Toward Community-Based Monitoring in the Hog Industry in Manitoba

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1. Executive Summary

Rapid changes in hog production in Manitoba are occurring within the context of an outdated regulatory framework and uncertain environmental impacts. The purpose of this report was to explore the potential for community-based monitoring of the hog industry in Manitoba. Information was gathered though an in-depth literature review, encompassing scholarly literature, government and non-governmental organization publications, and documents presented at recent and on-going public hearings in Manitoba and elsewhere.

Findings suggest that, while there is recognition that monitoring is a critical tool for understanding change in complex social-ecological systems, it is often underutilized. Although monitoring may serve a range of functions, including the confirmation of predicted changes and the identification of unanticipated changes (progress monitoring), and the collection of new baseline information, cumulative effects assessment and evaluating progress towards sustainable development (knowledge monitoring), it is most often employed strictly to ensure that specific activities are conducted within parameters established by a permit, license, regulation or statute (enforcement monitoring). While this latter function is necessary, it is insufficient to achieve integrated, sustainability-oriented models of resource management. A "best practice" approach to monitoring brings together enforcement, progress, and knowledge monitoring, and works to legitimize important roles for policy actors other than government and industry.

Analysis of two models of "best practice" monitoring employed in Canada suggests that community-based monitoring (CBM) is the most suitable approach for intensive hog production in Manitoba. CBM is a process in which individuals, government agencies, the private sector, academics and community-based organizations work together to monitor, track, and respond to issues of common concern. This is simultaneously a participatory exercise, scientific process and a decision-support tool designed to generate understanding of complex systems, such as that created by industrial hog development. At the core of CBM is the gathering of systematic observations about the social-ecological changes for the purpose of managing, and responding to these changes. Within

the context of Manitoba's hog industry, CBM may be particularly adept at improving monitoring, enhancing social cohesion, and strengthening governance.

The paper does not offer a detailed prescription but instead outlines a preliminary blueprint, hinging on an incremental approach to developing a CBM program for the hog industry in Manitoba. We recommend a three-tier approach, involving a feasibility study, a pilot project and evaluation. First, the CEC should seek a renewed mandate from Manitoba Conservation with a particular focus on CBM and the hog industry. Second, a pilot project of at least three years in duration should be established guided by CBM best practices (or critical features of success). Finally, evaluation needs to be an integral part of the pilot project to ensure that adaptations are made on a regular basis and lessons are derived from the project's final results.

The three-tier approach should be grounded in legislation or other explicit policy document, and in this regard section 6(5) of *The Environment Act* could and should be used to grant to the CEC a mandate to oversee the project. Following the final evaluation phase, if a CBM program is adopted, it should be based in its own specific legislation, although section 6.1 of the *Livestock Manure and Mortalities Management Regulation* appears to be broad enough to found such an initiative.

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2. Introduction

Rapid changes in hog production in Manitoba are occurring within the context of an outdated regulatory framework and uncertain environmental impacts (Public Interest Law Centre 2007, 4). Monitoring is a critical but underutilized tool for managing on-going and future development in the complex system of livestock production. "[M]onitoring is an activity designed to identify the nature and cause of change. More specifically, it is a data collection activity undertaken to provide specific information on the characteristics and functioning of environmental and social variables" (Noble 2005, 141).

Monitoring is undertaken for a variety of reasons, which can be grouped into three broad interconnected categories: enforcement, progress, and understanding (Noble 2005). Enforcement or compliance monitoring is designed to ensure that specific activities are conducted within the boundaries described by regulation, statute, permit or license. Progress monitoring fulfils a watchdog function, meant to confirm predictions and identify unanticipated changes. Monitoring for understanding is designed to "increase knowledge and understanding" (Noble 2005, 144) about complex environments, thereby providing insight for future activities.

There are a variety of approaches to monitoring. Individual programs are tailored to specific functions, and thus have different temporal and spatial dimensions. While government and industry are fundamental participants of all environmental monitoring, the public is playing an increasing role in design, data collection, interpretation and communication of results. Such community-based approaches are becoming more prevalent in the context of environmental problems characterized by uncertainty, complexity and conflict (e.g. Ludwig 2001; Vaughan, Whitelaw, Craig, and Stewart 2003; Diduck 2004), and thus hold promise with respect to non-point sources of pollution. Non-point pollution sources, by their very nature (multiple, diffuse, obscure, episodic), are uncertain, raise scientific and management complexities, and are often rife with conflict (Raven and Berg 2004; Cunningham, Cunningham, Woodworth Saigo,

Bailey, and Shrubsole 2005; Marshall and Jones 2005). As such, there is a need to engage a broad range of policy actors in monitoring.

The purpose of this report is to explore the potential for community-based monitoring in the context of the hog industry in Manitoba. The report is an in-depth literature review, encompassing scholarly literature, government and non-governmental organization publications, and documents presented at recent and on-going public hearings in Manitoba and elsewhere.

2.1. Organization of the report

The report is presented in five parts. Section 3 provides a brief overview of the hog industry in Manitoba and situates this report within the CEC's terms of reference. Section 4 discusses monitoring, and identifies different approaches employed in environmental management in Canada. Stemming from this description is an argument about why community-based monitoring (CBM) serves as a highly promising approach, given the role of non-point pollution as an area of key concern for managing hog production. Section 5 presents an overview of CBM, including the history, opportunities and limitations, and potential models within this approach. A brief discussion of monitoring in the hog industry in Manitoba follows in Section 6. Section 7 identifies research conclusions and a set of recommendations for integrating CBM into the management and governance of the hog industry in Manitoba.

3. The hog industry in Manitoba

From the time of European settlement, agriculture has played a key role in the province. For approximately a century, production of wheat and other grain crops was the primary agricultural activity. Since the 1970s, however, the wheat economy has been in decline, increasingly being replaced by hog production. This trend is due to a number of factors, including depressed grain prices in the world market, higher shipping costs caused by railway deregulation and the loss of the Crow rate, and a rising demand for pork worldwide, particularly in Asia (Livestock Stewardship Panel 2000; Ramsey and Everitt 2001; Novek 2003b). In recent decades, the Manitoba government has been actively promoting the expansion of the hog industry based on its "Manitoba advantage," namely, inexpensive grain for feed and a large acreage of cultivated land that can be used for waste assimilation (Diduck and Mitchell 2003; Novek 2003b). Increases in hog production in Manitoba have occurred in three phases: 1968-1973, 1983-1988, and 1995-2000, with the largest increase occurring during the last phase (Ramsey and Everitt 2001). During the last decade, Manitoba has become the third largest hog producer in Canada, behind Quebec and Ontario, and hogs are now the leading source of revenue for Manitoba farmers (Novek 2003b). In 2005, 8.6 million hogs were produced in the province, the breeding herd consisted of 377,200 animals, and hog production contributed approximately $1.8 billion in farm cash receipts to the Manitoba economy (Manitoba Conservation 2006).

The expansion of the hog industry in Manitoba has been characterized not only by an increase in overall production, but also by a shift toward larger, more intensive operations. Formerly, hog farming tended to be undertaken on a small to medium scale as a part of diversified family farms (Qualman 2001). Today, the industry is much more concentrated, with fewer producers and much larger and more intensive operations (Qualman 2001; Ramsey and Everitt 2001; Novek 2003b). Vertical integration has also occurred, in which aspects of the hog production industry from barns, to feed mills, to packers, are working under the same umbrella through mergers or other agreements

(Qualman 2001; Novek 2003b). Simultaneously, corporate ownership is also on the rise (Novek 2003b). These changes are part of broader trends in the economy fuelled by the globalization of agriculture (Qualman 2001; Novek 2003b).

The shift toward larger, more intensive hog operations has introduced a host of environmental concerns. Primary among these is the amount of waste produced by hogs. Generally, hog manure is liquefied and stored in lagoons until it can be applied to the land as fertilizer (Qualman 2001; Novek 2003b; Manitoba Conservation 2006). The manure contains large amounts of nitrogen, ammonia and phosphorus, which become problematic when applied to the land in volumes that exceed the capacity of plants to use them (Draper and Reed 2005; Manitoba Conservation 2006). Excess nutrients are likely to leach into water systems, fuelling the growth of algae, which then reduce oxygen levels, clog fishing nets, and cause problems with drinking water. There is increasing concern that nutrients from hog manure are contributing to the decline in water quality in both the Assiniboine River and Lake Winnipeg, and water quality has become the primary environmental concern associated with intensive hog operations (Livestock Stewardship Panel 2000; Novek 2003b; Lake Winnipeg Stewardship Board 2006; Manitoba Conservation 2006).

There are also health concerns associated with intensive hog operations. A variety of infectious diseases that affect swine are also harmful to humans. These pathogens can be transmitted through manure if proper management practices are not used (Qualman 2001; Novek 2003b; Manitoba Pork Council 2007). Of particular concern is the fact that manure used for fertilizer is often not treated before being spread on fields (Qualman 2001). Furthermore, the routine use of antibiotics to promote growth and control disease in crowded barn conditions is a possible factor in the emergence of disease organisms that are resistant to antibiotics (Horrigan, Lawrence, and Walker 2002; Hays, English, Carter, Proescholdt, Lee, Wagner, and White 2003). The use of antibiotics is, however, strictly monitored by local veterinarians (Manitoba Pork Council 2007). Additionally, various aspects of these operations, including the storage and application of wastes, as well as the high density of the animals confined in barns, produce air pollution in the form of

gaseous emissions (e.g., hydrogen sulphide, ammonia, methane-related compounds), airborne particulates, and odour. More research is needed, but such pollution has been linked to adverse effects on psychological health (e.g., higher levels of tension, depression and anger), physical health (e.g., increased occurrences of sore throat, coughing and headache), and quality of life (e.g., prevented from going outside by bad odours) (Schiffman, Miller, Suggs, and Graham 1995; Wing and Wolf 2000; Thu 2002).

Provincial and municipal governments find themselves in a difficult position for addressing the environmental, social and economic issues related to the expansion of the hog industry. They are caught between their responsibility to promote development and their role as environmental regulators (Novek 2003b). When first confronted with this dilemma in the 1970s in the form of complaints about odour associated with hog operations, the provincial government responded with "right to farm legislation" that favoured the industry. Odour complaints were dismissed as subjective and the Manitoba government exempted livestock operations from *The Clean Environment Act* and passed *The Nuisance Act*, which prevented hog operations from being sued for nuisance (Novek 2003a; 2003b; Public Interest Law Centre 2007).

In 1978, a Clean Environment Commission investigation led to more regulation in the form of the *Livestock Manure and Mortalities Management Regulation*. While this improved environmental standards on paper, problems with enforcement have persisted (Novek 2003b). At this time, it was also decided that to mitigate odour problems, communities (e.g. rural municipalities) would be responsible for determining where hog operations should be located. Unfortunately, few communities had development planning mechanisms in place to deal with this responsibility and they lacked both the cultural authority and the technical expertise to engage in local regulation. Consequently, hog operations were introduced into many communities in the face of stiff local opposition. Many communities in southern Manitoba have become polarized and their social fabric has been tested through on-going conflicts over hog operations (Common-Singh, Guilford, Macdonald, Turnock, and Welsted 2000; Novek 2003a; 2003b).

Management of the hog industry came under review again in the late 1990s when the NDP government came to power. It appointed the Livestock Stewardship Panel to study the sustainability of the hog industry. A sustainable development approach was adopted in the resulting report (Livestock Stewardship Panel 2000), embracing the assumption that environmental and economic goals can converge. In practice, however, building bridges between these two imperatives has proved to be difficult, particularly in terms of regulation (Novek 2003b).

3.1. The CEC mandate in the hog industry review

Most recently, in November 2006, the provincial government imposed a temporary, partial moratorium on expansion of the hog industry, and charged the CEC with reviewing the sustainability of hog operations in the province. The moratorium was accomplished by amending the *Livestock Manure and Mortalities Management Regulation* to suspend the authority of the Director (appointed under *The Environment Act*) to issue permits respecting manure storage facilities and confined livestock areas capable of handling 10 animal units or more of pigs.[1] The moratorium was not absolute, as several exceptions to the moratorium were provided. For example, permit applications received before the Regulation was amended, as well as permits to repair and improve manure handling facilities may receive Director approval. The Terms of Reference for the CEC review, along with the November 6, 2006 letter of direction from the Minister of Conservation, required the Commission to:

- review and assess current environmental protection measures regarding hog production in Manitoba;
- convene public meetings and otherwise gather public comments on the matter;
- review the provincial government's recent report on the hog industry (namely Manitoba Conservation 2006);

[1] For the purposes of the *Livestock Manure and Mortalities Management Regulation*, "animal unit" means the number of animals of a particular category of livestock that will excrete 73 kg of total nitrogen in a 12 month period. One mature cow of approximately 1,000 lb. (454 kg) and a calf up to weaning, usually 6 months of age, is the standard measurement of an animal unit, which is equivalent to approximately 2.67 breeding hogs (Agriculture and Agri-Food Canada 2003; United States Department of Agriculture 2006).

- consider experiences from other jurisdictions with respect to the sustainability of hog production; and,
- make recommendations on how to improve the sustainability of hog production in the province.

In keeping with the broad parameters of the CEC's mandate in this matter (i.e., sustainability and environmental protection) this paper focuses on what is generally considered to be an essential element of sustainability-oriented resource and environmental management, namely monitoring (Mitchell 2002; Marshall, Arts, and Morrison-Saunders 2005; Sánchez and Figueiredo Gallardo 2005).

4. Environmental monitoring: a brief introduction

This part of the paper provides an introduction to monitoring, including how it relates to resource management, and the range of purposes to which it is often directed (Section 3.1). Enforcement monitoring, which has a relatively lengthy track record in resource management, is analyzed and critiqued (Section 3.2), and vexing questions that plague this form of monitoring provide the basis for identifying best practices in monitoring programs (Section 3.3). We then turn to two forms of monitoring that manifest several of these best practices: models reliant on independent oversight bodies (Section 3.3.1) and those that are highly community based (Section 3.3.2). Both of these models, particularly the community-based approach, are instructive when considering monitoring needs and opportunities in the hog industry in Manitoba.

4.1. A broad conception of monitoring

As noted earlier, our view is that monitoring is a critical but underutilized tool for understanding and managing changes in complex social-ecological systems, such as systems of intensive livestock production. In short, we agree with Nelson and Serafin's (1995; 1996) conceptualization of monitoring as one of six linked management processes that are necessary for understanding social learning for sustainability (Figure 4-1, page 9). In a similar vein, we agree with the model of resource and environmental management adopted by Indian and Northern Affairs Canada (2007), which again views monitoring as vital to making resource use decisions that are consistent with sustainability criteria (Figure 4-2, page 10).

We define monitoring as a set of activities that involves observing and describing changing conditions, identifying the potential causes of those changes, and translating data into useful information (Noble 2005). In environmental assessment practice, which includes a significant literature on monitoring, a narrower conception is often used. For example, the *Canadian Environmental Assessment Act* (1992, c. 37) treats monitoring as

just the first activity (data collection) in a set of four that are undertaken as part of "follow-up" (Marshall et al. 2005; Storey and Noble 2005). Data are then evaluated (activity two) and used to manage impacts (activity three) before results are communicated (activity four). However, consistent with our approach, outside the context of environmental assessment, monitoring is often viewed as involving data collection and management, and is often discussed in concert with evaluation (Mitchell 2002). As noted by McDonald (2002, 321) "[e]valuation must always be present to give a purpose and justification to monitoring." Thus, in our view, a comprehensive and complete monitoring program should address each of the activities described in environmental assessment follow-up.

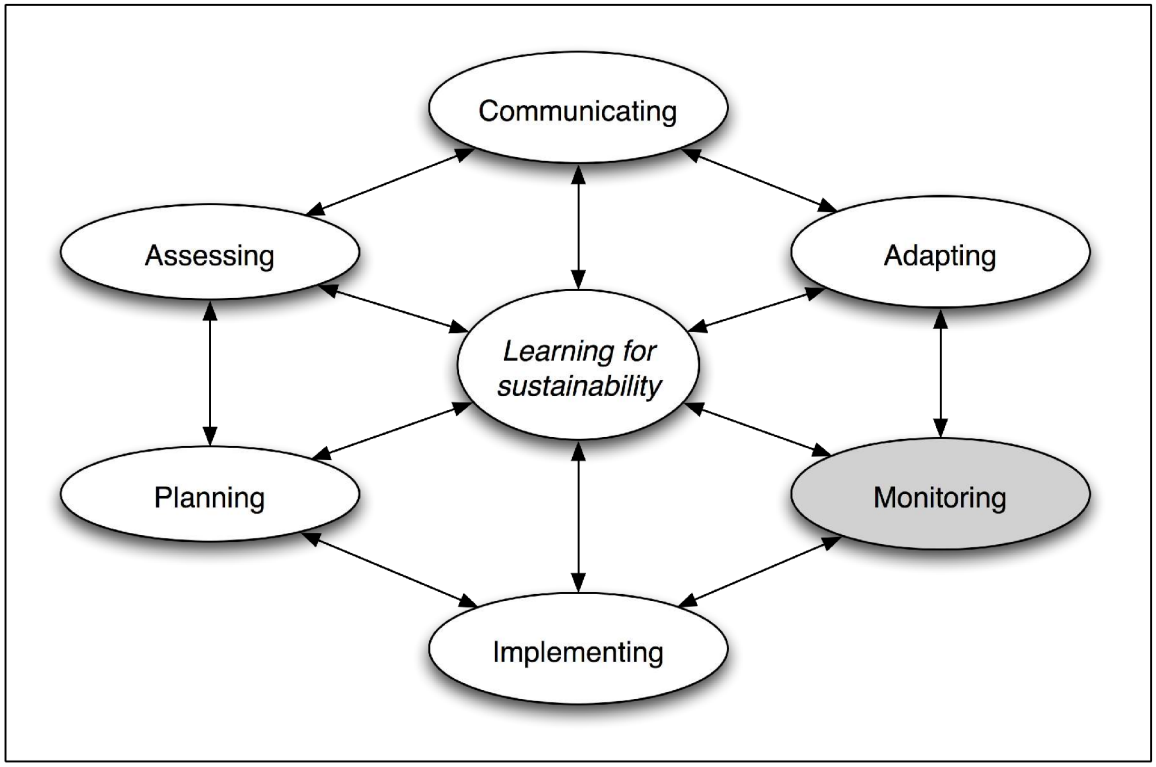

Figure -4.1: Monitoring as one of six fundamental management processes, linked through dynamic nonlinear interplay, which can help develop the understanding necessary to guide society toward greater sustainability (After: Nelson and Serafin 1995; 1996).

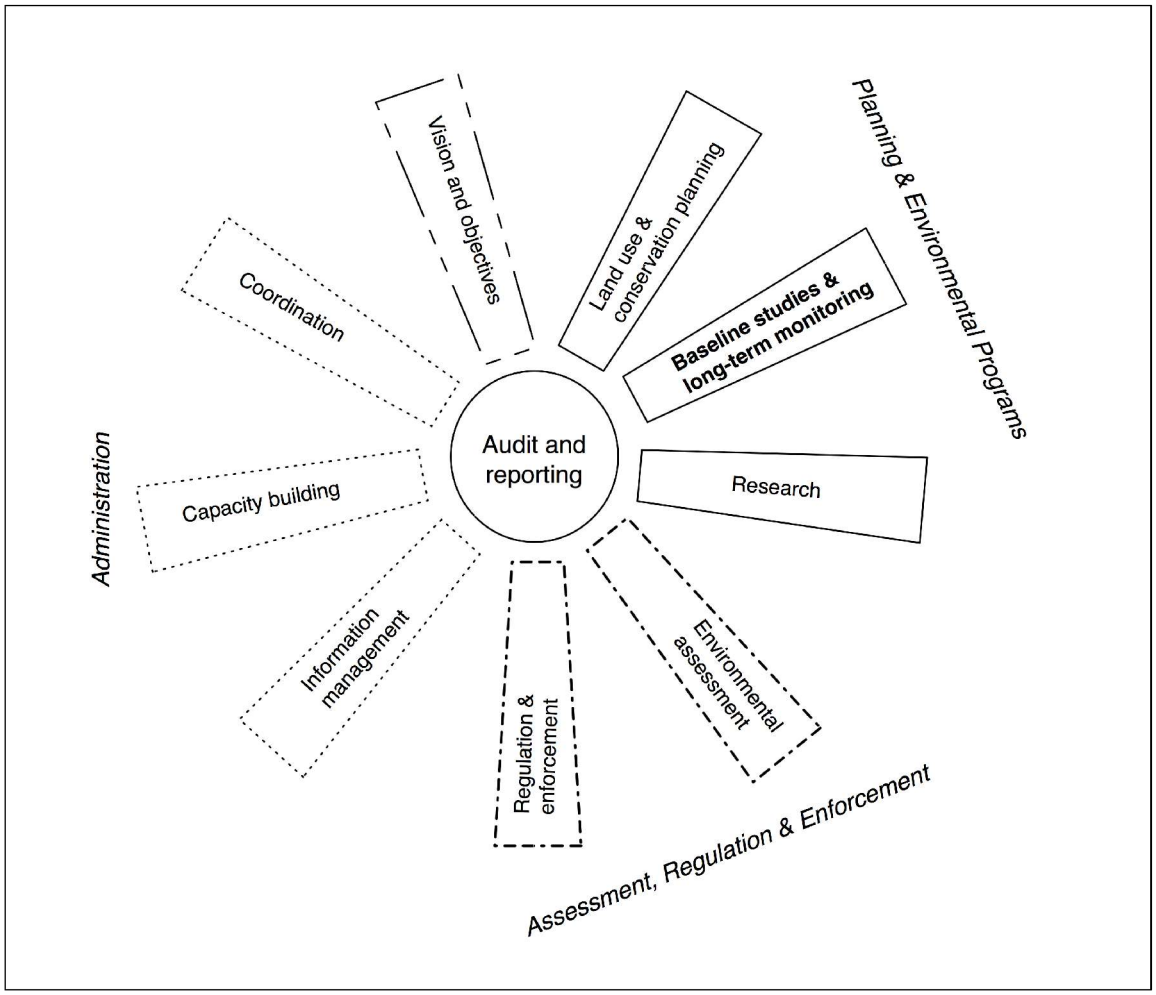

Figure -4.2: An adaptive and comprehensive model of environmental management, seeking responsible economic development in the context of sound management of natural resources and environmental services. Monitoring is a key part of this framework (Source: Indian and Northern Affairs Canada 2007).

As noted in Section 2, monitoring can be undertaken as a means of enforcement, to identify changes in systems, or to learn from experience (or as a way to accomplish a combination of these objectives) (Noble 2005). Within the context of these broad goals, monitoring can be used to:

- establish a baseline against which to measure and mitigate change (McDonald 2002; Mitchell 2002; Morrison-Saunders and Arts 2005; Indian and Northern Affairs Canada 2007);

- engage the public in environmental management activities, resulting in increased community capacity and access to information (Mitchell 2002; Morrison-Saunders and Arts 2005);
- verify research predictions and truth check theoretical models (Mitchell 2002);
- provide surveillance of complex systems against which unforeseen changes can be observed and managed (Mitchell 2002; Indian and Northern Affairs Canada 2007);
- illustrate (and provide information on) areas where insufficient data are available (McDonald 2002; Noble 2005);
- gather data for future decision making (Mitchell 2002); and,
- evaluate progress towards sustainable development, among other legitimate societal goals (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003).

4.2. Enforcement monitoring

Enforcement monitoring focuses on ensuring that specific activities are conducted within the parameters established by a permit, license, regulation or statute. A significant literature exists on various aspects of this form of monitoring, which typically involves industry and government as the main policy actors. Monitoring activities are primarily undertaken by industry, and periodically reviewed by government to ensure that the required monitoring is taking place, and that emissions of the substances in question do not exceed set standards.

Although a fundamental part of the environmental regulatory system in Canada, enforcement monitoring faces various vexing practical questions (Donnelly and Hagreen 2002; Webb 2002; Boyd 2003; Arts and Meijer 2005; O'Faircheallaigh 2006):

- Have implementation gaps been closed? Are opportunities and needs for monitoring established in legislation suitably implemented through regulations or other policy instruments?

- Are the correct system components being monitored? Does the existing legislative framework require monitoring of valued ecosystem components that enhance long-term understanding of the target environment (and potential changes to that environment)?
- Is each component being monitored correctly (over time and space)? Are the correct policy actors involved in conducting the monitoring?
- Are the standards that have been established adequate for protecting the target environment? Are they merely emissions based, or do they take into account the ambient environment?
- Do the capacity (both human and financial) and political will exist to avoid monitoring lapses? That is, are the resources and authority present to ensure that requisite monitoring is actually conducted? In this regard, are systems in place to monitor the monitor?

There is a growing recognition that enforcement monitoring does not easily afford satisfactory responses to the foregoing problematic questions. Further, it is not entirely compatible with the important functions envisaged for monitoring in the integrated, sustainability-oriented models of resource and environmental management depicted in Figures 4-1 and 4-2. Enforcement monitoring is traditionally associated with a specific project, undertaking, firm or industry, and there are few legislated requirements to feed monitoring results into broad, systems-oriented decision processes. That is, monitoring data are not necessarily shared across projects, firms, industries or sectors, and therefore are not necessarily taken into account in strategic, cumulative or regional resource and environmental analyses. Second, there is often inadequate baseline data, or information not directly linked to emissions from a specific firm or impacts from a specific a project or undertaking. Third, even if suitable data are available and shared, there is typically no oversight body mandated to analyze the overall (or cumulative) impacts on any given environment (Webb 2002; Boyd 2003; Arts and Meijer 2005; O'Faircheallaigh 2006).

Finally, there is mounting evidence that conventional enforcement monitoring suffers from a lack of public confidence. In the context of environmental protection regulation, this problem stems in part from enforcement deficits, i.e., patterns of instances in which prosecutions are not advanced despite monitoring having detected noncompliance (Donnelly and Hagreen 2002). In the context of environmental assessment, a representative of Indian and Northern Affairs Canada recently articulated this lack of confidence at hearings into the proposed Mackenzie Gas Project. When asked to consider the monitoring program that could be established through the existing regulatory framework, the official observed that:

> [The instruments] appear to cover all the technical elements [of a robust monitoring program] … but it may not accomplish some of the small "p" political concerns…the concern[s] that northerners have about ensuring that development proceeds in a responsible fashion, that it provides the benefits, that it results in minimum harm and, frankly, their skepticism that that can be entrusted to government and industry alone to ensure it happens. That's part of the issue that we need to deal with. The transparency of the process, the ensuring that information is readily available so that people can confirm for themselves that things are going well is a big part of it (Joint Panel Review 2007, 9135).

4.3. Moving to more integrated models

Given the shortcomings in conventional enforcement monitoring identified above, attention is increasingly being paid to the other types of monitoring described by Noble (2005). To reiterate, progress monitoring is focused on confirming environmental impact predictions and identifying unanticipated effects. Monitoring for understanding is focused on increasing knowledge of complex systems and improving social capacity to adapt to system changes. Additionally, numerous authors have identified various best practices that span Noble's (2005) typology and present indicators of an integrated approach to monitoring (Table 4-1). Such an approach brings together the enforcement, progress, and understanding functions described above, and legitimizes important roles for policy actors other than government and industry.

At least two broad Canadian models can be identified that go beyond conventional enforcement monitoring to address, to varying degrees, the best practices described above. The first, described in the ensuing section, is drawn from experiences in northern Canada with mega projects, such as mineral and large hydroelectric developments. The second, described in Section 4.3.2, is more decentralized and community-based, associated with a range of resource sectors and issues, and found in many regions of Canada.

Table -4.1: Aspects of best practice in environmental monitoring generally

CRITERIA	DESCRIPTION
AUTHORITATIVE	The program should have a clear (and where possible legislated) mandate so project proponents and regulated industries cannot avoid their monitoring responsibilities (Rafique Ahhamed and Nixon 2006).
RESOURCED	The program needs sufficient human and financial capacity and political for implementation.
ADAPTIVE	The program must have a feedback function, so that results have an impact on future resource management activities (Marshall et al. 2005; Indian and Northern Affairs Canada 2007), including legislative, regulatory and project specific monitoring requirements
COMPREHENSIVE	Monitoring requirements should address both project specific impacts and cumulative effects.
LEARNING ORIENTED	The programs should promote continuous learning from experience to improve future practice (Marshall et al. 2005).
PARTICIPATORY	Monitoring should include participation by industry, regulators and the public (Marshall et al. 2005; Morrison-Saunders and Arts 2005).
INTERACTIVE	The program requires organizational structures to ensure communication and facilitate collaboration among different actors (Shindler, Cheek, and Stankey 1999; Mitchell 2002; Rafique Ahhamed and Nixon 2006).
ACCESSIBLE	Results should be publicly accessible.
GROUNDED	The program should reflect the cultural and societal context in which it is developed and implemented (Marshall et al. 2005).
TIMING	The program should be established as early as possible after legislation is passed, permits or licenses are issued, or management interventions occur (Rafique Ahhamed and Nixon 2006).
FOCUSED	The program should identify on what basis it defines success (of the monitoring program) will be established (Shindler et al. 1999; Mitchell 2002).

4.3.1. Independent oversight bodies

Monitoring involving an independent oversight body is a relatively recent innovation in resource and environmental management in Canada. In this model, which has been employed in a small but growing number of resource development projects in Canada and the United States, the independent agency typically serves as a public watchdog over specific large-scale projects. This characteristic is unlike the hog industry, but other aspects of the oversight body model are indicative of Table 4-1's best practices and are directly relevant to our analysis. The broad lessons summarized below are drawn from the experiences of four agencies established in northern Canada:[2] the BHP Independent Environmental Monitoring Agency, the DDMI Environmental Monitoring Advisory Board, the Snap Lake Environmental Monitoring Agency, and the Voisey's Bay Environmental Management Board (O'Reilly 1998; O'Faircheallaigh 2006; 2007; O'Reilly 2007; Fitzpatrick Revised and Submitted). Detailed information and web sites about these agencies can be found in Appendix 1, page 52.

A central feature of the independent agency model is that the agency is *authoritative* and serves as an advocacy organization for ensuring that monitoring is conducted and results are used to affect resource management decisions. Although the mandates of the four agencies we examined differ, in general, each body ensures that monitoring is conducted (by both the project proponent and government), data are analyzed, results are communicated, and where necessary, project activities are altered to minimize negative effects (e.g. Ross 2007). In this way, although the oversight body does not actually complete the monitoring, it has authority over and is active in each phase of monitoring. In each case examined, a key to the agency having sufficient and legitimate authority was founding the authority in a binding contract among the essential policy actors (usually the provincial/territorial government, the federal government, the project proponent, and Aboriginal organizations) (O'Faircheallaigh 2006).

[2] We focused on these four agencies despite the relative dearth of publicly available literature on the subject. More information is available on experiences in Quebec, such as Gagnon et al.'s (2000) research monograph prepared for the Canadian Environmental Assessment Agency.

Another important feature of the model is that the enabling contract is sufficiently detailed to clearly establish the mandate, or *focus*, of the monitoring program, including laying out monitoring requirements and commitments and providing financial recourse for failure to comply (O'Reilly 2007). The most recent contract, established for the Snap Lake project, goes so far as to identify in a schedule to the agreement each commitment made by the project proponent during the environmental assessment process (O'Faircheallaigh 2006, 46).

A further instructive aspect of the oversight body model is the extent to which it has successfully established roles for civic, or community-based, policy actors. In many ways, the oversight bodies we examined are highly *participatory* in nature. For example, in each case, Aboriginal organizations were involved in, or parties to, the environmental agreement that established the oversight body. Moreover, the bodies are comprised of appointments made by Aboriginal organizations, in addition to industry and government representatives. That being said, it is important to note that finding a balance between the technical and participatory mandates of the agencies has been a challenge. As noted by O'Reilly (2007, 33), the BHP agency "has been praised by Aboriginal and public governments for its technical advice but its contributions to capacity building could be improved."

In addition, in practice, the oversight bodies ensure monitoring data and results are both publicly available and *accessible* (e.g. Ross 2007). A small example of this effort is that the BHP agency releases both a technical and plain language annual report (BHP Independent Environmental Monitoring Agency 2007). The agency also has a public registry and resource center. Finally, when monitoring is not undertaken, or results are not satisfactory, the agencies have been *interactive*, taking active roles in negotiating remedies with industry and government.

The foregoing lessons are instructive in a general way, particularly when combined with what can be learned from the community-based models described in Section 4.3.2 and Section 5 of the paper. However, it is important to be cautious in generalizing from the

independent agency model to the hog industry in Manitoba. First, as already noted, the model has emerged with respect to specific large-scale projects, and thus typically focuses on a limited number of pollution sources, project proponents, and operational issues. Second, the agencies' enabling contracts, which vested authority, created capacity, and established mandates, were negotiated prior to the government leases and licenses being issued that permitted development to proceed. Third, extensive funding is required to support the agency, which is usually provided in large part by a well-resourced project proponent, such as a transnational mining company.

4.3.2. Community-based models

Another model reflective of the best practices summarized in Table 4-1 is community-based monitoring (CBM). CBM is a process in which individuals, government agencies, the private sector, academics, and community organizations work together to monitor, track, and respond to issues of common concern (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003; North-South Environmental Incorporated 2004; Quinn and Dubois 2005).

CBM is a highly participatory process, requiring partnership development, consultation and outreach, visioning, and capacity and trust building. It is, of course, also a scientific process and a decision support tool. At its core is the gathering and recording of systematic observations about ecological or social conditions (regarding, for example, local species, habitats, ecosystems, ecosystem processes, and anthropogenic drivers, and the integration of such local information into planning and decision making) (Gayton 2003; Yarnell and Gayton 2003; North-South Environmental Incorporated 2004).

A criticism made of CBM is that it is yet another example of government off loading problematic mandates with no short-term payoff to the voluntary sector (Gayton 2003). However, it can also be viewed as an important reclaiming by civil society of essential governance functions, and an acknowledgement that in some respects citizens and civil organizations have delegated far too much responsibility to government. CBM "may

actually represent a re-assumption of those ecological responsibilities that we never should have delegated to governments in the first place" (Gayton 2003, 4). Moreover, consistent with Nobel's (2005) third type of monitoring (i.e., monitoring for understanding), CBM is a highly promising platform for developing new social and knowledge relations (Quinn and Dubois 2005).

Our view is that CBM is suitable for application to intensive hog production because of the extent to which non-point pollution[3] is a problem in the industry (Raven and Berg 2004; Manitoba Conservation 2006). Consistent with the subsidiarity principle[4] and emerging doctrines in adaptive governance (Folke, Hahn, Olsson, and Norberg 2005), CBM offers a highly promising tool for developing policy and management responses to the problems posed by non-point sources of pollution. Such sources are by nature multiple, diffuse, obscure, and episodic, and therefore much more difficult to measure and regulate than point source pollution (Sawicki and Judd 1983; Cunningham et al. 2005; Cunningham and Cunningham 2008). Regulatory frameworks that use a command and control approach have proven incapable of effectively addressing non-point source pollution problems, but the strengths of CBM, particularly in terms of its expanded scope of inquiry and the contribution of local knowledge, suggest that it may provide promising solutions to this problem.

Given its potential for application to the hog industry, CBM is examined in more detail in Part 5 of the paper.

[3] Non-point source pollution refers to the process of land pollutants entering water bodies over large areas rather than at a single point (Raven and Berg 2004).
[4] The subsidiarity principle encourages the involvement of local people in environmental and resource management decisions by suggesting that decisions affecting peoples' lives should be made by the lowest capable social organization (Dearden and Mitchell 2005).

5. Community-based monitoring (CBM)

This part of the paper provides an in-depth review of community-based monitoring, covering context and history (Section 5.1), benefits and opportunities (Section 5.2), challenges, constraints and limitations (Section 5.3), and lessons and recommendations (Section 5.4). Additionally, Section 5.5 presents various CBM models that, together with the lessons derived from the independent agency experiences (Section 4.3.1), furnish an excellent starting point for discussing a CBM program for the Manitoba hog industry.

5.1. Context

Community based monitoring in North America has been taking place in some form since the late 19th century. Early monitoring programs involved community members and amateur naturalists in tracking weather patterns and bird populations (Mayfield, Joliat, and Cowan 2001; Yarnell and Gayton 2003). Water quality became an additional focus of community monitoring activities in the 1960s and 1970s (Mayfield et al. 2001). In many cases, these projects were initiated by community advocates in response to local environmental or health crises (Heiman 1997). During the same period, programs were developed in Holland through which local, contextual knowledge provided by citizens was combined with technical scientific data at universities. These programs, known as "science shops," are currently operating across Europe (Quinn and Dubois 2005).

In recent decades, CBM initiatives have been on the rise. Various factors are responsible for this development, including:

- a decline in state funding for environmental monitoring, resulting in a reduced ability to monitor ecosystems (Heiman 1997; Au, Bagchi, Chen, Martinez, Dudley, and Sorger 2000; Whitelaw, Vaughan, Craig, and Atkinson 2003; Yarnell and Gayton 2003; Sharpe and Conrad 2006);
- public mistrust of government's ability and willingness to manage and mitigate environmental risks and threats (Au et al. 2000; Sharpe and Conrad 2006);

- mistrust of scientists and "experts" who produce data that are incomprehensible and inaccessible to those for whom they are most relevant (Au et al. 2000);
- inadequate government monitoring programs for addressing complex and emerging issues (Whitelaw et al. 2003);
- a break down in public or private land management (Bliss, Aplet, Hartzell, Harwood, Jahnige, Kittredge, Lewandowski, and Soscia 2001);
- increases in pollution due to urbanization, economic activity and industrialization (Au et al. 2000); and,
- an associated increase in public environmental concern and interest (Whitelaw et al. 2003; Yarnell and Gayton 2003; Sharpe and Conrad 2006).

The growth in CBM is part of a larger trend toward increased public participation in decision making (Bliss et al. 2001; Savan, Morgan, and Gore 2003; Sharpe and Conrad 2006). Decision makers are recognizing that if sustainability is to be achieved, stakeholders and citizens must be involved in both planning and management processes (Whitelaw et al. 2003). Issues such as climate change, invasive species, non-point source pollution, and development impacts are so complex and multi-faceted that collaborative approaches that involve the public are the only way to develop solutions which address the issues comprehensively and effectively (Vaughan et al. 2003).

5.2. Benefits and opportunities

Involving community members in monitoring programs presents numerous opportunities, both in terms of practical advantages and in terms of broader social and political benefits.

5.2.1. Practical advantages

From a practical perspective, CBM programs can generate large amounts of data while minimizing costs to institutions traditionally engaged in monitoring, such as government and industry (Au et al. 2000; Mayfield et al. 2001; Craig, Whitelaw, Robinson, and

Jongerden 2003; Whitelaw et al. 2003; Yarnell and Gayton 2003; North-South Environmental Incorporated 2004). Within the public, there exists a pool of potential volunteers with skills, knowledge and enthusiasm who can be trained to gather information efficiently for little or no pay (Stokes, Havas, and Bridges 1990; Cuthill 2000; Tegler 2004). By engaging these publics in CBM, the number of paid human resource positions required to undertake monitoring decreases. These cost savings are further magnified through improved and more efficient operations, superior due diligence protection, lower insurance premiums, diminished risk resulting in lower bank loan rates, and inclusion in ethical funds (Pollock, Whitelaw, and Atkinson 2003; Tegler 2004).

In addition to efficiencies in cost and personnel, CBM also carries the potential for much more effective monitoring programs through its ability to produce an expanded assembly of data and knowledge (Au et al. 2000; North-South Environmental Incorporated 2004; Tegler 2004; Quinn and Dubois 2005). Volunteer monitors can contribute to building a broader and more comprehensive data set than would be possible with a small group of paid staff because they can be recruited in greater numbers and they have the ability monitor on broader temporal and spatial scales. For example, volunteers can make observations outside of regular office hours and over a broader geographical area (Stokes et al. 1990; Nicholson, Ryan, and Hodgkins. 2002). Furthermore, community volunteers may have access to local, anecdotal knowledge, particularly knowledge of an historical nature and practical knowledge gained through daily experience. This knowledge can provide key insights into environmental problems and would not necessarily be obtained by expert scientists (Stokes et al. 1990; Heiman 1997; Quinn and Dubois 2005). One result of this type of community input that has been found to be particularly useful is accurate and functional maps (Hunsberger, Gibson, and Wismer 2003b).

In general, monitoring programs which involve both experts and local citizens address a much broader scope of inquiry, including key baseline information, early warning of trends, and other important indicators that might be ignored without community input (Hunsberger, Gibson, and Wismer 2003a; North-South Environmental Incorporated 2004). Furthermore, the combination of local and scientific knowledge frequently results

in synergies and mutual learning which lead to the creative solutions necessary to address complex environmental problems (Pollock and Whitelaw 2005).

Not only is the knowledge gained more comprehensive, but access to and communication of that knowledge are also likely to be improved with CBM programs (Craig et al. 2003; Yarnell and Gayton 2003). With members of the public involved in collecting information, government or industry monitors are less able to shelve and ignore negative results. Community groups are generally more motivated and willing to share their information with the public, which leads to greater progress (Rousseau, McNeill, and Hildebrand 2004).

5.2.2. Social and political benefits

From a social and political perspective, the participatory aspect of CBM is in itself a significant benefit (Nicholson et al. 2002; Yarnell and Gayton 2003; Quinn and Dubois 2005). As mentioned above, public participation is becoming an increasingly valued component of the decision-making process. By seeking meaningful collaboration between citizens and the government, CBM initiatives can contribute to this goal (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003, 8; Pollock et al. 2003). The numerous social and political advantages of public participation include education of the public, improved relationships between governing bodies and the public, increased public influence on decision making, and the building of social capital. These benefits, in turn, are seen as critical ways of achieving sustainability (e.g. Gibson 2005).

Improving public awareness and understanding is a key outcome of both public participation and CBM (Au et al. 2000; Bliss et al. 2001; Nicholson et al. 2002; O'Rourke and Macey 2003; North-South Environmental Incorporated 2004). By involving members of the public in collecting and generating scientific information, citizens develop the capacity to understand what is taking place in their environments and their communities. They also learn about the complex issues that may be involved in

addressing local problems, and how to influence the process through which solutions might be crafted (Stokes et al. 1990; Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003; Pollock et al. 2003; Pollock and Whitelaw 2005). Community members become empowered through their ability to "test and defend – rather than just trust – their own common sense" (Heiman 1997, 297). Participating in monitoring activities generates insight into individual and community relationships and values respecting the local environment (Hunsberger et al. 2003a). Furthermore, the public gains a better understanding of the economic costs involved in environmental protection and are therefore better equipped to contribute to the discourse over how issues should be addressed (Hunsberger et al. 2003a; North-South Environmental Incorporated 2004; Tegler 2004).

Public participation in monitoring can contribute to improved governance in a variety of ways. The expanded pool of knowledge and resources made available to decision makers through CBM equips them to make informed choices that are adaptive and responsive (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003; Pollock et al. 2003). The inclusion of various partners and stakeholders in the decision-making process allows for networks and partnerships to form and brings together a broader set of skills, perspectives and ideas to contribute to creative problem solving (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003; Pollock et al. 2003; Quinn and Dubois 2005). CBM programs provide a neutral terrain in which these diverse partners can work together on a shared task and engage in non-confrontational discussion of issues. This type of forum is an important aspect of a more deliberative system of governance (e.g. Dryzek 1987; Baber 2004; Parkins and Mitchell 2005).

The type of collaboration and networking described above in the governance process lends greater legitimacy to governing institutions and tends to improve trust and public support (Pollock and Whitelaw 2003; Yarnell and Gayton 2003; Tegler 2004; Quinn and Dubois 2005). Active involvement in data collection contributes to decision making, nurtures a sense of responsibility and support, and builds more trusting relationships

between the public and authorities (Au et al. 2000). By participating in such programs, industry partners also benefit by building better relationships with local communities, improving their public image, and developing effective mechanisms to address pressures from civil society (Pollock et al. 2003; Tegler 2004).

The opportunity for members of the public to influence and play a meaningful role in decision making is key to the improved governance in CBM (Yarnell and Gayton 2003). With greater access to information and knowledge, community members have the ability to effectively inform local land use, resource management, and environmental planning (Craig et al. 2003; Whitelaw et al. 2003; North-South Environmental Incorporated 2004). This opportunity is also an important motivation for communities to become involved in CBM projects (Bliss et al. 2001).

The benefits and opportunities associated with public participation in monitoring intersect to build social capital and cohesion (Au et al. 2000; Mayfield et al. 2001; Craig et al. 2003; Pollock et al. 2003; Whitelaw et al. 2003; North-South Environmental Incorporated 2004; Quinn and Dubois 2005). Social capital refers to "the combination of people and their skill sets and trust of another that allows for commitment to working together for the betterment of their community" (Pollock et al. 2003, 83). It is measured by "the strength, density and intensity of connections among and between individuals and groups of individuals within a community" (Sharpe and Conrad 2006, 403). Empowering community members to feel engaged and relevant in addressing a particular problem is an important component of building social capital, transforming them from victims, or by-standers, to agents of change (Heiman 1997; Cuthill 2000; Bliss et al. 2001; O'Rourke and Macey 2003).

CBM activities provide participants with the opportunity to contribute key information while making important connections with other community members and gaining knowledge about the issue at hand (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003). This particular combination inherent in the CBM process can help to transform adversarial conflicts into cooperative

ventures in creative problem solving (Stokes et al. 1990; Bliss et al. 2001). Partnerships and networks facilitate the identification of common concerns and resource values, the sharing of information, and the development of possible solutions, giving communities a greater capacity to work toward sustainability (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003; Pollock et al. 2003).

Sustainability has become a widely shared ideal and CBM can help communities to advance along this path. The activities of monitoring increase the participants' environmental awareness and may instigate reflection on both environmental realities and how human activities affect them, potentially leading to changes in behaviour and policy at the personal and community level and beyond (North-South Environmental Incorporated 2004). At the same time, the knowledge gained through monitoring data provides an important contribution to defining sustainability and identifying the desired future which policy and management choices should strive to produce (Quinn and Dubois 2005). Gains in social capital contribute to sustainable community development (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003), because "progress toward a common vision of sustainability is most successful when it is driven by local information needs and community values" (Lynch and Aupers 2004, 14).

5.3. Challenges, constraints and limitations

CBM programs offer many opportunities, but as more programs are being initiated, challenges that are inherent to the process, and limitations and constraints on achieving the benefits described above, are becoming apparent.

While CBM offers potential financial and personnel savings, long-term programs have struggled to maintain enduring gains in these areas. It can be difficult to secure volunteer commitment over a long period (Stokes et al. 1990; Craig et al. 2003; Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003; Whitelaw et al. 2003). Similarly, convincing governments to provide

long-term support for such programs can be challenging (Hunsberger et al. 2003a). While the monitoring work is primarily done by volunteers in CBM programs, they still require funding, administration, coordination, and scientific support (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003; Pollock et al. 2003). This may in fact place additional demands on existing resources and personnel (Bliss et al. 2001). Inconsistent funding may result in fragmented data (Craig et al. 2003; Whitelaw et al. 2003), and there is a danger that governments may use the creation of CBM programs to justify reducing the budget of existing monitoring programs (Craig et al. 2003). Limited funding opportunities may also instigate competition between community groups that might otherwise be collaborating.

One of the most significant critiques of monitoring efforts that involve volunteers is that the quality and accuracy of the data may be compromised since the data are not being collected by trained professionals (Stokes et al. 1990; Mayfield et al. 2001; Craig et al. 2003; Hunsberger et al. 2003a; Whitelaw et al. 2003; Yarnell and Gayton 2003). Several studies have investigated this question, and the general consensus is that community volunteers, even high school students, can collect accurate, reliable and valid scientific data that are comparable to those collected by experts (Heiman 1997; Au et al. 2000; Mayfield et al. 2001; Sharpe and Conrad 2006). The result depends, however, on careful program planning and design, which will be addressed in the following section. For example, some parameters seem easier for volunteers to measure accurately than others (Nicholson et al. 2002), and design components such as standardized protocols also play a key role in ensuring the quality of the information (Milne, Rosolen, Whitelaw, and Bennett 2006). Despite these assurances, the fact that the accuracy of volunteer data continues to be questioned remains a significant challenge to CBM programs, particularly when industry partners may be hesitant to associate themselves with projects involving data that are perceived to be bad (Tegler 2004).

Several more specific data-related challenges exist. The types of problems that require monitoring tend to be complex and multi-faceted. While CBM programs are able to encompass a much more comprehensive set of indicators, integrating all the relevant

social and ecological factors can still be difficult (Bliss et al. 2001; Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003; Pollock et al. 2003). In addition, various aspects of data management often prove to be troublesome, and given the importance of standardized protocols and monitoring methods, the lack of protocols for specific indicators may also be a serious obstacle (Bliss et al. 2001; Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003; Pollock et al. 2003).

The ability to build social networks and trusting relationships between citizens and decision makers is a key opportunity of CBM, but these benefits may be severely compromised if preconceived perceptions and biases about the motivations and positions of other actors persist. While community volunteers may seem less biased than scientists who are often bound by industry funding, they are also likely to have a deep personal investment in the environment in which they are working (Heiman 1997; Yarnell and Gayton 2003). This investment leads to a sense of ownership and commitment which can make them ideal monitors, but also feeds into questions about their objectivity (Stokes et al. 1990; Craig et al. 2003; Whitelaw et al. 2003). Research has found that governments tend to perceive that citizen groups are overly biased toward conservation objectives. Conversely, the public tends to view governments as likely to consistently choose in favour of economic development objectives to the detriment of environmental considerations (Hunsberger et al. 2003a).

Achieving collaboration between various stakeholders, another component of building social capital, can also be a fleeting benefit (Bliss et al. 2001). In any situation, bringing polarized groups together at one table is challenging (Craig et al. 2003). Problems arise in maintaining open communication between government and non-government actors, and coordinating between numerous jurisdictions that share authority over an ecological area (Hunsberger et al. 2003a). Similarly, non-governmental groups with overlapping mandates and capabilities may disagree over roles and responsibilities leading to turf- and ego-related conflicts (Craig et al. 2003). Government bodies may also lack the flexibility and adaptability to surrender some of their power and submit to a group process.

Government scientists sometimes refuse to accept lay involvement in collecting scientific data (Yarnell and Gayton 2003), and government institutions may resist changes to the status quo (Bliss et al. 2001). This is particularly the case when powerful information in the hands of the public may be embarrassing and have the potential to threaten established authorities (Au et al. 2000; Bliss et al. 2001). Industry may also be unwilling to participate if they fear loss of control and increased exposure to public criticism (Tegler 2004).

One of the most enduring challenges for CBM programs, and perhaps the most difficult to overcome, is achieving relevant and effective influence on decision making. While CBM initiatives seem to experience widespread success in empowering and educating citizens through their programs, the process stagnates at the point where that information and influence should connect to local decision-making structures (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003; O'Rourke and Macey 2003; Pollock et al. 2003; Conrad 2006; Milne et al. 2006). Consequently, programs fail to meet their public participation goals. In addition, the benefits of the participants' empowerment is compromised as they become frustrated by futility of their efforts (Sharpe and Conrad 2006), which further undermines the trust relationships between governments and the public (Milne et al. 2006). Careful consideration of how this problem can be overcome must, therefore, be a key component in planning any CBM initiative.

5.4. Lessons and recommendations

Obstacles and limitations to receiving all the potential benefits certainly exist, but through the experiences of past and existing CBM programs, solutions to many of these problems can be found. The following lessons and recommendations address program planning, administration, methods and data collection, participants, and social and political outcomes.

5.4.1. Program planning

As with any other program, it is important at the outset of planning to establish a clear purpose and set of objectives. Objectives should address both the short and the long term, since monitoring should be both an anticipatory and a follow-up activity (Hunsberger et al. 2003a). Because CBM is a participation tool, it is imperative that the purpose and objectives of the program, and the ultimate uses of the information collected, are determined with the involvement of all the key participants in the project. This is an important step to promote meaningful collaboration, prevent conflict from arising, and guide the development of program methodology and the identification of indicators (Hunsberger et al. 2003a; Savan et al. 2003; Yarnell and Gayton 2003). The community members involved in the project are, of course, key to this process, and it is imperative to ensure that the project is fundamentally grounded within a vision that is accepted widely in the community. The initial step may be so broad as defining sustainability according to the particular community, followed by the identification of ecosystem functions and characteristics which the community values (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003).

5.4.2. Program administration

The creation and continued success of CBM initiatives depend on stable and long-term funding and support. Although CBM programs depend primarily on volunteers, they are not cost free. Both the support of volunteers and the management of data require financial resources, therefore securing adequate funding for the duration of the project is essential (Whitelaw et al. 2003; Yarnell and Gayton 2003). A variety of potential funding sources exist, including government support, partnerships with industry, voluntary contributions, contributions from project proponents, user pay systems, and the local tax base (Hunsberger et al. 2003b).

Experience shows that having a paid coordinator to facilitate volunteer activities contributes significantly to the success of these programs (Hunsberger et al. 2003a). The

coordinator fills the important role of ensuring that the project stays in line with the purpose and objectives established in the planning process. The coordinator also provides training and support for volunteers, and mediates any conflicts which might arise (Guijt 2000). It is useful to create the coordinator position with some kind of institutional affiliation to facilitate the community group's ability to tap into existing organizational structures (Quinn and Dubois 2005).

5.4.3. Methods and data collection

Several key considerations must be incorporated into program design and methodology. The complexity of both the social and ecological environments in which the monitoring will occur requires that CBM programs be designed to be adaptable and flexible, while at the same time containing an element of continuity (Bliss et al. 2001; Quinn and Dubois 2005). Incorporating an evaluation step into the program design helps to achieve this (Bliss et al. 2001). Methods should also be appropriate to the community and participants involved in the project. This means adopting methods that reflect the established goals of the project, conform to local cultural contexts, and are suitable to understanding, skills, and equipment available to the participants (Stokes et al. 1990; Cuthill 2000; Guijt 2000). Simplicity is generally the best approach, both in terms of the data collection method and the necessary training for its implementation (Guijt 1998; Whitelaw et al. 2003). To ensure that these requirements are met, while also maintaining scientific integrity, the program should be designed in collaboration with professional researchers (Yarnell and Gayton 2003). Finally, it is important to ensure that community leaders and participants are provided with all the necessary information to run their program effectively (Milne et al. 2006).

A key component of project design is determining what type of information is to be collected and what the indicators of this information will be. Many types of data can be collected, and often, a broad range of indicators will best meet the goals of the program. Many sustainability issues require that ecological, social and economic factors be considered (Yarnell and Gayton 2003). A comprehensive monitoring system is, therefore,

likely to seek both qualitative and quantitative data, that is, both objective factual information (say, in the form of biological or chemical samples) and opinions, value judgements, and local knowledge of the landscape (Stokes et al. 1990; Bliss et al. 2001; Fleming and Henkel 2001). Some of these types of data will be more easily accessed and measured than others. Decisions about which indicators to use should be based on the objectives of the project; they should not be chosen, as often occurs, on the basis of how easily they can be collected (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003). At the same time, the choice of indicators must be realistic and attainable. Guijt (1998) uses the acronym SMART to guide the selection of good indicators: they should be specific, measurable, attainable, relevant, and timely.

An example of a successful indicator for volunteer monitoring of water quality is the use of benthic macroinvertebrates. These organisms are ubiquitous, sedentary, easy to identify and collect, and are not valuable as economic or recreational resources. They are good indicators of long-range water quality and aquatic ecosystem health (Heiman 1997; Jones, Craig, and Dmytrow 2004) because they "provide a cumulative assessment of overall environmental quality based on the diversity, abundance, trophic relationships and other attributes of particular groups of organisms" (Savan et al. 2003, 564).

The challenge of ensuring that data are accurate, and thus gaining confidence in the information volunteers collect was discussed earlier. Various steps can be taken to address this issue. First, the program participants should decide on the level of rigour or external validity that is necessary to meet their objectives. This will depend on who is using the information and for what purpose (Guijt 2000). In some situations, pragmatic considerations may justify the lowering of scientific standards (Nicholson et al. 2002). Once the level of rigour has been established, appropriate standards should then be set from the beginning, and mechanisms for testing whether standards are being met should be incorporated into the program design, and possibly included as a condition of funding (Stokes et al. 1990; Sharpe and Conrad 2006). Spot testing or parallel testing are two mechanisms that can be used (Stokes et al. 1990; Heiman 1997), and testing will be more

legitimate if it is undertaken by independent actors (Au et al. 2000). In addition to testing, adequate training, supervision, equipment and resources will further improve the quality of data (Whitelaw et al. 2003; Sharpe and Conrad 2006). Other strategies for ensuring accuracy include the use of interdisciplinary teams, large sample sizes, triangulation through multiple methods, and adopting simple methodologies (Stokes et al. 1990; Guijt 1998; Au et al. 2000; Fleming and Henkel 2001).

One of the best ways to guarantee the reliability of the data collected by volunteer monitors is through the use of standardized scientific protocols (Hunsberger et al. 2003a; Sharpe and Conrad 2006). Protocols developed by recognized agencies or institutions can increase the respectability of the data, and by standardizing methods across a wider political or geographic area, the applicability and comparability of information can be increased (Hunsberger et al. 2003a). Standardizing protocols across Canada, for example, would increase the value of monitoring by allowing information to be shared and trends to be tracked within entire landscapes and among multiple communities (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003; Pollock et al. 2003). Such protocols, however, must be sufficiently flexible to be adapted to local conditions and capacities (Hunsberger et al. 2003a). Appendix 5 (page 58) contains information on efforts by the Ecological Monitoring and Assessment Network standardize community-based monitoring protocols.

Finally, data management and sharing must be considered briefly, since these are often the least well-implemented step (Guijt 2000). As mentioned above, data-sharing capacity is greatly improved through the use of standardized protocols. Data management structures are also necessary both for internal storage and use and for sharing and communication between groups and agencies (Sharpe and Conrad 2006). Searchable digital databases have proved useful for this purpose (Hunsberger et al. 2003a). Some questions that can guide data documentation and management include (Guijt 2000):

- for whom are the data being collected?
- how are they to be used?

- what precisely is being documented?
- what form should the documented data take?
- where will they be stored? and,
- how often will the data be shared?

5.4.4. Participants

Public participation is a key component of CBM, as is ensuring that participants are properly integrated into the program. Sometimes, CBM programs grow from the ground up, but in other instances government or other outside agencies initiate them. In the latter case, the first step in developing a community-based program is to facilitate public interest and involvement. Guijt (1998) warned that it should never be assumed that local people are automatically going to be interested. It is sometimes necessary to build support for the project by demonstrating the need for monitoring and by establishing a recognition of that need across the community (Bliss et al. 2001; Pollock et al. 2003). The next step is to ensure that all of the key community members and stakeholders are represented in a meaningful way in the program processes (Bliss et al. 2001). This involves identifying who should be involved and designing transparent, inclusive, constructive and efficient participation processes, such as roundtables, workshops, visioning sessions, and consensus-based decision-making models (Pollock et al. 2003). There may also be existing similar programs and initiatives that should be recognized and possibly involved in some form of collaboration (Bliss et al. 2001).

Once volunteers are recruited into the program, it is important that they understand the value of their work, both in terms of environmental sustainability and in terms their contributions to local decision making (Quinn and Dubois 2005). Opportunities to participate in the program should be meaningful and tailored to the abilities of the people involved. To maintain participant satisfaction with the program, it is important to ensure that participants have a clear understanding of what they are expected to do and the time commitment involved, leaving room for flexibility within roles and responsibilities (Guijt

2000). Ongoing feedback to communicate the results of the monitoring and how they are being used should be provided to both the volunteers and the broader community (Pollock et al. 2003; Whitelaw et al. 2003). Finally, volunteers should be recognized for their contributions through a volunteer appreciation program (Whitelaw et al. 2003).

Various members of communities may play a special role in monitoring programs. High school students are seen as prime candidates to be volunteers in such programs: they are perceived as unbiased, they are an integral part of the community, and they are likely to already have the necessary equipment in their school laboratories (Au et al. 2000). This approach works best with Grade 12 students who have strong support from teachers and the curriculum.

Universities and the private sector can also provide essential support to CBM programs in a variety of ways. The expertise and resources available at universities can be used for training volunteers, analysing, interpreting and reporting on data, and general advising and facilitating. University partners can also contribute by developing protocols, providing quality assurance and quality control procedures, incorporating students into the program as monitors or trainers, and providing administrative support in terms of space, leadership, and grant administration. Finally, affiliation with a university can help to confer credibility on the community volunteers' data (Savan et al. 2003). Similarly, industry partners can provide technical and methodological advice, facilitate funding, and assist in the analysis, management and communication of data and results (Tegler 2004).

The relationship between the monitoring group and the government authorities must be considered and engineered carefully to ensure that the community group has both sufficient autonomy and sufficient influence. "Power relations between citizen participants and conventional decision makers are key factors in determining the potential for meaningful participation in environmental monitoring and knowledge creation" (Hunsberger et al. 2003a, 13). While mutual respect and cooperation must be present, there should be an arm's length relationship between public monitors and environmental authorities and industry. In this way, information discovered by monitors will not be

suppressed and can be used at their discretion for advocacy, legal action, or local rehabilitation initiatives (Au et al. 2000; Savan et al. 2003).

5.4.5. Social and political outcomes

Public education and capacity building are recognized benefits of CBM programs. For these benefits to be received, special efforts must be focussed on training, certification and empowerment (Heiman 1997; Milne et al. 2006). Not only does this improve the quality of the data that collected, it also contributes to strengthening the community and building social capital. "CBM is self-reinforcing. Capacity building feeds into dialogue for effective information delivery and use. The effective use of locally collected information and the power to change decisions lead to stronger and wider community engagement, and so on" (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003, 19).

Social capital is also built through the process of collaboration. The simple act of bringing diverse stakeholders and community members together in a collective activity is a powerful beginning (Pollock et al. 2003), but for profound collaboration to occur various factors must be considered. The participants should be involved at all stages, and active partnerships with government should be formed at the beginning of the process (Hunsberger et al. 2003a; Yarnell and Gayton 2003). Furthermore, careful attention should be paid to process, a task which is often overlooked in favour of focussing on outputs and outcomes (Conrad 2006). Important process components include establishing open and safe forums where participants and stakeholders can engage in discussions about valued ecosystem components and thereby develop the objectives and design of the monitoring program. Effective and trusted facilitators are key to the successful execution of this process. Governance structures, communication processes and inter-personal skills development are also necessary (Pollock et al. 2003).

Effective public contribution to decision making is essential to both public participation objectives and building social capital. "When participants in a CBM project know that

their efforts are making a real difference, it creates a sense of ownership over the project, fosters a sense of place, and generates commitment within the community" (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003, 19). As mentioned above, achieving this level of influence has proven challenging, but several steps can be taken to improve the community's potential influence. Achieving influence should be built into the project's goals and objectives at the outset (Pollock et al. 2003; Quinn and Dubois 2005, 81), and then strategic measures must be taken to ensure their success.

Simply providing information or demanding changes in policy are usually not sufficient to change the direction of decision making. Active partnerships and two-way dialogue between local community actors and decision-making bodies are necessary for true influence over policy development (Pollock et al. 2003; Yarnell and Gayton 2003; Quinn and Dubois 2005). Through this process, collaborative efforts can be made to determine what kind of information is most relevant to decision makers and in what form it can best be presented. In general, environmental information should be "targeted and relevant to problems and players; accessible and understandable to the audience; integrated; usable (form and context); and timely" (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003, 13). The delivery and communication of this information should "suggest a course of action; allow decision-makers to weigh consequences; and make those involved feel they are in control of the problem" (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature Federation 2003, 13). Partnerships should also be built with business and industry as another avenue of influence (Pollock et al. 2003; Quinn and Dubois 2005).

5.4.6. Best practices of CBM

The accumulated wisdom of lessons from past experiences in CBM are summarized in Table 5.1, which is a list of best practices (or critical features of success) (Ecological Monitoring and Assessment Network Coordinating Office and Canadian Nature

Federation 2003; Sharpe and Conrad 2006). More detailed information of various CBM case experiences, along with web sites for key CBM organizations, can be found in Appendices 2 and 3 (pages 55-57).

Table -5.1: Best practices (or critical features of success) of community-based monitoring

COMMUNITY-BASED MONITORING REQUIRES:	• a context specific approach to engaging the community
	• adequate long-term funding
	• involvement of scientific professionals in developing and evaluating data collection and analysis procedures
	• creation of a meaningful experience for participants
	• effective coordination, under the leadership of a steering committee with representation from the community, academia, government agencies, and the private sector
	• building partnerships in pursuit of sustainability
	• implementation of collaborative approaches
	• results to be publicly accessible
	• effective communication of data and results to the volunteers and to the broader community
	• engagement and dialogue between politicians and decision makers and volunteers

5.5. CBM models

Models and frameworks provide a useful guide for visualizing the CBM process and identifying the necessary steps involved. At the same time, models must be used with care because a tension exists between adhering to a set cycle or framework and the need for flexibility and being specific to context (Guijt 2000). Successful CBM programs tend to exhibit similar characteristics, which provide the basis for model creation, but the diverse contexts in which a model will be applied guarantees that adaptations will be necessary. Good models are designed with an awareness of this paradox and are built to be flexible (Pollock et al. 2003). The following discussion presents several models that strive to strike this balance.

5.5.1. Canadian Community Monitoring Network Model

In the early 2000s, the Canadian Community Monitoring Network was established through the initiative of the Ecological Monitoring and Assessment Network and the Canadian Nature Federation. The network was initiated through a pilot project working with community monitoring in 30 Canadian communities. A framework was developed through literature review and NGO experiences to guide these projects. The framework consisted of two phases: 1) an infrastructure development phase, involving governance analysis, consultation and outreach, identification of champions, partnership development, fundraising, and the adoption of an organizational structure; and 2) a launching phase, linking monitoring activities and results to decision making. The tasks involved at this stage included community visioning, skills assessment, capacity building, achieving influence, and communication (Whitelaw et al. 2003).

Through the CCMN pilot project, this initial framework was evaluated and modified. The strengths of the framework include its clear and simple structure, its generic applicability across a range of communities, and the fact that it is presented as a loose guide rather than a rigidly prescriptive recipe (Pollock and Whitelaw 2005). At the same time, a number of limitations were identified. These include (Pollock et al. 2003, 65-66; Pollock and Whitelaw 2005):

- an underestimation of community and ecological complexity;
- limited definitions of framework components, resulting in a failure to convey the wide range of possible interpretations and the fluid nature of CBM practice;
- an inadequate demonstration of the inter-relationships between components and the important role played by these interfaces;
- a false linearity implied by two distinct phases of the framework: in reality, the process is more iterative and discursive; and,
- insufficient recognition of the importance of adaptation to environmental change.

In response to this evaluation, an enhanced model was developed which is more versatile, flexible, iterative, adaptive and opportunistic (Figure 5-1, page 41).

5.5.2. Adaptive CBM framework

This framework used the CCMN enhanced model as a starting point, but was adapted to the context of CBM groups in Nova Scotia. The model revolves around the goal or common vision of initiative as its central core. Radiating from this centre are the tasks, process, and evaluation components which constitute a complete program (Figure 5-2, page 42) (Conrad 2006).

5.5.3. Key steps for participatory monitoring

Through her international development work in agricultural projects, Guijt (1998; 2000) identified key steps in participatory monitoring, noting that the steps do not necessarily occur in this exact order and that some steps often need to be repeated. The steps she identified were:

- confirming the intention to engage in monitoring;
- identifying participants;
- identifying and clarifying expectations, and defining priorities;
- identifying indicators;
- selecting methods, responsibilities and timing of the project;
- preparing methods and collecting information;
- adapting methods as needed;
- analysing data;
- documenting findings and agreeing on use of the findings;
- applying information; and,
- determining the duration of the project.

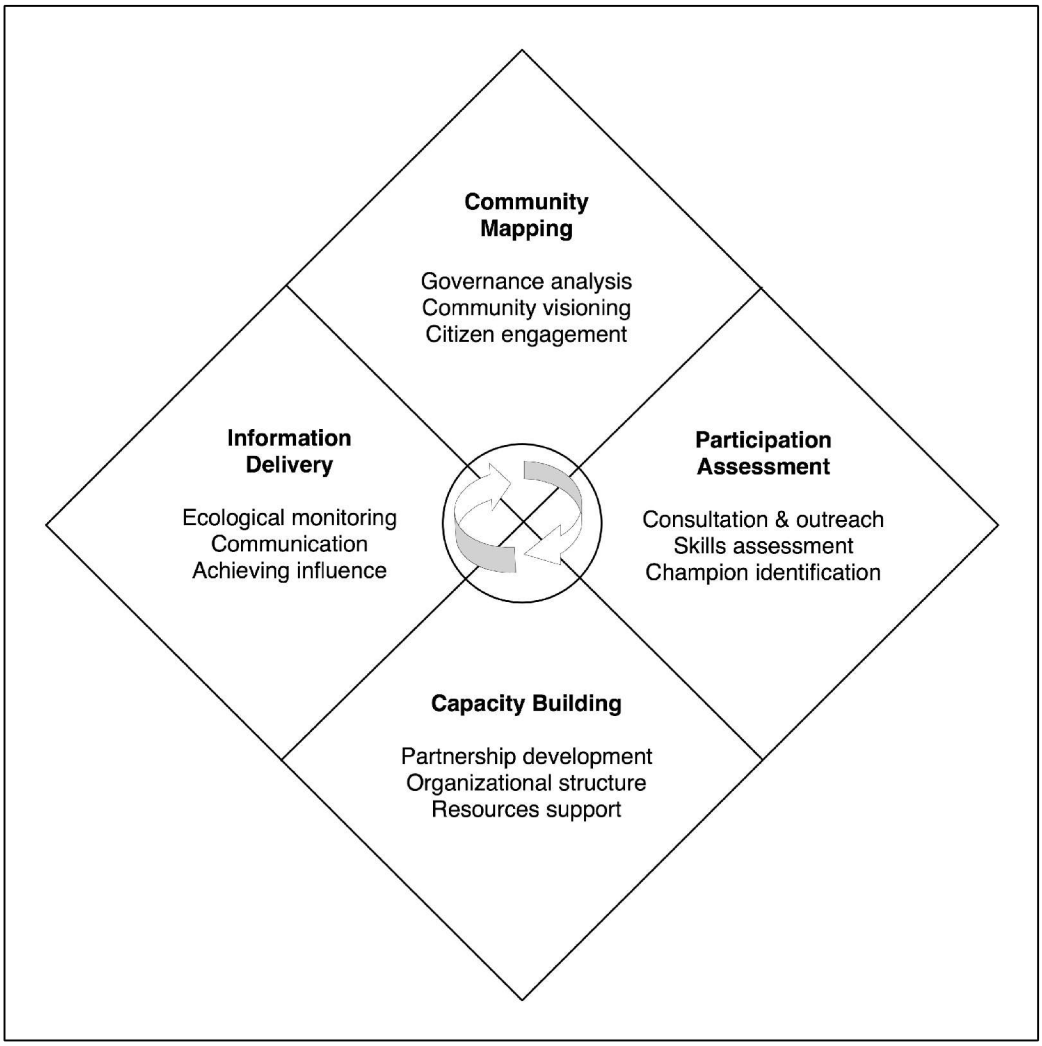

Figure -5.1: An enhanced framework for guiding community-based monitoring in Canada (Sources: EMAN & CNF, 2003; Pollock et al., 2003; Pollock and Whitelaw, 2005; Quinn and Dubois 2005)

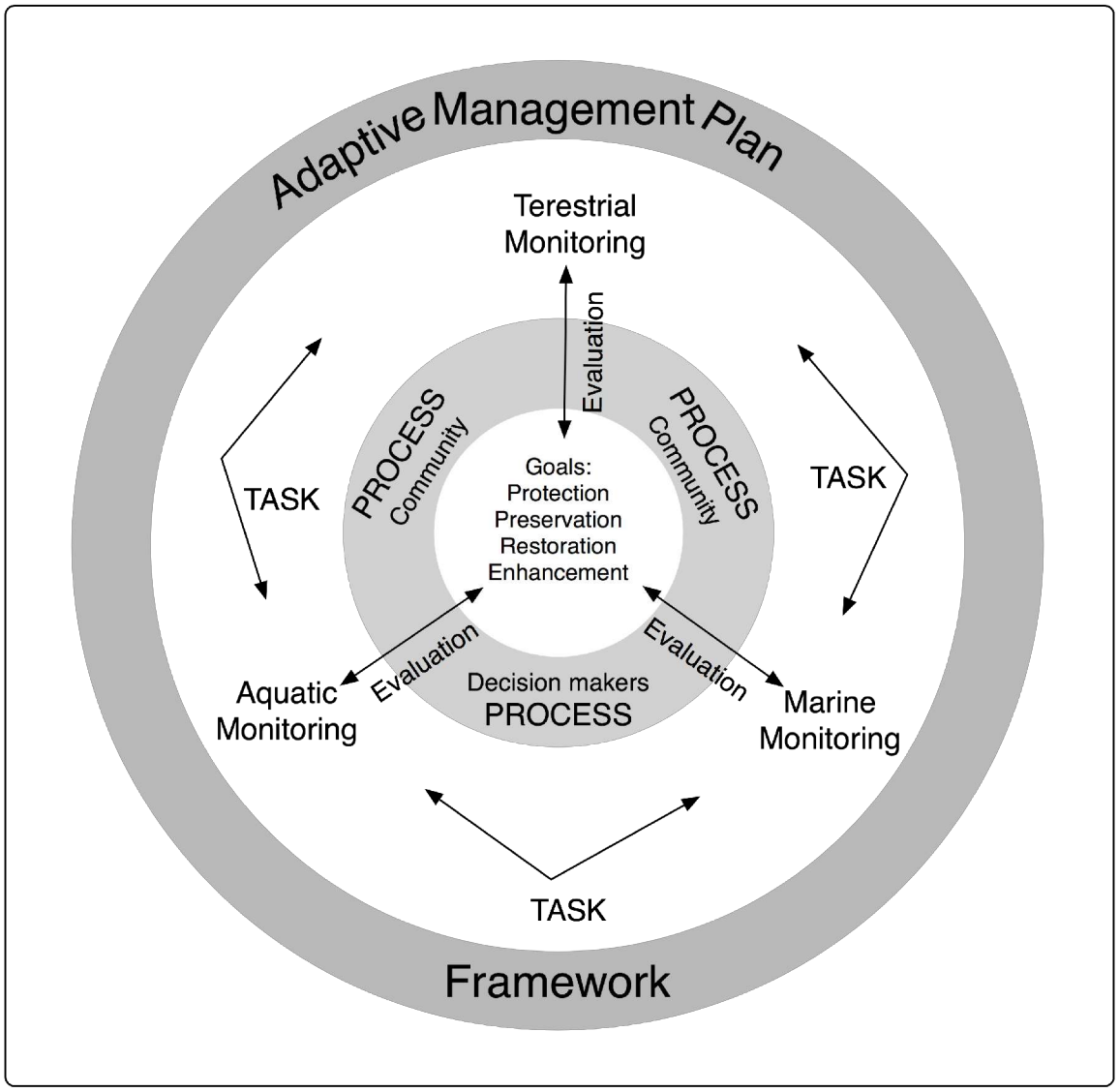

Figure -5.2: A framework for adaptive community-based monitoring (Source: Conrad, 2006)

5.5.4. The monitoring cycle

Bliss et al. (2001) presented their monitoring model as a cycle intertwined with the adaptive management cycle. The key steps involve the identification of monitoring goals and participants, the selection of social and ecological indicators, the development of monitoring protocols, evaluation, followed by adaptation (Figure 5-3, page 43).

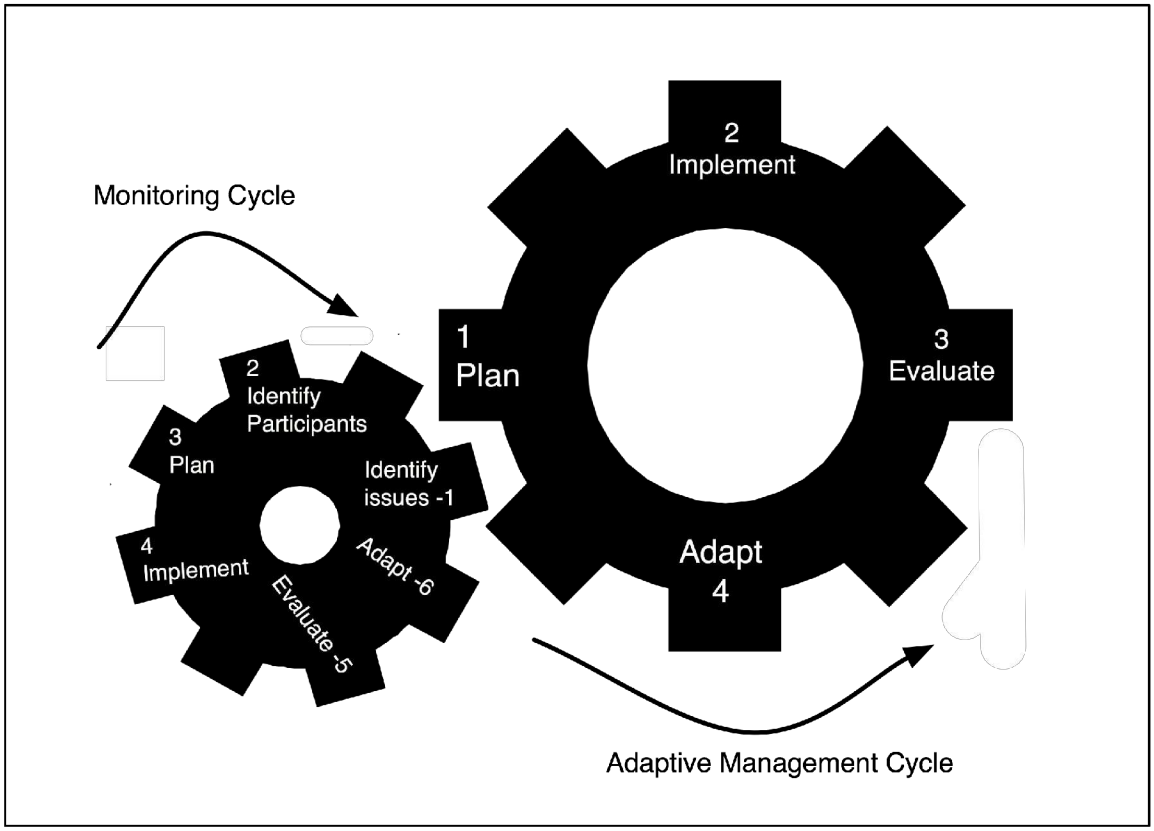

Figure -5.3: The monitoring cycle meshes with the adaptive management cycle (Source: Bliss et al., 2001).

6. CBM and hog production in Manitoba

6.1. Why the CEC should consider CBM

Without reiterating the numerous benefits and opportunities outlined in Section 5.2, what follows is a synopsis of the potential advantages of adopting CBM in the context of Manitoba's hog industry, focusing on improved results, enhanced social cohesion, and better governance.

6.1.1. Improved monitoring results

First and foremost, CBM can contribute to an improved monitoring system, both in terms of filling the current implementation gap and expanding monitoring beyond its present scope. The Livestock Stewardship Panel (2000, 30) report recognized that monitoring and enforcement of existing regulations and guidelines were not sufficient: "inadequate monitoring of current livestock operations, and cutbacks in the 1980s and 1990s to both federal and provincial government water quality monitoring programs have left us in the situation of not being able to adequately assess the water quality effects of large livestock operations." It further recommended that water quality monitoring should be increased, a suggestion echoed by the panellists in the community-based Citizens' Hearing on Hog Production and the Environment, who called for the creation of a systematic monitoring program with an increased number and frequency of tests (Common-Singh et al. 2000). A major constraint to this kind of expansion in monitoring activity is a lack of staff (Livestock Stewardship Panel 2000), but involving volunteer monitors in a CBM approach could help alleviate this problem.

Adopting a CBM program could also improve monitoring by broadening the scope of the information being collected and by incorporating local knowledge and experience. While the government has made progress in increasing the resources available for monitoring, and improving monitoring focused on water quality, in-barn compliance, and the health

and safety of workers (Manitoba Conservation 2006), CBM could further enhance these programs. Furthermore, various socio-economic aspects of the hog industry are not currently being monitored, including odour, health effects and impacts to quality of life. The capacity for capturing a broader spectrum of indicators using CBM provides an opportunity to address this shortcoming.

6.1.2. Enhanced social cohesion

The public participation component of CBM can play an important role in facilitating social learning, building trust and thereby enhancing social cohesion. Insufficient monitoring, or the perception thereof, is a key contributor to the public's apprehension about intensive livestock operations (Livestock Stewardship Panel 2000). By placing the responsibility of monitoring in their hands, members of the public can feel more confident that adequate monitoring is being done, and can also have access to the information necessary to better determine the desirability and sustainability of intensive farm operations within their communities.

The collaboration inherent in participatory programs such as CBM also provides a means of addressing conflict, as outlined in Section 5.2.2. Tensions are rising in many communities as the hog industry expands, and a new discourse is needed, "one that could better balance the interests of the various stakeholders in the hog industry debate, including corporate producers, small farmers, environmentalists and rural municipalities" (Novek 2003a, 20). Furthermore, the industry is tired of being demonized and is requesting stricter regulation to legitimize its activities. It is likely, therefore, that industry actors may be willing to work with communities and government in the development of a CBM program that improves the rigour and transparency of monitoring efforts.

6.1.3. Better governance

Cutting across the arguments in the two preceding sections, CBM can help address various problematic governance issues. In his analysis of the hog industry in Manitoba

and related governance, Novek (2003a, 4) suggested that a process of disembedding is occurring, in which "economic activities become separated from the social bonds of local communities and then recombined across larger units of time and space". This process is fuelled by both economic globalization and government policy that favours deregulated markets, concentrated production and industrial methods of farming. As a result, communities experience a loss of control while at the same time receiving the environmental externalities created by globalized economic activities (Common-Singh et al. 2000; Novek 2003a; 2003b). CBM could help counter this process by facilitating the development of innovative cross-scale institutional arrangements (e.g., partnerships among local producers and community groups, rural municipalities, provincial and federal government agencies, and regional and national companies).

Capacity building within communities through CBM will also enhance governance processes. In Section 3, it was noted that rural municipalities were given the responsibility to determine where hog operations should be located but that some communities lack the necessary expertise to make these decisions effectively. CBM would place a wealth of technical expertise and data in the hands of the local community and thereby assist in this type of planning and decision making.

Finally, CBM can assist in solving the problem of the government's contradictory role "as development promoter and environmental regulator" (Novek 2003a, 5). This tends to result in uncertain implementation of environmental regulation, as governments are hesitant to jeopardize economic opportunities. By placing the responsibility of collecting data and the power to disseminate that data in the hands of the community, governments will be prevented from shelving information that supports one of its mandates because it is in conflict with another mandate.

6.2. Advancing the CBM agenda: some preliminary suggestions

This section does not offer a detailed prescription but instead outlines a preliminary blueprint, hinging on an incremental approach to developing a CBM program for the hog

industry in Manitoba. With respect, we suggest that:

- The CEC should seek a new mandate from Manitoba Conservation regarding CBM and the hog industry, involving a feasibility study, a pilot project, and an evaluation.

  The feasibility study should build on the literature review provided here by zeroing in on the practical implications of adopting CBM in the specific context of Manitoba's hog industry.

  The study should consider specific monitoring parameters and protocols currently in place and cost estimates for reasonable alternative models for the pilot project.

  The study should also involve meaningful consultations (using devices such as workshops, interviews and focus groups) with producers, the Manitoba Pork Council, local government leaders, relevant provincial government departments, environmental organizations, academics, and rural schools and community groups.

  Moreover, the study needs to pay special attention to resolving existing conflict over hog industry expansion. Specifically, the study needs to consider that while mobilization of some communities in opposition to the expansion of the hog industry provides a ready and likely enthusiastic group of potential volunteers, steps will need to be taken to transform their position with respect to industry and government from that of adversarial activists to collaborative partners.

- Building on the feasibility study, a pilot project of at least three years in duration should be implemented guided by the best practices (or critical features of success) presented in Table -5.1.

  To ensure a context specific approach (the first bullet in Table -5.1), the pilot project needs to be a logical extension of the feasibility study, which will have been informed by the local knowledge, values and expertise specific to hog production and the social-ecological conditions in Manitoba.

To ensure effective coordination (another of the bullets in Table -5.1), the project should not only have a legitimate and authoritative multi-sectoral advisory committee, it requires a secretariat with a paid coordinator, administrative assistance, and a suitable operating budget.

Given that hog industry expansion is part of larger global trend, the pilot project should ensure that data produced through CBM experiences influence decision making not only at the local level, but also at regional, national and international levels – both for governments and industry. Developing effective cross-scale linkages along these lines would be an innovative contribution to CBM governance experiences in Canada.

In identifying the valued ecosystem components, the project should aim for as integrated or holistic a framework as is practicable, encompassing a full range of biophysical indicators but also a complete set of social, economic and cultural criteria. The extent to which the project pushes the bounds of integration in this respect would be an innovation in hog industry management and governance.

- In keeping with the adaptive and learning oriented best practices criteria in Table -4.1 and the overall tenor of CBM (Table -5.1), evaluation must be an integral part of the pilot project.

  Evaluation should be done on an ongoing basis to ensure that adaptations are made during the life of the project and lessons are derived from the project's ultimate outcomes.

  The evaluation should be both situated (i.e., reliant on criteria established by the project participants) and neutral (i.e., based on criteria derived from best practices and the project's own purposes and objectives).

6.2.1. Potential legislative bases

Consistent with the imperative that monitoring programs need to be authoritative (see Section 4.3.1), we suggest that the aforementioned feasibility study, pilot project and evaluation be clearly grounded in statute, regulation or other explicit policy document. Section 6(5) of *The Environment Act* could and should be used to grant the CEC the mandate to oversee such initiatives. This section states that:

> The commission shall, upon request of the minister, (a) provide advice and recommendations to the minister; (b) conduct public meetings or hearings and provide advice and recommendations; (c) conduct investigations into specific environmental concerns; and (d) act as a mediator between two or more parties to an environmental dispute and report back to the minister.

Following the pilot project evaluation, if a long-term CBM program were to be established, the program should be based in its own regulatory framework, although section 6.1 of the *Livestock Manure and Mortalities Management Regulation* is broad enough to encompass such an initiative. Section 6.1 grants to the director appointed under *The Environment Act* wide-ranging powers to impose monitoring requirements as conditions in manure storage facility permits. [5] Important advantages of passing a stand-alone CBM regulation are the increased public awareness and broad-based social learning associated with media exposure of, and public participation in, regulatory development and promulgation. Further advantages are the enhanced clarity of purpose and added legitimacy that flow from having a separate regulation dedicated to a particular policy

[5] The provisions of section 6.1 are reproduced verbatim below.

6.1(1) Without limiting the generality of subsection 6(5) [which gives the director the general authority to include conditions in permits], the director may require an operator to install monitoring wells in relation to a manure storage facility. The operator shall install and maintain the monitoring wells in accordance with the director's requirements or in a manner that is satisfactory to the director.

6.1(2) The operator shall submit water analysis reports of water samples from the monitoring wells collected and analyzed in accordance with the sampling, analysis and reporting protocol for monitoring wells approved by the director under subsection (4).

6.1(3) Without limiting the generality of subsection (1), the operator of an agricultural operation with 300 animal units or more shall submit an annual water analysis report of water from the operation's livestock drinking water source collected and analyzed in accordance with the sampling, analysis and reporting protocol for water sources approved by the director under subsection (4).

6.1(4) The director may approve sampling, analysis and reporting protocols for the purposes of subsections (2) and (3).

6.1(5) In addition to requiring an operator to comply with subsections (1) to (3), the director may require an operator to implement a monitoring and reporting program if the director believes that the storage, handling and management of livestock manure in the agricultural operation is causing or would likely cause pollution of surface water, groundwater or soil.

initiative. These advantages are important for most, if not all, major public policy initiatives, but are particularly vital for the type of community-based initiative contemplated here, which would rely heavily on public involvement and support.

7. Summary and conclusion

CBM is a process in which individuals, government agencies, the private sector, academics and community-based organizations work together to monitor, track, and respond to issues of common concern. This is simultaneously a participatory exercise, a scientific process and a decision-support tool designed to generate understanding of complex systems, such as that created by industrial hog development. At the core of CBM is the gathering of systematic observations about the social-ecological changes for the purpose of managing, and responding to these changes.

As discussed in Section 5.2, CBM furnishes a range of benefits, based largely on involving community members in the monitoring program. For example, CBM can generate large amounts of data while minimizing costs to institutions traditionally engaged in monitoring. With members of the public involved in data collection, there is increased access to information. The participatory aspect of CBM also serves to improve public awareness and understanding and, ultimately, strengthen governance. Adoption of CBM as a means of monitoring hog development in Manitoba would move monitoring in the province from a tool used strictly to ensure compliance with government standards, to one that begins to address a range of sustainability-related aspects of development.

However, successful adoption of CBM is contingent on a clear, thoughtful design. The program must ensure clear authority is vested in the monitoring body, with a clearly defined feedback function so that monitoring will impact resource management. While CBM also offers potential financial and personal savings, the program must be adequately resourced, with long-term funding, so as to be able to encourage and train volunteers, and build organizational structures necessary to facilitate collaboration among different stakeholders. Communication must also be clearly defined; ensuring results are available to the participants, and broader public. Finally, while the program should be community-driven, professionals must be engaged to develop data collection procedures, and work with analysis.

To implement a CBM program within Manitoba, we recommend a three-tier approach, involving a feasibility study, a pilot project, and evaluation. First, the CEC should seek a renewed mandate from Manitoba Conservation with a particular focus on CBM and the hog industry. Second, a pilot project of at least three years in duration should be established guided by best practices of CBM (or critical features of success). Finally, evaluation needs to be an integral part of the pilot project to ensure that adaptations are made on a regular basis and lessons are derived from the project's final results.

The three-tier approach should be grounded in legislation or other explicit policy document, and in this regard section 6(5) of *The Environment Act* could and should be used to grant to the CEC a mandate to oversee the project. Following the final evaluation phase, if a CBM program is adopted, it should be based in its own specific legislation, although section 6.1 of the *Livestock Manure and Mortalities Management Regulation* appears to be broad enough to found such an initiative.

In conclusion, as Manitoba continues to wrestle with the opportunities and challenges presented by expansion of the hog industry, community-based monitoring (based on a made in Manitoba pilot project and embedded in a clear legislated mandate) can help the province find and keep to a path consistent with the sustainability imperative. All that is needed is political will, management innovation, and a fairly modest allocation of resources.

Appendix 1: A Synoptic Table and a List of Internet Resources Regarding Selected Independent Oversight Bodies in Northern Canada

	Purpose (related to monitoring)	Composition	Authority	Funding	Notes
BHPB IEMA	Reports on company & govt "enforcement" monitoring Monitors govt "progress" & "understanding" activities Seeks integration of traditional knowledge in company plans & programs	7 member board: 1 appointed by each of the 4 Aboriginal parties 3 appointed jointly by BHP, the federal & territorial govts	Contract (i.e., Environmental Agreement) Parties: Proponent, federal & territorial govts	Years 1 &2 $350 K from BHPB $100 K from govts Years 3+ Negotiated with BHPB	The IEMA does not have decision-making authority
DDMI EMAB	Reports on company "enforcement" monitoring Provide for additional "progress" monitoring, where needed Creates opportunities for community and public participation	8 member board: 1 appointed by each of the 4 Aboriginal parties 1 appointed by DDMI 1 appointed by the federal govt & 1 by the territorial govt	Contract Parties: Proponents, federal and territorial govts, and 5 Aboriginal parties	Years 1 &2 $600 K from DDMI $200 K from govts Years 3+ Negotiated with DDMI	The EMAB does not have decision-making authority
SLEMA	Not available	Components: Core group with representatives from Aboriginal Parties Science & technical panel 2 traditional knowledge working groups Secretariat	Contract Parties: proponents, federal and territorial govts, and 4 Aboriginal parties	Not available	Commitments made by the proponent are terms of the agreement
Voisey's Bay Environmental Management Board (EMB)	Provides advice on the specific instruments, including biophysical monitoring framework and follow-up program, among others	9 member board: 2 appointments by each party 1 independent chair appointed with written approval of each party	Contract Parties: Innu, Inuit, Canada & Newfoundland and Labrador	Years 1- 5 Up to $450 K funded by federal & provincial govts Years 6+ Subject to review	The EMB does not have decision-making authority

Environmental Monitoring Advisory Board [for Diavik diamond mine]
Website: http://www.emab.ca/
Environmental Agreement: http://www.emab.ca/pdfs/diavik_enviro_agree.pdf

Independent Environmental Monitoring Agency [for BHP Ekati diamond mine]
Website: http://www.monitoringagency.net/Portal/
Environnemental Agreement:
http://www.monitoringagency.net/Portal/Portals/0/pdf/key_documents/BHP%20Environmental%20Agreement1997.pdf

Snap Lake Environmental Monitoring Agency [for DeBeers diamond mine]
Website: http://www.slema.ca/
Environmental Agreement:
http://www.slema.ca/documents/debeers_fnl_envir_agreement.pdf

Voisey's Bay Environmental Management Board [INCO nickel mine]
Website: http://www.vbemb.net/index2.html
Environmental Agreement: http://www.nr.gov.nl.ca/voiseys/pdf/envmanagement.pdf

Appendix 2: List of Community-Based Monitoring Case Examples

Name & Location	Description	Contact	Academic Citation
EMAN CO-CNF Voluntary Sector Initiative Project Canada	a pilot project that investigated best practices for CBM using 31 cases in communities across Canada	http://www.ccmn.ca/english/location.html	EMAN & CNF, 2003; Pollock et al., 2003; Vaughan et al., 2003; Pollock & Whitelaw, 2005
Nature Watch Programs Canada	volunteer monitoring programs administered through EMAN, Nature Canada and the University of Guelph; include FrogWatch, IceWatch, PlantWatch & WormWatch	EMAN Coordinating Office 905-336-4414 info@eman-rese.ca http://www.naturewatch.ca/english/	Whitelaw et al., 2003
Atlantic Coastal Action Programs Nova Scotia, New Brunswick, PEI, Nfld & Labrador	an Environment Canada program facilitating community-based restoration and sustaining of watersheds and adjacent coastal areas	902-426-8679 http://atlantic-web1.ns.ec.gc.ca/community/acap	Rousseau et al., 2005; McNeil et al., 2006
Citizen's Environmental Watch Ontario	a program providing education, equipment & support for community-based ecological monitoring and stewardship across Ontario; affiliated with the University of Toronto and other partners	647-258-3280 info@citizensenvironmentwatch.org http://www.citizensenvironmentwatch.org/	Savan et al., 2003; Yarnell & Gayton, 2003
Ontario Benthos Biomonitoring Network Ontario	will coordinate the evaluation of aquatic systems using shallow-water benthos; co-founded by the Ontario Ministry of the Environment and Environment Canada's Ecological Monitoring and Assessment Network	Chris Jones 705-766-1724 f.chris.jones@ontario.ca http://obbn.eman-rese.ca/PartnerPages/obbn/index.asp?lang=en-ca	Jones et al., 2005
WATER (Watershed Action Towards Environmental Responsibility) Hamilton, Ontario	a coalition of community groups that tracks the health of local waterways in conjunction with a program at McMaster University and trained high school students.	Dr. George Sorger, McMaster University Department of Biology 905-525-9140 ext 24376 gorger@mcmaster.ca	Au et al. 2000

Tri-Community River Clean Up (part of EMAN CO-CNF Voluntary Sector Initiative Project) Black Diamond, Turner Valley, Okotoks, Alberta	a project coordinating three communities in promoting sustainable water use conservation, community engagement and public education	Maureen Lynch Maureen_lynch@hotmail.com; Wendy Aupers w.aupers@telus.net	Pollock et al., 2003; Lynch and Aupers, 2005
Baynes Sound Stewardship Action Group/Comox Valley Project Watershed Society Vancouver Island	a community watershed stewardship group involved in activities such as monitoring urban storm water, on-site sewage system care & addressing agricultural run-off	Project Watershed Society 250-703-2871 projectwatershed@shaw.ca http://www.projectwatershed.bc.ca/index.htm	Pinho, 2000; Hunsberger et al., 2003b
Waterwatch Victoria Australia	national community-based water monitoring network administered by the Department of Natural Resources & Environment	jane.f.ryan@nre.vic.gov.au www.vic.waterwatch.org.au	Nicholson et al., 2002

Appendix 3: Key Community-Based Monitoring Organizations

Canadian Community Monitoring Network
Website: http://www.ccmn.ca/english/

Canadian Nature Federation
Website: http://www.naturecanada.ca/nature_network.asp

Community-Based Environmental Monitoring Network (St. Mary's University, Halifax)
Website: http://www.envnetwork.smu.ca/

Ecological Monitoring and Assessment Network
Website: http://www.eman-rese.ca/

Monitoring the Moraine
Website: http://www.wixnet.ca/watersheds/test/monitoring/council.html

Ontario Ecosystems Monitoring Council
Website: http://www.wixnet.ca/watersheds/test/monitoring/council.html

Appendix 4: Community-Based Monitoring Protocols Matrix

In an effort to standardize community-based monitoring protocols, the Ecological Monitoring and Assessment Network hosts a database (http://www.eman-rese.ca/eman/ecotools/protocols/matrix/intro.html). CBM initiatives are encouraged to share information on the valued ecosystem components for which they are monitoring, as well as the processes through which data are collected. Material is then shared through an on-line database, as illustrated by the screen captures below.

Figure A4-1: Opening screen for the on-line searchable database of CBM protocols. Users may refine search by a variety of aspects, including geographic location, level of effort and outcome.

Figure A4-2: Two "hits" which may have relevance for a CBM set up surrounding the hog industry in Manitoba.

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Patricia Fitzpatrick is an Assistant Professor in the Department of Geography at the University of Winnipeg. Her research is concerned with the changing nature of resource management within Canada, where rapid development is occurring within the context of evolving environmental assessment processes and changing relations with First Nations. Specifically, her research explores the linkages between governance designed to engage the public in decisions that affect them, termed deliberative democracy, and sustainability. To this end, she is interested in if and how deliberative processes (i) foster participation, (ii) encourage learning, (iii) impact decisions, and, ultimately, (iv) contribute to environmental sustainability.

Alan Diduck is an Associate Professor and Director of Environmental Studies at the University of Winnipeg. Prior to joining the University of Winnipeg, he was a lawyer and Executive Director of the Community Legal Education Association, a nonprofit organization promoting civic and legal competence. His research deals with public involvement and social learning in resource and environmental management. The broad goal of the work is to contribute to the ongoing development of governance approaches that recognize and respond to complexity, uncertainty, and conflict. Such approaches are fundamental to the search for new scientific paradigms (e.g., sustainability science), and are linked to important emerging models of social-ecological systems.

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