhances its resilience and integrity, we also generate benefits for ourselves (and our systems) from the environment (Kay 1994).

Lessons from complex systems understanding can contribute to the development of indicators as resource management tools. First is the notion that *an ecosystem has integrity* – the sum of its organization and ability to self-organize and re-organize in the face of stress (Parrish et al. 2003). Kay (1994, n.p.) describes this characteristic well: "A damaged ecosystem, left to its own devices, has the capability to regenerate, if it has access to the information required for renewal, that is biodiversity, and if the context for the information to be used, that is the biophysical environment, has not been so altered as to make the information meaningless".

According to this perspective, there are three aspects of ecosystem integrity:

- 1. Ecosystem health or well-being in normal environmental conditions;
- 2. A changing environment resilient to stress:
- 3. Ability to 'self-organize' or change from within.

Thus, indicator systems and indices, in order to support resource management strategies, should reflect at least the above three aspects of ecosystem integrity.

Second, indicator development can draw from the knowledge that ecosystems and human systems are invariably linked and are affected by many variables, including processes and cycles through time and space. In their discussion of developing community sustainability indicators, Valentin and Spangenberg (2000) emphasize the importance of looking at the linkages connecting system parts, noting that these are the system's 'operational qualities' and consideration of targets and indicators for these is also required.

Third, despite increasing knowledge, these systems, subsystems, linkages, processes, feedbacks, time lags and cycles are enormously complex and present degrees of uncertainty, especially in the sense of scientific understanding. Complexity and uncertainty are discussed in more detail in section 2.6.

2.2.2 Applying complex socio-ecological system understanding to indicator development

The application of indicators and indices for environmental management typically has been primarily of a technical or biophysical nature, focused mainly within an 'ecosystem' boundary, such as the Shannon-Wiener Index of Biodiversity (Peet 1975) or the Water Quality Index (CCME 2002). Jackson et al. (2000, 8) describe an ecological indicator simply as "a measure, an index of measures, or a model that characterizes an ecosystem or one of its critical components". This interpretation may be useful for furthering biophysical understanding; however, it falls short of demonstrating that most ecosystems do not exist separately from human systems, activities, and impacts, as described above and also that many 'critical components' of ecosystem integrity are associated with social dimensions. Thus, when necessary, the definition of an ecological indicator should reflect that phenomenon, as should indicator systems and indices. Ervin (2003) suggests the inclusion of threats and stressors in ecological evaluation, which should include anthropogenic stressors.

2.3 Indicator Use in Water Resources Management

Indicators offer a tool to measure, assess, and communicate the sustainability of water resources. In watershed management, indicators ideally allow elements of a complex system to be simplified in a way that still reflects selected human and biophysical components of the integrity of the resources in question. In general, indicators provide utility when designed to reflect the following attributes:

- providing accurate and timely information
- reducing costs and efforts of data management
- providing early-warning of impacts
- informing decisions on financial support
- monitoring progress towards objectives
- assisting in prioritization of goals and objectives
- simplifying communication among partners/stakeholders

- increasing education, understanding and sharing of information
- increasing support for management projects and activities
- enhancing collaboration and integration

Sources: Noss 1995; Mlote et al 2002; Walmsley 2002; Bowen and Riley 2003; FAO, 2006

Furthermore, indicator systems based on a watershed unit may reach beyond administrative or political boundaries to engage relevant stakeholders and provide a tool to enhance cooperation and integration (Bowen and Riley 2003). Through these features, some barriers to integration may be overcome.

Indicator systems and indices for water resources that link human activities to freshwater sustainability are in broad use globally, nationally, and within Canada, at the regional and watershed scales. For example, the United Nations World Water Development Report identifies water-related indicators for each of the Millennium Development Goals (UN-WWDR2 2006, 30). As well, the European Environment Agency Water Framework Directive has applied a broad indicator-based assessment of Europe's water systems (EEA 2009).

Indicators and indices require further refinement for application in regional or local ecosystem-based units. In Canada, research by Dunn and Bakker (2010) itemized efforts to use indicators of water resources sustainability at various scales, including that of the watershed. Veale (2010) further compared watershed reports cards and the use of indicators at the watershed level and found that, while their use is widespread in Canada, high variability in their design among watersheds limits comparisons.

Indicator-based watershed assessment is in the early stages of development for multi-use areas of Canada's national parks. Prince Albert National Park serves as an initial example for which the Water Quality Index was used as an assessment tool (Fitzsimmons and Evans, n.d.). Other parks, including Kluane, Waterton, Pacific Rim, and Gwaii Haanas, have included water quality and/or aquatic contamination as part of wider ecological integrity assessment (Timko and Innes 2009).

The Policy Research Initiative of the federal government initiated a pilot study on developing a *Canadian Water Sustainability Index (CWSI)* as a community-scale assessment tool (Canada 2005). The concept for the CWSI was based on the globally employed Water Poverty Index prepared by the Centre for Ecology and Hydrology (Sullivan et al. 2003). The CWSI is a

tool for indicator-based assessment and reporting that includes both ecological and social aspects of water in Canadian communities.

2.3.1 Indicators and Integrated Water Resources Management (IWRM)

2.3.1.1 Integrated water resources management (IWRM)

In many ways, this research is built upon the principles of integrated water resources management (IWRM). A definition of IWRM by the Global Water Partnership (GWP 2000, 22) highlights the socio-environmental importance of water resources: "IWRM is a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". The work of the GWP, as well as Mitchell (1990; 2005), Fitzgibbon et al. (2006), and Mitchell and Shrubsole (2007), further describes IWRM. They all emphasize the necessity of meaningful involvement by governmental and nongovernmental stakeholders and agencies, particularly towards understanding the multiple uses of resources and the incorporation of that knowledge into decision making. Section 2.4 of this chapter is focused on stakeholder participation in indicator development. Biswas (2004, 2008) points out, however, that meaningful implementation of IWRM principles requires consideration and actions beyond what is given by the definition of IWRM crafted by the GWP, such as scalar considerations and what should be integrated (Biswas lists 41 possibilities (2008, 10)). Garcia (2008) concurs that IWRM is a small conceptual step, but "a giant step for practitioners" (p.28) and identifies practical difficulties such as an emphasis on diagnosing problems over providing solutions; solutions that do not suit economic or political situations; and, the perception of bias in the sharing of resources.

IWRM strategies are developed to integrate what Holling (1998, n.p.) calls "the science of parts", meaning that while specific understanding of these 'parts' is essential to successful resource and environmental management, so also is understanding and implementing integration strategies regarding related resources and multi-stakeholder interests. Dovers and Price (2007) subsequently have offered principles for integrated management that may contribute to the successful development of socially-relevant indicators of ecological integrity. These include:

- Problem focus.
- Openness to other disciplines.
- A systems orientation, appreciating the whole, both qualitative and quantitative components, considering feedbacks, path dependency, thresholds, and time lags.
- Appreciation of multiple and dynamic spatial and temporal scales, and historical determinants.
- Appreciation of personal/group qualities, as well as previous interactions.
- Recognition of multiple purposes of integration.
- Close connection between problem definition and the contributions of different disciplines and knowledge systems (mix of skills and understanding to specific problems).
- Recognition of intra-disciplinary variation; that is, differences that occur within disciplines
- Communication as central to integration.

As discussed above, biophysical understanding alone is inadequate to protect or conserve natural systems or resources. IWRM can increase understanding of linkages within and between environmental (natural) and social systems, as well as inform policy processes, organizational structures and institutional settings. Integrated resource management is not limited to improving environmental quality, and should include social (cultural, economic, institutional) measures (Bowen and Riley 2003).

2.3.1.2 Is an integrated approach appropriate?

It is worthwhile to consider the extent to which integration is appropriate. Dovers and Price (2007) caution that knowing when or when not to integrate is necessary because situations exist in which an individual or single agency response is sufficient. Depending on the resource management problem or issue, however, integration may need to take place:

- in time addressing biophysical temporal scales; policy making; administrative time scales; etc.;
- in space reflecting natural processes; political or administrative boundaries; etc.;
- within and across disciplines, professional domains, and policy/management divisions;
- vertically in social systems;
- horizontally within and across sectors;
- regarding understanding of natural systems, economic, institutional, and social contexts;
- among different societal groups and their knowledge systems; and
- in communication of information and understanding.

These attributes of integration apply to indicator development in two ways. First, they serve as a reminder that indicators must reflect IWRM by measuring diverse components of systems that interact through time and space. Second, IWRM practices are helpful in determining in what ways public participation is useful and possible in indicator identification and design.

Mitchell (2005) usefully differentiates between a *comprehensive* approach, considering a system in its entirety, and an *integrated* approach that is more selective and focused. He advises a phased approach; because comprehensiveness is inclusive of all identifiable variables in a system, its broad scope may be useful at *strategic levels* that precede integration. On the other hand, integration becomes more useful at *operational levels* due to the selection of key variables that cause the most systemic variability and are amenable to management interventions. This approach may allow greater focus of limited time and financial resources at the stage of implementation, while a broad comprehensive understanding allows identification of overall system components, linkages and trends useful for planning.

2.3.1.3 Indicator-driven communication as support for IWRM

Resource management and protection can benefit from collaboration among disciplines and knowledge systems (Berkes 2009). Communication is a key strategy for successful integration, while lack of integrated information or access to information can constrain IWRM efforts (Hooper and Lant 2007). Where possible, channels for communication among stakeholders should be established or enhanced (Dovers 2005). Indicator development and use, as a means of sharing of information and knowledge, can facilitate learning, understanding, and support for decisions and actions (Bowen and Riley 2003).

Communication can benefit integration through knowledge transfer, enhanced ownership, and uptake of information, especially that which was otherwise unconnected (Dovers and Price 2007). Dale and Newman (2007) observe that interested parties are increasingly dissatisfied with accepting decisions of their representatives at face value and are calling for criteria and explanations of those decisions. Efforts to communicate and share information are significant factors in collaboration and project support, as well as for achieving positive results (Deconchat et al. 2007).

2.3.2 Ecosystem-based management and indicators in Canada's National Parks

Grumbine (1994; 1997) defines ecosystem management (EM), as follows: 'Ecosystem management integrates scientific knowledge of ecological relationships within a complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long term' (1994, 31). More recently, Slocombe (2010, 409-410) has observed that "Ecosystem approaches address common problems that have been identified time and again in resource and environmental management over the past several decades." He notes that these problem include: (1) viewing people and their activities as separate from nature, (2) fragmented knowledge or disciplines, ecosystems, jurisdictions, and management responsibilities; (3) emphasizing single resource uses or economic sectors and avoiding or ignoring conflict over possible alternate uses; (4) failing to recognize the many ways in which ecological and socioeconomic systems are interconnected; (5) ignoring the propensity of biophysical and socioeconomic systems to change; sometimes rapidly and unexpectedly; and, (6) reacting to rather than anticipating change and problems, leading to attempts to eliminate uncertainty by controlling complex, dynamic systems instead of adapting to them.

Parks Canada, while primarily aiming to achieve and/or maintain ecological integrity of the areas within its jurisdiction, seeks also to provide multiple use of protected natural areas, such as for educational experiences and visitor enjoyment (Dearden and Rollins 2008; Dearden, 2010). Furthermore, Parks Canada depends upon partnerships and non-Park stakeholders in order to protect aquatic systems, especially across park boundaries (Parks Canada Charter 2002). Traditionally, biophysical monitoring strategies have been employed to assess the state of an aquatic ecosystem; however, given that many national parks and protected areas strive to satisfy multiple goals, interests, and stakeholders, it is necessary that this latter aspect be reflected and clearly communicated in assessment efforts.

Defining 'greater park ecosystem boundaries' (Grumbine 1990) is imperative to understand how stresses from beyond park boundaries will influence ecosystems and ecological integrity within the park, as well as inform about the multiple spatial scales at which human and environmental processes occur (Zorn et al. 2001). The greater park ecosystem should form the basis for which an *area of cooperation* can be defined, encompassing relevant stakeholders and

agencies whose jurisdictions interact with and within the ecosystem, and who must collaborate to succeed (Zorn et al. 1997).

According to Zorn et al. (2001), ecological indicators are required in a national park setting to increase understanding of the biophysical science needed for successful resource management, as well as to improve decision-making processes through enhancement of communication and coordination within the greater park ecosystem. In an inventory analysis of Parks Canada's data holdings, they found that inventories were "strong in terms of the types of information collected, but were confined to park boundaries and did not reflect ecological boundaries" and should be spatially extended to identify gaps in understanding (Zorn et al. 2001, 355). They recommended that Parks Canada share data holdings among partner agencies through an information network that can be supported by indicators. Indicator-style reporting can also contribute to a communications strategy aimed at improving public awareness and stakeholder support (Sportza 1995). In 2008, analysis showed that the ability of four Canadian national parks to maintain ecological integrity and achieve conservation goals was still hindered by lack of data with which ecological integrity could be assessed according to park management plans (Timko and Innes 2008).

2.4 Participatory Development of Socially-Relevant Ecological Indicators

2.4.1 Why Participatory Methods?

Participation of stakeholders and partners has received increasing attention in resource and environmental management as an important component of developing *community ownership* to secure effective management strategies and resource sustainability. In the past few decades, academic literature has become much more rich with contributions describing and assessing participatory approaches to various environmental issues (Varley and Schullery 1996; Mitchell 2002; Waltner-Toews 2004; Ramirez and Fernandez 2005; Fraser et al. 2006; Power et al. 2008).

The need for a more diverse and flexible management structure has emerged from the recognition that problem-based, highly compartmentalized governance design is normally inadequate to address complex, interdependent issues, such as those related to watershed management (Dale and Newman 2007; Mostert et al. 2007). As a result, movement towards

inclusive public participation based on rights, interests, and competencies (Stanghellini 2010) has been initiated related to integrated decision-making processes, with the understanding that many dimensions need to be considered when accommodating multiple interests (Ramirez and Fernandez 2005; Dale and Newman 2007). Depending on the design of the participatory method, it may enhance education, increase participation and action, or harness knowledge and information. Waltner-Toews (2004) suggests that an ecosystem approach strives for some of each. In contrast, Zorn et al. (2001) have noted that, for Canada's national parks, lack of stakeholder involvement can create problems, namely miscommunication, mistrust, and lack of support, or opposition. "Bringing different perspectives to bear on a problem and recognizing the differences in perspectives are critical" (Dovers and Price 2007, 49).

Participation by stakeholders can assist the resolution of water management issues by assisting problem definition; providing interdisciplinary perspectives and information for decision making; generating potential solutions; rallying support; facilitating implementation; and generating a sense of ownership among concerned parties (Mitchell 2002; Watson 2004; Fitzgibbon et al. 2006; Mostert et al. 2007; Petts 2007; Genskow et al. 2008; Newig et al. 2008). Stakeholders can also help refine the 'area of cooperation', defined by Zorn et al. (2001, 357) as "the jurisdictions of adjacent agencies and stakeholders who must work collectively to achieve environmental management success". Depending on the nature of the issue at hand, an integrative approach may call on natural scientists, social scientists, policy makers, representatives from various levels of governments (local, regional, provincial, national, First Nations), landholders, community members, user groups, members of agencies and interest groups, and representatives from funding bodies (Dovers 2005). Lesser and Prusak (2000) note that 'communities of interest' are often as important as 'communities of place', and that Canadians often subscribe to multiple communities via their interests and activities (see also Ramirez and Fernandez 2005). Members of these 'chosen' communities want to participate in decision-making structures that are issue-based, capable, and dynamic.

2.4.2 Participatory Research in Development of Ecological Indicators.

Along with analysis of biophysical data and information provided by experts, participation by partners and stakeholders is important to develop meaningful, socially-relevant ecological indicators. Partners and stakeholders can contribute by describing the knowledge, values, needs,

beliefs, interests, goals, thoughts, questions, and understanding of both biophysical and human elements of ecological integrity that guide behaviour and choices. As well, indicator development can benefit from information on skills, capacity, attitudes, and constraints of groups and individuals affected or involved with an environmental management program or project.

Understanding key issues should help to guide the selection of indicators that support communication and adaptive management with regard to local needs. Jackson et al. (2000) note that the paradigm through which indicators are selected, such as expert opinion, national and international agreements, and local knowledge and information, will influence which indicators are chosen and how they are implemented. They recommend that selection occur through using several paradigms in order that indicators are best suited to the needs of the intended audience.

2.4.3 Challenges to Participation

It is worthwhile to consider the obstacles to meaningful stakeholder involvement. For instance, various worldviews, positions, and levels of anxiety will shape the participant experience and perspectives (Ramirez and Fernandez 2005). Key obstacles include at least the following:

- Gaps in understanding. Just as there are gaps in scientific understanding that may be filled through knowledge shared by local stakeholders, there are limits to what information stakeholder participation can provide. Strategies to integrate local, traditional, and scientific information, using a systems approach, can inform a more comprehensive perspective that benefits from inclusion of all available types of knowledge.
- Conflict. Multi-stakeholder participation will almost certainly reveal disagreements over the nature of resource use and protection, and will require trade-offs among interests (Grimble 1996). However, it is often these conflicts between stakeholders that can lead to negotiation and innovation in natural resource planning and management (Daniels and Walker 1997). It is also important to remember that, even when consensus is reached, it may be a temporary state (Ramirez and Fernandez 2005). They also emphasize that conflict and collaboration are parts of the same process and stakeholders may shift between these states throughout the process, if there is to be adaptive capacity and the potential for experiential learning, and recommend focusing on *facilitating collaboration* rather than *conflict management*.
- **Power imbalances.** Ramirez and Fernandez (2005, 10) note that, "it is those empowered with knowledge and capacity that participate as 'social actors'". They also note that the identification and involvement of stakeholders is usually a function of *power, urgency* and *legitimacy*. Differential knowledge is associated with

perceived power imbalances between scientific disciplines, or between biophysical and social sciences in general, and between science and society. Power is also associated with influence, authority, and perceived validity, which may resonate in participant involvement, relative impacts of findings, resource allocation and policy decisions (MacMynowski 2007). Powerful interests can manipulate understanding and decisions (Holling 1998). Additionally, for some stakeholders in the policy arena, another issue may hold precedence over integration in watershed management and may affect their perception of the issue. For example, recognition of the watershed management unit may pale in comparison to another scale that appears more appropriate (Ferreyra et al. 2008).

- Validation. "Participation does not equal participatory research unless the contributed knowledge brought to the process by those participating (e.g. landholders, Indigenous owners) is treated as a valid knowledge system" (Dovers and Price 2007, 46). The absence of key participants or powerful stakeholders can hinder the perceived legitimacy of a participatory process (Ramirez and Fernandez 2005).
- Lack of Trust among partners will negatively influence their willingness to interact, share information, and ask questions about issues on which they are not specialists. New ideas are more likely to emerge when interactive engagement is favoured over passive communication (listen-tell) (Jakobsen et al. 2004).

One of the purposes in my research is to examine the benefits and limitations of stakeholder participation in indicator development, and to analyze their significance in the Clear Lake case study. Identifying knowledge gaps, conflicts, and lack of trust that exist within the case study knowledge base and community will be a part of this investigation. The results presented here will hopefully fill some knowledge gaps and help stakeholders to become more informed and, through their contributions, feel more validated.

2.5 Developing Indicators for Use in Monitoring, Assessing, and Communicating Ecological Integrity of Watersheds

The development and use of indicators specific to ecological integrity at the watershed scale is growing in Canada, but watershed reporting, including indicator-based, varies significantly in purpose and approach (Veale 2010). In the last 20 years, methods have emerged in academic literature and in practice regarding participatory development of indicators for resource management (Fraser et al. 2006; Reed et al. 2008). These include problem identification,

ecological and social analysis, community definition, a common vision, and framing the issues within interdisciplinary frameworks. Using the socio-ecological understanding developed through this investigation, issues with relevance to the audience will be identified. Indicators can then be selected with reference to the needs of the user groups and the defined issues, as well as according to basic criteria for indicators (Section 5.6).

2.5.1 Issues framework and socio-ecological system description

As already noted, achieving a focused description of issues is a critical phase in forming the foundation for an indicator tool. This task can be accomplished through a socio-ecological description that includes data and information regarding the 'system' being focused on: the social (including economic and cultural) and environmental components, the interactions within and between these, and the changes in these relationships in time and space.

2.5.2 EM and the question of scale: thinking beyond the watershed

The development of freshwater indicator systems requires sensitivity to regional variation if they are to adequately represent and summarize social and biophysical information within complex socio-ecological systems in a way that is informative and not misleading for water resource decision makers. It is particularly crucial that the indicator system be employed across the boundaries of protected areas in the event that the watershed unit is not completely housed within them. Another noteworthy aspect requiring attention is the frequent mismatch of ecological scales in time and space with those of human systems, such as administrative or political (Fraser et al. 2006).

While it is logical to delineate the management unit by the ecosystem in question, as advised by principles of ecosystem management, some authors have noted that social components do not necessarily directly coincide with such natural boundaries (Ferreyra et al. 2008). The ecological scale tells us something about which stakeholders may be involved in this 'community of place'; however, some stakeholders are better identified by their 'communities of interest' and so scalar considerations must reflect boundaries that are socially constructed (Ferreyra et al. 2008). As well, capacity, skills, and resources required for watershed management are often housed within various agencies and authorities (Mostert et al. 2007), meaning that social or political boundaries may have to be overcome in order to have cohesive

management capacity. In integration, scales should be a result of regionally-sensitive adaptive governance that reflects administrative, political, cultural, historical, economic, and ecological characteristics (Sneddon 2002; Cleaver and Franks 2003) as well as appreciation that socially constructed communities of interest are normally not permanent (Ferreyra et al. 2008).

2.5.3 Defining the Community

In order to define an indicator system using participatory methods, the participant community must be defined. This will guide indicator development towards the needs of the user groups, including the type of information they require, and in what form (Kay 1994).

Ramirez (1999) describes a framework for stakeholder analysis that begins with understanding the nature of an issue, its boundaries, and those individuals or groups who have ownership. He goes on to discuss that stakeholders may also be defined by their membership in social activities and networks.

2.5.4 Visioning of desirable future conditions and identifying goals and values

Significant time may be needed to develop a common vision that all or most stakeholders can agree to, but it is a worthwhile exercise to successfully guide indicator development. Emergent goals and values will help form a vision of the desired future state, and well-defined and locally relevant goals will facilitate the identification of relevant indicators (Valentin and Spangenberg 2000).

2.5.5 The DPSIR Framework

Interdisciplinary frameworks are helpful for breaking down complex system information into comprehensible parts and for identifying linkages between these parts to provide an integrative view (Holling 1998, 2001). Additionally, such frameworks may help to cope with "fuzzy" or "soft" questions (Gibson 2003). If an indicator is to provide a representation of environmental conditions, as well as pressure on the environment or society's response, an appropriately interdisciplinary framework should underpin indicator development.

The DPSIR, or Driving Force-Pressures-State-Impact-Response, framework demonstrates a high degree of sensitivity to context and relationships (Figure 2.3). Built upon the Stress-Response (SR) framework (Rapport and Friend 1979) and the subsequent Pressure-State-

Response (PSR) framework (OECD, 1993), the DPSIR extended the PSR framework in order to emphasize the driving forces that create the environmental pressures, as well as the impacts that result from a change in environmental status (Walmsley 2002). Rapport (2010) and Veale (2010) both note the value of the DPSIR framework as a basis for environmental reporting.

Driving forces involve large-scale factors or conditions underlying the system, such as land-use changes or alterations in the agricultural sector. Understanding driving forces is useful for planning responses to environmental events, as well as for long-term planning. However, while this understanding can provide useful contextual insight about the system, driving force indicators may pose a challenge to incorporating 'integration' into an indicator system because they tend not to be 'responsive' or 'elastic' to changes in the system. *Pressures* are those activities, events, or processes that directly affect the environment in question, such as water extraction or waste-water treatment. *State* indicators measure changes in the target environment and are useful for providing current baseline information from which to assess change. But, they have been noted as being 'slow' because anthropogenic or environmental pressures may take time to resonate within the ecosystem (Walmsley 2002). *Impacts* are those changes in the social or ecological system as a result of changes in the state of the environment. Impact indicators demonstrate trends and patterns in a socio-ecological system that may facilitate responses, particularly in actions and behaviours. These may be even slower to emerge and it may be difficult to identify strong correlations with pressures and impacts due to other variables. **Response** refers to institutional reactions to changes in the system and the success of responses may be seen in pressures and states (Bowen and Riley 2003; Tapio and Willamo 2008).

Walmsley (2002) discusses the usefulness of the DPSIR framework in identifying and developing indicators for catchment management. In doing so, he defines DPSIR as follows:

- Driving forces are the natural conditions occurring in the catchment, as well as the development and economic conditions;
- Pressures include those of water supply, water demand, and water pollution;
- State indicators can be divided into those describing quantity and quality;
- Impacts either affect the resource directly or its use value to humans; and
- Responses are measured in social actions, policies, regulations, programs, research and behaviours.

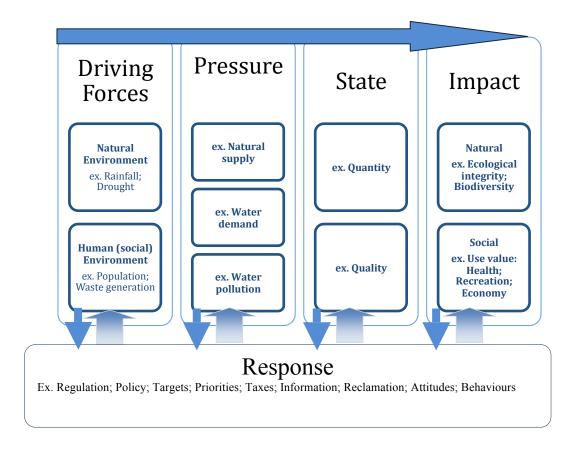


Figure 2.3 DPSIR framework.

Adapted from Walmsley 2002.

While it is helpful and important to employ the guidance of an interdisciplinary framework, such frameworks must contain adaptive capacity to allow for their evolution. For this capacity to be possible, Pickett et al. (1999) recommend that continual review be incorporated regarding what has been gained in data, information, and results regarding the original intent of the program.

In this study, the DPSIR framework was useful as a tool for conceptualizing the social and environmental elements of the Clear Lake watershed, as well as the ways in which they are connected and interact. The framework helped me to determine various social aspects of the watershed that would be suitable for further inquiry in the literature, survey, and interviews. In particular, DPSIR was an important reminder to reflect on 'response' feedbacks. Beyond this, I did not apply the framework in a systematic way. Table 5.3 and Section 5.3.1 address how the CWSI and new indicators can be perceived with reference to DPSIR components.

2.5.6 Indicator identification

2.5.6.1 Identifying component areas, linkages, parameters, targets, protocols and indicators

While the interdisciplinary frameworks outlined above are helpful in describing socio-ecological systems, it is also useful to identify broad categories that represent system components, such as *environment*, *society and culture*, *economic*, *technical*, *financial*, or *institutional*. Like the interdisciplinary frameworks described above, these categories allow issue specification but at an even higher resolution. They are also useful in organization of the final indicator system.

Criteria can be defined within each general component area. For instance, water demand is a criterion pertaining to resource use (the component area). Each criterion can be described by measurable and non-quantifiable parameters or variables. Indicator identification results from reviewing these variables to select those that address the goals and interests of stakeholders, are understandable, are sensitive to change, and are feasible to measure and evaluate. Indicators will reflect change as it pertains to baseline information, concrete aims, targets, and thresholds against which progress can be assessed (Walmsley 2002).

2.5.6.2 Filtering and Selection

For management purposes, a short list of representative indicators is desirable. Selection should be based on both practical and scientific considerations (Waltner-Toews 2004). As discussed above, Table 2.1 provides criteria for indicator development. Using these criteria in combination with values, goals and interests of stakeholders will provide information and insight upon which selection of socially-relevant indicators can be based. In addition, however, given there is much concurrence in academic literature that indicators must meet logistical and financial criteria (Zorn et al. 2001; Valentin and Spangenberg 2003; Bell and Morse 2008), these two aspects must also be considered. In addition, the final selection of indicators should be subject to a professional review to ensure adequate scientific rigor.

Selection can occur through various ways. Review by stakeholders can be carried out using a scoring method to rank on a scale of importance (Mostert et al. 2007) or pair-wise ranking (Mendoza and Prabhu 2000). Pair-wise comparison is a simple method of ranking that is suited to a focus group. Mendoza and Prabhu (2000) recommend that specialists, researchers,

and scientists form a separate group from other stakeholders for this exercise, in order to maximize the emergence of unique preferences. Pair-wise ranking involves the systematic comparison of pieces of information against each other (in pairs). Participants individually declare them as "more significant" and "less significant" relative to one another. The issues will then be ranked from those that were identified as "more significant" most often to least often (by simple summation of the number of times an issue was labeled "more").

The selection of indicators from a long list to a short, useful, feasible list can be done by scoring indicators according to the following themes (Jackson et al. 2000; Gomontean et al. 2008):

- 1. Relatedness to goals (conceptual relevance)
- 2. Understandability (interpretation and utility)
- 3. Precision/replicability (response variability)
- 4. Effort and cost-effectiveness (feasibility of implementation)

The primary reasons for eliminating indicators are expected to relate to (Gomontean et al. 2007):

- High technology needs
- Time-consuming monitoring techniques
- Ambiguousness/unable to understand, and
- Redundancy

Final selection must reflect a systems perspective with regard to social and ecological components of ecological integrity, as well as pressures, status, impact, and responses surrounding its management. In order to assure that the final product reflects ecological integrity and is adequately rigorous, scientific advice through a professional review must be sought.

2.5.7 Implementation, Reporting and Adaptive Capacity

When possible, indicator-style assessment and communicating should be incorporated into existing monitoring and evaluation efforts (Bowen and Riley 2003). Reporting of the results of the indicator development project, as well as of the indicator measurements and evaluation, is imperative. Publishing these outcomes, along with an overview of the goals, will further public understanding and learning, and create the opportunity for adaptation to both the indicator tool and management strategies. It is recommended that a report be made available as a discussion

paper for stakeholder meetings or community forums, especially as the indicator set is being developed, and may assist the selection or re-evaluation of the core indicators (Valentin and Spangenberg 2000). However, sufficient organizational capacity must exist for this to occur. Kay (1994) recommends addressing responsibilities at the outset regarding who will be responsible for creating the report and whether they will have access to necessary resources. Further, a follow-up to the report can inform whether or not it was useful and what changes may be required.

2.5.7.1 Communicating scientific information

It is critical that any reporting or communication occur in a manner that is clear and understandable for any user groups or that sufficient clarification or education is available (Schiller et al. 2001; US-EPA 2009). Schiller et al (2001) recommend developing suitable language for both scientists and non-scientists, which can be achieved through stakeholder participation and education.

2.5.7.2 How indicators assist adaptive approaches to management and governance

Generating or maintaining resilience of socio-ecological systems to sudden or unanticipated change is central in adaptive management (Francis 2005). Holling (1998, n.p.) captures the essence of need for adaptive management:

Knowledge of the system we deal with is always incomplete. Surprise is inevitable. There will rarely be unanimity of agreement among peers - only an increasingly credible line of tested argument. Not only is the science incomplete, the system itself is a moving target, evolving because of the impacts of management and the progressive expansion of the scale of human influences on the planet.

When dealing with complexity and uncertainty of socio-environmental systems, it is now understood that organizational flexibility is a required characteristic of adaptive resource management and governance. Essentially, natural resource management is a learning process requiring the development of capacity, including knowledge, attitudes, skills, and behaviours, to adapt to change and to cope with uncertainty (Holling 1978; Mostert et al. 2007). Adaptive management follows the concept that resource management actions are basically experiments

wherein an action is chosen, implemented, evaluated, and described (Noble 2010). From this experience, lessons are learned and further actions are revised (Hooper and Lant 2007).

Indicator-style approaches to monitoring, assessment and communication can facilitate learning through enhanced sharing of information among stakeholders. This outcome can further lead to increased trust and support, understanding, empowerment, and heightened participation in decision making (Mostert et al. 2007). Considering that learning will increase support, flexibility is an important characteristic of indicator tools to ensure their continued relevance and applicability to the audience (Sullivan et al. 2005). At the same time, such management flexibility must be coupled with responses that are diligent, intense and persistent to ensure that reporting remains consistent (Francis 2005).

2.6 Limitations and Considerations on the Development and Use of Indicators Systems

Simplification of information, audience appropriateness, data availability and gaps, scale, and complexity and uncertainty, can each influence the outcomes of indicator development and their use. This section describes these and suggests the ways that they may be overcome.

- 1. **Indicators as simplifications.** Because indicator systems are a necessary simplification of complex information, the possibility exists that an important factor is underrepresented or not represented at all. Problems can arise from oversimplification, or unwavering adherence to the original monitoring and assessment strategy in the face of changing evidence or environments (Bell and Morse 2008). This challenge must be carefully considered during indicator development and selection, and caution must be exercised to ensure that an indicator set is the best possible representation of the socioecological environment, given situational constraints, and be reviewed regularly.
- 2. **Audience appropriateness.** Indicator systems should be developed with regard to the needs of the audience(s). Highly technical indicator systems and indices, such as the *Shannon-Wiener Index of Biodiversity*, are well-developed to represent the biodiversity of an eco-community in a single number which, in turn, allows for simple comparisons

between sites. Many technical tools like this index, including the *Water Quality Index*, are very good when used to improve scientific understanding. However, they are not well-suited for sharing information beyond biophysical specialists. As discussed below, bridging biophysical understanding with that of human systems, through a participatory process, can create an indicator tool that enhances communication among a wider audience, informs decision making, and furthers the adoption of integrated water resource management principles. This view does not assume that highly technical information is unattainable by those not conversant in biophysical sciences, but the style of presentation of such information is central to facilitating its understanding (Bell and Morse 2008).

- 3. **Data availability.** In the development of water resource indicators, many projects have faced difficulty with data availability (Canada 2007; Veale 2010, 213). Hanna (2007) points out that data gaps limit understanding and hence can delay or prevent the achievement of objectives in resource management. Given gaps in data, as well as the cost and effort of establishing new protocols, priority should be given to the use of existing datasets and monitoring programs to reduce costs and efforts. However, when data are judged to be critically important to create needed indicators, then strategies need to be considered regarding how such data can be collected.
- 4. **Gaps in understanding.** The development of indicators of ecological integrity will reveal gaps in understanding. Zorn et al. (2001) recommend that information gap analysis should occur and those gaps should be ranked according to environmental management goals and objectives. Improved understanding of knowledge gaps will then allow future research to be tailored towards these areas and improving environmental understanding, which indicators can then be chosen to reflect.
- 5. **Scale.** The temptation to work at an ecosystem scale should be tempered with recognition that human activities often occur at scales that may not match that of the ecosystem (Fraser et al. 2006). This reality requires thought about the relevant boundaries of the problem, as well as temporal scales. There are always alternative scales/perspectives from which to look at a problem and each will reveal different insights on an issue. There is an appeal to studying problems at a larger spatial scale, so

- that certain processes may be revealed, but this is not to suggest that these are immune to external factors or smaller-scale processes (Berkes 2006).
- 6. **Uncertainty and complexity.** Ecosystem management must occur in the face of uncertainty and complexity. Uncertainty results from the degrees of unknowability and unpredictability that exist in both ecosystems and human systems. Complexity results from multiple scales of interaction, response, non-linear relationships, time lags, multiple stakeholders, contrasting objectives, trade-offs, importance of context, common properties, and ownership issues (Sayer and Campbell 2004)

2.7 Chapter Summary

This literature review shows that indicators can be used to communicate complex environmental information in a simplified form. This simplification can translate into both monetary and effort savings. Stakeholder participation can help to ensure the relevance of this information to the audiences for which it is intended. In some cases, communication can fail because of a mismatch of the information presented and the audience's interest and knowledge. This problem becomes even more challenging when there are multiple audiences with a broad continuum of knowledge about socio-ecological systems, making it difficult to determine which set of indicators will meet the needs of most or all stakeholders.

Socially-relevant ecological indicators will reflect the qualitative elements of the system in question as derived through participatory research. Both biophysical and human perspectives are relevant components of ecosystem analysis and reveal different representations of that system. Meanwhile, the integration challenge is to be able to reflect the whole system (Kay 1994).

Chapter 3 Case Study Background

3.1 Introduction to the Case Study Area

Clear Lake, an unusually deep and cold lake in Manitoba, is a highlight for visitors to Riding Mountain National Park (RMNP) and key feature of the area for the local community. While Clear Lake is protected within the boundary of RMNP (and its shore forms the boundary to the south and west), its watershed extends into privately and publically owned lands of the Rural Municipality (RM) of Park (South) and Keeseekoowenin Ojibway First Nation (KOFN). Outside the park boundaries, the watershed is also under the jurisdiction of the Province of Manitoba and the provincially overseen Little Saskatchewan Conservation District. Clear Lake is a major attraction for visitors and recreationalists to the area, and it supports a unique ecosystem.

In this chapter, my purpose is to provide basic information about the Clear Lake watershed. An appreciation of the conditions in the watershed makes it easier in the following chapter to explain the rationale for the research design and methods used in this study, as they can be related back to the situation in the basin.

3.2 Ecological Integrity of the Clear Lake Watershed

In the Clear Lake watershed, the focus of ecological integrity (EI) initiatives has been largely on the biophysical state of Clear Lake with most management efforts originating with the RMNP and occurring within park boundaries. This limited perspective does not reflect ecosystem boundaries related to the water system, and also does not adequately address the pressures that influence the state of EI nor allow it to be protected or improved. The state of the lake and its watershed reflects activities and events, both natural and human-driven, occurring within and around it. Efforts must be made to better integrate watershed data, information and knowledge, as well as to generate new data and information on the pressures, state, impacts, and management responses involved in this watershed.

The authors of *Securing the Integrity of Clear Lake and Area* (Parks Canada 2005) expand the perspective of ecological integrity to include watershed-based considerations. They identify the following primary threats to ecological integrity of the lake system:

- In contrast to mesotrophic Clear Lake, its subwatershed South Lake (connected to Clear Lake by a seasonally ephemeral isthmus) is hypereutrophic and hosts extensive seasonal algal blooms;
- Wasagaming's wastewater treatment system is in need of repair/replacement (and is linked to South Lake):
- Shoreline integrity is affected by development, including that within the RM of Park;
- Septic fields along the shoreline of Clear Lake include those within the RM of Park; and
- Potential changes to groundwater.

In light of current research, efforts by park managers since 2005 have focused on cooperation and collaborative management with partners and stakeholders, including those whose activities occur outside of the park. The formation of the Lake Group, a stakeholder and partner advisory body, is one result of these new efforts. The first meeting of the Lake Group was held on February 18, 2009.

3.3 Summary of the Socio-Ecological Environment

This section briefly summarizes the key components, linkages, and trends regarding ecological integrity of Clear Lake watershed in terms of the complex socio-ecological environment. For more detailed information, *Securing the Integrity of Clear Lake and Area* (Parks Canada 2005) provides a thorough overview of the components of ecological integrity as part of an investigation into an appropriate management strategy for RMNP.

3.3.1 Physical Location and Setting of Clear Lake Watershed

3.3.1.1 Nested Hierarchy of Watersheds

Clear Lake watershed is part of the Hudson Bay drainage system, and is a subwatershed in the Little Saskatchewan River basin, MB, which originates in Riding Mountain National Park ('RMNP' or 'the Park') and joins the Assiniboine River to the south near Brandon, MB. Clear

Lake watershed is centrally located along the southern border of RMNP (Figure 3.1) and drains to the southwest into the Little Saskatchewan River system.

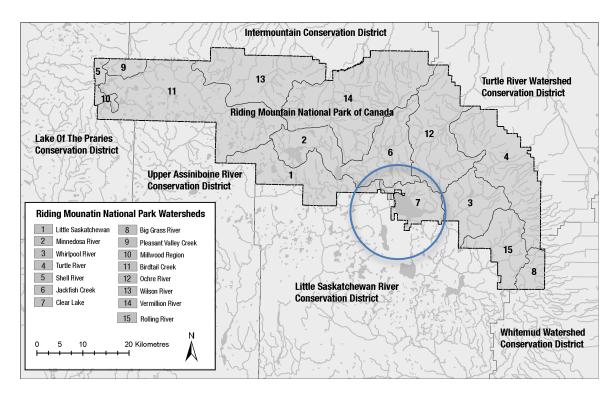


Figure 3.1 The Clear Lake watershed (7) as one of 13 defined within Riding Mountain National Park of Canada (RMNP).

Source: Parks Canada, 2007.

Thirteen watersheds are located within RMNP. Clear Lake is one of the smallest by area, but has the largest lake. Clear Lake watershed is approximately 142 km², and two-thirds (~100km²) lies within the Park. Clear Lake watershed is further divided into 10 sub-watersheds, some of which extend beyond the park boundary (Figure 3.2). The area of Clear Lake is 20.7% of the total watershed area. The lake has a mean depth of 11.5m and a maximum depth of 34.2m (McGinn et al. 1998; Parks Canada 2005).

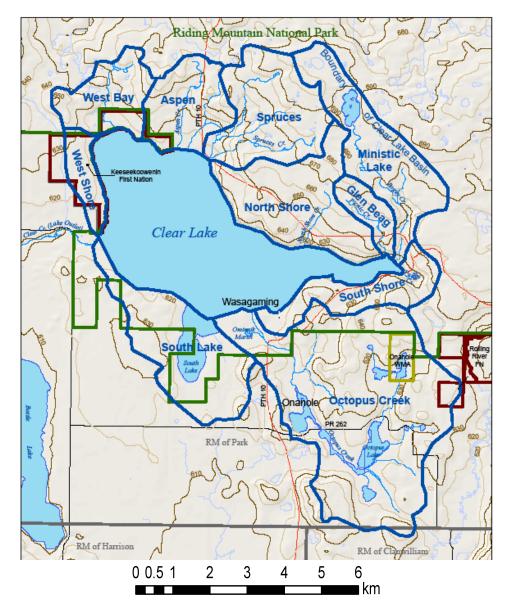


Figure 3.2 The Clear Lake watershed and 10 sub-watersheds.

The green line indicates the southern boundary of Riding Mountain National Park. On the west shore, the shore forms the Park boundary, then the boundary leaves the shore at the Aspen subwatershed and continues east. Source: Parks Canada, Riding Mountain National Park from the Manitoba Land Initiative, May 2005.

3.3.1.2 Riding Mountain National Park of Canada (RMNP), Riding Mountain Biosphere Reserve, and Little Saskatchewan River Conservation District

RMNP is 2,969 km² of protected mixed-wood forest and grassland ecosystems amidst vast plains converted for agricultural use (Parks Canada 2007). Moderate elevation (maximum 732 m.a.s.l.) supports unique ecosystems and hydrology that features many lakes and rivers (McGinn 1991; Parks Canada 2007).

The Park is 274 km northwest of Winnipeg, 97 km north of Brandon, and 15 km south of Dauphin (Parks Canada 2007). In terms of regional management, RMNP is nested within the Riding Mountain Biosphere Reserve that extends beyond the Park boundaries. The Biosphere Reserve works with 15 municipalities surrounding RMNP to promote sustainable development, conservation of biodiversity, and capacity building, seeking to "balance the conservation of natural and cultural heritage with sustainable resource development" (RMBR 2010, np). RMNP is working with the Riding Mountain Biosphere Reserve to explore the establishment of a science advisory board for the Biosphere Reserve including the Park, which would advise Park managers, and partners, on ongoing and future research and monitoring initiatives in the region. The results of scientific research and monitoring programs are shared through ongoing stakeholder consultation processes, as well as through the Park's interpretive outreach and education programs. In terms of the Clear Lake watershed, there is an opportunity for RMNP and the RMBR to work together on watershed-specific activities.

3.4 The Biophysical Environment

This section highlights key features of the biophysical environment of Clear Lake watershed. Clear Lake is classified as mesotrophic due to low plant nutrients. Mean total phosphorus concentration is very high, but not biologically available for plant growth; the reason(s) for this situation are still being investigated by researchers. Surface water flow in Clear Lake watershed mainly stems from eight of the 10 sub-watersheds. Ongoing studies aim to determine the extent to which groundwater flow contributes to the water budget of Clear Lake.

3.4.1 Hydrological characteristics of Clear Lake watershed

3.4.1.1 Surface water in Clear Lake watershed.

Clear Lake is the largest storage component within the watershed and holds approximately 338, 075, 015 m³ of water (McGinn et al. 1998). Hummocky, ridge, and swale terrain influences surface water drainage and has created a network of small lakes, creeks, streams, bogs, and marshes that drain into Clear Lake (Parks Canada 2005). Aside from Clear Lake, considerable storage components in the Clear Lake watershed are Octopus Lake, South Lake, Ominik Marsh, Pudge Lake, and Ministic Lake (McGinn et al. 1998). The most prominent surface drainage is from Octopus Creek and, intermittently, by flow from South Lake. Other notable creeks providing inflow to Clear Lake are Aspen, Bogey, North Shore, Picnic (or Glen Beag), Pudge, and Spruces.

A single, unregulated outlet, Clear Creek (or Wasamin Creek), drains Clear Lake at the western end and flows approximately 12 kilometres to the Little Saskatchewan River. Discharge from this outlet is low, ranging from 0.0 - 2.8 m³/s, and has been impeded by overgrowth and beaver dams. However, it is thought that groundwater discharge may contribute significantly to drainage (McGinn et al. 1998).

Other hydrological characteristics are:

- The **flushing period** is estimated at 10.72 years and equates to approximately 338,075,015 m³ at a mean daily discharge of 0.1 m³/s (range of 0.0-2.8 m³/s; spring melt average approximates 1.0m³/s) (McGinn et al. 1998).
- Lake levels Clear Lake exhibits relatively long-term wet and dry cycles (McGinn et al. 1998) and the average annual lake level in 2010 was 615.243 m.a.s.l. (Tim Sallows, pers. comm. 2011), which is approximately the middle of the cycle.
 - o Historical mean daily low of 614.788 m.a.s.l. occured on November 13, 1961, during a severe regional drought from 1960-1962.
 - Historical mean daily high of 615.723 m.a.s.l. occured on June 1, 1970 after a period of high precipitation and low evapotranspiration (McGinn and Tolton 1989).
- **Groundwater** The KGS group (1993) reported that groundwater is held in both shale bedrock formations and in glacial till overburden aquifers. With reference to the Clear Lake watershed, the southern half exhibits groundwater flow to the north-northeast that

- discharges into Clear Lake (Parks Canada 2005). Current studies are intended to create further understanding of groundwater flow in the watershed.
- Clear lake is dimictic it is covered in ice in the winter, thermally stratified in the summer
 and has full mixing events in the fall and the spring when the water temperature throughout
 the lake is approximately the same (Bazillion and Braun 1992; McGinn et al. 1998).

3.4.1.1.1 Notable sub-watersheds in the Clear Lake watershed

Octopus Creek Sub-watershed. Octopus Creek is the largest sub-watershed draining into Clear Lake. Most of Octopus Creek sub-watershed lies outside the boundary of RMNP to the southeast and features Octopus Lake as well as small ponds. Outside of RMNP, Octopus Creek lies within the Rural Municipality (RM) of Park, which houses the town of Onanole, and scarcely reaches into the RM of Clanwilliam to the south. The town of Onanole, rural-residential development, and agricultural land contribute to surface run-off into Clear Lake through this portion of the subsystem network.

South Lake Sub-watershed. South Lake sub-watershed is largely covered by South Lake. This lake is separated from Clear Lake by a narrow bar across the bay mouth. South Lake is thought to have been a shallow bay of Clear Lake that became isolated in recent geological time. The nature of this separation is somewhat irregular. Records demonstrate that low water levels between 1930-1945 likely prevented surface water flow. Similar events observed throughout the 1960s led to discussions that establishing a permanent connection would support pike spawning, although attempts in the 1980s were not successful. This watershed is noted as being the biggest threat to Clear Lake water quality due to its hypereutrophic state and the irregular and narrow divide that separates the two lakes (Scott et al. 2003).

3.4.2 Biological characteristics of Clear Lake

While it is noted for its low productivity due in part to plant nutrient deficiencies, Clear Lake is on the cusp between oligotrophic (Bazillion and Braun 1992) and mesotrophic status (Bob Reside, pers. comm. 2009). Clear Lake could be defined as oligotrophic according to plant nutrient deficiencies, Secchi disk measurements and Chlorophyll *a* concentration, but its unusually high phosphorus concentration could lead to a mesotrophic classification.

3.4.2.1 Phosphorus Loading

The mean total phosphorus concentration is as high as would be measured in eutrophic waters (0.020-0.050 mg/L) or hypereutrophic waters (>0.050). The mean total phosphorus concentration in Clear Lake (measured 0.054 mg/L) is well above the norm for an oligotrophic or mesotrophic lake (Hawryliuk 2000). In north temperate zones, oligotrophic lakes are categorized at <0.010 mg/L and mesotrophic lakes typically have 0.010 - 0.020 (Reckhow and Chapra 1983).

3.4.2.2 Secchi Disk Measurements

Secchi disk visibility in Clear Lake, 3.8-4.5m between 1973 and 1988, is concurrent with that of an oligotrophic lake, >3.7m (Parks Canada 2005). More recent data are not available.

3.4.2.3 Chlorophyll a Concentration

Chlorophyll *a* concentration provides a measure of algal abundance that is related to nutrient availability in water. In Clear Lake, average concentrations of chlorophyll *a* were less than 3.0 micrograms/L in open water seasons. Oligotrophic lakes are classified as having less than 7.0 micrograms/L. (Hawryliuk 2000).

3.4.2.4 Biological Communities: Species of Interest

Species of interest in understanding ecological integrity may include algae, macrophytes, and fish. Algal abundance has a positive relationship to nutrient concentration, namely carbon nitrogen and phosphorus, and can be estimated by the concentration of chlorophyll *a* measured in the water column, as discussed above.

Macrophytes are aquatic plants and are gaining popularity for their potential as indicators of aquatic environments. They may be emerged, submerged, or floating and provide important habitat for fish and invertebrates. A survey of macrophytes found that up to 88 species occur in Clear Lake due to habitat diversity (Kooyman and Hutchison 1979; Parks Canada 2005). According to the US-EPA (2009), macrophytes can provide indicator functions because they:

• respond to nutrients, light, toxic contaminants, metals, herbicides, turbidity, water level changes, and salt,

- can be easily sampled by transects or aerial photography, and do not require laboratory analysis,
- can be measured by calculating simple abundance, and
- are "integrators of environmental condition".

Fish species are significant to ecological integrity of Clear Lake. The lake supports 14 species, listed in Appendix 1 (Parks Canada 2005). Of these, the northern pike, whitefish, yellow perch, and slimy sculpin have been noted by Parks Canada as potential 'indicator species' and further investigations by RMNP researchers are occurring to determine the feasibility of implementing these as indicators (Parks Canada 2005).

3.4.3 Terrestrial environment

Clear Lake watershed is located within the Boreal Plains forest ecozone, a transitional ecosystem between prairie grasslands to the south and boreal forests to the north. The forest predominantly features tree species such as white spruce, aspen poplar, and lowland black spruce, with fewer occurrences of green ash, balsam poplar, and tamarack. Understory species include small shrub and tree species, such as mountain maple, chokecherry, pincherry, nannyberry, high-bush cranberry, and red oisier dogwood; as well as wetland species such as willows, cattails, bulrushes, and slough grasses. (Eilers and Lelyk 1990; Parks Canada 2005; NRC 2007)

Soils are an important component for biophysical understanding of this region, as it is the areas of sand and gravel that have high percolation rates that increase the risk of groundwater pollution (Sie and Gauthier 1978). Soils were identified by the Land Resource Unit (1998) as loamy tills (luvisols), sandy lacustrine deposits, and sand and gravel soils.

3.5 The Social Environment

This section describes key economic, demographic, political, governance, and social characteristics and events relevant to the ecological integrity of Clear Lake Watershed. The human population experiences seasonal fluctuations due to the heightened summer visitation to Clear Lake region. The extent of land development and use varies across the park boundary.

Increasing stakeholder and partner involvement in Clear Lake watershed governance has led to a clearer picture of issues related to ecological integrity in this complex socio-ecological system.

Rather than provide a detailed history of the social environment, this section highlights key stakeholder groups and their interests and concerns. Nevertheless, important historical events are highlighted, such as the expropriation of the Keeseekoowenin Band Indian Reserve 61A lands in 1935, discussed in Section 3.5.4.2, which creates ongoing distrust by Aboriginal peoples of government-based planning initiatives, continues to require substantive effort to build trust between park mangers and the Aboriginal people, and creates challenges in having Aboriginals become engaged in initiatives such as this research intended to incorporate local knowledge into resource planning and management.

3.5.1 Watershed Population

The human population in the watershed is subject to significant seasonal flux, especially within the Park, due to recreational and visitor tourism to Clear Lake from May to September. Wasagaming townsite is closed to cottaging and commercial business between October and April. During this winter period, recreation is permitted within the Park and day visitors enjoy cross-country skiing, snowshoeing, and ice fishing.

Year round facilities are available outside the park boundary in the RM of Park. The year round population in the RM of Park (South) was 1,003 in the 2006 census (Statistics Canada 2008). In the summer, however, the population swells with visitors. RMNP hosts approximately 250,000 visitor days annually, the majority of whom visit between May and September (Sharon Vanderschuit, pers. comm. 2010).

3.5.2 Watershed Land-Use

Land-use within the RM of Park is primarily mixed farming, including cropland and forage/grassland for cattle, and agriculture is a key economic component of livelihoods in this region. Forest cover data for the larger LSRCD indicate that trees make up 30% of the land cover, with maximum coverage occurring within RMNP and minimal coverage occurring in the southernmost portion of the Little Saskatchewan River basin. Forested areas within Clear Lake watershed are well protected within RMNP and KOFN lands. Some public and private lands

outside of these boundaries have been converted to other land uses, creating a degree of fragmentation. Tree coverage in the RM of Park is moderate; satellite images for 1999-2002 indicate that tree cover accounts of about 50% of the land cover in this part of the Little Saskatchewan River Basin. (LSRCD 2008)

3.5.3 Defining the Stakeholder Community

3.5.3.1 The Lake Group

In this research, the stakeholder and partner community was largely defined as those individuals and groups invited to participate in the Lake Group. The participants were identified by Parks Canada, RMNP, as having a 'direct interest in the lake and its immediate watershed' (draft of purpose & structure of Lake Group – not published). Table 3.1 outlines these members and their relationship with the watershed.

The Lake Group first met in February 2009 when a daylong workshop was organized by RMNP. It is intended that the Lake Group will define its own vision statement, activities, and operations. To September 2010, the Lake Group had met bi-annually in February 2009, October 2009, and March 2010. These meetings have thus far been used mainly to present results from research being carried out in the watershed. A vision statement is still in the development stage (See Section 4.3.4).

Membership in the Lake Group is diverse and has stakeholders and partners from many aspects of the watershed community. The mix of stakeholders is appropriate and mostly representative of the community. However, young people and KOFN partners are sometimes under-represented in the meetings. The involvement of KOFN is described more thoroughly in Section 6.3.1.1. Greater effort also could be made to involve younger members of the community in Lake Group planning and activities in order to gain long-term support and engagement.

Table 3.1 Description of the partner and stakeholder community engaged in Clear Lake watershed governance.

CLWWG Membership	Relationship, interest, and/or responsibility
Keeseekoowenin Ojibway First Nation (KOFN) as a Parks Canada Agency Partner.	 KOFN is a partner to the ministerial agreement, the Senior Officials Forum, signed with Parks Canada in 1998. KOFN maintains a subsistence fishery on Clear Lake and is a landholder on its northwest shore.
Wasagaming Tenants Association	Water utilities; cottaging and recreation tied to Clear Lake; development.
Resort owners, represented by Mooswa Resort and Elkhorn Resort & Conference Centre	Water utilities; cottaging and recreation tied to Clear Lake; development.
Clear Lake Cabin Owners Association	 Water utilities; cottaging and recreation tied to Clear Lake; development.
Boaters	 Effects of motor-type on water quality; quantity of boats; recreational appeal; sport fishery.
Onanole residents	 Water utilities; recreation; land use and development.
Clear Lake Marina	 Economic reliance on state and aesthetic appeal of Clear Lake.
Shoreline summer camps, Camp Wannakumbac and Camp Wasaga	 Water utilities; economic reliance; aesthetic appeal.
RM of Park	 Water utilities; recreation; land-use activities; development; responsibilities to maintain Octopus Creek and South Lake sub-watersheds of Clear Lake Watershed.
Clear Lake Golf Course	 Water utilities, especially those tied to course maintenance; aesthetic appeal.
Little Saskatchewan River Conservation District (LSRCD)	 Greater land area of the watershed falls within the LSRCD.
Nature Conservancy of Canada	 Non-profit organization working to conserve ecologically significant lands.
Manitoba Water Stewardship	Stewardship of provincial waters.
Friends of RMNP	 Environmental programming and education.

Riding Mountain Biosphere Reserve	Coordination and cooperation to protect and build support for unique ecosystems, such as Clear Lake.
Researchers	 Contributing to further biophysical and social knowledge and understanding regarding Clear Lake and its watershed.
RMNP	 Maintain and preserve ecological integrity; maintain the cultural heritage of Clear Lake, as well as the visitor appeal.

The workshops have met many of the criteria of workshop design recommended by Ramirez and Fernandez (2005), including:

- Engage the relevant stakeholders in a process of learning and negotiation.
- Ensure that a balanced group of stakeholders is brought together.
- Have agreement on the rules for the workshop.
- Share participants' expectations for the workshop.
- Visioning of a desired future state, as a first step towards agreement for a common vision.
- Unravel conflicts by having stakeholders explain their world-views and perspectives through using visual tools.
- Create awareness of the potential for unexpected situations to arise.
- Provide stakeholders with a summary of workshop deliberations.

Discussions at the workshops are open and respectful, while following an agenda fairly closely. Participants have the opportunity to submit agenda items in advance and, in this way, are able to help plan the nature and topics of the meetings. The first meeting in February 2009 involved visioning activities, and the sharing of expectations and experiences by each member. Further meetings have featured presentations and topics brought forth by various participants, including KOFN, researchers, and other community members. Finally, participants are always provided with a written summary of workshop proceedings shortly following the meetings. These types of workshop activities help to support a comfortable and functional atmosphere for the participants.

3.5.3.2 'Lake Group' Initiatives and Vision

A report from the first Lake Group workshop identified *watershed awareness outreach*, *'greening' strategies, citizen science programs, continued monitoring and research* among the top preferred initiatives to be supported by the Lake Group (Lake Group workshop proceedings 2009). A vision statement is forthcoming regarding the goals of the working group. The workshop proceedings suggest that the vision statement will address the following:

- Keeping the 'clear' in Clear Lake;
- Recognizing the watershed as the basis for the lake, and that activities within the watershed may affect the state the of the lake;
- Monitoring the 'health' of the lake;
- Ensuring sustainability of the ecosystem, and "preserving, protecting, and commemorating Clear Lake for present and future generations" (Lake Group workshop proceedings 2009, n.p.)
- Using partnerships and communication to build and support understanding and awareness;
- Recognizing the importance of the people, their memories and history, as well as their wilderness experience opportunities.

3.5.3.3 Political Jurisdictions and Partnerships

Land use and development within Clear Lake Watershed is governed by five political jurisdictions and partnerships: Parks Canada, Keeseekoowenin-Ojibway First Nation, RM of Park, the province of Manitoba, and the Little Saskatchewan River Conservation District (LSRCD) as Clear Lake watershed is a sub-component of the Little Saskatchewan River basin (Figure 3.3).

3.5.4 Historical Context

Clear Lake has a rich history of human engagement with this unique environment. This section briefly describes notable components of human activity in the area.

3.5.4.1 Recent history

Recreational use and cottaging on Clear Lake began in 1917 when Riding Mountain was a Dominion Forest Reserve (Parks Canada 2005). The Park was established in 1933 and, since

then, limited development of the Wasagaming townsite has been permitted. Recreational activities in this area remain popular today and hundreds of thousands of visitors per year are attracted to Clear Lake and Wasagaming townsite.

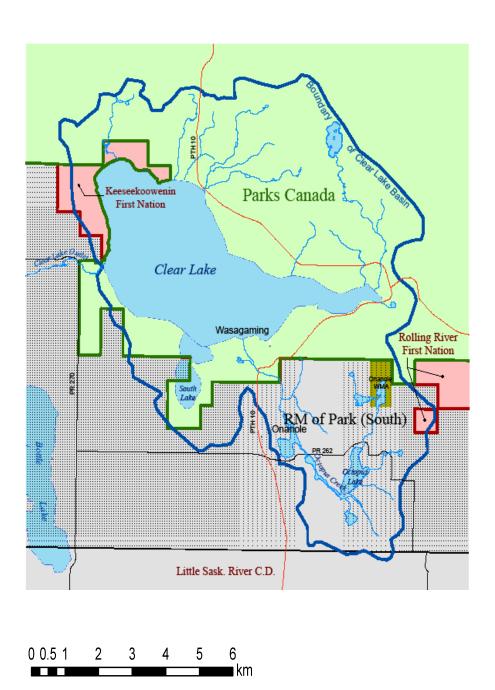


Figure 3.3 Political jurisdictions in the Clear Lake watershed.

Source: Parks Canada 2005 and the Manitoba Land Initiative.

3.5.4.2 Keeseekoowenin Ojibway First Nation (KOFN) and Indian Reserve 61A.

Riding Mountain has supported Aboriginal inhabitants for more than 6000 years. In 1896, the Department of Indian Affairs and the Department of the Interior agreed to set aside 756 acres (3 km²) on the shores of Clear Lake as a fishing station for the Keeseekoowenin Band, now known as Keeseekoowenin Ojibway First Nation. This land was designated as Indian Reserve (IR) 61A.

RMNP was formally established in 1933 and encompassed Clear Lake and its shores. In 1935, the *National Parks Act* allowed the land of IR 61A to be expropriated from the Keeseekoowenin Band, along with any rights of land and resource use. The members of the Band living there were forcibly removed and relocated 30km southwest to Elphinstone, the main reserve of KOFN, while their homes and possessions at IR 61A were burned.

The land expropriated in 1935 was returned to KOFN in 1991. Since then, Parks Canada and KOFN have undergone efforts towards reconciliation. Clear Lake is a sacred component of the KOFN culture and, today, KOFN is a partner to the ministerial agreement, the Senior Officials Forum, signed with Parks Canada in 1998. KOFN maintains a subsistence fishery on Clear Lake and is a landholder on its northwest shore (ICC 2005; Parks Canada 2005).

3.5.4.3 Clear Lake Stakeholder Workshop, 1993

A stakeholder workshop regarding Clear Lake was held in 1993 in Brandon. It has not been possible to determine how similar the participants in this workshop were compared to the current exercise, but those participants in the earlier workshop identified their main concerns as:

- Drinking water quality
- Recreational water quality
- Biological water quality
 - Terrestrial & Aquatic Environmental Managers Manitoba Inc. 1993

A common vision for water quality was agreed upon: We, the stakeholders as stewards of Clear Lake basin, will work in partnership to sustain and enhance water quality to ensure social needs, economic variability, and ecological integrity (1993, 2). While this vision statement is still referred to by RMNP, a goal of the Lake Group is to establish a new vision statement that reflects current concerns and understanding.

3.6 Linkages and Interactions

The key linkages and interactions between the social and environmental elements of the Clear Lake watershed are outlined below in Table 3.2. This system is complex and many variables are yet unknown or poorly understood. However, it is possible to identify significant linkages based on past and current research. Further studies, along with stakeholder and partner information, will help to improve the understanding of these relationships and how they may be changing, as well as novel or previously unknown interactions.

3.7 Trends in the Clear Lake Watershed

Trends have emerged in the watershed related to its position as a major recreation and tourism destination, with a particular focus on Clear Lake. These trends include:

- Increasing development of cottages and homes in the watershed *outside* of the Park boundary, in the RM of Park, many being year-round dwellings. The growth rate is estimated at eight dwellings per year, or just less than one percent (Parks Canada 2005).
- After declining between 2002 and 2007, park visitation has stabilized at 250,000 visitor days per year (Parks Canada 2007)

Growth or development of cottages or homes *within* the Park boundaries portion of the Clear Lake watershed is prevented by zoning and regulations in townsite and park management plans. These constraints within the Park may have encouraged development outside of park boundaries, in the RM of Park, and relieved pressure to loosen or reduce regulations within the Park; however, development outside of the Park has increased the watershed population dependent on the resource for various uses.

Table 3.2 Key linkages between social and environmental components in the Clear Lake watershed.

Water
supply/water
demand

Water supply in Wasagaming townsite is sourced from Clear Lake. Many households in the watershed outside of the Park boundary rely on well-water. The quantity of water removed from the ecosystem can affect ecosystem functions. As well, drinking water quality must be maintained in the interest of human health. A state-of-the-art water treatment facility was opened in Wasagaming townsite in 2007 and the surrounding area (RM of Park) is being planned for hook-up.

Storm water and wastewater treatment

The efficacy of storm water and wastewater facilities and infrastructure directly influences ecological integrity of the Clear Lake watershed, as this water is returned to the ecosystem through groundwater and surface drainage.

Known nutrient pollution sources

Ecological integrity may be impaired by various known anthropogenic nutrient sources in Octopus Creek sub-watershed, South Shore sub-watershed, North Shore sub-watershed, and South Lake sub-watershed.

Septic fields

Nutrient-loading originating from outdated sewage disposal sites poses a significant threat to the state of Clear Lake. Conversion of septic fields to pump-out tanks in the RM of Park (Octopus Creek sub-watershed) will assist the protection of ecological integrity of the Clear Lake watershed. As well, sewage disposal in the North Shore subdivision, group camps, and at the golf course should be converted to holding tanks and pump-outs.

Subsistence fishery

The subsistence fishery of the KOFN must be maintained as a feature of livelihood and cultural well-being, but also must not exceed what can be sustained by the ecosystem. Baseline data about the fishery stocks are required.

Sport fishery

This highly popular activity must be maintained in a way that does not negatively influence biodiversity or ecological integrity. A creel survey conducted in 2009 will provide more information on the state of the fishery when the results become available.

Lake levels and shoreline deterioration

High lake levels are associated with a "high-energy phase" responsible for shoreline erosion/sedimentation equilibrium (McGinn et al. 1998) over which stakeholders have noted concern. While naturally occurring processes, shoreline alterations can affect bank failures and harbour siltation.

Recreation

Many visitors to RMNP rely on Clear Lake as a setting for cottaging, seasonal camping, picnicking, boating, fishing, and golfing. Economic activity in the Clear Lake watershed relies upon the maintenance of the ecological, aesthetic and cultural appeals of Clear Lake.

3.8 Issues Summary from Literature and Past Projects

Issues will be defined further in the thesis by information collected from stakeholders and partners. My preliminary review of recent studies and workshop proceedings, however, suggests that the main concerns regarding the EI of Clear Lake watershed include:

Greatest Concern – Threats to Lake Water Quality

- In contrast to mesotrophic Clear Lake, South Lake is hypereutrophic and hosts extensive seasonal algal blooms.
- Wasagaming's wastewater treatment system is in need of repair/replacement (and is linked to South Lake);
- Storm water drainage, including increasing awareness by visitors that what goes into the sewer ends up in Clear Lake;
- Shoreline rehabilitation Understanding the extent to which Clear Lake shoreline integrity is affected by development, including that within the RM of Park.
- Septic fields along the shoreline, including those within the RM of Park and at the group camps on the southwest shore of Clear Lake, pose a significant risk to ecological integrity via groundwater flow. As a solution, the RM of Park is investigating the conversion of septic fields to pump-out tanks.

Moderate Concern

- Maintenance and understanding of the sport and subsistence fisheries;
- Watershed awareness At this point, the focus on the lake has eclipsed the understanding of conditions in the overall watershed;
- Improving communication regarding Clear Lake watershed initiatives among stakeholders and partners
- Continued collaboration with KOFN partners to ensure a shared vision of ecological integrity of Clear Lake watershed.

Low Concern

- Quantity of water removed to support the human population in the watershed;
- Maintenance of aesthetic appeal upon which the viability of the tourism sector depends.

3.9 Chapter Summary

The Clear Lake watershed extends outside the boundaries of Riding Mountain National Park, while its main feature, Clear Lake, is completely within the Park. The area is a popular vacation destination in the summer season and provides for multiple water-based activities. It is in the interest of RMNP, and other governmental and stakeholder groups, to manage these human activities while maintaining a healthy state of ecological integrity.

The Clear Lake region is biophysically unique, characterized by its deep, cold lake and its biogeochemical make-up. It could primarily be defined as oligotrophic based on Secchi disk

measurements and chlorophyll *a* concentrations, but elevated phosphorus concentrations suggest that a mesotrophic classification may be more appropriate.

A diverse group of partners and stakeholders has interests in the wellbeing of Clear Lake and its area. The watershed falls under the jurisdiction of multiple governments: Government of Canada; province of Manitoba; Rural Municipality of Park (South); and Keeseekoowenin-Ojibway First Nation. Lake users, cottage and cabin owners, year-around community members and business owners, including those from surrounding First Nation reserves, have shared and unique interests in the area. Many of these stakeholder and partners participate in the Lake Group, a stakeholder advisory board on lake-related matters.

Items of greatest concern in the watershed are water quality in the South Lake sub-watershed, wastewater treatment, storm water drainage, shoreline integrity, and septic fields. There is moderate concern about maintaining and understanding sport and subsistence fisheries, watershed awareness and communication, and collaboration with KOFN partners on a shared vision of ecological integrity. The issues of least concern are those of water quantity and maintaining the aesthetic appeal of the area.

Chapter 4 Research Methods

This chapter presents the methods used to meet the goals of the research. A case study approach in the Clear Lake watershed was chosen in order to gain insight into public participation. A questionnaire and interviews were employed in the Clear Lake community as the most appropriate methods to gather baseline information on local concerns and knowledge regarding watershed issues. The literature review, presented in Chapter 2, provided a basis for this project regarding peer-reviewed research in watershed management, indicators, and public participation.

The methodological approach for this study used a combination of qualitative and quantitative methods in order to understand and interpret numerical results with regard to the nature and context of the case study area. Qualitatively, this research investigated the general experiences and impressions of community members through interviews and community meetings. Quantitatively, the results of the questionnaire, and how they may be translated into indicator style variables, are interpreted primarily based on statistical findings while heeding what was learned through qualitative methods.

4.1 Introduction

My role as a researcher in the Clear Lake watershed and this study was shaped by my longtime experience in the region. As I was raised just 60km north of Clear Lake, in Dauphin, MB, I have enjoyed much leisure and recreation time in this area. I was employed with RMNP Visitor Services for six years during high school and my undergraduate degree, and have also worked at other businesses in the watershed. It was these connections that created the opportunity for me to conduct this case study and helped my understanding of the watershed and its community.

I approached RMNP to participate as a case study in this research when I became aware that they were developing biophysical indicators for Clear Lake and also interested in expanding the level of stakeholder engagement. Meetings with Park managers led to a stakeholder engagement strategy that was primarily designed by me for the Clear Lake watershed to facilitate public participation in identifying issues, developing and filtering indicators, and determining plans for monitoring and reporting. This strategy was designed to align with the meetings of a

newly formed partner and stakeholder advisory body, the Lake Group, in pragmatic recognition of constraints on time, cost, and volunteers. I proposed four phases in Spring 2009 – 1) Defining the issues; 2) Generating indicators; 3) Final selection of indicators; and 4) Reporting. The intent was to complete the first two phases in one year, and that was accomplished. Final selection and reporting to stakeholders and partners, phases 3 and 4, will occur at RMNP later in 2010-2011 through engagement with the Lake Group.

Phase 1 of this research was designed to define watershed issues, using information gained through three approaches: literature review, questionnaire, and interviews. The literature review relevant to participatory methods was presented in Chapter 2.

A public participation effort was begun through surveys and interviews carried out in three parts. First, the initial contact was made with stakeholders and partners on February 18, 2009, at the first meeting of the Lake Group. Second, the survey and interviews occurred from August 1st to December 1st, 2009, to gather baseline information from community members. Lastly, I assessed the Canadian Water Sustainability Index and recommend alterations based on what was learned from the community.

It is worthwhile noting that a survey, interviews, and observation alone are not a public participation program. These are useful information gathering tools and contribute to a larger program underway in RMNP that includes ongoing discussions and actions by stakeholders and partners, primarily through the Lake Group. Additionally, focus groups were considered but discarded due to time constraints, specifically related to developing meaningful activities, and the possibility of over-extending the commitment of volunteer community members, many of whom are a part of the Lake Group and had also agreed to interviews. For this study, the survey, interviews, and observations were best suited to the purpose and time requirements. Longer-term research could be devoted to further study and development of the public participation program in RMNP (Section 5.6).

4.2 Study Site and Target Audience

The Clear Lake watershed was chosen because of the desire of RMNP to engage the local community in watershed governance, as well as the interest by RMNP in developing watershed reporting. This watershed is distinctive in that the lake is 'protected' by its situation within

national park boundaries, but its watershed drains from outside the boundary into the Park, creating the potential for its ecological integrity to be threatened from beyond the Park's jurisdiction. At the same time, the methods used in this case study could be effective in other multi-stakeholder watersheds without the jurisdictional complexity of Clear Lake.

The Clear Lake watershed boundary, shown in Figure 4.1, was used to define the target audience for this research, estimated to be not more than 1,800 households and businesses. All 'year round' and seasonal households and businesses within the watershed boundary were provided with one questionnaire package, including a postage-paid return envelope. As well, questionnaire packages were delivered to two First Nation communities outside of the watershed boundary for whom the lake and watershed are culturally significant (Section 4.3). In all, 1789 packages were distributed.

4.3 Questionnaire

The target audience for the questionnaire was the 'watershed community', designated to include each household, year round or seasonal, within the watershed boundary. The exception to this watershed boundary rule was the mail delivery to members of KOFN, who have traditional lands on the shore of Clear Lake, but reside on reserve lands adjacent to Elphinstone, MB, rather than within the watershed boundary. As well, 114 surveys were provided to two drop-off/pick-up points for members of Rolling River First Nation because, while they do not reside within the watershed, it is a culturally important area to them. Figure 4.1 shows the delivery areas and their response rates.

Due to the relatively small size of the target population, the questionnaire was distributed to the entire population. Samples of convenience were avoided where possible and efforts were made to be inclusive. Due to limited mail delivery to those households and businesses within RMNP and to certain seasonal developments outside of the park, hand delivery was used to reach those units. Households and businesses within the RM of Park were assumed to have mail delivery (except those seasonal developments already mentioned that received hand delivery) and a mass mailing of the questionnaire package was employed for them.

In total, 1789 questionnaires were distributed between August 1 and September 1, 2009. 348 were completed by October 15, 2009 (the official deadline was September 15, but I accepted

those that arrived until mid October). The questionnaire distribution is summarized in Table 4.1 The overall response rate for the questionnaire was 19%.

The survey content addressed: demographic information; watershed awareness; lake and watershed activities; importance and connections to the resource; understanding of how activities impact the watershed/lake; types of household/business water sources and wastewater disposal; estimated quantity of water used/for what; water efficiency efforts; satisfaction with current water supply; and, opinions on freshwater management. The survey is provided in *Appendix B*. Analysis was carried out using PASW (SPSS) Statistics 18 software. Charts were created using this software and Excel 2008 v. 12.2.5.

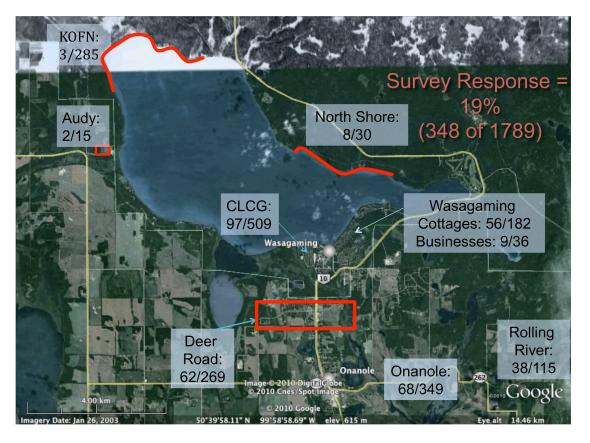


Figure 4.1 Survey areas and response for the Clear Lake watershed community questionnaire, 2009.

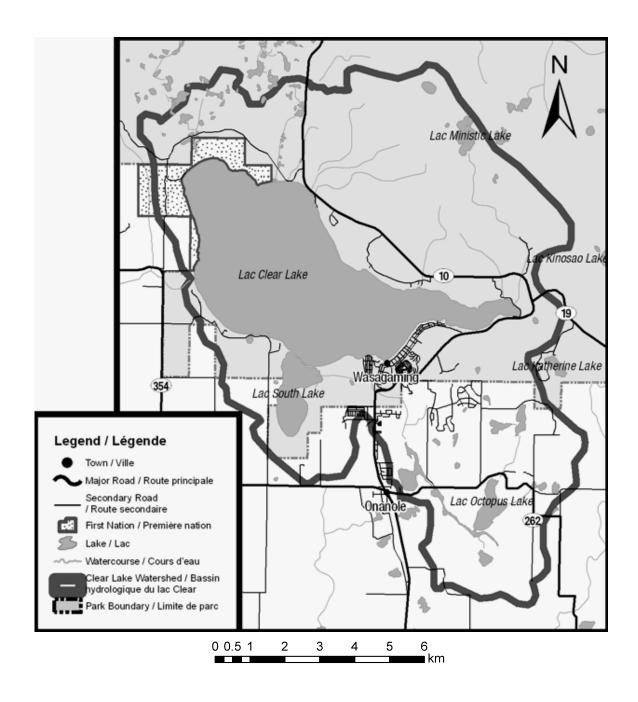


Figure 4.2 Boundary of the Clear Lake watershed, MB.

S. Frey, RMNP, 2009.

Table 4.1 Summary of delivery and completed 'Clear Lake Community Questinnaire'.

Available August-October 15, 2009. Clear Lake Watershed, MB. KOFN = Keeseekoowenin Ojibway First Nation.

Distribution area (Method)	Delivered (#)	Completed (#)	Completed per # delivered (%)	Completed (% of total completed)
Lake Audy (hand delivery)	15	2	13%	1%
Wasagaming businesses (hand delivery)	36	9	25%	3%
Clear Lake campground (CLCG) (hand delivery)	509	97	19%	28%
Grey Owl and Deer Road cottage developments (hand delivery)	269	62	23%	18%
KOFN (mail, drop-off)	285	3	1%	1%
Onanole (PO boxes)	349	68	19%	19%
North Shore subdivision (hand delivery)	30	8	27%	2%
Wasagaming cottages (hand delivery)	182	56	31%	16%
Rolling River First Nation (drop-off)	114	38	33%	11%
Missing*	-	5		1%
Total	1789	348	19%	100.0
Overall Response Rate = 19%				

^{*} We were unable to verify the origin of five completed questionnaires.

4.3.1 Prize Draw

A prize draw was used to attract participation in the questionnaire. An entry form was provided in the questionnaire package, separate from the questionnaire to ensure that respondents could not be identified. A draw was held and the winner was given a choice between two prizes, each valued at approximately \$100CAD.

4.4 Key Informant Interviews

Between September 26 and December 1, 2009, 11 interviews were held with key stakeholders and partners. These individuals were selected either based on their affiliation with the Clear Lake Watershed Working Group or by recommendation from Parks staff. I attempted to select interviewees who represented the diverse user groups. There was also 'self-selection' by individuals who chose not to participate in the interviews. In general, the interviewees represented cabin owners, cottage owners, small and large business owners, motorized and non-motorized boaters, Onanole residents, Clear Lake Golf Course, Little Saskatchewan River Conservation District, RM of Park, and KOFN.

The interviews lasted approximately one hour each, during which the interviewees were asked questions that expanded upon the survey information. These questions were drawn from an interview guide² (Appendix D).

The interviews were designed to gather information about perceptions, changes through time, ecological integrity, and future expectations, as well as past problems and solutions. Interviews also provided an opportunity for 'brain-storming' about the range of available and potential knowledge, and included discussions about the level of interest and capacity to participate in watershed governance.

4.5 Secondary Information (Literature review)

The literature review (Chapter 2) was used to gather peer-reviewed information on public participation, watershed management, and indicators development. Also, past research done by or on behalf of RMNP was reviewed in order to gain a better understanding of the current context (including in Chapter 3, the case study description).

4.6 Limitations to Public Participation and Response Rate

Participation in the questionnaire and interviews may have been influenced by:

Time constraints on scheduling interviews

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² Developed with Tracy Bowman and Rachel Cooley at the Parks Canada Western and Northern Science Centre, and Sharon Vanderschuit at RMNP.

- Seasonality and flux (even weekly, with higher visitation on weekends, especially long weekends) in the visiting watershed population affected the ability to reach more cottage and cabin owners.
- While an effort was made to simplify the questionnaire content, the technical subject matter and the length of the booklet may have deterred participation. As well, poor understanding of questionnaire terms and phrasing (ex. *Ecological integrity*) may have negatively influenced participation.

Participation by KOFN was particularly low compared to other groups. This may be related to ongoing negotiations with the Park. KOFN participation is discussed further in Chapter 6.

The questionnaire was carried out in a census style. The response rate was 19% overall. This is consistent with the usual response in the literature for a mail drop approach.

4.7 Ethics

The Office of Research Ethics at the University of Waterloo reviewed and approved the participative methodology and the questions posed in the survey and in the interview. For the survey, consent of the participants was assumed when they chose to return the survey package. For the interviews, the participant and a witness signed a letter of consent at the time of the interview.

Chapter 5 Results of Community Input on Watershed Issues

5.1 Introduction

The information from the Clear Lake watershed community questionnaire and interviews provides a baseline of community perspectives from which indicator-style reporting can be developed by Riding Mountain National Park staff in cooperation with stakeholders and partners. It provides details about the community's interests, concerns, and awareness to be addressed by such communication.

The questionnaire and interview results also provided information to guide the use of the Canadian Water Sustainability Index in the context of the Clear Lake watershed. The discussion in this chapter is focused on how the priorities of the watershed community can be incorporated into the Canadian Water Sustainability Index (CWSI), developed by the PRI in 2007, to create locally relevant monitoring and reporting in the Clear Lake watershed. The use of an existing index, even if modified according to community-provided information, will still allow this watershed to be compared more readily to others that adopt the same index.

In this chapter, following a summary of what was learned from the community survey and interviews, four main findings are considered as the basis for alterations to the CWSI. Thus, this chapter reviews the survey and interview results, provides an overview of the CWSI, and demonstrates the ways that the questionnaire findings can guide the use of the CWSI in the Clear Lake watershed.

5.2 Community Survey and Interviews: Summary of Findings

The community consultation provided key insights regarding water resources in the Clear Lake watershed. These findings, summarized below, can guide modification and application of the CWSI for this area.

5.2.1 Respondent Demographics

Questionnaire respondent demographics were gained directly through the questionnaire, as well as by inferences made related to delivery area. Table 5.1 summarizes respondent demographics.

Delivery of the questionnaire took place in nine main areas of the Clear Lake watershed. In the previous chapter, Table 4.1 shows the proportion of responses corresponding to those areas.

Table 5.1 Respondent demographics of community questionnaire, the Clear Lake watershed, MB. August – October 15, 2009. A census-style was used, and so percents reflect the percent of the population (as households). 'Valid percent' is calculated by excluding 'missing' values.

(n = 348)	Frequency	Percent	Valid Percent
Location of household	193 Within RMNP	56%	58%
	142 Outside RMNP	41%	42%
	13 missing	4%	
Permanent or seasonal	261 Seasonal	75%	77%
	76 Permanent	22%	23%
	11 missing	3%	
Gender	176 Male	51%	52%
	160 Female	46%	48%
	11 missing	3%	
Drinking water supply	199 RMNP	57%	59%
	waterworks		
	72 Well water	21%	21%
	59 Bottled	17%	17%
	water/water coolers		
	9 Other	3%	3%
	9 missing	3%	

5.2.2 Water Supplies

Water supplies for people living (year round or seasonally) in the watershed area come primarily from well water, a new water treatment system installed by Riding Mountain National Park in 2006, and/or bottled water/water coolers (Figure 5.1).

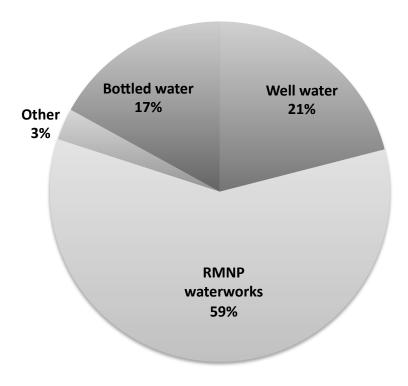


Figure 5.1 Main household and business water supplies for respondents of community questionnaire in the Clear Lake watershed, MB, 2009.

A very small proportion (3%) of respondents reported their drinking water supplies as 'other', including:

- Water brought in from other locations, especially Brandon and Winnipeg.
- Bottled water used in the winter
- Cistern in the winter
- Water delivery
- RMNP water processed by personal systems
- Bottled water for drinking; well water for other activities
- Water picked up from RMNP taps (e.g. Pumphouse) to be used in home.

5.2.3 User Confidence in Water Supplies

Users were asked to indicate their confidence in the quality and safety – and, for well water users, quantity - of water supplies on a 7-point scale (1 = Not at all confident; 7 = Very confident).

Quality and safety reflect different dimensions. *Safety* refers to a state in which no harm would result from the exposure to the water in question. The EPA describes safe water as, "Water that does not contain harmful bacteria, or toxic materials or chemicals. Water may have taste and odor problems, color and certain mineral problems, and still be considered safe for drinking." (EPA 2009, n.p). *Water quality* generally refers to the biological, chemical, and physical characteristics of water (EPA 2008) and not only to those conditions with the potential to cause harm.

Table 5.2 shows a comparison of mean confidence in quality and safety of water supplies according to the type of supply. In general, well-water users and RMNP waterworks users are more confident in water supplies than those who rely on bottled water, indicating that these latter respondents use bottled water in response to a perceived lack of confidence in local supplies. Awareness campaigns on the high quality and level of treatment of local supplies may instill more confidence in these users.

Table 5.2 Mean confidence in drinking water quality and safety by supply type in the Clear Lake watershed, MB.

This table compares mean confidence in the quality and safety of drinking water supplies by supply type in the Clear Lake watershed. Respondents rated their confidence on a scale of 1 to 7 (1 = Not at all confident; 7 = Very confident

	RMNP	Well Water	Bottled
Quality	6.2	6.0	4.5
Safety	6.2	5.9	4.3

In general, confidence in the quality and safety of the drinking water supply is high. Water quality, especially of drinking water, is a very high priority for the watershed community. Lake Group meetings have included presentations on lake water quality and ongoing science, and tours of the watershed have emphasized potential hazards to current water quality. One

meeting of the Lake Group included a tour of the new water treatment facility (tours have also been done for the public) and many supportive comments were made regarding the very good quality of the drinking water. Efforts should be made to monitor and maintain the current state of water quality in the watershed.

5.2.4 Stakeholder and Partner Watershed Priorities

Understanding and integrating important stakeholder activities in a watershed should be a key aspect of watershed management. The priorities identified by stakeholders and partners regarding valued activities and uses can guide resource managers toward management strategies that preserve and enhance these elements.

Each interviewee emphasized the importance of the lake and surrounding area to their experiences. Business owners acknowledged that their business absolutely depends on the lake; aboriginal community members spoke of the traditional, historical, spiritual, and current importance of the area and lake-related resources; cabin and cottage owners explained the reasons behind their return visits to the area. Lake-based activities, such as boating and swimming, are particularly important to visitor and local experiences. As well, the interviewees acknowledged the inherent ecological value of the watershed which suggests that they have an understanding of ecological integrity.

5.2.5 Preferred Activities

Questionnaire respondents were asked to rate lake-based activities on a scale of importance from 1 (very unimportant) to 7 (very important). These activities were:

- Beach and/or swimming
- Motorized boating
- Non-motorized boating
- Recreational fishing
- Subsistence fishing, and
- Agricultural land/water use

The categories, excluding agricultural land/water use, were used to group users into 'beach only', 'moderate lake users', and 'heavy lake users' due to insufficient numbers for analysis based on the original specified groupings. Parks Canada staff felt that these new groupings would still be helpful in determining management implications, and the new

groupings were classified by using cluster analysis (Analyze > Classify > Cluster) in SPSS that based the new groupings on mean responses to each category. As shown in Figure 5.2, the largest group (59%) of respondents can be defined as moderate lake users, meaning that they generally scored lake-based activities as of medium importance related to their experience in the watershed. Heavy lake users, at 29%, still form a significant proportion of respondents. A smaller proportion of respondents (11%) reports that the beach is the sole focus of their watershed experience.

As with the other individual categories addressed above, of the 321 occasions in which people answered the question of how important this activity is to them, agricultural land/water use received too few rated responses to provide extensive analysis. 62% (202 responses) rated this as zero ("does not apply") or one ("not at all important"). 22% (71) were spread quite evenly across scores 2 to 6, and 15% (48) of respondents gave this a score of seven ("very important"). Due to this scoring pattern and excluding the 147 'zero' responses, the mean based on the remaining 174 entries is 3.9 with a standard deviation of +/- 2.7.

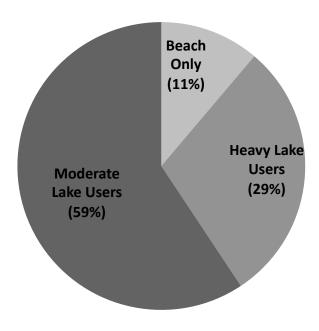


Figure 5.2 Lake user types, Clear Lake, MB

A breakdown of lake user types based on questionnaire responses regarding intensity of lake-based activities. Clear Lake watershed, MB, 2009.

5.2.6 Other Preferred Aspects of the Watershed Area

Questionnaire respondents were asked to assess various aspects of living in or visiting the watershed that they deemed important to their watershed experience. From the responses (Figure 5.3), the key aspects of the watershed are the aesthetics and natural surroundings, and as a place for family and individual experiences related to its role as a vacation destination. These views were reinforced by the interviewees as already noted in Section 5.2.4. This ranking may provide resource managers with a notion of the community's priorities in the watershed and may help to gear management actions to achieve and/or protect what is valued.

5.2.7 Community Knowledge of and Observations on Ecological Integrity

Community observations regarding the watershed may confirm or provide early detection of changes to ecological integrity (EI), along with those from resource managers. Participants were asked to select any changes they had observed in ecological integrity up to and including the past 10 years from a prepared list that included 'none' and 'other'. Thirty-three (9.5%) respondents to the questionnaire selected 'none', while 70 respondents (20%) did not respond at all. In this latter case, where the questionnaires were generally filled out thoroughly, I assumed that no response is equal to 'none'. This interpretation was based on advice from the Parks social scientist who worked closely with me on the project. However, I am aware that such an interpretation has limitations. For example, a 'no response' could reflect a lack of understanding of ecological integrity and changes to it. As a result, the implications of these findings need to be treated with caution. Figure 5.4 shows the most noteworthy responses of the remaining 70% of respondents, taken as those categories selected by more than 15% of respondents. 'Increased land development' in the watershed is the most noted change that affects EI, with over 50% of respondents mentioning this aspect. Shoreline changes were also observed by a large proportion of respondents (39%).

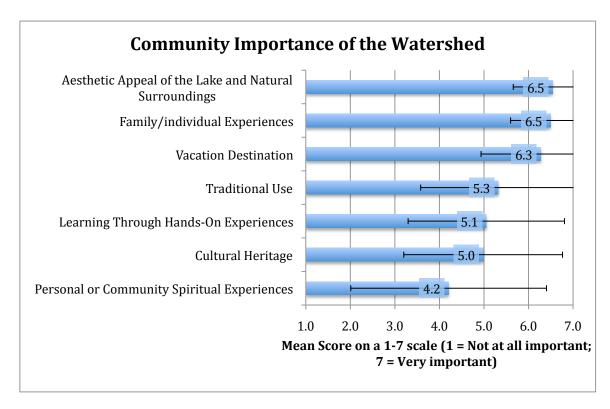


Figure 5.3 Average scores and standard deviation for important aspects of the Clear Lake watershed, MB, reported by the local community.

Results of scoring aspects of the Clear Lake watershed in order to determine the level of importance to the community. Clear Lake watershed Questionnaire, August, 2009.

Presence of aquatic plants and algae (observed by 17% of respondents) may indicate changes in EI, particularly in nutrient levels. Algae and aquatic plants are being investigated in other regions as indicators of water chemistry and these have potential as such in the Clear Lake watershed. As well, observations about the presence of shorebirds and waterbirds, late spring ice break-up, and increased lake levels may prompt further investigation by resource managers about these elements of the ecology of the region.

Ecological Integrity in the Clear Lake Watershed: Community Observations

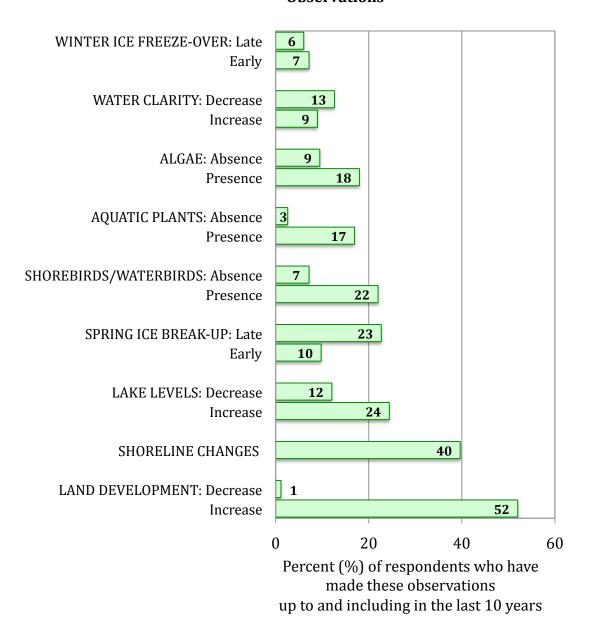


Figure 5.4 Community observations of changes to ecological integrity in the Clear Lake watershed, MB.

Observations made by the community in the Clear Lake watershed (up to and including the past 10 years) that could indicate changes in ecological integrity. Clear Lake watershed questionnaire, 2009.

5.2.7.1 Perceptions of Water Quality in the Watershed

Respondents to the questionnaire rated the water quality of the Clear Lake watershed highly. Of 285 scores on a 7-point scale (1=very poor and 7=excellent), the mean score was 5.73 with a standard deviation of 1.18. It would thus appear that most respondents believe the water quality is very good.

5.2.7.2 Perceptions of Influential Factors in Ecological Integrity

Questionnaire respondents were asked to gauge the influence specified factors have on ecological integrity (EI) in the Clear Lake watershed. A list of 17 items was provided. Respondents scored each on a scale from -3 (most negative influence) through 0 (no impact) to +3 (most positive influence).

The most positively perceived factors in ecological integrity (EI) (Figure 5.5) were, in rank order:

- Monitoring by resource managers
- Cooperative management
- Policies and regulations
- Fishing quotas, and
- Water and wastewater treatment

The most negatively perceived factors influencing EI of the watershed (Figure 5.6) were, in rank order:

- Agricultural run-off
- Leaking septic tanks and septic fields
- Invasive or exotic species
- Barriers preventing fish access to spawning areas
- Erosion, and
- Other nutrient addition to the lake.

Responses were moderate and mixed about the remaining factors demonstrated by scores that varied widely (Figures 5.7). This pattern could be the result of lack of awareness or education, controversial opinions, simply a lack of concern, or misunderstanding the question or its set-up. For instance, 'storm water management' received scores across almost the whole spectrum. This could occur from misunderstanding or misinterpreting the term, the question, or what it involves, or what the state of storm water management is in the watershed.

Most interviewees identified agricultural run-off, nutrient addition, leaking septic tanks and septic fields, and shoreline erosion as perceived threats to Clear Lake. There seems to be fairly widespread knowledge of outdated septic tanks and fields in the watershed and, as a result, the RM of Park and RMNP have gained the support of the community in a broad wastewater treatment project. As well, a number of interviewees noted that residential development in the watershed had increased and wondered what effect that might have on the natural surroundings and processes.

Many of the interviewees partake in recreational fishing and boating and none identified any issues or changes to their experiences. This is contrary to the negative perception apparent in the questionnaire response to 'boat traffic' which received only negative responses. Three interviewees took issue with the lack of boat launches for the number and size of boats and this could explain the negative response. However, while this is important to the visitor lake experience, it is not highly relevant to ecological integrity of the watershed at this time.

Exotic species, barriers preventing fish access, and subsistence fishing were not discussed at any length with any of the interviewees. Cooperative management and monitoring were also not discussed *per se*, but a number of interviewees noted that 'cooperation' with and between federal and municipal managers had positive effects of the overall management of the watershed.

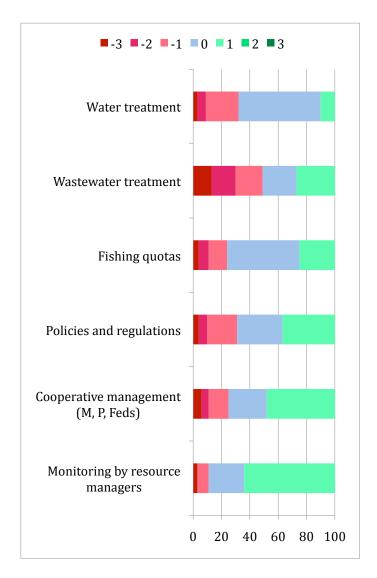


Figure 5.5 Most positively perceived factors of influence on ecological integrity in the Clear Lake watershed, MB.

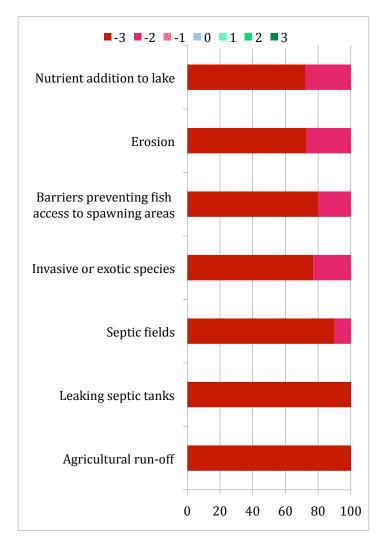


Figure 5.6 Most negatively perceived factors of influence on ecological integrity in the Clear Lake watershed, MB.

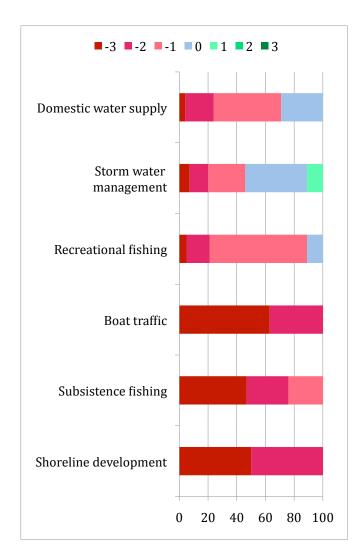


Figure 5.7 Moderately perceived factors of influence on ecological integrity in the Clear Lake watershed, MB

5.3 Canadian Water Sustainability Index

The Canadian Water Sustainability Index (CWSI) was developed by the Policy Research Initiative to evaluate 'water well being' at the community scale (Canada 2007). The index integrates data and information related to community water issues in a way that facilitates comparisons between and within communities through time.

The CWSI scores water 'well being' in five component areas (resource, ecosystem health, infrastructure, human health and well-being, capacity) with three indicators each (Table 5.3). The component areas are designed to encompass a spectrum of water-related activities and services that contribute to the integrity of the water resources upon which communities rely.

The strengths of the CWSI include its holistic structure, design by a diverse project committee, and test application in communities with varying water situations, including three First Nations. The current iteration of the CWSI has wide-ranging component areas which include indicators that represent human interactions with the environment, allowing the CWSI to depict both biophysical and social measures of water well being for the watershed or community in which it is being used. As well, the CWSI is designed to summarize the component scores to produce a measure of water well being out of 100. This scoring system allows for comparisons among communities or in one community through time.

The main weaknesses of the CWSI are gaps in knowledge and data availability. In the initial pilot project in six communities (Canada 2007), every community had multiple issues regarding data availability. As well, of the 15 indicators, only two could be completed by all six communities. Veale's (2010) research also confirms these two problems in her assessment of watershed report cards in Canada that included 13 case studies. One particular challenge noted in the CWSI project report was the significant time required to acquire data from government departments. Nevertheless, communities that piloted the CWSI concluded that the results would be useful to planning decisions, making applications for funding, and for funding decisions (Canada 2007, 28-29).

5.3.1 The CWSI and DPSIR Framework

The DPSIR Framework (Section 2.5.5) is a tool that can be used to represent a system in comprehensible parts and linkages. In indicator development, the design and choice of

indicators can be informed by this conceptualization of system components. Table 5.3 shows how the indicators present in the CWSI can be related the DPSIR framework. Pressure, state, impact, and response indicators occur more often than driving force indicators. This finding is not unexpected, as Walmsley (2002) points out that driving forces are often broad and difficult to define in a way that can produce adequate and measurable sensitivity to changes in the system.

Table 5.3 Canadian Water Sustainability Index (Canada, PRI, 2007) with assessment of Clear Lake suitability, MB.

= Suitable for immediate use = Requires some adaptation before use = Not suited to local needs and can be discarded			
Component	Indicator	Relationship to DPSIR Framework*	Description
RESOURCE	Availability	State	The amount of renewable freshwater available per person
	Supply	Pressure	The vulnerability of the supply as caused by seasonal variations and/or depleting groundwater resources
	Demand	Pressure	The level of demand for water use
ECOSYSTEM	Stress	Impact	The amount of water removed from the ecosystem
	Quality	State/Impact	The Water Quality Index score for the protection of aquatic life
	Fish	Impact	Population trends for economically and culturally significant fish species
INFRA- STRUCTURE	Demand	Driving Force	How long before the capacity of water and wastewater services will be exceeded due to population growth?

	Condition	State/Impact	The physical condition of the water mains and sewers as reflected by system losses – May want to design an indicator that reflects the hook-up to the water treatment system
	Treatment	Response	The level of wastewater treatment
HUMAN	Access	State	The amount of potable water accessible per person
HEALTH	Reliability	Impact	The number of service disruption days per person
	Impact	Impact	The number of waterborne illness incidences
CAPACITY	Financial	Response	The financial capacity of the community to manage water resources and respond to local challenges
	Education	Response	The human capacity of the community to manage water resources and address local water issues
	Training	Response	The level of training that water and wastewater operators have received

^{*} DPSIR refers to Driving Force-Pressure-State-Impact-Response Framework (Walmsley, 2002).

5.3.2 Phased Implementation

While it is unlikely that the CWSI can be implemented in full at this time due to data gaps and constraints on time and financial resources in the Clear Lake watershed, the information gathered in this study can be used to facilitate a phased strategy for implementation. Further discussion will determine which indicators can and should be implemented first, which need more development, and what the data needs/gaps may be to fulfill the requirements of the CWSI.

Table 5.3 shows which of the indicators in the CWSI could immediately be implemented, those that will take more time or development of data, and those that are unsuitable or very difficult to employ. Indicators highlighted in green are those for which RMNP either has data or has the capacity to gather the required data and information with relative ease. Indicators highlighted in yellow are those that may require some adaptations to better suit local needs, extra time and/or financial resources to implement, or are not highly relevant to the Clear Lake watershed. The indicator highlighted in red, vulnerability of water supply, is not relevant for the Clear Lake watershed at this time and may be discarded in favour of an indicator that is more

locally suitable, such as those discussed below, or CWSI indicators highlighted in green or yellow.

5.4 Opportunities for Developing Locally-relevant Indicators

Issues of local relevance became apparent during the process of local engagement and these guide the following recommended additions to the CWSI. Water bottle use, reliance on well water, water conservation and efficiency, and communication/information sharing could each be considered for addition to the CWSI. Below, each of these is considered, their relative importance to the community is noted, and suggestions for how to move forward in developing relevant indicators are offered. Table 5.4 shows these four indicators as they may be appended to the current CWSI and how they relate to the DPSIR framework, as follows:

- Bottled water can be perceived as an indicator of either 'Resource' or 'Infrastructure' as its use reflects the human response to the natural resource and/or the capacity of the infrastructure in place to maintain quality drinking water. Within the DPSIR framework, bottled water reliance may be identified as part of the current 'state' of water use; as an 'impact' of low confidence in drinking water treatment; or as a 'response' to water quality issues (real or perceived).
- Regarding the CWSI component areas, connecting well water users to the water treatment system is primarily an indicator of the available infrastructure. This feature can be identified as a 'state' component of the DPSIR framework, referring to the state of water services, or as a 'response' component, as conversion can be viewed as a response by community members and governing bodies.
- Water efficiency and conservation is both an issue of resource demand and human capacity with regard to the CWSI. Measures of demand for water resources will certainly be affected by the degree of water efficiency and conservation in effect. Similarly, water efficiency and conservation depends on the capacity of users to take part in such efforts. In terms of the DPSIR framework, water efficiency and conservation efforts can be seen as a 'response' to the current state and impacts of human activities on water resources in parallel with heightened awareness.
- In terms of the CWSI, communication is a straightforward indicator of capacity as it relates to the education of the watershed community. This indicator is suited best to the 'response' section of the DPSIR framework, referring to both the increased use of communication (as a response to the desire to increase awareness) as well as enabling further responses of water users based on increased awareness.

Table 5.4 Additional 'local' indicators to the CWSI, the Clear Lake watershed, 2010.

Potential Component Area(s)	Indicator	Relationship to DPSIR
Resource/Infrastructure	Bottled Water	State/Impact/Response
Infrastructure	Well Water Conversion	State/Response
Resource/Capacity	Water Efficiency &	Response
	Conservation	
Capacity	Communication	Response

5.4.1 Bottled Water

Bottled water use has been a focus of the stakeholder/partner advisory group and a bottled water ban (within RMNP) has been proposed by this group. However, in the interviews, business owners noted the difficulty that they have had in encouraging guests to drink tap water. One main barrier to promoting tap water is the convenience of bottled water to visitors who are out walking, golfing and spending time on the beach. Discussions are ongoing about placing drinking fountains and water stations around the townsite. Measuring and reporting a reduction in bottled water reliance would be of local interest, readily measureable, and create an indicator of both confidence in local water quality and environmental action.

From the results of the questionnaire, 17% of community members rely on bottled water as their primary source of drinking water while in the watershed (Figure 5.1). Action can be taken to understand the causes behind this reliance and to increase confidence in and use of local water supplies. A relevant indicator of bottled water use should be the top priority if one or more locally identified indicators is to be added to the CWSI.

Indicator: Number and proportion of households relying on bottled water as primary source of drinking water while in the watershed.

5.4.2 Conversion from Well-Water to Water Treatment System

Reliance on well water is evolving in the watershed. Within the boundary of the RMNP, the new Wasagaming water treatment plant services the cottages, cabins, and businesses. In the coming

decade, most of the homes and businesses outside of the park boundary will be connected to this system. From comments made in interviews and at Lake Group meetings, feelings are mixed regarding the new water treatment systems. Negative perceptions are mostly based on the hookup cost to the user levied through municipal taxes. At the same time, supporters of the water treatment system recognize that household water quality will improve.

The shift in water services represents a change in the state of water resources and can easily be measured and reported. Consequently, the priority for such an indicator is very high, and because data would be readily available, the proposed indicator should be prepared immediately.

Indicator: Number and proportion of households relying on well water.

5.4.3 Water Efficiency and Conservation

Water efficiency and conservation are discussed regularly at Lake Group meetings. Participants seem eager to encourage the local and visitor community to be more water conservative, and this aspiration may become one of the goals of the group to be achieved through watershed awareness and water conservation projects.

Respondents to the questionnaire were asked about their household water use in terms of water conservation and efficiency measures. Table 5.4 outlines the proportion of respondents using selected water conservation methods in their Clear Lake watershed households. Handwashing dishes in a water-efficient manner, efficiencies in clothes washing, and repairing leaks were the top three measures identified by respondents. Excluding 'none', 'other', and 'pool cover', the least used water conservation and efficiency measures are water-saving dishwashers, water recycling/grey water reuse, and composting toilets.

Changes in water efficiency and conservation would be an encouraging indicator for the public, and a simple quantification for those charged with its measurement. Measuring the change in use of water saving technologies, practices of water efficient landscaping, and reliance on bottled water could be suitable starting points for use in the set of indicators. However, some time and resources must be allocated to developing a systematic method and timeframe for

ongoing measurement, possibly through repeating this portion of the survey on an annual basis. This could also be facilitated by an online tool.

5.4.3.1 Incentives for Water Efficiency and Conservation

Incentives to adopt technologies and behaviours that would contribute to water efficiency and conservation are largely absent in the Clear Lake watershed. Households and businesses relying on RMNP waterworks are unmetered and pay a flat rate for services. Therefore, they do not experience financial savings related to water conservation efforts. Neverthless, the topic of encouraging water conservation arose at two meetings of the Lake Group and was corroborated in four of the interviews. The following questions were included in the survey:

"To what degree do you feel water conservation or efficiency techniques provide financial saving for your household in the Clear Lake watershed?" and.

"To what degree do you feel that water conservation or efficiency techniques protect the integrity (health) of the Clear Lake watershed?"

Respondents to the questionnaire do not strongly relate water conservation or efficiency techniques to financial saving in their households in the watershed. The mean score from 263 responses to this question was 3.19 (standard deviation = 2.1) on a scale of 7, where 1 = no savings and 7 = significant savings. A further comparison of this mean score with the respondents' selected water supply (q.8) was carried out in order to understand whether perceived financial savings could be related to the type of supply (ie. Well-water; bottled wat er; RMNP waterworks). The conclusion is **no** apparent relationship between these factors.

According to their responses to the question of ecological integrity protection, questionnaire respondents generally believe that water conservation or efficiency techniques protect the ecological integrity of Clear Lake and its watershed. Of 267 respondents to this question, the mean score was 5.1 (standard deviation = 1.3), where 1 = no protection and 7 = significant protection.

Table 5.5 Water conservation and efficiency measures used by households and businesses in the Clear Lake watershed, 2009.

Water Conservation & Efficiency Measures	Percent (%)	#
Hand-washing dishes in a water efficient manner	66	229
Clothes washing: only full-loads or using load settings`	50	173
Repairing leaks	49	171
Reduced showering times	45	155
Trigger nozzle on hoses	41	141
Low-flow showerheads	39	134
Water saving tech. (low/dual flush toilets; aerators; etc.)	35	122
Reduced lawn watering (once a week or less)	34	117
Watering lawn and garden before 8am & after 8pm	22	79
Water efficient landscaping with water-wise plants	19	67
Water-saving clothes washer	17	60
Rain-water collection	15	53
Water-saving dishwasher	14	48
Water recycling or grey water reuse	10	34
Composting toilet	3	12

Water efficiency and conservation could be further encouraged as a means to protect ecological integrity through education and awareness campaigns. Strengthening the relationship between financial savings and water efficiency may facilitate conservative water use, and is recommended as a focus for managers and communication strategies over the next two years, and involving further research into pricing techniques and market-based conservation incentives. The Lake Group could also assist in awareness campaigns surrounding these issues.

5.4.4 Communication and Information Sharing

Communication and information sharing is another example of a locally-relevant issue that can be measured as an indicator of watershed well being, as it is both a concern to questionnaire respondents and is contained within the CWSI as the 'education' aspect of the capacity component. The literature suggests that ongoing communication about work being done in watershed management, projects, and research performed will continue to attract support for this

work (Fraser et al. 2006; Veale 2010). Resource managers should continue to address items of community concern and communicate to the community the ways in which they address these impacts. As well, in some cases, the perception of an issue may not match the actual state. In these cases, communication should be arranged to resolve the misconception in question.

The questionnaire included a section on *information sharing* to determine the ways in which respondents voice their ideas, support, or concerns regarding the watershed. They were also asked if they have ever received watershed information (and, if yes, how?) and, if not, would such information be of interest if it were provided by Parks Canada. While only 31 percent of respondents indicated that they had received information on the watershed, the majority (91%) would like to receive such information.

Of the 31 percent (94) of respondents who indicated they had received information, the main information sources were (in order of importance):

- 1. RMNP 63 respondents (with notable emphasis on the newsletter of Summer 2009);
- 2. Cottage and cabin owners' associations, and the Wasagaming Tenants' Association 16;
- 3. the South Mountain Press 8;
- 4. the RM of Park 7; and
- 5. by employment with RMNP 5.

Less mentioned sources of information (<3 mentions) were the Clear Lake Watershed Working Group, RMNP Visitor Centre and interpretation, this survey, and 'community meetings'. Specific comments about information sources that may further inform choice of communication methods include: RMNP lectures, pamphlets; RMNP spring letter; posters (including those in the Park washrooms), presentations, printed materials, and one mention of the RMNP website. When asked about information sharing, respondents also drew attention to the need for more regular communication, and some indicated that they had to seek information rather than it being provided on a regular basis.

There is an apparent desire and opportunity for more regular communication of watershed information and news. The newsletter of Summer 2009 received very positive reviews and should be an annual publication. The RMNP website, enhanced with watershed specific information, could also become a source for watershed information. An indicator measuring watershed specific communication is something that is easy to prepare and measure, and could be promptly added to the CWSI for use in this area.

Indicator: Number of watershed specific publications distributed per year (as a proportion of the population) OR Number of CWSI reports distributed per year.

5.4.4.1 The Public Voice

Questionnaire respondents were asked to identify ways that they have had in the past or currently have to voice their ideas, support or concerns regarding the Clear Lake watershed. Multiple selection was allowed among the seven options, and Figure 5.8 shows the tally for each. In this figure, it appears that RMNP, community meetings, and the RM of Park have provided the main forums for members of the community to discuss water and watershed- related issues.

The multiple selections allowed in the question also provide insight into how many ways community members currently use public forums for discussion. While 60 percent of respondents do not voice their opinions, 21 percent have one preferred forum and 19 percent of respondents tend to use two or more ways to communicate their opinions or concerns. By reviewing these results on how opinions are being voiced, we see that a majority of respondents (60 percent) do not share their opinions on watershed issues. It cannot be determined from this research whether this finding is because they do not feel the need to, or because they do not know where or how to do so.

Further research could determine whether the existing forums adequately suit the need for public discourse on watershed issues. The newly formed 'Clear Lake Watershed Working Group' or "Lake Group", an advisory body composed of stakeholders and partners, appears to be providing an appropriate setting for watershed specific discussions based on its diverse, and dedicated membership and bi-annual meetings. This group is the only stakeholder and partner organization of its kind, with its focus on watershed issues and level of engagement with Parks Canada in the Clear Lake watershed.

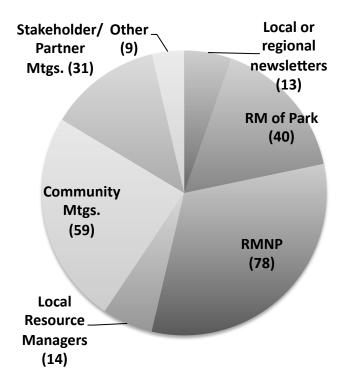


Figure 5.8 Frequency of use by respondents of current public forums for voicing opinions and concerns regarding the Clear Lake watershed.

Prevalence of use by the public for communicating opinions and concerns (figure shows how often each option was selected (n=244)).

5.5 Reflecting on El Indicators Recommended in 'Securing the Integrity of Clear Lake and Area'

A report for Parks Canada in 2005, *Securing the Integrity of Clear Lake and Area*', outlined potential indicators (Parks Canada, 2005). In light of what has been learned from this research, some of these indicators have better potential than others. Implementing the CWSI would capture many of the indicators recommended in the Parks Canada report.

5.5.1 Indicators of Clear Water and the WQI

'Securing the Integrity' lists six main parameters for measuring 'clear water' (Appendix C). These align well with the concerns of respondents expressed through the questionnaire. The Water Quality Index (WQI), developed by the Canadian Council of Ministers of the Environment (CCME 2009) and contained within the CWSI, captures these concerns well. The WQI is also designed to be flexible in terms of including locally appropriate variables and timelines. While the WQI is highly technical and not suitable for communication with the general public, the index score presented in the context of the CWSI could better communicate the state of 'clear water' to the public.

Prince Albert National Park (PANP) during 2005 piloted a version of the WQI that it refers to as the 'Lake Ecological Integrity (LEI) Index' (Fitzsimmons and Evans, n.d.). This report could provide guidance for a similar effort in RMNP for employing the WQI. However, while the LEI Index was piloted on Waskesiu Lake to measure "threat[s] to declining ecological integrity due to nutrient inputs, water level regulation and heavy recreational use (eg. angling and boating)" (p. 3), the use of the WQI model is limited to measuring anthropogenic pressures on EI before biophysical changes occur. The LEI Index could prove to be very useful if placed among measures of human interactions with EI.

5.5.2 Endemic Fish Species

As recommended in 'Securing the Integrity', the abundance and health of endemic fish species is under investigation by RMNP resource managers for use as indicators. These attributes can feed directly into the CWSI in the 'fish' aspect of ecosystem health.

5.5.3 Shoreline and Lake Use, Park Visitor Use and Property Values

There are insufficient data and understanding related to property values and park visitors to use them as indicators of ecological integrity in the Clear Lake watershed. The understanding of the direct relationship among property values, park visitation and ecological integrity is not sufficient to make definitive statements of causation. For instance, because property values are influenced by many factors, it is not possible to determine a meaningful correlation between fluctuating property values and changes in ecological integrity. The relationship between park visitorship and EI is much the same. These items could be used as indicators only if the nature

of these relationships becomes clearer as the result of further investigation. In terms of cost and effort, at this time it is more immediately effective to employ indicators, such as water quality measurements and presence or absence of some aquatic species, for which the relationship with ecological integrity is better known, and likely more direct.

Shoreline and lake use, including motorized and non-motorized boating, have potential as indicators in this watershed. According to the watershed questionnaire, 39% of respondents observed shoreline changes as a change in the ecological integrity of Clear Lake. Further research could identify the nature of these changes and suitable solutions. At this time, 'shoreline changes' is not specific enough to be measured and reported in an index, but holds potential with further development.

Motorized and non-motorized boating is important to the local community, and was not perceived by respondents as a significant concern in terms of traffic, lake crowding or interactions between motorized and non-motorized boats. However, before 2007, concerns were raised regarding emissions from boat motors into Clear Lake. In response, the RMNP and the boating community cooperated to promote a higher environmental standard for boat engines. Boat motor compliance to 2006 EPA emission standards for marine engines has been in effect in the RMNP since January 1, 2007 and is nearly 100 percent. This new standard means that all internal combustion marine outboard motors must be either 4-stroke or directly injected 2-stroke engines. Compliance to this standard could be employed as an indicator.

5.6 Indicator Selection and Public Participation

Indicator selection may occur with reference to four main themes (Jackson et al. 2000):

- 1. Relatedness to goals (conceptual relevance)
- 2. Understandability (interpretation and utility)
- 3. Precision/replicability (response variability)
- 4. Effort and cost-effectiveness (feasibility of implementation)

Considering each potential indicator in relation to these themes provides resource managers with a straightforward method of selection and prioritization. Managers may use these four themes to determine which potential indicators are the most suited to local needs, abilities/capacities, and goals.

Continued public participation in the indicator selection and development process is recommended. Further discussion can occur in focus groups, workshops, and community meetings. As well, the survey can be repeated (or another, more specific questionnaire could be developed) and further interviews could be conducted, to review past issues, measure progress towards goals, and to detect any new topics of interest.

Focus groups, workshops and community meetings present challenges and limitations that may be overcome by attentiveness to the contributions of all parties. Conflicts may arise between stakeholders as the result of differing resource perceptions and goals (Grimble 1996). It should be noted that subjectivity cannot be avoided during the selection of indicators, especially related to local knowledge and understanding. As well, power imbalances among stakeholders have the potential to influence outcomes if efforts are not made to ensure that the opinions and knowledge of all participants are substantiated. Such validation may occur by moderating group sessions to ensure that all willing participants may contribute, recording these contributions, and investigating each idea fairly. Participants will be more likely to engage in focus groups, workshops, and community meetings if the setting conveys trust and legitimization of ideas, opinions and knowledge. When conflict does arise, a focus on collaboration may even evoke innovation as the result of initial conflicting interests (Daniels and Walker 1997).

The benefits of community engagement may be limited by knowledge gaps. Where possible, information and education should be provided by the organizing group to facilitate discussions and decision making. Given limits to the types of information that stakeholder participation will provide, strategies to integrate local, traditional and scientific information can encourage a more comprehensive perspective.

5.7 Chapter Summary

This chapter summarizes what was learned through efforts to engage the public in identifying issues to be considered for indicator-style reporting. The community questionnaire, interviews, and Lake Group meetings illuminated issues of importance to the local community and also provided insight into some information and communication gaps.

The issues of most importance to the community and that are proposed as potential indicators are:

- Bottled water use
- Conversion of well-water to treated water system
- Water efficiency and conservation
- Watershed-specific communications

These topics, arising in interviews, meetings, and the questionnaire, undoubtedly reflect the interest of the community and have both social and ecological relevance. Customizing the CWSI to accommodate these issues would increase the local relevance of the reporting, thereby creating opportunity for greater support and uptake of information.

In other ways, the community survey reinforced the subjects already contained in the CWSI. Concern for quality of drinking water, ecological integrity, fish species, and water and wastewater services were among the topics that the CWSI thoroughly covers.

Chapter 6 Conclusions and Implications

6.1 Introduction

In designing the CWSI, the Policy Research Initiative created a useful tool for measuring water 'well being' for communities. Further benefits may arise when each community customizes the index to suit and reflect unique local conditions.

This research has provided insight into the contributions of the public, as part of an ongoing public participation program, to the process of customizing an existing index. Specifically, the information gained from the Clear Lake watershed community, through the questionnaire and interviews, as well as observation at workshops, was used to identify the ways in which the CWSI could be modified to suit local scenarios (see Section 6.4). The emphasis was to understand the knowledge, values and interests of stakeholders in order to determine what modifications might be made to the CWSI, and how indicator-based information and insights can most effectively be communicated to stakeholders. At the same time, attention was given to key social and political aspects, such as historical and current relationships between the Aboriginal communities and park planners, to examine how the former can be more systematically engaged in the development and dissemination of indicator information (see Section 6.3.1.1). Furthermore, attention was given to the strengths and limitations of various participatory methods, in order to identify those most likely to enhance future engagement initiatives (see Section 6.3.1).

This chapter highlights the key results of this investigation and offers recommendations for future work.

6.2 Key results

This research was undertaken to meet four main goals:

- 1. To gather baseline information from stakeholders and partners in the watershed community regarding their interests, concerns, priorities, and knowledge.
- 2. To recommend measurable indicators which reflect baseline stakeholder information with regard to ecological integrity both human and biophysical dimensions of the Clear Lake watershed.

- 3. To examine how stakeholder and partner involvement may enhance or disrupt the development and use of indicators for monitoring, reporting, and communication.
- 4. Identify and recommend ways in which the CWSI may be used to enhance monitoring, reporting, and communication within this watershed.

As discussed here, much was learned through this research and these goals were met in various ways. The questionnaire was distributed to all possible households and businesses within the watershed, and its results provided a baseline that gauges the knowledge of respondents on many watershed related topics. The survey results were corroborated through interviews with individuals representing specific stakeholder interests, and by observation at the advisory group meetings. These results pointed to the interest of the community in bottled water, well water, water conservation, and watershed-specific communication, and these aspects are recommended as additions to the CWSI in future watershed reporting. As well, in some cases, limitations of the research were illuminated, including the low participation rates by KOFN and the interview process.

6.3 Community Participation

The watershed community was invited to participate in this research through a questionnaire and interviews and to share their personal perspectives and information on the watershed. The questionnaire provided insight into the interests and knowledge of the community regarding their water supply, water use, ecological integrity, importance of the lake and area, and communication. The interviews were especially useful for contextual background information that guided the interpretation of the survey data.

348 questionnaires were returned out of 1789 delivered, for a response rate of 19%. The response rate of 19% was higher than the expected 10-15 percent typical for a census drop-style survey, indicating that this was an appropriate technique for this community, and that the community is concerned with the topic. During the same time period, communication with the public was carried out at three meetings of the Clear Lake stakeholder and partner group, in February and October 2009, and in March 2010.

Looking at survey responses based on distribution by area (Table 4.1), most areas are well represented, with the exception of KOFN. Unfortunately, only three surveys were returned

of the 285 provided to KOFN members and make up much less than 1 percent of all the surveys returned. It is evident from this low response that a greater effort is required to obtain information about the concerns, knowledge, and interests of these community members (Section 6.3.1.). Participation may have been limited by the delivery method (post-office box drop-off) or by the state of KOFN's relationship with RMNP, as discussed in Section 6.3.1.1.

6.3.1 Strengths and Weaknesses of Community Input in the Clear Lake Watershed

The overall elevated response may be the result of an unusually high degree of interest in Clear Lake by the local community. In my discussions with community members, both casually and in interviews, it was often clear that Clear Lake and its watershed are integral to the social fabric of this region. Survey respondents and interviewees were thus very willing to share their perspectives on the watershed.

Nevertheless, the survey technique has some limitations. For ease of interpretation, most questions were 'closed' and prevented the respondent from providing extra information or details. To alleviate this weakness, a comment box was included at the end of the survey so respondents could provide additional feedback if they so wished. However, this box was not used very often. Where possible, 'Other' options for specific questions were provided with a blank to capture responses not listed. Again, this opportunity was only used very occasionally. Another limitation is that the response rate of 348 (19%), while good, does not allow for many breakdowns for analysis because sub-groups are usually quite small. For example, in analyzing watershed uses, agricultural land/water use was discarded due to very few responses. This pattern of responses indicates that a greater effort is necessary to reach this stakeholder group and others under-represented.

This research project was the first time that a questionnaire such as this type was used in the watershed for the purpose of gauging the public's knowledge, interest, and concerns, and much can be learned from its design. For example, in order to capture a wide variety of topics that may have value in indicator development for this locale, the questionnaire became long and inclusive. With this questionnaire providing a baseline, it is recommended that future questionnaires be shortened and focused on fewer key ideas related to socially relevant indicators.

The interviews were effective for gaining more contextual information than the community survey allowed. The interviewees discussed the Clear Lake watershed and their involvement related to its integrity. They openly talked about their personal histories, associations or organizations with which they are affiliated, and their experiences in dealing with other stakeholder and partners.

The interview process is limited, however, because it is time-consuming and difficult to interview a large number of people. Efforts were made to interview individuals representing diverse interest groups in the watershed. Eleven interviews were completed, and the subjects were selected to represent the diversity of stakeholders and partners. They included cabin and cottage owners, boaters (motor and non-motor), resort managers, a conservation district manager, a reeve, and members of local First Nations.

Completing interviews at such an early stage in the Clear Lake research had benefits and drawbacks. It was helpful to gain contextual information and a sense of the place through early meetings. But, just as the questionnaire had to be broad to include many topics with potential utility in the project, so did the interviews, making the acquired information fairly general.

The conversations usually flowed through:

- personal background (history) in the area
- current experience and involvement in the area
- opinions on how things were/are/could be
- opinions on interactions among stakeholders/partners/interest groups/ and the Park.
- information sharing.

The information arising from these conversations is valuable, although not directly useful in identifying topics for indicators due to the early stage in the research. Discussions with specific individuals or small focus groups would be more valuable to selecting indicators at a later stage of indicator design and development.

The interview process may also be useful following the first round of watershed reporting. This would allow the interviews to be focused on the quality of the reporting tool and how it can be improved to better suit the interests of the public.

6.3.1.1 Power and Positionality with the Community

While it was not a focus of this study, power and positionality often play an important role in community relations and the Clear Lake watershed is no exception. Certain stakeholder groups are more involved, organized, and influential than others, and efforts are being made to level the playing field by providing more opportunities for individuals to share knowledge, ideas, and issues, such as the advent of the Lake Group. Meanwhile, some positions and power relationships, specifically between RMNP and members of KOFN, will require significantly more time and effort to be re-established in a way agreeable to all partners (Section 2.3.1.2).

RMNP is the main focus of resource management relations in the area and other stakeholders occasionally identify it as a cause of frustration. The Park, being a federal agency and the largest landholder, holds the most decision-making power and requisite resources, including data and information. It is perhaps this power that irks non-Park stakeholders, including the Rural Municipality, and in combination with leftover contention regarding the creation of the Park. The conservation goals of RMNP are seemingly opposite to those of some public interests inside and outside of the Park boundary, including land development, water services, hunting, and some recreational activities (such as all-terrain vehicles, the use of which is banned within national parks). Some community members may harbor disagreement with the Parks Canada mandate based on their preferred activities or past issues and misunderstandings. However, as RMNP increases information sharing and opportunities to collaborate with stakeholders, it will likely experience increasing support for conservation. The current 'climate' is one of growing cooperation and all stakeholders, including the Park, will benefit from collaborative projects and common goals, as well as an increasingly environmentally conscious public.

6.3.1.2 Keeseekoowenin-Ojibway First Nation

For this questionnaire, the number of responses was insufficient to make inferences that could be directly linked to the preferences, concerns, and knowledge of the members of Keeseekoowenin-Ojibway First Nation (KOFN). However, the interviews and discussions held with KOFN members call attention to the experience and knowledge housed in a rich oral history of this

community. It is recommended that efforts be made to further engage KOFN in community meetings regarding the watershed.

The low engagement in this research by KOFN was likely affected by their involvement with Parks Canada to define a cooperative lake management agreement that reflects the place of Aboriginal traditional activities in the watershed. This process is an ongoing one for which time and patience is of the utmost importance. As mentioned in Chapter 3, after being removed from their traditional lands in the Clear Lake area in 1935 and having land returned in 1991, KOFN is now working with Parks Canada to mend relationships and establish cooperation in resource management. Thus far, work towards a cooperative management agreement has been necessarily quite private between the two groups in order to protect the fragile nature of the trust and relationships being established. In terms of this research, it is likely that KOFN community members who are most inclined to participate are preoccupied with work on the cooperative management agreement.

Interviews indicated that, in the past, negotiations between KOFN and RMNP were frustrated by the feeling of imbalances in power and authority. Future efforts must emphasize establishing and validating the roles of KOFN in the management of the watershed. If that outcome is achieved, higher levels of engagement in future research should be possible.

6.4 New Indicators and Support for Existing Ones

Four potential indicators arose from the community surveys that are different from the existing CWSI indicators:

- Number and proportion of households relying on bottled water as primary source of drinking water while in the watershed;
- Number and proportion of houses relying on well water;
- Measurement of selected water conservation and efficiency measures, such as those measured in the questionnaire.
- Number of watershed specific publications distributed per year (as a proportion of the population) OR number of CWSI reports distributed per year.

Customizing the CWSI to accommodate these issues would increase the local relevance of the reporting, thereby creating the opportunity for greater support and uptake of information.

6.4.1 Contributions to and Limitations of the CWSI

The community survey reinforced the subjects or topics already contained in the CWSI. Concern for quality of drinking water, ecological integrity, fish species, and water and wastewater services were among the topics that the CWSI thoroughly covers. As discussed above, community participation helped to identify four indicators that should be added to the CWSI in the Clear Lake watershed because of their local relevance. As well, the participative process provided support for other aspects already contained in the CWSI. In these ways, public participation could improve the application of the index with regard to its social relevance.

However, in some ways, the participative process of this research could have been designed to better fit with the CWSI subject matter. Because it was necessary for the questionnaire to be very broad in order to capture a wide range of watershed issues, it was not possible to address specific indicators of the CWSI. In the future, a questionnaire or community survey could be used to actually provide data for one or more indicators to be reported.

6.4.2 Benefits of and Limitations to Public Participation

Fullenkamp (2003) cautions that questionnaires gather public perceptions, but are not a true substitute for public participation. Based on the experience in this research, it is recommended that future work emphasize ongoing public participation by:

- Continuing to develop the responsibilities of the Clear Lake stakeholder and partner group;
- Holding interviews, workshops and focus groups specific to goal development, indicators, monitoring and reporting; and
- Revising and repeating the community questionnaire.

To reduce the time and resource constraints often cited as limitations to public participation, a mixed-method approach is recommended for future public engagement. When possible, workshops and focus groups involving all concerned stakeholders and partners should be employed. However, to maximize the involvement of relevant stakeholders, Fontalvo-Herazo et al. (2007) suggest preparing open questionnaires for those individuals and parties unable to attend, including researchers and experts who may not reside in the area, but could provide valuable input.

Community engagement in the Clear Lake watershed through the stakeholder and partner meetings, the questionnaire, and the interviews provided an initial opportunity for community members to share information and perspectives on the watershed. This study was an opportunity for the interests and concerns of the public to be viewed regarding potential indicators with real value as additions to the CWSI, and should be viewed as part of what is to become a larger program of community engagement.

6.5 Recommendations

This project was the first time that research such as this type was undertaken in the Clear Lake watershed. Much was learned about the process of engaging the public and the following recommendations are offered for future work.

6.5.1 Future Participation

In continuing the project of identifying locally suitable indicators, a strategy for further community participation can include workshops, focus groups, interviews and questionnaires. The methods employed in this study were suited to its needs and timeframe and can be viewed as part of the beginning of a longer participative process. It may suit RMNP to repeat some aspects of this study, and also to alter them according to future research needs.

The questionnaire in this research was useful for identifying trends, concerns, and perceptions. While this outcome was sufficient for these early stages of the project in the Clear Lake watershed, future work could focus on gathering measurable information from the community that directly feeds into one or more indicators, such as those addressing bottled water dependency or water conservation techniques. The questionnaire might also be revised to be more specific to local issues as they emerge and as the community interests and knowledge evolve.

Workshops and focus groups for stakeholder groups, sub-groups and/or multi-stakeholder workshops may vary in success, depending on the stakeholders in question. Discussions spurred on by workshops may be beneficial to stakeholder awareness, although time and resource constraints must be considered and efforts made to accommodate the attendance of a diverse group of interested community members. Stanghellini (2010) offers a stakeholder analysis

methodology that may facilitate further participation by helping RMNP to better understand the stakeholder community.

Meetings of the Lake Group have been approximately twice each year, day-long events, which is a schedule with benefits and limitations, and may require alterations in the future. Having an entire day to devote to discussing watershed issues and other activities (ie., Watershed tours, water treatment plant tours, presentations) is very beneficial to fostering a high level of engagement, sharing and further understanding. However, twice a year meetings and a reliance on email follow-ups in the interim seem to have thus far hindered vision, goal, and project development. The Lake Group risks floundering in these early stages if visions, goals, and timelines are not readily developed. Future meetings must focus on deciding what the specific purpose(s) of the Group will be.

Future engagement may benefit from the recommendations of Fontalvo-Herazo et al. (2007), who suggest that workshop or focus group activities include:

- Reflections on past problems and current solutions,
- Stating current issues,
- Identifying desirable futures, and
- Defining indicators of change.

6.5.2 Reporting

The style and frequency of reporting should be decided among the stakeholder groups, very much according to practicality and feasibility. Reporting of indicator results is a key component of adaptive management. Through reporting, learning can take place that will influence management strategies. It should be noted that if indicator targets are met or there is a change in goals and objectives, or if changes to the environment occur, then the indicator suite can be adjusted to reflect these developments.

In the CWSI (2007) pilot study, community input suggested that annual reporting would be most beneficial. The seasonality of RMNP and the Clear Lake watershed visitorship indicates that annual reporting would suit this area, as well.

6.5.2.1 Reviewing

Further review of the potential and existing indicators is recommended before and after the first round of reporting using the customized CWSI. Before the customized CWSI will be ready for use, workshops may be planned and devoted to ranking issues of local concern using the scoring method described in Chapter 5. As well, it is suggested that stakeholders and partners identify common goals for the future of the watershed and review the CWSI material in terms of these.

A round of evaluation should also occur after the implementation and distribution of the index to the watershed community. This evaluation could occur through interviews or a simple mail-back survey distributed to the community. Such an evaluation would allow the index to be revised further to suit local conditions and public interests. As well, this could also help to determine if the stakeholder input actually improved the quality of the product.

6.5.2.2 Final Indicator Selection

Stakeholders and partners can advise on selection of the final indicator set. Scoring, described in Chapter 5, will provide information regarding the suitability of indicator options. Final selection must reflect a systems perspective with regard to social and ecological components of ecological integrity, as well as pressures, status, impact, and responses surrounding its management. In order to assure that the final suite of indicators for reporting reflects ecological integrity and is adequately rigorous, scientific advice through a professional review should be sought.

6.5.2.3 Monitoring and Reporting Responsibilities

Due to financial and time constraints on RMNP and other stakeholders and partners, it is necessary that monitoring and reporting responsibilities be established for both the short-and the long-term. This need should be discussed at further meetings of the Clear Lake Watershed Working Group.

6.6 Conclusions

This research has provided insight into some ways in which community members may provide information to better understand the application of the CWSI in a watershed and to the process of

establishing indicators for watershed reporting. It shows that understanding local issues can guide the way that a reporting tool such as the CWSI is used in each unique community.

6.6.1 Future Research and Implications for the Literature

Future research could focus further development of the process to involve the public in defining indicators. As this research was used mainly to gather baseline information on the watershed as it relates to the community, development of engagement strategies should focus specifically on indicator selection or measuring information and data.

The questionnaire is a limited two-way relationship, but proved to be useful when nested within the stakeholder group structure. In the case of this watershed, the stakeholder and partner group are carving out decision-making and advisory responsibilities with the support of Parks Canada. Future research could focus on other components of Parks Canada decision making and the ways in which public participation fits in.

6.6.2 Final Note: The myth about "Keeping the 'clear' in Clear Lake"

Clear Lake ecological integrity may suffer from over-emphasis on maintaining the unique clarity of Clear Lake. While every effort should be made to prevent anthropogenic nutrient loading that could lead to an undesirable change in trophic status and clarity of the lake, the association of 'clarity' with a judgement on lake health or ecological integrity is erroneous. Ecological integrity, when defined in terms of an ecosystem's resilience (*ability to change*), may exhibit a naturally-driven change in nutrient content, in which case clarity may be reduced as a result of increased productivity of biological communities.

Appendix A

Appendix A: Fish species occurring in Clear Lake. Source: Parks Canada, 2005.

Scientific Name	Common Name
Salvelinus namaycush	Lake Trout
Coregonus artedii	Cisco
Coregonus clupeaformis	Lake Whitefish
Esox lucius	Northern Pike
Rhinichthys atratulus	Blacknose Dace
Pimephales promelas	Fathead Minnow
Notropis hudsonius	Spottail Shiner
Notropis heterolepis	Blacknose Shiner
Catostomus commersoni	White Sucker
Percopsis omiscomaycus	Trout-Perch
Perca flavescens	Yellow Perch
Stizostedion vitreum	Walleye
Etheostoma nigrum	Johnny Darter
Cottus cognatus	Slimy Sculpin

Appendix B – Survey



Clear Lake Watershed Survey

Where are You in the watershed?

By living within or near the Clear Lake watershed boundary (see map below) you are a part of the watershed community and your actions and activities play an important role in keeping Clear Lake healthy. What happens in the Clear Lake watershed, even on the land, is reflected in Clear Lake.

We want to know about your activities, interests, concerns, knowledge and priorities regarding the watershed. This information is an important part of conservation efforts.

Your information will be used to help Parks Canada set priorities for further research, monitoring, and tracking the health of the watershed.

As a thank you for participating, you may enter a draw to win your choice of a Char-Lake dinner cruise for two aboard the Martese OR dinner (TR McKoy's) 8 a movie (Park Theatre) for two. To enter, please fill out the accompanying entry form that will be separated from your questionnaire response to ensure anonymity.

Please give the questionnaire to the person in the household who has the next birthday and is over the age of 17. The questionnaire takes about 20 minutes to complete. Your responses will be kept confidential and treated in accordance with Canada's Privacy Act.







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ABOUT YOU AND THE CLEAR LAKE WATERSHED

The Clear Lake watershed is 141km: (14 075ha) of drainage area that surrounds Clear Lake (please
see the map on the first page). Like you, many people live in or near the Clear Lake watershed and
experience many benefits of living in this area. This section poses questions related to your residence
and your activities in the watershed.

1. I	n (or near)	the Clear	Lake watersh	id, our home,	, cottage, o	r cabin is located	E

- O Within the boundaries of Riding Mountain National Park
- Outside the boundaries of Riding Mountain National Park
- 2. How many years have you owned this home, cottage, or cabin?

or cabin?	
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- 3. In or near the Clear Lake watershed, are you a:
- O Year round resident (skip to Q5)
- O Seasonal resident

4. If a seasonal resident, in a typical year, how many days in total is your cabin or cottage occupied?

□ Less than 7 days	 4 weeks to just under 5 weeks
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or these 6	managir w
w	ess than 6

- O 2 weeks to just under 3 weeks O 6 weeks or more
- O 3 weeks to just under 4 weeks
- 5. How many people normally reside at your Clear Lake watershed residence?

nce?	
------	--

Please rate how important each of the following activities are to your experience in the Clear Lake watershed area.

	THE PARTY WATER AND STEEL.	Does not Apply	Not at all Important 1	2	3	4	5		Very Important 7
	Beach and/or swimming	0		0		0	0	0	0
	Motorized boating	0	0	\circ	0	0	0	0	0
	Non-motorized boating	0	0	0	0	0	0	0	
	Recreational fishing	0	0	0	0	0	0	0	0
41	Subsistence fishing	0	0	0	0	0	0	0	0
8	Agricultural land/water use	0	0	0	0		0	0	0
(5	Other pecify)	•	0	0		0	0	•	•

The traditional use of land/water	of land/water				Not at all						W
place for family/individual experiences The setting for personal or community spiritual experiences The cultural heritage of the Clear Lake region The aesthetic appeal of the lake and Rs natural surroundings The ability to learn through hands-on experiences in nature As a vacation destination Other (specify): WATER QUALITY, SUPPLY & DEMAND 8. While in the Clear Lake watershed, the majority of your drinking water is supplied by the surrounding water of the content water water water water water supplied by the confident are you in the following aspects of your drinking water supply? Well-water Quantity Well-water Quantity Well-water Quantity	Resperiences If experiences If experiences If the lake and surroundings If the lake and surr			Know		2	3	4	5	6	
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Safety O O O O O O O O O O O O O O O O O O O	water quality in the Clear Lake watershed is:	Bottled water/water coolers	O We	I water		of yo	ur drini	king wa	iter is s	upplie	d by
Well-water Quantity	water quality in the Clear Lake watershed is:	Bottled water/water coolers RMINP waterworks	Oth the foll	Il water er (spec owing a Not at a Confiden	aspects of	of you	ır drinki	ing wat	er supp	oly? Very Confide	
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			Clear Lai	ce has:			Changed	Don't
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				showers	do you t	ake per	week?	0
			mir	utes per	shower	(on ave	irage)?	
				baths	do you t	ake per	week?	0
teeth	brushi	ing, han	d washin	ig, and si	having e	vents p	er day?	
			loads	of laund	y do you	do per	week?	Ò
		times	do you h	and-was	h your d	ishes p	er day?	0
		time	s do you	run the	dishwas	her per	week?	P
			times do	you wa	sh your c	arperi	month?	
tir	mes do	you wa	ter your	garden a	and/or la	wn per	week?	0
minu	tes do	you wat	ter your	garden a	nd/or la	wn eac	h time?	0
ninutes do yo	u rins	e equipa	nent, dri	veways	ır sidewi	ilks per	week?	0
b. Do you ow	n a sw	imming	pool?	Yes C	No (ski)	to Q1	3)	
s. What is the	сарас	city of y	our swim	sming po	ol (in cul	bic met	res)?	
12d. Ho	w man	y times	per year	do you d	empty yo	ur swir	nming pool	•



13. Please indic in the Clear						-	ures that y	ou use w	hile
O Water recyclin	ng or gre	iy wate	r reuse						
O Water saving	technolo	igles, s	uch as lo	er or dual	flush toil	ets or fa	ucet aerato	rs	
Composting b	oilets								
O Reduced show	wering ti	me							
C Low-flow show	werhead	s							
O Rainmater col	lection								
O Repairing leaf	ks								
O Water-saving	distrwas	her							
O Hand-washing	g dishes	in a wa	ter effici	ent mann	er, such a	s tumin	g off the wa	ter betwe	en rinses
O Water-saving	clothes	washer							
O Clothes washi	ing anly	when t	here is a	full load	or using l	oad-size	settings		
O Reduced lawn	waterin	g (once	a week	or less)					
O Watering laws	n and ga	rden be	efore 8an	n and afte	er 8pm				
O Water efficien	it landsc	aping w	ith wate	r-wise (at	ten mativ	e or ada;	ptive) plants	5	
○ Trigger nozzle	on hose	86							
O Pool cover									
Other (Please	specify)	:							
O I do not use a	any wate	roonse	rvation o	r efficien	cy measu	res			
14. To what deg saxings for No Se	your ho						Substantial Substantial Substantial 7	Don't Know	ide <u>financial</u>
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	0	0	Ô		Ò	0	0	0	

ECOLOGICAL INTEGRITY

Ecosystems have **ecological integrity** when their native components (plants, animals, and other organisms) and processes (such as growth and reproduction) are intact. This section poses questions related to your observations of ecological integrity in the Clear Lake watershed.

of Clear Lake ha Not Change at All						Changed Significantly	Don't Know	
1	2	3	4	5	6	7		
0	0	0	0		-0-	9	0	
			ecologío	al integ	rity d	ecreased (-) or improv	ed (+)
	Decrease Significant						Improved Significantly	Bon't Know
	-3	-2	-1	0		+1 +2	+3	
	0	0	0	0		0 0	0	0
6c. Please indicate including the p						Clear Lake	watershed	up to
16c. Please indicate including the place increased lake levels			ade all ti		y)		watershed	up to

Increased lake levels Decreased lake levels	Presence of aquatic plants Absence of aquatic plants
Early spring ice break-up Late spring ice break up	Presence of shorebirds or waterbirds Absence of shorebirds or waterbirds
Early wiinter ice freeze-over Late wiinter ice freeze-over	Increased water clarity Decreased water clarity
O Shoreline changes (natural or otherwise)	O Increased land development (within the watershed)
Presence of algae Absence of algae	One characteristic content of the material content of the content
T3	○ None





17. How do the following factors influence the ecological "health" (integrity) of Clear Lake and its watershed? Please rate each factor on a scale of -3 to +3, where -3 is 'very negative influence' and +3 is 'very positive influence'.

	Don't	Negative Influence			No Impact		Positive Influence	
	Know	-3	-2	-1	0	+1	+2	+3
Shoreline development	. 0	0	0					0
Domestic water supply	0	0	0	0	0	0	0	0
Water treatment	0	0	0	0	0	0	0	
Wastewater treatment	0	0	0	0	0	0	0	0
Storm water management	0	0	0	0	0	0		0
Boat traffic	0	0	0	0	0	0	0	0
Recreational fishing	0	0	0	0	0	0		0
Subsistence fishing	0	Q	0	0	0	0	0	0
Fishing quotas	0	0	0	0	0	0	0	0
Barriers preventing fish access to spawning areas		0	0	0	0	0	0	0
Leaking septic tanks	0		0	0	0	0	0	0
Septic fields	0	0	0	0	0	0	\Box	
Agricultural run-of	y O	0	0		0	0	0	0
Erosion	0	0	0	0	0	0	0	0
Invasive or exotic species	s 0	0	0	0	0	0		
Nutrient addition to lake from ground and surface run-off, other than agricultural	ı v	D	0	Q	0	0	0	0
Municipal, provincial, and federal cooperation on management of natural resources	10	۰		•	•	۰	•	•
Policies and regulations	, 0	0	0	0	-0		0	0
Monitoring (water quality and ecological integrity) by resource managers			0	0	0	0	0	0
Other:	0	0	0	0	0	0	0	0

Have you voiced ideas, support or concerns regarding the Clear Lake watershed to any of the following? (Shade all that apply)
O Local or regional newsletters
Organization newsletters
Rural municipality of Park
O Riding Mountain National Park (RMNP)
O Local resource managers
O Community meetings: (Please specify which community)
Stakeholder meetings specific to Clear Lake watershed
Other:
9. Have you received information regarding Clear Lake watershed?
Yes → How?
No ¬,
If Parks Canada made it available, would this type of information be of interest to you? O Yes O No
TELL US ABOUT YOURSELF Gender Gender
20. Please indicate your
21. Are you an Aboriginal person? O Yes O No (Skip to Q22)
21b. Are you O First Nation O Metis O Inuit
21c. Which community are you from?
22. Do you agree to the use of anonymous quotations arising from your comments or expansion on responses to questions to be used in reports or publications that result from this research? Over ONO Additional comments relating to your experience in the Clear Lake watershed area:
4200
Thank you for your participation! Please return the questionnaire in the postage paid envelope provided. As a member of the Clear Lake watershed community, your contribution to this research is very valuable. Don't forget to fill out your prize draw!

INFORMATION SHARING

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Appendix C – Securing the Integrity Indicators

Table 2: Ecological Integrity Indicators

Ecological Integrity Indicators	Measurable Parameters & Guidelines
Clear Water	• Secchi Disk visibility, a key measure of water clarity, must be maintained at or above 3.7 metres (See Table 3, Section 2.1.4).
	• Chlorophyll a, the key indicator of algal biomass, must be maintained at a low concentration, not exceeding 7 micrograms per litre (µg/L), and with a mean open water season value of 2.15 µg/L (See Table 3).
	• The total Phosphorous concentration must not exceed the current annual mean concentration of 54 micrograms per litre (µg/L) and the Total Dissolved Phosphorous concentration must not exceed the current annual mean concentration of 26 µg/L (See Tables 3 & 4, Section 2.1.4).
	 Fecal coliform levels attributable to human activities must be maintained below 200 CFU/100 ml, consistent with current Manitoba and National guidelines for body contact water recreation.
	 Nutrient loading from ground and surface water sources in the lake basin must be managed to maintain the current oligotrophic conditions as per the above parameters.
	 The sustainability of the lake water for drinking must be maintained such that the water will require no more than disinfection and filtering for safe consumption, as demonstrated by regular monitoring.
Endemic Fish Species	• The abundance and health of endemic northern pike, whitefish, yellow perch and slimy sculpin populations must be sustained, as determined by regular monitoring to determine health and age class distribution.
	 Monitor the abundance and health of whitefish and slimy sculpin in the hypolimnion.
Shoreline and Lake Use, Park Visitor Use and Property Values	Annual park visitor use will be monitored and any trends in reduced numbers assessed re: Clear Lake integrity.
	 Regularly monitor property value trends in Wasagaming and the RM of Park as indicators of Clear Lake integrity.
	 No net new development of Clear Lake's shoreline should occur on those lands controlled by Parks Canada. Other development and redevelopment that may occur in the future should be planned to conform to the current scenic aesthetics of the lake, with no additional nutrient loading into the lake.
	 Power boating on the lake should be annually monitored to ensure that excessive crowding, noise and disruptions to wildlife, shoreline stability and the natural experiential opportunities for all lake users, do not occur. Emerging indications of such problems should be addressed by preparing lake planning and carrying capacity guidelines and regulations.
	• By 2007, all boat motors must comply with 2006 EPA emission standards.

Appendix D- Interview Guide

Interview notes:

- Thank you for meeting with me today.
- This will be an informal discussion, we'll just be chatting so feel free to ask questions throughout or interrupt me if something doesn't make sense or if something comes to mind.
- May take an hour, more or less.
- Please be as honest as possible. This discussion is confidential. If you don't mind, we will be recording this to help me capture what we talk about. Only I will listen to the record as I transcribe it. This helps me have an accurate record of what we speak about and then I erase the recordings when the research is completed (in a few months). You will not be identified in the report, and only the organizations from which representatives were interviewed will be noted in the appendix of the reports arising from this research (my thesis and reports for the Park).

I am conducting these interviews:

- To better understand your activities, interests, concerns, knowledge, and priorities regarding the Clear Lake watershed.
- We will also be talking about how we can use the knowledge and information from stakeholders and partners, like you (and your organizations), and how Parks can facilitate information sharing and public participation.

Background:

- 1. Let's first talk a bit about you:
 - Do you represent a local organization or interest group in the area? (Cottage Owners Association, Grey Owl, Tenants' Association, Boaters' Association, Non-motorized Boaters, Friends of the Parks)
 - Are you a seasonal or year round resident of the Clear Lake Watershed area? Are you a cottage / cabin owner?
 - Are a business owner? Is this a seasonal or year round business? (Resort, restaurant, retail store, golf course, church camp, etc.)
 - Do you represent any of the surrounding communities (Onanole; Keeseekoowenin-Ojibway First Nation; rural areas)?
 - Do you represent RMNP? Member / part of a resource management specialist or agency?
 - Can you show me on this map whereabouts you reside in the watershed?

- If you are a seasonal resident, about how many weeks / days do you spend at your cabin / cottage?
- How long have you lived / owned or operated a business / owned a cottage or cabin in the Clear Lake watershed area?

During this interview, if your own personal views are different from those of the organization you are representing, please make them known as it is important for us to have a clear understanding of where everyone stands on the issues.

2. What types of activities do you do in the Clear Lake watershed area? How do you / your family / your organization / use the watershed?

Probes:

- Swim / beach
- Motorized boating
- Non-motorized boating canoeing, kayaking, rafting
- Recreational fishing
- Subsistence fishing
- Agricultural land / water use
- Drinking water / Use water for household purposes
- Other

Water consumption in the Clear Lake watershed:

- 3. Has your water consumption changed / increased / reduced / stayed the same over the past 10 years, for example? How? Why / why not?
 - How about how and for what you use water has this changed over time?
 How? Why / why not?
 - What types of things do you / your business / community / organization does to conserve water while in the Clear Lake watershed?

Probes (if necessary):

- Water recycling or grey water reuse
- Water saving technologies, such as low or dual flush toilets or faucet aerators
- No-flow toilets

- Reduced bathing time
- Low-flow showerheads
- Rainwater collection
- Repairing leaks
- Water-saving dishwasher
- Hand-washing dishes in a water efficient manner, such as turning off the water between rinses.
- Water-saving clothes washer
- Clothes washing only when there is a full load or using load-size settings
- Reduced lawn watering (once a week or less)
- Watering lawn and garden before 8am and after 8pm
- Water efficient landscaping with water-wise (often native or adaptive) plants
- Trigger nozzle on hoses
- Pool cover
- Other
- 4. (If you have another / permanent residence other than the one located in the Clear Lake watershed) Is your water consumption different at your residence / business in the watershed compared to your permanent / other residence not located in the watershed? How? Why / why not?

Securing ecological integrity of Clear Lake watershed / water quality:

- 5. How would you rate the water quality in the Clear Lake watershed? Why?
 - Is the water quality of the Clear Lake watershed important to you? Why / why not?
 - Has the water quality changed over the years? How? Significantly or only slightly? Why do you think that is?
 - Have you done anything about the water quality issue or changed your water use habits? (Probe: now drink bottled water, don't swim in Clear Lake, conserve water, have talked to Parks Canada or water resource management representatives, etc.)
- 6. Are you concerned about the Clear Lake watershed? Why / why not? What are the major issues for the watershed community? Do the water quality / water related issues in the watershed have an effect on:
 - Tourism industry? Why / why not? How?
 - Aesthetic appeal of the lake and natural surroundings? Why / why not?
 How?

- As a vacation destination? Why / why not? How?
- Area for enjoyment by families and children? Why / why not? How?
- 7. What about the traditional use of land / water? Does this have an impact on the watershed? How?

Probes:

- Subsistence fishing
- Place for community or spiritual experiences
- Cultural heritage of Clear Lake region
- 8. What regional strengths, if any, are supported by Clear Lake and its watershed?
 - a. Is **financial wellbeing** in the region dependent on or supported by the watershed and its related resources, such as domestic water supplies, fishing, recreation, aesthetics, etc? (ie. In what ways does the region benefit financially from its relation to the watershed?) *If yes, in what ways?*

Probes: Water dependent activities and water resources: tourism industry, agriculture, fishing, recreation.

- b. How does social wellbeing in this region depend on or benefit from the watershed and its related resources? *If yes, in what ways?* Probes: sense of community, education, recreation, spiritual experiences, traditions, health.
- c. Are there ways that we might be able to measure and report on these components of regional wellbeing?
- 9. How well do you think RMNP is managing various watershed activities? You may also describe watershed initiatives put forth by the RM of Park, the Little Saskatchewan River Conservation District, Keeseekoowenin-Ojibway First Nation, etc.

Probes:

- Recreation (boating, swimming, etc.)
- Vacation destination

- Hands-on / experiential learning This refers to the 'outdoor classroom' concept, where natural science and appreciation of nature is conveyed through experiential learning.
- Personal or community spiritual experiences Is Clear Lake and/or its watershed important to you in a spiritual sense? Has this changed for you or is has the opportunity for spiritual experience been maintained?
- Cultural heritage *Are the cultural aspects of Clear Lake and its watershed (present and historical) being adequately protected and presented?*
- Traditional uses What traditional uses of Clear Lake and its watershed area are important to you? Have you experienced changes to these? Have some been lost? Have some been maintained?
- Agricultural land and water use / management *This is tied to the concept that what happens in the watershed is connected to the lake, so agricultural activities impact, and are impacted by, the Clear Lake watershed.*
- Aesthetic appeal of Clear Lake and its surroundings *This is a major draw for visitors and households in the area. However, the aesthetics change*
- Domestic water supply *Water for use in households, businesses, including drinking water.*
- Wastewater treatment *The treatment of domestic water supplies that eventually is returned to the ecosystem.*
- Water-related requirements for biological function (EI) *The ecological functioning of the Clear Lake watershed depends on certain water-related necessities. Have human activities infringed on these?*
- Information management, access and sharing This refers to the idea that the various agencies and groups (including stakeholders and partners) hold information and knowledge about the Clear Lake watershed area. There are potential benefits in greater sharing of information and ease of access to information among these agencies and groups.
- Stakeholder / partner relations / cooperation on watershed issues.
- Other family / individual experiences general / other
- 10. In your opinion, how can these issues be resolved? Do you have any suggestions for improvements?
- 11. How can the Clear Lake watershed community be encouraged to be more efficient or conserve freshwater resources? What about those who participate in similar activities as you do (i.e., other boaters, business owners, community residents, cottage owners, etc.)?

Public involvement:

- 12. What is Parks Canada's / Riding Mountain National Park's role in the watershed's resource management?
 - Do you see there being enhanced cooperation between RMNP and the public?
 - Would this be going in the right direction or on the wrong track? Why?
 - Is this important / desirable to you? Why / why not?

Let's talk specifically about how the public and Clear Lake watershed community can be involved in this process and in the long term, considering the importance and significance of these issues.

- 13. How can the watershed community / public be involved in assisting with the resource management of Clear Lake and its watershed?
 - How do you foresee this cooperation working? Is anything happening right now in the way of Parks Canada and public cooperation?
- 14. Are you interested in becoming involved in this process? How? Why / why not? What about the organization or community you represent?
 - How do you see yourself being involved?
 - What do you think of when I say, "citizen science"? How could you contribute to citizen science in terms of the Clear Lake watershed?
 - Do you / the organization or community you represent have any special knowledge or skills that could contribute to a citizen science program or approach? What are they?
- 15. What are the benefits / drawbacks of cooperation for the public and the park? Why?
 - Are there any (perceivable) limits to this cooperation made by RMNP or the public?
 - What are the opportunities for greater coordination or cooperation? Why / why not?
- 16. What, if any, are the opportunities for greater coordination or collaboration in the management and monitoring of the Clear Lake watershed?
 - a. Among resource management bodies (governmental or non-governmental)? The watershed falls under the jurisdiction of several political bodies: Parks

Canada; RM of Park: Province of Manitoba (Little Saskatchewan River Conservation District); Keeseekoowenin-Ojibway First Nation; UN Biosphere Reserve. There may be opportunities for greater coordination among these.

- b. Among communities (of either 'place' or of 'interest groups')?
 - i. Places: Wasagaming (inside the Park); Onanole (outside the Park); Keeseekoowenin; and rural surroundings
 - ii. Interest: Could there be greater cooperation between various (and sometimes competing) interest groups)?
- c. Between resource managers and communities?

Thank you for your participation!

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