Linking Ecological Monitoring to Decision-Making at Community and Landscape Scales

Edited by:

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Created by:

The Ecological Monitoring & Assessment Network Coordinating Office, Environment Canada

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Canada

Linking Ecological Monitoring to Decision-Making at Community and Landscape Scales

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Introduction

Hague H. Vaughan

In the fall of 2001, the Ecological Monitoring and Assessment Network (EMAN) Coordinating Office in partnership with the Nature Canada (formerly Canadian Nature Federation) and supported by the Federal Voluntary Sector Initiative initiated a study in 31 Canadian Communities on how to engage Canadians in the monitoring of their local environment and in the effective delivery of the resulting information to local decision-makers. From a National perspective, one objective was to derive consistent data and information from across the country through the use of standardized monitoring protocols. This could be used to inform policy and decision-making at all scales. Of equal importance was how to deliver such information effectively so that decisions and choices were, in fact, better informed.

The results of the study were creation of a standardized but flexible approach and tools for linking community based monitoring to local decision processes that can be applied with a high degree of success in communities across Canada and possibly elsewhere. Essentially we conducted 30 new experiments in how to best implement demand-driven ecosystem monitoring that supports and informs local decision-making while also contributing to nationally standardized data bases and our ability to manage policy, monitoring and research in an increasingly responsive and adaptive manner. The initial review of past experience, the detailed report and an accessible summary can all be found in the library section of the Canadian Community Monitoring Network website (www.ccmn.ca).

The study demonstrated that the nature of the information which best informs decision-makers is somewhat different than that which science routinely provides. Information which is timely, integrated and non-confrontational is required in support of adaptive management. Such information trades off certainty for timeliness but delivers risk-based feedback that fuels sustainability, a process of iterative adaptive decisions based on timely information. This approach complements the fundamental science required for the understanding, predictive modelling, and the management of critical issues such as those that are acute or localized. Both are required in order to achieve sustained ecosystem services and resilient development, policy decisions adequately reflecting interacting economic, social and environmental factors and an engaged public making increasingly informed choices. The papers in this collection examine that proposition and expand upon it in a number of areas.

The following three figures demonstrate the evolution of our conceptual framework for community-based monitoring through the course of the study.

The first is the adaptive management model which was tested in the communities. The first major step was to engage all stakeholders in a definition of "sustainable" based on "what would we not wish to compromise in the maximization of local development". Some communities had already initiated a visioning process. Concerns for swimable and fishable watersheds; healthy air, healthy trees and soils were routinely expressed as well as a desire to know whether "things" are getting better or worse. EMAN standardized protocols can be used to monitor most such concerns since they are designed to act as a suite, looking for change in all environmental compartments. If present conditions established by an initial survey are the reference point, regular community-based monitoring will indicate where sustainability as locally defined is possibly going off track requiring adaptive responses such as further investigation of cause, research into mechanisms or development of options. This then becomes an effective point of engagement for professional science.

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Figure 1. EMAN Adaptive ecological management model.

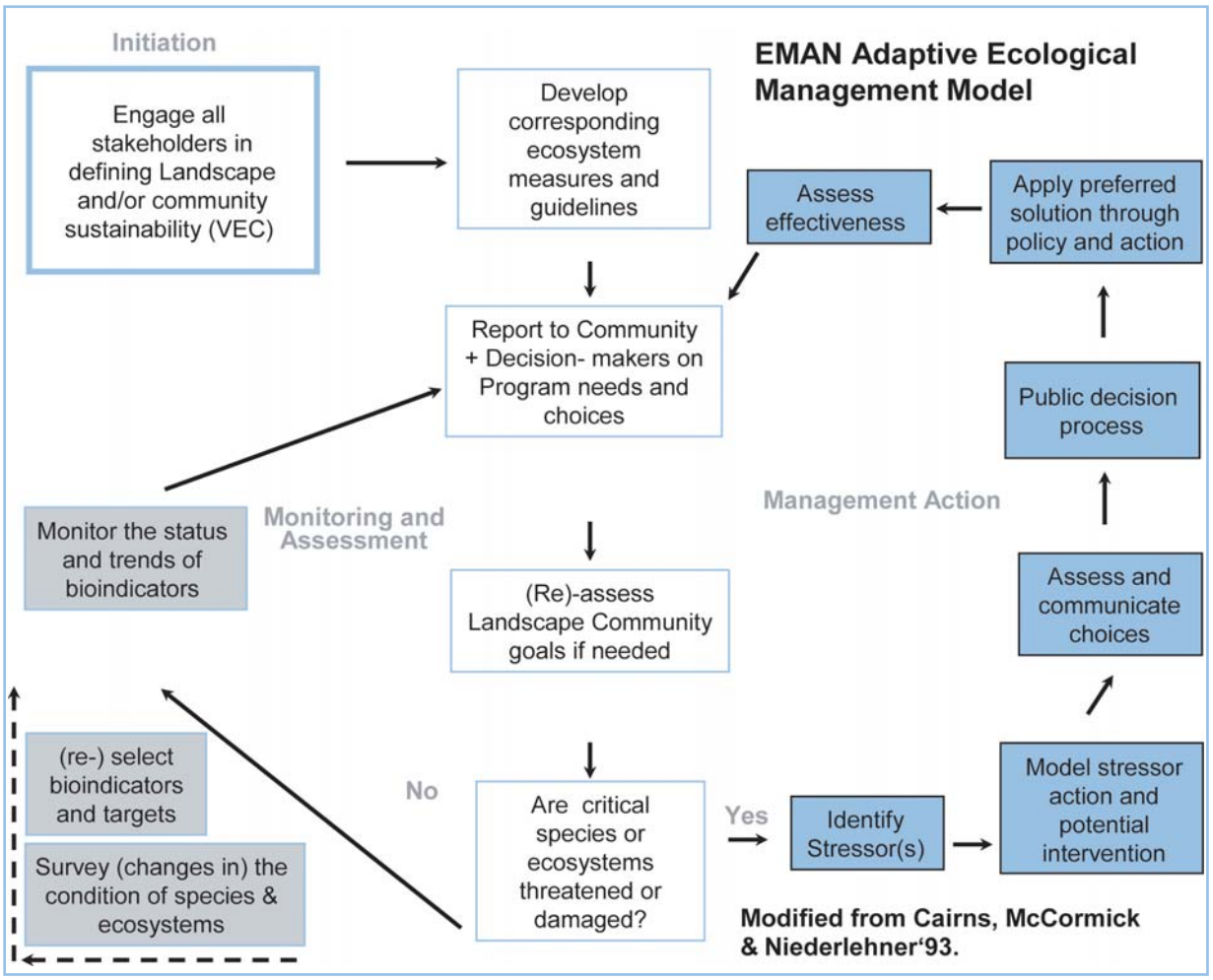

Table 1 lists the initial results of the community studies and reflects the anticipated linearity of the outcomes. Factors and conditions that could be used to derive a set of best practices for engaging communities were identified. This linear model failed to include the dominant role of social capital in providing positive feedback and reinforcement to the sustainability process.

Table 1: Linear Themes

Initial Context	Potential Catalysts	Potential Outcomes	Broader Outcomes
Existing capacity	Coordination	Ecological Monitoring	Knowledge Social Networks
Timing & Readiness	Inciting Issues Articulated	Volunteers & Champions	Improved Governance
Political Will	Planning Needs	Adaptive Management	Demand-driven Science
Partnerships	Multi-stakeholder Dialogue	Political Influence	Sustainability Models
Environmental Values	Vision for Sustainability	Measurement of Indicators	

The last figure represents the revised model for community based monitoring based on the lessons learned in the participating communities. The model illustrates the process of community based monitoring as flexible, iterative and self-reinforcing. Positive feedbacks within successfully initiated local programs result in their becoming increasingly embedded within the community. Once information is delivered effectively, the capacity to use that information increases. The power to affect decisions leads to wider community engagement, and so on. This process ultimately builds social capital: the combination of people and their skill sets as well as trust in and respect for one another that allows for commitment to working together for the betterment of their community.

Figure 2:. Phases of Community Engagement Spiral

EMAN is exploring opportunities to examine appropriate mechanisms to link community monitoring to decision making in landscapes and watersheds where there are a number of communities. This changes the dynamics in identifying the relevant decision making regime, in characterizing and delivering needed information, in defining sustainability and in choosing between policy options and trade-offs. Such a scale is required to manage and improve wildlife habitat and biodiversity, water resources, and sustainability in complex cultural landscapes. The results of some of those early applications were presented at the Denver meeting and are reported here.

Overview

By Maureen Lynch

Informed decisions, made at local and landscape levels, assist communities in their quest for sustainability. Community Based Monitoring (CBM), a process in which stakeholders collaborate to monitor, track, respond and adapt to issues of common community concern (EMAN CO and CNF 2003), is emerging as an effective way to fill data gaps in professional monitoring; it provides opportunities to engage citizens in monitoring the impacts of development activities. A key function of CBM is the timely identification of ecological changes, which (in addition to seeking the assistance of professional scientists) is critical to developing adaptive management responses. CBM activities help communities monitor and inform decision-making at local and landscape scales. Mechanisms of networking and information exchange allow local data to be combined with regional data to provide insight into local differences and regional trends. As a result, CBM becomes validated, communicated and incorporated into local and landscape decision-making processes, thereby contributing to sustainability.

In September 2004, the Ecological Monitoring and Assessment Network (EMAN CO) hosted a special session on *Linking Ecological Monitoring to Decision-Making at Community and Landscape Scales* at the Consortium for Advancing Monitoring of Ecosystem Sustainability in the Americas: Monitoring Science and Technology Symposium. The Symposium allowed more than 600 international environmental monitoring professionals to share their vision on the role of monitoring in sustainability. In this context, sustainability is defined as a complex, inter-disciplinary, cross-sectoral *process* of continuous monitoring and iterative adaptive management actions that engages people in raised awareness of social, economic and environmental interconnections and responsibilities, and improves human-environment relationships. The process relies on science, as well as communication mechanisms, to ensure shared ethics, human values and future options are kept open.

The EMAN CO session provided an opportunity to profile six Canadian initiatives that are improving local decision-making through collaborative, multi-stakeholder CBM activities. Contributors gave insights from academic, industry, government, and non-government perspectives, demonstrating a breadth of approaches that link CBM activities to decision-making. The presentations were joined by several common themes: building community capacity and social capital, inclusiveness, partnerships, and informing local decision-making.

These initiatives have educated communities about their environment and decision-making processes, empowering citizens to generate relevant ecological information and take action. CBM activities that are driven by common local needs help communities move towards greater sustainability. The papers demonstrate that an inclusive local monitoring process that values stakeholders and takes an ecosystem approach can help communities better identify and respond to early indicators of environmental change. By working in partnership, communities can increase the effectiveness of local monitoring programs, reduce duplication, and create new knowledge and tools for greater sustainability. These papers emphasize the importance of delivering timely information to improve knowledge for decision-making through a shared and transparent process.

In Alberta, three rural municipalities participating in the Tri Community Watershed Initiative now manage themselves in a healthier, more sustainable way. Maureen Lynch explains how the Towns of Black Diamond, Turner Valley and Okotoks connect residents and decision makers to environmental issues through hands-on activities that help build relationships, link common interests and maintain open communication. The Tri Community Watershed Initiative is ensuring that local choices are informed and reflect the collective beliefs of the community. By identifying values and engaging in local watershed activities, the communities are monitoring their progress towards sustainability. Articulating the information needs of decision-makers can be a difficult, but important, step in identifying specific community concerns and solutions. The Tri Community Watershed Initiative supports the process of learning through community engagement and seeks to achieve collective action in an environment that is ready to adapt and change. As a result, participating town councils have improved water efficiency policies and programs.

In Atlantic Canada, the Atlantic Coastal Action Program (ACAP) is helping communities to help themselves through local capacity building and education. Francine Rousseau describes how ACAP has been providing community-based programs centered on local involvement and action for more than 13 years. ACAP has an innovative multi-stakeholder community-based process to help traditional adversaries band together on common interests. ACAP groups have

experience in collaborative ecosystem management that have influenced local and regional decision-making; successes include solving problems related to sewage treatment, toxic contaminants and water quality, building local capacity and educating communities on issues related to pollution prevention, monitoring, climate change, assessment and household hazardous wastes. ACAP has shown that when communities realize they can solve their own problems, they are empowered to influence their own sustainability processes.

Brent Tegler's examination of CBM activities that engage industry in community decision-making reveals the ingredients of success in working with industry at the community level. CBM is often directed at examining significant environmental impacts arising from industry activities. When industry is included as an active partner, CBM results can be shared with decision makers in ways that can lead to positive outcomes. Using an inclusive process to ensure that open communication is maintained with all stakeholders, CBM can allow the public, government and industry to share knowledge, resources and concerns. Together stakeholders can develop solutions to common problems and cooperate in the pursuit of continuous improvement.

Liette Vasseur describes how the Southern Gulf of the Saint Lawrence Coalition on Sustainability (SGSLS) is taking an inclusive approach to build capacity and inform decision-making. This multi-stakeholder watershed project provides a regional, participative forum of partners who share a common solution-oriented vision of regional sustainability. The Coalition provides participating communities with opportunities to share information through meetings, workshops and task forces. As a result, local communities, decision-makers, and private and academic sectors in the Southern Gulf of the Saint Lawrence are improving local environmental awareness and decision-making and moving towards greater sustainability. Vasseur also examines SGSLS's academic-community partnership, and discusses the challenges that face stakeholders in promoting sustainability.

Sean Dolter demonstrates how partnerships are building a program that provides much needed information for forest management. The Biodiversity Assessment Project (BAP) being developed by the Western Newfoundland Model Forest (WNMF), in cooperation with the Institut Quebécois d'Aménagement de la Forêt Feuillue, will help forest managers assess future conditions of Newfoundland and Labrador's forests. WNMF works with a diverse range of partners to formulate approaches to sustainable forest management. BAP provides an opportunity for partners with similar academic and management interests to come together to resolve ecological challenges.

Chris Jones illustrates how partnerships are crucial to the success of the Ontario Benthos Biomonitoring Network (OBBN). This aquatic macro-invertebrate biomonitoring network for lakes, streams and wetlands will allow partners to evaluate aquatic ecosystem condition using the reference-condition approach and shallow-water benthos as indicators of water quality. The network is based on CBM-consistent tenets: free data sharing, standardization, and partnership. The OBBN facilitates collaborative collection of data on aquatic ecosystem condition and will build capacity for adaptive water management by enhancing the link between science and decision-making in Ontario.

Conclusion

Gathering information at the community level helps ensure that CBM is relevant to each individual community. The CBM process allows decision-makers to describe their information needs and strengthen relationships with stakeholders. When information needs are identified, monitoring becomes demand-driven, informing the development of effective tools and solutions for local environmental issues. Decision-makers and citizens can then feed this knowledge and skill into adaptive local choices and behaviours.

The six initiatives described herein successfully link CBM to decision-making and establish relationships by taking a multidisciplinary, ecosystem approach to monitoring. Using interdisciplinary partnerships at community and landscape scales, they build capacity to address ecological challenges resulting in adaptive environmental management and informed local choice.

Definitions

The following definitions may assist in a common understanding of terms used throughout the case studies:

Community-Based Monitoring: a process in which stakeholders (citizens, government, industry, academia, community groups and local institutions) collaborate to monitor, track and respond to, issues of common concern. (Ecological Monitoring and Assessment Network Coordinating Office and the Canadian Nature Federation 2003.)

Ecosystem: a system of interdependent organisms, including human beings, and the physical environment they inhabit. It includes interacting environmental, social and economic aspects (adapted from Kemp 1998).

Sustainable ecosystem management: the integrated, careful and skilful use, development and protection of ecosystems using ecological, economic, social and managerial principles to sustain ecosystem integrity and desired conditions, uses, products, values, and services related to all development over the long term (Vasseur and Hart 2002).

Sustainability: a complex, inter-disciplinary, cross-sectoral process of continuous monitoring and iterative adaptive management actions that raises awareness of social, economic and environmental interconnections and responsibilities and improves human-environment relationships.

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Tri Community Watershed Initiative Towns of Black Diamond, Turner Valley and Okotoks, Alberta

Promoting Sustainable Behaviour in Watersheds and Communities

By Maureen Lynch and Wendy Aupers

Abstract

Since 2002, three rural municipalities in Alberta have been working together to promote sustainability. The towns share the belief that water is an integral part of their communities; they have formed a Tri Community Watershed Initiative to help manage their shared water resources. Activities of the Initiative include changing municipal policies, writing municipal water and river valley management plans, working with partners, hosting community events, engaging media, and assisting residents in water conservation efforts. To date, 100 percent of the households – more than 15,000 residents in approximately 6,000 households – have participated in community-wide water conservation campaigns.

The Initiative has improved local policy and decision-making through a collaborative multi-stakeholder approach. Involvement of residents, town councillors and stakeholders in watershed activities has allowed local decision makers to gain awareness and strengthen community capacity. The Initiative is also ensuring that local choices are informed and reflect the collective beliefs of the community. By identifying values, engaging in local watershed activities and defining sustainability, the communities are able to monitor progress and feed into adaptive decision-making processes. The framework and best practices the towns have developed will be discussed as well as lessons learned.

Introduction

In March 2002, the Alberta Towns of Black Diamond, Turner Valley and Okotoks supported a proposal to participate in the Canadian Community Monitoring Network (CCMN), a one-year pilot initiative of Environment Canada and the Canadian Nature Federation. The purpose of the project was to determine the best approaches for engaging communities in activities that link monitoring to decision-making. Twelve regional coordinators in 31 Canadian communities participated in testing and refining different Community Based Monitoring (CBM) approaches. Communities used a range of context-specific approaches and tools.

Water as a Bridge Between Communities

As three southern east slope communities located in the foothills of the Canadian Rocky Mountains, the Towns of Black Diamond (population 1,900), Turner Valley (population 1,500) and Okotoks (population 15,000) share a history of almost 100 years of living and working within the same watershed. The Sheep River is a natural free-flowing river, with no in-stream or off-site water diversion facilities to store and protect municipal water supplies. The communities rely on natural flows and the wise and responsible use of water resources to provide for their needs. Threats from various urban uses have the potential to contribute to watershed deterioration. Climatic conditions, such as droughts, and lack of scientific data to evaluate aquatic ecosystem condition are ongoing water management concerns.

The towns, situated within a 20-km radius near Calgary, face a variety of challenges relating to local growth, urban sprawl, forestry, oil and gas exploration, tourism, recreation, and agriculture. Local town councils must respond to increasing demands for policies that address social, economic and environmental issues. Residents share concerns about their own awareness and knowledge of the use and stewardship of their water resource and the need to act to reduce impacts. A common vision of preserving and protecting the Sheep River has begun to emerge. Local action is linked to community engagement and public education programs, to build capacity on watershed issues.

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As a CCMN pilot site, the Towns of Black Diamond, Turner Valley and Okotoks conducted a variety of activities, including river clean ups, high school water quality monitoring, issue identification, skills development, partnership development, fundraising efforts, participation in meetings and presentations, focus group sessions, awards recognition and water conservation activities. The towns learned that progress toward a common vision of sustainability is most successful when it is driven by local information needs and community values. They also learned that local monitoring information can be integrated into adaptive decision-making structures respond to early indications of environmental change.

The CCMN pilot led to the development of a four-phase model: *Community Mapping* (gathering local information ensures CBM is unique to community needs, allows decision-makers to describe their information needs and provides the opportunity to maximize partnership collaboration); *Participation Assessment* (finding the best approaches for building capacity and understanding the people involved in CBM helps to engage them, use their skills and meet their needs); *Capacity* Building (enhancing the community's ability to carry out CBM requires capacity, coordination, training and information delivery mechanisms), and; *Information Gathering & Delivery* (when information needs, such as educating participants, identifying local priorities and reporting results, are identified, monitoring becomes demand-driven, provides more effective solutions and allows decision-makers to make more informed choices).

The Tri Community Watershed Initiative

The Towns of Black Diamond, Turner Valley and Okotoks have identified the importance of working together to engage residents of the Sheep River Valley in personal action toward the preservation and protection of their watershed. As a result, they developed a Tri Community Watershed Initiative to help promote more sustainable use of local water resources through water conservation strategies and policies, community engagement opportunities, and public information and education programs.

The Tri Community Watershed Initiative includes several citizen-led watershed efforts. To date, three annual tri-community river clean ups, involving more than 350 volunteers and 9 llamas, have gathered 7 tonnes of garbage – including everything from tractor tires to kitchen sinks. Decision-maker involvement in river clean up activities includes town councillors, mayors, staff and residents. Additional community engagement opportunities help to further build capacity regarding the importance of local watershed protection. More than 100 students from local Foothills Composite and Oilfields High Schools have conducted water quality monitoring tests on the Sheep River with RiverWatch, an award-winning not-for-profit organization that links water monitoring activities to the Alberta Learning Curriculum. Students, town councillors and local media participated in pre- and post-field work, in-class discussions and data collection to measure physical, chemical and biological river variables. In addition, RiverWatch Summer Science Water Camp activities have provided an opportunity for 25 children to float down the Sheep River in inner tubes and learn about natural history, aquatic health and river safety while monitoring water quality. The towns have also held a Facilitation Skills Workshop to train 25 residents, staff and decision-makers in local sustainability issue management. Meetings with neighbouring communities provide further opportunities to discuss water-related issues; as a result, nearby towns Cochrane and Canmore are introducing similar residential water conservation programs and water policies in their communities.

Raising Awareness and Knowledge Through Community Action

An important component of the Tri Community Watershed Initiative is the implementation of community-based social marketing (CBSM) campaigns, which employ a two-way dialogue to influence residential behaviour. The CBSM approach is based upon the premise that behavior change can best be achieved through community level initiatives. By focusing on personal communication to identify barriers and constraints, individuals can be encouraged to engage in sustainable behaviours. Once barriers are uncovered, tools and incentives can be used to foster and maintain behavior change. CBSM encourages individuals to adopt behaviors that are resource efficient, which, in turn, helps communities move toward sustainability.

Using a CBSM strategy, the Towns of Black Diamond, Turner Valley and Okotoks hold focus groups with residents to discuss water conservation issues and identify barriers and constraints. Community education coordinators visit residents at their doorstep to discuss water conservation issues and promote wise water use through a two-way dialogue. Coordinators emphasize watering facts (such as lawn watering only one inch a week) to help residents identify unnecessary watering practices. To date, 100 per cent of residential households (5,400 households, 15,000 residents) have received water efficiency incentives such as fact sheets, hose washers, tap timers and drought tolerant wildflower

seeds. The incentives provide information of a variety of water saving opportunities and help stimulate discussion about water conservation methods.

The towns monitor residential water consumption by means of bulk metering reading. The program has achieved an approximate 20 percent reduction in peak summer residential water consumption through this initiative. Water saved through water conservation efforts helps to defer the need for water supply infrastructure expansion, providing greater economic value to the municipalities.

The towns reinforce wise water use messages through utility bill inserts, mail-outs, highway signs, newsletters, and newspaper articles. The communities also share a common Horticultural Hotline in which the Town of Okotoks' Open Spaces Staff answer more than 1,000 telephone calls per year from area residents on water related gardening techniques and yard maintenance.

The CBSM strategy is well suited to residential water conservation efforts; face-to-face communications are more likely to change residents' long-term behaviour compared to traditional communication vehicles, such as print information materials. The towns are finding that establishing normative behaviours, which focus on voluntary adoption of best management practices, is proving to be an effective approach in influencing municipal water policies and residential water use.

Capacity Building – Remind, Reinforce and Reveal to Succeed

Capacity building is another important component of the Tri Community Watershed Initiative. The towns believe in working together to manage change, enhance coordination, foster communication, and share information within the Sheep River watershed. The Initiative supports the process of learning through interaction and community engagement and seeks to achieve collective action in an environment that is ready to adapt and change. The three town councils have improved water efficiency policies by passing low-flow fixture bylaws (for new homes, businesses and renovations), water conservation bylaws, joint resolutions to work together, right-to-know pesticide bylaws, and operational budget funding for residential water conservation programs.

As a result, the Tri Community Watershed Initiative has resulted in five key accomplishments:

1. Action on river valley issues.
2. Engagement of the communities in residential watershed activities.
3. Active community input into water conservation policies.
4. Joint commitment of municipal councils to watershed management.
5. The development of resources, expertise and partnerships to raise watershed awareness, knowledge and personal action.

The Tri Community Watershed Initiative has also provided financial contributions to the three communities, including funding from EcoAction ($100,000), Environment Canada/Canadian Nature Federation – CCMN Project ($39,000), cash investment from the Towns of Turner Valley, Black Diamond, and Okotoks ($32,000), in-kind donations ($10,000), Community Animation Program ($9,000), and Community Initiatives Program ($7,000).

Public involvement within the Towns of Black Diamond, Turner Valley and Okotoks has been extensive, with more than 15,000 participants (4,000 volunteer hours) taking part in watershed activities to date. Demographics range from residents, students, councillors, town staff and environmental partners. Face-to-face meetings, presence and visibility within the communities, and exchanging information have all been successful methods of sharing knowledge and expertise. Approximately 150 meetings have been held within the three communities to discuss water related issues, with more than 2,000 participants (all meetings combined) in attendance.

Specifically, the Tri Community Watershed Initiative has provided the towns with:

- Personal contact with 5,400 households and 15,000 residents to discuss water conservation issues and identify barriers and constraints to wise water use, resulting in a 20 per cent reduction in summer residential water use.

- Community capacity with local schools, resulting in 100 local high school students and 25 elementary-aged students conducting water-monitoring activities. Six local teachers have been trained in RiverWatch monitoring protocols.
- Improved aquatic health of the Sheep River through river clean-up activities, resulting in 350 volunteers and 9 llamas collecting 7 tonnes of garbage and ongoing annual efforts.
- Tools to link community watershed activities to inclusive decision-making, resulting in five new water-related bylaws and three town council resolutions to work together on watershed protection.
- Twenty-five community members trained in meeting facilitation skills.
- Increased media profile of tri community efforts, resulting in 25 newspaper articles, 10 radio interviews, 5 magazine articles, 1 television commercial and 3 television interviews to date.

The Tri Community Watershed Initiative has also been recognized for its commitment to the preservation, protection, enhancement and sustainability of the environment and its positive, tangible, long-term impact on the Sheep River Watershed. It has received two APEX Awards of Communications Excellence (an international annual competition for writers, editors, publications staff and business and nonprofit communicators) and has been named as a Finalist in the Alberta Emerald Award Foundation for Environmental Excellence (which recognizes outstanding leadership to protect, preserve, enhance and sustain our environment).

Working with Partners to Influence Watershed Behaviours

The Tri Community Watershed Initiative has created strategic linkages with a variety of partners including Calgary Regional Partnership, RiverWatch, Earthwatch, Cows & Fish, Highwood Business Development Corporation, Headwaters Health Authority, and Canadian Cattlemen's Association.

Recently, the Initiative formed a formal partnership with the Bow River Basin Council (BRBC) a non-profit, non-government organization dedicated to the protection of the Bow River Basin. With a membership of more than 125 organizations, BRBC maintains a forum for members to share perspectives, exchange cooperative water use management strategies and participate in activities that demonstrate awareness of water use management issues.

BRBC recognizes that by providing the opportunity to more formally capture and share project results among BRBC members, the Initiative will enable other municipalities to replicate similar successes. This multiplier effect will contribute to the overall health and management of the Bow River Basin watershed (which includes the Sheep River), allowing more communities to learn from, and adapt and adopt, developed strategies.

The Tri Community Watershed Initiative and BRBC have created a two-year project entitled *Influencing Watershed Behaviours* to protect the Sheep River watershed. Specifically, the project will help promote municipal water conservation, reduce residential pesticide use, protect river valley lands and share tools and resources among interested stakeholders. *Influencing Watershed Behaviours* project activities include replacement of residential water meters, distribution of residential water conservation kits, focus groups, in-store displays, discount coupons, media activities, surveys, workshops, door-to-door visits, public education materials, website information, water efficient demonstration sites, meetings and presentations.

Lessons Learned

The Towns of Black Diamond, Turner Valley and Okotoks have demonstrated leadership, responsibility, and cooperation through their involvement in the Tri Community Watershed Initiative. Their collective efforts are improving quality of life through local level policy processes and watershed activities that reflect the desires of community residents and the legacy they will leave for future generations. The towns are connecting residents to environmental issues and demonstrating innovation and excellence through the development of knowledge, practices, and processes that suit the watershed needs of the three communities.

The timing of the Initiative has proven to be an important factor for success. As CCMN participants, the Towns of Black Diamond, Turner Valley and Okotoks saw the opportunity to work together on watershed issues. One of the first steps the towns took was to assess existing monitoring, groups and potential partners to identify ongoing issues,

concerns and activities. The Town of Okotoks was already involved in water monitoring and local groups such as the Sheep River Valley Preservation Society and the Healthy Okotoks Coalition were involved in a wide range of environmental issues. Partnerships with non-profit groups, such as the Bow River Basin Council, introduced opportunities for active community mapping and stewardship-based management.

Pilot results from CCMN indicate that local monitoring information can be integrated into adaptive decision-making structures in response to early indications of environmental change. Information delivery involves a two-way dialogue of information to create improved knowledge for the decision-maker. For more effective community-based decision-making, environmental information should be timely, relevant, useable, targeted, accessible, understandable, integrated, and suggest a course of action. To achieve these goals, local capacity must be developed to generate, deliver and use ecological monitoring information.

CCMN results also indicate that community-based monitoring of environmental change is an effective tool for building community capacity, local networks, stewardship and public education. Enhanced capacity enables more effective public participation in local governance, which can, in turn, lead to a more inclusive decision-making process. This results in better choices related to conservation and sustainability that incorporate increasingly complex aspects of social, economic and environmental factors.

The Towns of Black Diamond, Turner Valley and Okotoks have learned that residents are motivated by concern for their environment, and need to feel that their contributions are valued and make a difference. To increase engagement in community watershed protection, decision-makers were invited to participate in hands-on activities, building relationships, linking their common interests, and maintaining open communication. All three councils have been identified as champions of the Tri Community Watershed Initiative. Participation in the River Watch program helped build capacity with local schools by providing protocol training, equipment and data management.

Communication mechanisms such as media coverage, word of mouth, web sites, presentations to council, community information boards and regular updates have enhanced public awareness and understanding of watershed activities.

CBSM survey techniques have helped to build capacity with residents through door-to-door visits. CBSM is proving to be an excellent tool for water conservation practices and wider education about community based monitoring.

Conclusion

The Towns of Black Diamond, Turner Valley and Okotoks share an identity that transcends political boundaries; they believe it is important to protect the environment in which they live. Articulating the information needs of decision-makers can be a difficult, but important, step in identifying specific community concerns and solutions. Heightened awareness through education and information sharing is another important step.

The environmental benefits of the Tri Community Watershed Initiative are directly impacting the towns. Residents who are installing water-saving devices and adopting water conservation behaviours, for example, are contributing to a decrease in water consumption and better progress towards demand management of water while saving money. The Initiative is reducing peak flow demands on infrastructure, stretching the use of available water, providing consumer savings, protecting the aquatic environment, contributing to sustainability, ensuring adequate water quantity and protecting water quality.

Decisions made at local and landscape scales have a direct impact on sustainability. The Tri Community Watershed Initiative is helping the Towns of Black Diamond, Turner Valley and Okotoks to engage the residents of the Sheep River Valley in personal action toward sustainability and greater ecological health.

Quotable Quotes

Here's what people are saying about the Tri-Community Watershed Initiative:

"The CCMN project helped us to strengthen links between community-based environmental monitoring and decision making. It was a unique opportunity to broaden the network of communities in southern Alberta. This national program provided resources that might not otherwise be available. Some of these opportunities would not exist without this program."

Maureen Lynch, CCMN Project Coordinator for the Towns of Black Diamond, Turner Valley and Okotoks on the formation of the Tri-Community Watershed Initiative

"The river clean-up is an opportunity to show respect for the green areas of town. Picking up litter and garbage in our river valley means that litter and garbage isn't going to continue down the valley. If we keep litter out of the river valley it will continue to look like a natural area. The regional aspect of the clean up is very important. We have to monitor the quality of water and ensure that the entire river valley is clean and tidy. If we clean all that up we will feel better about the environment we live in."

Karen Brewka, Town of Okotoks Horticultural Specialist, on the importance of the Sheep River Clean Up Day

"We finally get to go outside and do something instead of learning about it in a book. Everyone learns differently. Not everyone learns from books. The more you're able to use your hands in things like this, the more you remember."

Linnea Morris, Oilfields High School Biology 20 student, participating in the CCMN/RiverWatch monitoring day on the Sheep River in Black Diamond.

"The average Canadian adult spends six minutes a day outside…we really have sheltered ourselves. The students are here and they're learning data but being outside is teaching them to become better people in the world too."

Jim Christie, Oilfields High School Biology Teacher, on the importance of field trips such as RiverWatch as an essential way for students to learn.

"I think it's a great thing for everyone to be learning, especially when you live in the area. It's important for town council to support programs that involve our environment, youth and everything that directly affects our drinking water."

Kristie Tucker, Black Diamond Town Councillor, on her participation with local Oilfields High School students in the CCMM/RiverWatch monitoring day

"Local residents are sophisticated in their understanding, and as politicians we need to listen. They've been very effective in directing water quality decisions. I feel pretty optimistic about the progress we can make as communities sharing the same watershed. We've come a long way. We're recognizing the impact we can have by working collectively."

Jane Toews, Black Diamond Councillor regarding local residents' profound influence on environmental decision making

"Well done! Keep up the excellent work in engaging your communities in the governance of the Sheep River watershed. The community-based social marketing approach is proving to be very successful. These innovative and creative approaches are a very worthwhile means of achieving the healthy watershed that all three communities are striving for. Outreach and sharing is very important both within and among the three communities and out to others."

Teresa Chilkowich, Environment Canada EcoAction Coordinator

"This clean water project clearly demonstrates your organization's commitment to protecting and preserving our environment, and I am pleased to have your organization help us in our efforts. You are to be commended for your initiative in taking action in support of a healthy environment."

David Anderson, P.C., M.P., Environment Minister on his approval of funding for "Influencing Watershed Behaviours" project

"I am sure that your project will not only make a tangible contribution to the quality of the environment in your community, but also encourage others to do their part. Individual Canadians, and groups such as yours, can help shape our country's environmental future."

A. Anne McLellan, P.C., M.P., Edmonton West on the Tri Community Watershed Initiative project "Influencing Watershed Behaviours"

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Partnerships in Community-based Approaches to Achieving Sustainability:

The Atlantic Coastal Action Program

By Francine P. Rousseau, Colleen McNeil, Lawrence P. Hildebrand

Abstract

Environment Canada has been actively working in the Atlantic Region for more than a decade to help citizens create a healthier environment by providing local communities with the means to develop their own vision of sustainability. In this regard, the Atlantic Coastal Action Program (ACAP) has been one of Environment Canada Atlantic Region's greatest success stories.

ACAP is a community-based program that promotes local leadership and action. For more than 13 years, ACAP activities have involved thousands of community residents working as volunteers in local and regional initiatives. Successes include solving problems related to sewage treatment, toxic contaminants and water quality, building local capacity, and educating communities on issues such as pollution prevention, monitoring, climate change, assessment and household hazardous wastes.

By working in partnership with local communities rather than working in isolation, Environment Canada has helped a diversity of communities to address local environmental issues. When communities realize that they can solve their own problems, they are empowered to influence decision-makers and policy makers. ACAP groups have experiences in collaborative ecosystem management that have influenced local and/or regional decision-making. This paper outlines a number of these experiences, describes ACAP and its process as well as ACAP's influence within Environment Canada and the Atlantic Region.

Introduction

In November 2002, the Government of Canada made a financial commitment towards the construction of a sewage treatment plant for St. John's Harbour in Newfoundland. This announcement was the result of many years of applied research, monitoring, educational campaigns, and numerous related efforts to influence decision-makers, conducted by a dedicated group, St. John's Harbour ACAP Inc. The St. John's group is a member of a community-based program, launched in 1991 by Environment Canada (EC), known as the Atlantic Coastal Action Program (ACAP) (Environment Canada 2003).

St. John's Harbour ACAP Inc. is one of 14 organizations in Atlantic Canada under the ACAP umbrella. There are two ACAP sites in Newfoundland, two in Prince Edward Island and four each in the provinces of Nova Scotia and New Brunswick (See figure 1). All ACAP sites are dedicated to sustainability and have influenced local and regional policy and decision-makers. Examples of these successes, including that of St. John's Harbour ACAP Inc., are outlined in this paper.

ACAP and the ACAP Communities

Environment Canada initiated the ACAP program as a strategy to restore and sustain watersheds and adjacent coastal areas in the Atlantic Provinces and satisfy the growing public demand for involvement in decision-making. The main objective of ACAP was to involve communities in harbour and estuary restoration and maintenance programs in Atlantic Canada. The process has involved the development and implementation of comprehensive environmental

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management plans (CEMP) in communities, as well as partnership building, local action and awareness projects, and the advancement of science. With an initial focus on water quality issues, the program has evolved to wider sustainability issues, including those of an economic and social nature.

The 14 coastal communities involved in ACAP were identified at the outset as "hot spots" of ecological degradation. The communities range from urban settings with polluted harbours, to polluted industrial areas and farmland. In accordance with this range of characteristics, ACAP community successes also range from solving complex problems related to sewage treatment, toxins and water quality, to building local capacity and educating communities on pollution prevention, monitoring, assessment and household hazardous wastes. ACAP accomplishments are widely recognized and they continue to gain respect and credibility locally, nationally and internationally (Environment Canada 2003).

Figure 1. ACAP sites.

ACAP Phases I, II and III

In Phase I (1991-1996) of the program, Environment Canada (EC) provided 'core funding' to independent, non-profit ACAP organizations to hire an executive director, set up an office and complete regional planning documents. The CEMP was the primary focus of this phase and involved an investigation of local resource issues, an assessment of the available remedial options, and a review of options, which best served the environmental and socio-economic objectives of the community. CEMPs guide communities in ecosystem management by outlining timeframes and responsibilities for implementation.

For Phases II and III of ACAP, Environment Canada has provided annual funding to groups for implementation of CEMPs. Specifically, funds are provided for work in: knowledge generation, capacity building, direct action and the

advancement of science. This support helps to build the local capacity and knowledge required for communities to make informed decisions and address complex issues related to the environment.

ACAP relies on local involvement and support. While Environment Canada contributes to project funding, community stakeholders supply resources through volunteer labour, in-kind contributions, and levered financial support from government, academia, environmental non-government organizations, industry and local businesses. ACAP projects, thus, result in a variety of partnerships and demonstrate the value of an inclusive community-based approach.

Science Linkages Program

In Phase II of ACAP, a Science Linkages Program was launched to enable ACAP organizations to develop partnerships with EC scientists. The program responds to requests from ACAP sites and EC scientists, allowing sites to take responsibility for their part of the ecosystem and possess the skills and information required to carry out those responsibilities. Scientists benefit from having trained volunteers to fill information gaps and to do quality science. Together, the partners develop proposals, conduct scientific work of mutual interest, and report results. Since its inception in 1997, more than 60 EC scientists have transferred their knowledge of scientific methods and practices to ACAP organizations, while the organizations in turn have helped government scientists to gather missing data, brought partners to the table who would not normally participate with government and, provided volunteer hours and valuable knowledge about local science needs and ecosystems (Environment Canada 2003).

Windows

Environment Canada has developed a unique way to maintain its connection to the individual ACAP communities. A formal link to and from each site is maintained via a "windows" approach. Windows are EC employees who sit on each Community Board of Directors as ex-officio members. The windows provide a link between the groups and EC staff, as well as with other government departments. This has led to a high level of understanding and cooperative working relationships among participants. Most windows have been with their ACAP sites for fairly lengthy terms, some as long as 10 years. The windows provide a personal connection to the Department, which has established trust, credibility and respect (Environment Canada 2003).

ACAP's Impact and Influence

Economic Impact

A recent study (Gardner Pinfold 2002) conducted for Environment Canada shows that ACAP programs costs are low. Environment Canada's total ACAP investment from 1997 to 2001 was approximately $6 million; based on the analysis conducted, it would have cost the federal government 12 times that amount to directly deliver a similar internally run program. As well, hundreds of direct and spin-off jobs are created annually throughout Atlantic Canada through ACAP. In total, the economic impact (GDP) for this same period was about $22 million in direct and spin-off economic activity.

ACAP organizations are able to secure funds from local partners, industry and other government departments. Money invested in local communities benefit those communities. An example of the economic returns of ACAP groups is the $4.6 million per annum that has been generated by the creation of a 63 km interprovincial linear park managed by the Société d'aménagement de la rivière Madawaska et du lac Témiscouata inc. (SARMLT) in partnership with Québec (Gardner Pinfold 2002).

Impact on Environment Canada Business Lines:

Although ACAP sites are independent organizations and conduct their own business, Environment Canada is a partner in each of the initiatives and thus participates in setting direction, identifying issues and selecting responses. Environment Canada windows act a two-way channel from EC to the ACAP sites and help keep sites well informed on EC priorities and targeted results. In most cases, EC's vision and goals align well with ACAP organizations. As a result, more than 1,000 community projects delivered by the ACAP organizations have contributed to EC priorities, or 'business lines', as shown in table 1 (adapted from Trites-Tolson 2002):

Table 1: Estimated ACAP Contribution to Environment Canada Business Lines

Business Line	Estimated % Contribution1
Nature	44 per cent
Clean Environment	33 per cent
Management and Administration	12 per cent
Weather and Environmental Prediction	11 per cent

ACAP sites participate in multi-partner scientific projects that link directly or indirectly to EC priorities. Bluenose Coastal Action Foundation (BCAF)'s current project, summarized below, provides an example of the type of collaboration.

The BCAF project concerns the provision of a prototype for the development, by Nova Scotian scientists from Dalhousie University, Environment Canada and the Department of Fisheries and Oceans Canada (DFO), of a new form of coastal monitoring and management system. Their goal is to use environmental observation systems and advanced numerical models to describe physical, chemical, and biological changes in the marine environment (BCAF 2004).

BCAF's role is to aid in the development and validation of bio-optical data products for use in coastal observation and prediction systems in Lunenburg Bay, Nova Scotia, as well as to develop an extensive education and outreach program for the Town of Lunenburg. BCAF personnel are responsible for an extensive water-sampling program that includes the collection and analysis of water samples as well as sea-truthing samples. Collected samples will be processed by BCAF staff and analyzed for chlorophyll and absorption by particulate and dissolved materials. Other sampling measures include water clarity and optical properties. While direct measurements such as temperature and salinity have a direct physical interpretation, optical measurements, such as the penetration of different wavelengths of sunlight through the water column, are made to infer the concentrations of phytoplankton in the water. All are core measurements for optical observation systems that will be used in the larger project, along with remote sensing of ocean color, to monitor the state of coastal ecosystems in coming decades (BCAF 2004).

This long-term project will eventually offer local fishermen accurate real-time weather and water conditions and will provide a sound scientific basis for detecting and describing weather and climate related influences on coastal ecosystems. The project will also assist in determining the effects of new sewage treatment measures implemented in the Town of Lunenburg in 2003. A coastal monitoring and management system has been a primary area of development within EC's Atmospheric Science Division and also fits well with the Department's mandate of safety and security for the Canadian public. In addition, the project offers both EC and BCAF the chance to create new partnerships within the scientific and international arena.

Influence on Policy and Decision-Makers Within Environment Canada

The ACAP Science Linkages Initiative was launched to link EC scientists with ACAP organizations. In her December 2003 report on the Initiative, the author noted, "Science Linkages fosters true partnerships between ACAP communities and EC scientists whose working relationships are built on mutual trust and respect"(Dech 2003). This mutual trust and respect had to be earned over time and was not so apparent in the early days of the Initiative. For many EC scientists there were questions of quality control, reliability of data, and duplicability of tests. For the communities there was concern that the federal government was downloading its environmental responsibilities for clean up and remediation onto them.

Effective project results, the reconciliation of diverse interests and, recognition and praise from peers and other scientists have answered many of the questions raised for both the scientists and communities. Today, ACAP's success has a great influence on how business is done within EC Atlantic.

EC scientists involved as ACAP windows have reported that the experience has broadened their perspectives and given them insights into the issues of importance to communities. It has also helped them to articulate science to citizens, and recognize interrelationships between the environment and social and economic conditions (Hildebrand 2002). Furthermore, it has provided partnership opportunities and access to funding not normally available to governments.

It is now common for EC scientists to actively seek out the help of the ACAP organizations. Volunteer monitoring supplement EC's efforts; in some cases it is the only data available for a given site. "Most EC scientists", says Hugh O'Neill of Environment Canada's Environmental Quality Laboratories in Moncton, N.B., "have a high regard for the ACAP process… but, in retrospect, many scientists did not realize the capacity that some communities had access to, ranging from university and industrial scientists and their labs and dollars, to local bird watchers." (O'Neill pers. comm. 2004).

The ACAP sites are involved in monitoring activities, including well-established programs such as River Guardians, Swim Watch, and Air Watch. A number of ACAP sites have also established their own labs to conduct such activities as fecal coliform bacterial analysis. Although these labs have not been directly involved in regulatory-decision-making (in Canada, only data from "accredited" labs can be used in court cases and the cost of accreditation is just too high to be borne by most volunteer groups), EC and other organizations with enforcement mandates launch their own investigation based on the sampling results obtained from the ACAP groups, as will be seen in the description of the St. John's Harbour ACAP Inc. project (page 9) which was noted in the introduction.

Environment Canada is involved in a number of on-going monitoring programs to which the ACAP sites are regular and long-term contributors. The response from the lead

EC scientists to ACAP's contributions have been positive. Dr. Amar Menon, former head of EC's Shellfish Monitoring Program in the Atlantic Region, is a scientist with a high regard for ACAP and community-based monitoring. Dr. Menon has been involved with numerous ACAP volunteers (and others) in water quality monitoring where shellfish are harvested at various coastal locations in Atlantic Canada. EC's biologists provide the training and ACAP volunteers monitor and sample in local waters. Volunteers must follow very prescribed and detailed protocols and undergo regular audits conducted by the EC Scientists (Menon pers.comm. 2004).

Environment Canada's other responsibilities under the Canadian Shellfish Sanitation Program (CSSP) include the promotion of pollution prevention and remediation of shellfish growing areas. ACAP sites are able allies to scientists. Several of the ACAP communities have begun remediation and shellfish restoration activities. In Charlotte County along the Bay of Fundy in New Brunswick, ACAP groups (working with the Premier's Clam Bed Action Committee) are active in pursuing the clean up of bacterial contamination in the area.

Remediation activities, throughout the Atlantic Provinces, have been successful in re-opening 2485 hectares of shellfish closures for commercial shellfish harvesting. This is of extreme importance for the area, where 2000 km2 of coastal waters (representing 33 percent of the classified shellfish growing area) have been closed to the harvesting of shellfish due to fecal bacterial pollution since the 1960s. Reopening of some of these areas for commercial harvesting could not have been done without the help of community-based monitoring and remediation projects (Environment Canada 2004).

ACAP monitoring and data gathering capabilities are also valued by EC's Environmental Emergencies Section (EES). EES has developed a geographic information system (GIS) for the Atlantic region to provide instant environmental data for decision-making responses to the thousands of spills involving oil or other hazardous substances that threaten the coastal zone resources of the region. The need to update and add to the mapping of more than 35,000 km of shoreline is a constant one and EC benefits greatly from the willingness of ACAP organizations to collaborate in collecting new information (Laflamme pers.comm. 2004).

The first such collaboration was between EC and the St. Croix Estuary Project, Inc. (SCEP). In 2001 to 2002, SCEP collaborated with EC, through a Science Linkages project, in collecting data from the Passamaquoddy Bay area, which helped in the development of a local community contingency plan for oil spill response. SCEP is unique from other ACAP sites in that it is located on an international river and represents the interests of both Canadian and American residents of the St. Croix Valley.

A similar collaboration is currently being developed between Environment Canada and the Miramichi River Environmental Assessment Committee (MREAC). Other partners include the Department of Fisheries and Oceans Canada (DFO) and government organizations whose cooperation will give MREAC and EC access to some of the local information that is often the hardest to obtain. Completed web-accessible map layers (of endangered species, nesting sites, spawning areas, valuable lobster and oyster habitats, coastal marshlands, beaches, municipal and other discharge zones etc.) for the Miramichi coastal zone and estuary will prove invaluable to the Environmental Emergencies Section, to local emergency response units and to MREAC, which has become a centre for information for community stakeholders (MREAC 2004).

Local and Regional Influence on Policy and Decision Makers

Community-led, multi stakeholder organizations such as the ACAP sites are inclusive and strive to include people who represent a cross-section of their individual communities including, citizens, business, industry, academia, non-government organizations and various levels of government. ACAP's biggest success is the use and acceptance of multi-stakeholder community-based processes, which have shown that even established adversaries can work together when common interests are evident. The program has produced a dynamic network of relationships, joint ventures and other strategic alliances, with ACAP organizations serving as effective facilitators and brokers. The example of the St. John's Harbour ACAP Inc.'s effort to get the issue of sewage treatment on the political agenda, illustrates the effectiveness of understanding players, forming strategic alliances and doing good science.

Long before the Government of Canada made the financial commitment announcement to help finance the construction of a sewage treatment plant for St. John's Harbour; the ACAP organization gathered data on the need for municipal wastewater treatment, conducted related monitoring projects, sought public consensus and sought to convince government that treatment was essential.

By 1997, St. John's Harbour ACAP had acquired the support of three local municipalities for conducting an investigation into the best way to handle the sewage problems in the local harbours. However, they needed to convince the municipal officials that it would take more than a pipe extension to tackle the problem. Results of community-led bacterial monitoring assisted the ACAP group in this regard. The results also influenced the provincial government and in 1999 it joined with St. John's Harbour ACAP and the three local municipalities in clamouring for treatment. ACAP St. John then increased its bacterial monitoring studies through a Science Linkages project in an effort to get the backing of the federal government. The ACAP group monitored fish and shellfish from 2001 to 2002, with the help of EC's Moncton lab and DFO, to determine if fish found in the Harbour proper were contaminated. This included monitoring for chemical contamination of fish and shellfish (metals, mercury, pesticides, Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), and dioxins were analyzed in lobster and flounder). Microbiological studies of the Harbour and nearby environment. were also carried-out (at Memorial University).

The monitoring results led to DFO closing shellfish and fish harvesting in the Bay (Baird pers.comm. 2004). This was a first in Canada – DFO had never accepted community-monitoring results as the basis for looking into harvesting closures. DFO's own monitoring confirmed the ACAP organization's results and they declared that sewage discharges were having an impact on human health. The federal government came "on board" and tri-level government funding was announced in November 2002.

According to Diana Baird of St. John's Harbour ACAP "One of the problems with government doing the monitoring in these cases is that the data tends to get shelved…, government officials don't seem to want to approach the media with negative results whereas community groups do." So, according to Ms. Baird, community groups are better at getting information to the public and this leads to greater progress – "you can't expect communities to get involved or to support something or to change their ways, if they don't have the information" (Baird pers.comm. 2004).

The discharge of raw or partially treated municipal sewage into rivers, estuaries and harbours is one of the most frequently raised issues by the ACAP organizations and many other Atlantic community groups and the lessons learned by the St. John's group are of value to all.

In recapping the more than eight years of struggle to get sewage treatment for the St. John Harbour area, Diana Baird had this to say about the ACAP process: "it is really the collaboration that has the value – getting all that knowledge and participation around the table was a new way of doing things…the first year was very much a feeling process, we had to establish trust… Thanks to Environment Canada, people from all sectors sat around the table to work things out…DFO has now become more open to us…And it has opened our links to local universities, to labs…we have credibility and value…We now get more and more calls from all over (EC, DFO, municipalities, etc.) for information about the Bay…scientist are coming to us" (Baird pers.comm. 2004).

Extending the Reach of ACAP

ACAP groups not only network individually but increasingly join-together in multi-site partnerships that have regional and national impacts. When scientists from Environment Canada's National Water Research Institute (NWRI), Canada's largest freshwater research facility, developed a national strategy for monitoring and assessment of aquatic biodiversity in Canadian inland waters, one of the goals was to develop a national, volunteer-based, invertebrate stream bio-monitoring network.

ACAP sites were the primary target for network participants in the Atlantic region. In fact, in 2002, out of 17 community sites involved in the Atlantic Network, 10 were ACAP sites. It was recognized that they were already well established, very successful and had a history of working well together. In a letter to the ACAP Science Linkages coordinator, Dr. Trefor B. Reynoldson, then leading the Atlantic portion of the program, noted that "The Institute [NWRI] sees the Science Linkages program as an important step in developing a Canadian Aquatic Bio-monitoring Program (CABIN)" (Reynoldson 2002). Four of the ACAP sites originally involved in the Atlantic Network have now banded-together, under the leadership of NWRI scientists and Acadia University, to adapt and transfer some of the bio-monitoring techniques they have learned in inland waters to estuarine waters.

The ACAP organization is building on success in other ways. For instance, in addition to working on geographical expansion into Labrador and networking together to increase their collective strength, the ACAP sites are adopting and/or mentoring adjacent watersheds and neighbouring coastal areas. The ACAP approach is further evident in a number of larger Atlantic Region multi-stakeholder coalitions, some with three or four ACAP groups in the membership, organized around larger regional ecosystems (for example, the Gulf of Maine, the Bay of Fundy and, the Southern Gulf of St. Lawrence). ACAP's influence can even be felt in inter-departmental and inter-governmental collaborations working towards improving government program service delivery to communities such as the Nova Scotia Sustainable Communities Initiatives and the Collaborative Environmental Planning Initiative for the Bras d'Or Lake in Cape Breton, Nova Scotia. These and other organizations help to ensure that the ACAP pillars of sustainability, multi-stakeholder partnerships, and community empowerment will continue to support the environmental health of Atlantic Canadian communities for generations to come.

Conclusion

One of the most important contributions of community-based environment management, such as that provided by the ACAP program, is the ability of the communities involved to bring to light potential and existing environmental, social and economic problems to decision-makers at all levels and in all sectors. That the participating community organizations can also be full partners in finding and implementing possible solutions that are scientifically defensible, economically advantageous, socially acceptable and environmentally sound is evidenced by the ACAP experiences described in this paper.

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Engaging Industry in Community Decision Making for a Sustainable Future

Dr. Brent Tegler

Abstract

Community based monitoring (CBM) is often directed at examining significant environmental impacts arising from the activities of industry. When industry is included as an active partner or stakeholder in CBM, the results of monitoring are shared and there is a good opportunity to inform decision makers in ways that lead to positive outcomes. Too often, however, there is an antagonistic relationship between those undertaking environmental monitoring and those managing industry. CBM provides an alternative by utilizing an inclusive process that ensures communication with all stakeholders from the outset of monitoring initiatives. In this way the public, government and industry participate as a team sharing knowledge, resources and concerns to develop meaningful solutions to shared problems. This paper discusses elements of CBM that inform community decisions and contribute to the sustainability of communities. The ways is which industry is engaged in CBM informing community decisions are discussed with current examples from within Canada.

Introduction

Whether consciously or unconsciously, community members make trade-offs among the priorities of economic, social and environment well being. Community members would agree, however, that the choices made should not compromise the provision of our most basic needs such as clean air and water for life support and food for sustenance. There are ideals held by community members that suggest communities want to act sustainably. To know if a community is sustainable, information must be collected about the state of the ecosystem, including social, economic and environmental conditions. Monitoring the ecosystem is therefore a core activity, fundamental to a community that strives to function sustainably.

Across Canada, a variety of monitoring projects have achieved positive results for communities working towards sustainability. Community Based Monitoring (CBM) provides an opportunity to gather relevant information in a timely fashion to Inform Community Decisions (ICD). Community Based Monitoring Informing Community Decisions (CBM-ICD) is defined as a process in which concerned citizens, government agencies, industry, academia, community groups and local institutions engage in a collaborative community effort to monitor, track and respond to locally identified issues (EMAN CO and CNF 2003). CBM-ICD activities include partnership development, consultation and outreach, visioning, capacity building, monitoring of an environmental issue or concern, and linking gathered information to local decision-making that supports sustainability and adaptive management.

CBM-ICD Success

When community members take an active role in ecosystem monitoring, multiple community benefits result. There is an increased awareness and understanding of human-environment interactions among those who participate in monitoring, such as school children, teachers and citizen groups and to those who provide support such as researchers, corporations and government scientists. In addition, this knowledge is shared with a wider community when CBM practitioners communicate their monitoring results. Informed decision-making and adaptive management is positively changing the way we manage human activities in the environment.

Local data derived from CBM-ICD initiatives can provide cost effective, and meaningful data to assist in monitoring programs, thereby helping to establish baselines and provide early warning of larger trends that merit further investigation. CBM-ICD extends the geographic and temporal reach of existing monitoring programs and provides data gathering at a much finer scale. Our knowledge of the impact of human actions on the environment is greatly expanded because CMB-ICD provides monitoring data collected by citizens who look at local environments.

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CBM-ICD promotes progress towards a common vision of sustainability by providing opportunities for dialogue between citizens, government and industry. Collaboration, a key characteristic of CBM-ICD, increases communication among all stakeholders allowing people to more directly benefit from the collective knowledge of partners. In return CBM-ICD provides an understanding of local issues and concerns and disseminates this information to others.

CBM-ICD Inclusiveness

Sustainability is a process that engages people through programs that make them aware of social, economic and ecological interconnections and responsibilities. The sustainability process works best when people make decisions and take actions based on good information and clear choices. The sustainability process relies on communication mechanisms that ensure human values are considered, tradeoffs are discussed and future options kept open.

CBM-ICD initiatives can involve local industry. Industry forms an integral part of communities through direct and indirect employment, infrastructure development and financial contributions to the local tax base, to non-government and non-profit organizations. Industry can also affect the environment within a community in both positive and negative ways.

There is often reluctance by the community to work with industry due to a fear that exposure of industry's shortcomings may lead to the termination of benefits that are seen to sustain the livelihood of a community. In addition, there is a culture of fear within industry when it comes to meaningful public reporting of performance. In most cases, government is the go-between, establishing and enforcing guidelines, standards and requirements that must be met by industry in the interest of the public good. Consequently, industry works to comply with existing government regulations.

When industry works directly with the community in a CBM-ICD initiative, new opportunities to act sustainably are created. Monitoring fosters greater environmental responsibility among all members of a community (including industry); it provides a cost-effective mechanism to effect change in the stewardship and protection of the environment.

CBM-ICD Partnerships and Networking

CBM-ICD creates forums that allow stakeholders to share a wide range of interests, abilities, knowledge and concerns. Stakeholders in CBM-ICD include: government; education institutions; industry and corporations; non-government organizations; and the general public. Stakeholders can be involved in the following activities: the sharing of monitoring knowledge and issue identification.

Community activities in monitoring and influencing local decision-making often involve new frontiers. To make the best use of information, neighbouring communities will ultimately compare approaches to monitoring, funding sources and the results of analyses. Networking is an obvious tool that CBM groups use to facilitate shared learning, data comparison and best practices.

Capacity Building

CBM-ICD bridges the gap between society and the environment by engaging communities in processes that define what sustainability means locally and tracks progress through ecosystem monitoring to produce relevant, timely information that informs decision-making. Experience has shown that the needs of ecosystem monitoring can be accomplished with minimal training, relying more on commitment than specialized knowledge.

The key components of CBM-ICD to engage communities include (North South Environmental Inc. 2004):

Getting started – organizing meetings, initiating partnerships, engaging stakeholders

Citizen-Science Monitoring Protocols – simple methods for scientific measurement of key sustainability indicators

Funding – need for long-term stability and partnerships

Data Analysis and Data Management – analysis methods, quality control and data storage

Communication – presenting results to educate communities and influence decision makers

Collaboration – sharing methods, results (data) and adaptive management responses, and

Capacity Building – training/technical assistance to achieve meaningful results.

Industry can assist in the capacity building of CBM-ICD citizen science. Community members may have concerns about what should be monitored and industry may provide advice in how to conduct monitoring. Direct funding for monitoring may come from industry and this may lead to matched funds from government or other stakeholders. Industry can participate in data analysis and management, which can assist in the communication of results to those within industry that can effect positive change. Industry can provide the technical advice, training and support needed as part of community capacity building.

Links to Decision Making

Sustainable ecosystem management is a process that explores social, economic and ecological interactions and the implications of human actions. When society is well informed, decision makers can recognize the tradeoffs required to balance ecosystem needs (social, economic, ecological). In essence, a sustainable society makes informed choices about the kind of environment in which they live. CBM-ICD contributes to this process through citizen engagement, the acquisition of information on ecosystem condition, reporting to decision makers, adaptation through changes in policies, and the implementation of actions that lead to an improved ecosystem condition.

Industry can be seen as a full participant in sustainable development, embracing an emerging vision of *whole ecosystem adaptive management* linking our knowledge of ecological trends and conditions to human economic and social activities. CBM-ICD embodies these principles through collaboration with all members of the community, including industry, in inter-disciplinary data gathering and analysis. The results of monitoring are communicated to key decision-makers so that they are better informed and can respond to local knowledge about the relationships between social, economic and ecological issues and needs.

What Role Can Industry Play in CBM?

Industry has an opportunity to be a major driver of environmental change

The activities of industry can result in wide-ranging environmental impacts from local to global.

Industry has a corporate responsibility to be good environmental stewards

Many industries possess environmental policy statements that acknowledge their role as good corporate citizens within their communities. This includes a responsibility to contribute to social, economic and ecological well being.

Industry involvement in CBM can help to achieve local scale monitoring objectives

Industries existing within local communities possess local knowledge that can contribute to community understanding of social, economic and ecological interactions.

Industry can implement an Adaptive Management Cycle

As industry strives to improve, it can contribute to creating more sustainable communities. Monitoring provides information for adaptive management within industry that can reduce negative social, economic and ecological impacts.

Industry has knowledge and capacity to engage the public

Public relations is an activity in which industry can benefit CBM-ICD programs.

What are the Impediments to Industry Involvement in CBM?

Exposure to public criticism

While the public looks upon participation in CBM-ICD favourably, there is often a concern by industry regarding the possibility that monitoring may reveal negative issues.

Industry's monitoring commitment is to the regulatory agencies that demand rigorous, scientific data

Industry acknowledges a monitoring responsibility to meet government standards but may consider CBM-ICD monitoring programs to be unprofessional and unlikely to provide meaningful information.

Cost & time commitment too large

The cost to industry for involvement in CBM-ICD can be considered to be unnecessary and often perceived as unlikely to provide positive returns.

Association with "bad data"

There is often a consideration among industry that monitoring methods used by CBM-ICD programs may not provide reliable data; industry involvement in the development of CBM-ICD monitoring programs could change this perception.

Liability issues around engaging citizens in monitoring

Industry is conscious of the fact that monitoring involves activities that may result in injury; this is of particular concern when monitoring is conducted on industry-owned property.

Loss of control

CBM-ICD is a collaborative activity with shared responsibility; when industry participates they must accept that those participating will expect thoughtful responses to the issues identified by monitoring.

What are the Benefits to Industry Involvement in CBM?

Positive public image

Public outreach and concern for the environment can result in a positive public image for industry.

Increased data collection

The public can provide cost-effective monitoring thereby adding to information industry has available to manage their operations.

Citizens can provide expert knowledge at low cost

Communities are composed of individuals with both local knowledge and scientific expertise that can benefit industry through collaborative CBM-ICD programs.

Public understanding of the cost of environmental protection

Industry involvement in CBM-ICD provides an opportunity for better public understanding of the cost of environmental protection.

Improved operations

The results of CBM-ICD monitoring programs can contribute to an adaptive management approach by industry that reduces their environmental impacts.

Working towards a sustainable community

Industry involvement is CBM-ICD can improve community collaboration, participation and ultimately sustainability.

The Four Levels of Industry Involvement in CBM-ICD

Example/Location	Activity	Industry Role	Evaluation
LEVEL ONE - Indirect involvement of industry in CDM-ICD with no feedback			
Oshawa Second Marsh, Lake Ontario, Canada	Restoration Monitoring	Financial support from a large car manufacturer	Industry a good corporate citizen but little has been learned about the environmental impacts of the car industry
LEVEL TWO - Direct involvement of industry in CBM-ICD with indirect feedback			
Stackwatch, Hamilton Harbour, Canada	Air Quality Monitoring	Financial and in-kind support from local steel industries	Monitoring data reported to government emissions regulator; industry accepts its responsibility to meet government standards (only)
LEVEL THREE - Direct involvement of industry in CBM-ICD with direct feedback			
1-800-Call-Odour Location withheld at industry's request	Air Quality Monitoring	Protocol development, citizen training, data analysis and problem resolution	Relevant monitoring data collected by citizens used to improve an industrial process; *adaptive management*
LEVEL FOUR - Shared involvement of industry in CBM-ICD with shared feedback			
Atlantic Coastal Action Program (ACAP), Atlantic Canada	Whole Ecosystem Monitoring	Community Mapping Participation Assessment Capacity Building; Information Gathering & Delivery	Communities are engaged in the sustainability process

Conclusion

CBM-ICD provides an improved ability to report on status and trends at local, regional and national scales. It also builds community capacity to understand and use ecological information, establishes improved partnerships and communication, and increases environmental knowledge and awareness within a community leading to a change in the day-to-day behaviour of individuals. Industry can be a full participant in CBM-ICD initiatives, contributing to an increased understanding of ecosystem condition, a more engaged and informed society and the creation of more sustainable communities.

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Science, Communities and Decision Making: How Can We Learn To Dance With Many Partners?

By Liette Vasseur

Abstract

Ecosystem management (also known as integrated management) can be defined as long-term integrated careful and skilful use, development and protection of ecosystems using ecological, economic, social and managerial principles to sustain ecosystem integrity and desired conditions, uses, products, values, and services. Although ecosystem management issues can have global, regional or trans-boundary impacts, most activities must be focused at the sub-regional and community level to be effective. The community is the often the most efficient unit for change in conservation management, provided that an understanding of concepts exists. Communities that use data and tools tend to be able to deal with issues in a more effective manner than communities where capacity and tools are non-existent. Monitoring activities allow communities to build capacity and awareness on local issues, increase sustainability and influence decision-making. Partnerships between public, academic, private and community constituencies can further improve knowledge and develop decision-making tools for greater sustainability. A case study example in the southern Gulf of St Lawrence provides an opportunity to examine lessons learned and the challenges that face communities, decision makers, private and academic sectors in promoting sustainability as well as actions that can be taken to improve awareness and decision making.

Introduction

Over the last two decades, the traditional approach to resource management has been re-examined to strengthen efficiency and long-term outcomes in accordance with principles of sustainable development. Building on the 1982 concept of sustainable management, Agenda 21, approved at the Rio Conference, affirmed that sustainable development required a new management approach incorporating an "integrated policy and decision making process, including all involved sectors, to promote compatibility and a balance of uses. Sustainability requires a process for developing the larger and longer-term vision of how resources and ecosystems can be sustainably managed.

Terms relating to sustainability and ecosystems can be complex and often confusing, especially for to the public. In this paper, ecosystem can be defined as an astonishing assortment of species that interact and are interdependent in many ways and in which humans are a component like any other species (Vasseur and others 2002a). Management involves general ecosystem components along with human activities and an integrated decision making process. This process should be inclusive, as natural resources and habitats are integral components of any healthy or sustainable ecosystem along with the human communities (Canadian Round Tables 1993). Although ecosystem management issues can have global, regional or trans-boundary impacts, activities focused at the sub-regional and community level are often the most effective. A basic knowledge and understanding of these concepts to sustain, use and protect natural ecosystems often leads to more integrated ecological, economic, and social development.

A regional or community approach can reach many stakeholders and thus improve decision-making efficiency and social acceptability. This paper examines the components of a model for ecosystem management of regional constituency that has as its main objective developing sustainability through public participation, education, communication, science and monitoring. The example represents one of the few groups in Canada on sustainability and ecosystem management to improve efficiency and decision-making at the regional level.

A Model for Sustainability and Ecosystem Management: Integrated Approach

In this model, sustainable/ecosystem management can be defined as the "integrated careful and skilful use, development and protection of ecosystems using ecological, economic, social and managerial principles to sustain ecosystem integrity and desired conditions, uses, products, values, and services related to all development over the long term"

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(Vasseur and Hart 2002, p. 42). Such management, which is based on sustainable development principles, includes different components that allow for flexibility, transparency and cooperation at all steps of the process, from the observation of an issue and decision making to the implementation of solutions and monitoring. This system is dynamic and allows conditions to evolve. This is a process balancing protection/maintenance and sustainable use of resources and the environment (including humans) and encompasses all interdisciplinary aspects of management, development and decision-making. For each issue tackled by the region or the community, all elements of the ecosystem, not only the human (and often economic) components, should be considered. Under this framework, the goals of community actions towards sustainability should satisfy several criteria as proposed by Hardi and Zdan (1997) and Slocombe (1998). It is essential that the plan itself be simple and understood by all stakeholders in order to be successfully implemented. In several cases, strategies are defined and developed without a good appreciation of all the components and their interconnections and this can lead to reduced efficiency or acceptability of the solutions (Vasseur and Hart 2002).

There are several levels of public participation in the decision process (Hance and others 1990). Certain types of public consultation merely show the environmentally sound intentions of the policy makers, but they do not usually consider public concerns in a meaningful way. At another level, the decision makers have to consult the population each time a problem occurs. In this case, the population has to vote on an issue after having received the proper information and all the alternatives available to resolve the problem. This type of public participation is more likely to be costly and may be a very slow process. It is especially not adequate for solving an immediate problem. The main challenge is in defining an approach in which decision-making and sustainable actions are well balanced. In addition, it is essential to define what the communities' stake is. In this paper, communities are defined as a group of people sharing a geographic context and interest in managing an environmental issue. Their involvement should lead towards consensus and social acceptability. The community can be small or large in size, number or interests.

This approach was implemented in the Southern Gulf of St. Lawrence region to improve sustainability through inclusiveness, partnership and as an aid in decision-making considering that all stakeholders can contribute to the building of regional sustainability. It can be shown that a region is the main unit for change when the components of this ecosystem, although larger in scale, are highly interconnected and therefore the actions of some people can affect the sustainability of others.

A Regional Example: The SGSL-Coalition

The coastal zone of the Southern Gulf of St. Lawrence contains salt marshes, dunes and beaches, estuaries and forests and is an important ecological, economic and social region of North America. It provides critical spawning, feeding and nursery habitats for numerous species of organisms. Communities depend on zone resources for income, recreational opportunities and their quality of life. Over the years, the sustainability of this region has been threatened by such activities as overexploitation of natural resources, coastal ecosystem degradation and pollution. To address the concerns raised through stakeholders consultations and discussions, the Southern Gulf of St Lawrence Coalition on Sustainability was created in November 1999, as a multi-stakeholder regional body representing the Nova Scotia, New Brunswick, Prince Edward Island and Quebec portions of the Southern Gulf of St. Lawrence ecosystem. Its vision is a future in which the Southern Gulf of St. Lawrence ecosystem is environmentally, economically and socially sustainable (SGSL-Coalition 2004).

Sustainability requires integrating three key elements: ecological, economic and social aspects. The Coalition establishes a mechanism for enhancing communication among partners, which allows for the sharing of knowledge and attaining consensus. The mission of the Coalition is to promote the long-term sustainability of its ecosystem through a shared and strategic Action Plan that aims to provide the tools required to address issues of common concern (SGSL-Coalition 2004).

A key component to an integrated planning process is the development of effective governance structures for sustainable development that foster open dialogue between governments, communities and citizens (Vasseur and others 2002b). The Coalition represents one of the first official governance mechanisms in Atlantic Canada to develop such an integrated planning process supported by representatives of non-government and community-based organizations, businesses and industries, academics, First Nations and municipal, provincial and federal agencies (SGSL-Coalition 2004).

Partnership with the Coalition: Challenges and Solutions

The SGSL-Coalition on Sustainability is a forum of partners who share a common vision towards defining solutions to ensure the sustainability of the region. The SGSL-Coalition facilitates meetings, workshops, forums and task forces on topics that are of interest to stakeholders.

Considering that the community should be involved in some way in each stage of the process, communication and information sharing remains one of the challenges for regional organisations such as the SGSL-Coalition. The main hurdle to overcome in this situation is the recognition of the responsibilities of the various jurisdictions that make up the Coalition. For example, it is essential that government agencies recognize that they cannot achieve their departmental objectives by acting alone. Recognition of each other's roles within the regional community is also required in order to increase the effectiveness of environmental protection and conservation measures, to maximize monitoring and compliance activities and to realize sustainable development potential. Over the years, the SGSL-Coalition has struggled mainly in the area of industry involvement. It has been a perception from the industry side that if they open up to discussions and public participation they could face increased problems, demands and delays in their actions (Shepherd and Bowler 1997). However, under ideal circumstances the participation of all stakeholders can promote sustainable development by recommending priority strategies, policies and regulations to government agencies and monitor implementation. Industries, for example, can profit from local knowledge and understand the limitations and vulnerability of the system (Sheate 1991, Bisset 2000). Additionally, any type of governmental or corporate actions that might have impacts on the environment, and therefore the sustainability of a region, should be monitored in order to make sure that the solutions implemented are adequate and if not, new strategies are implemented to improve effectiveness. The main danger coming from the implementation of a strategy is the lack of adaptive response due to limited or absent monitoring of the outcomes and the surrounding environmental conditions.

Academic institutions also have a great role to play in ecosystem regional management. The Coalition provides universities and colleges with the opportunity to apply sustainability concepts to a wide range of situations (SGSL-Coalition 2004). Since 1999, at least five academic institutions have been involved in this process. Solutions can be found to improve levels of participation from academia. For example, the SGSL-Coalition created a Sustainability Scholarship in 2003. It is given annually to a graduate student who has undertaken research in the southern Gulf of Saint Lawrence on issues of priority for the Coalition's members. This strategy has two goals: improving the involvement of researchers in the Coalition and also communicating the research results that are acquired by scientists in the region. It has been shown in the past that scientific information should also be available to members of the Coalition who need the information for decision-making.

Academic institutions have also played an important role in the sustainability of the organisation. For example, one of the universities hosts the offices of the Coalition. This has helped reduce the cost of office overheads. Other organisations might be able to play this role however this is often difficult, especially for NGOs that already have limited funding to support their own work. In addition, the question of neutrality and location always come up in discussions when such an organisation is created. Using the university as the home base for the Coalition has helped reduce neutrality concerns, as the university does not take a position in debates. Spatially, the Coalition is located in Moncton as it is relatively central to the region served by the SGSL-Coalition.

In-kind contributions in an organisation like the Coalition are crucial for its survival. Involving youth in this type of organisation is relatively difficult, although they are the leaders of tomorrow (Vasseur and others 2002b). However, their involvement might become essential as it is frequently reported that volunteer burnout is increasing. This has been seen in many rural or small communities, especially in regions like the Maritimes where volunteering has been a way of life for generations.

Towards Sustainability Through Community Participation: Lessons Learned From The SGSL-Coalition

In recent years, we have become aware of growing opposition from the general population to decisions, which could harm society and its environment. The concerns of the public about different management strategies may be due to a lack of knowledge and information or a fear of negative impacts. Since the population increasingly needs to be consulted in relation to environmental decisions and policies in North America, there is a move towards greater public participation in environmental debates. The example of the SGSL-Coalition shows the need for such groups to lessen

this gap in knowledge and information. Community or regional monitoring is one of the main actions that can help improve such knowledge upon which decision making and strategies can be based. Using data and information collected from CBM, decision makers can better address concerns and opinions from the general public before making decisions on environmental issues and sustainable development. This raises questions such as, what kind of public participation should we consider? What advantages or disadvantages does public consultation pose? Which conditions do we have to respect to obtain successful public participation in decisions on environmental questions? (Vasseur and others 1997).

Although the SGSL-Coalition is a young organization, already some lessons can be drawn from past experiences regarding decision-making and public participation in sustainability strategies. Assembling together stakeholders from all sectors of society can be advantageous as it can lead to greater discussion, consensus building and social acceptability. However, inclusiveness remains difficult to maintain.

The first challenge the SGSL-Coalition faced was the claim of objectivity and transparency. Some groups complain about the level of involvement and influence of various Coalition stakeholders. For example, objections have been raised about the objectivity of the Coalition given that it receives funding from the federal government. In this case, accounting and communication have to be as transparent as possible. To reduce concerns on this issue, the SGSL-Coalition management committee includes all stakeholders, but government agents are ex-officio and therefore do not influence funding allocations.

The type of actions that the Coalition can undertake have to be thought through carefully so as not to compete for funding and duplicate activities of other groups in the region. In fact, synergy should be promoted through the use of the Coalition as a mechanism to apply for greater funding on behalf of several smaller groups in the region. This occurred in 2004 with the implementation of a new monitoring program on a coastal aquatic ecosystem. With the help of a student supported under a federal employment program, more than 10 community and non-governmental groups have been linked together

The SGSL-Coalition is an information clearinghouse and thus has the advantage of acquiring information and communicating it in a more neutral way. There has been some debate over the years as to whether the Coalition should advocate for issues that have been of great concern for some members of the Coalition. For example, on several occasions, the SGSL-Coalition has been pushed to take a position regarding oil and gas development and the construction of incinerators. In all of these cases, the management committee has kept its role by reminding its members that the mandate of the Coalition is to help the decision making process through discussion and information sharing, not by taking a position that could be against the values and wishes of some of the members. Activism or position taking has been avoided in all cases although this has caused several groups to reduce their participation in the Coalition. This neutral role has also been a disadvantage in the profile building of the SGSL-Coalition. Because of its limited mandate, it has been viewed by other organizations as ineffective and lacking in terms of action. But it has the advantage, when well established, to be highly powerful, credible and well-accepted mechanism for helping decision makers. Consensus in decision-making is not automatically reached as soon as public participation is enhanced, but it certainly increases the possibility. This is the main goal that the Coalition is trying to achieve.

Conclusion

Environmental degradation, overexploitation and pollution are affecting the health of ecosystems and sustainability, often impacting human health, quality of life and traditional uses. Regional or community actions and information sharing can help improve sustainability. The SGSL-Coalition is an example of a regional participative and inclusive group successfully promoting sustainability of the southern Gulf of St Lawrence ecosystem. Communities of interests such as academic institutions, municipal agencies or First Nations, have the possibility to get together, discuss and build consensus that can influence the decisions that affect them, their sustainability and their environment. This group has been created from a community perspective and can therefore reach people from different constituencies.

The SGSL-Coalition faces several challenges. To be true to its mandate, the SGSL-Coalition has chosen to remain neutral, inclusive, transparent and objective leading the way to communication and information sharing. While this role is highly legitimate in the current society it also has some disadvantages. For the establishment of such a group, it is recommended that the mandate of the group be clearly stated to all members and non-members to ensure that there is not dissatisfaction regarding the work that the group can or cannot do. The group can, of course, evolve over

time and integrate more activities or strategies. For example, it is envisioned that over the next few years, community-based environmental monitoring will become part of the normal actions of the SGSL-Coalition. It is clear that monitoring is an excellent approach for gathering long-term data and trends, information greatly needed by decision makers for better sustainability of policies (Kappelle 2000, Yarnell and Gayton 2003).

The SGSL-Coalition is often perceived as a community group because it started at the grassroots/community level. Other such groups are often built from a science viewpoint with scientific partners. Exchanges on lessons learned with such groups showed that in the end, in order to sustain actions, a balance between community and science has to be established. In the case of the Coalition the community came first then the involvement of scientists. In other cases, when scientists were first involved in the creation of such groups, a community approach had to be added to maintain their actions and improve effectiveness. Decision-making is a process that can be done rapidly without consultation and information sharing. If a region is to be true in terms of supporting sustainable development and environmental protection, however, information sharing and inclusiveness should be amongst the main principles by which it is doing business. While this strategy is more time and resource consuming, long-term results should lead to greater social acceptability, consensus and sustainability. It is hoped that through this process, the region of the southern Gulf of St Lawrence can become a living example of these principles.

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Using Biodiversity Indicators to Assess the Success of Forecasting Adaptive Ecosystem Management: The Newfoundland and Labrador Experience

by C. Sean Dolter

Abstract

This paper reports on an initiative referred to as the Biodiversity Assessment Project (BAP). A suite of tools is being developed to assist forest managers in assessing the predicted future forest conditions of Newfoundland and Labrador's forests under a variety of management scenarios.

Since 1999, the Western Newfoundland Model Forest partnership has worked with the Institut Québécois d'Aménagement de la Forêt Feuillue (IQAFF) to develop a suite of strategic planning tools that assess the impact of various forest management scenarios on selected biodiversity indicators. This original approach began with Millar Western Forest Products Ltd. (MWFP) in Alberta, Canada, in cooperation with Peter Duinker, Lakehead University, and is now being modified to fit the Newfoundland and Labrador forest condition. The preliminary results show that forest management actions can have significant impact on various biodiversity indicators, depending on the selected management scenario.

There are several components to BAP. The coarse filter layer examines the ecosystem diversity and landscape structure indices. The fine filter layer focuses on species-specific Habitat Suitability Models (HSMs). WNMF is also defining the natural disturbance regimes for western Newfoundland and comparing the selected biodiversity indicators between a natural forest condition and a managed forest. This future control forest will be used to set the natural range of variation on each biodiversity parameter being used for assessment. The BAP tools will also be developed to assess central Newfoundland eco-regions so they can be used throughout the province and applied to specific situations, such as fire-dominated ecosystems. The BAP will begin to be incorporated in the provincial wood supply analysis starting in 2005 as a prototype assessment tool.

Introduction

Traditional Forest Management

What is now known as the province of Newfoundland and Labrador is two separate land masses. Newfoundland is often referred to as the island portion of the province and has a total land mass of 11.1 million hectares (ha). Labrador is located northwest of the province of Quebec and has a land mass of 29 million hectares.

Since the turn of the 15th century, the people of Newfoundland have been steadily evolving in the way they interact with the forest around them (Griffin 1979). Griffin used the following headings to define the history of forest management in Newfoundland and Labrador:

1. The period of destruction: 1497 to 1880
2. Exploitation and protection: 1880 to 1934
3. The foundation of an administrative framework: 1934 to 1949
4. The beginning of extensive forestry: 1942 to 1972

The forest of Labrador has seen limited development compared to the island of Newfoundland. Traditional use of the Labrador forest was primarily based on its utilization by Aboriginal peoples, Innu and Inuit, for subsistence living until the 20th century. Even today, sustainable forest management in Labrador is at a much smaller intensity with a harvest allocation of only 30% of the annual allowable cut (AAC). The Innu Nation and the Government of Newfoundland and Labrador see forestry in Labrador as a co-management challenge.

The island is a different story. Coastal regions of the island saw intensive development up until the late 1800s. Trees were used for building homes and commercial structures, boats, fishing flakes, stages, and for fuel-wood. Three miles in from

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the coastline was considered the 'three mile limit' and allowed fisherman to cut the forest within this area without restriction (Nazir and Moores 2001). Insular forest utilization before then was based on subsistence activities of the Beothuk Indians. European interests turned toward the forest in the mid to late1800s as the sawmill industry began to expand. In the early 1900s, the pulp and paper industry began to be the primary forest-based industry. Beginning on the west coast of the island, the pulp and paper industry swept across the province, utilizing the most merchantable and accessible stands. For the past 100 years, forest management has evolved from forest protection to timber management to multiple use management, and today, sustainable forest management (SFM) (Newfoundland Forest Service 2003).

Evolution to Sustainable Forest Management

Nazir and Moores suggested that Griffin could add two additional categories to the evolution of forestry in Newfoundland and Labrador to include:

5. Integrated management: 1972 to 1990 and

6. Sustainable forest management: 1990 to present (Nazir and Moores 2001)

Integrated management required managers to take a larger view of their activities regarding resource management. Having to integrate all parts of the resource equation to obtain a harmonious whole was the greatest challenge, causing conflicts with inter-governmental policies and responsibilities. After years of striving for accommodation and compromise, managers began to bring issues together and unite under common resource objectives (Mitchell 1986).

With the Canadian Council of Forest Ministers (CCFM) embracing the Criteria and Indicators definition of sustainable forest management (CCFM 1995), forest managers and decision-makers now had to think outside of anthropogenic causes and effects and begin understanding ecological processes outside their realms of expertise. The six criterion for SFM encompass every element of forests, not just the elements that are impacted directly by harvesting, road building, or silviculture. Talking about sustainable forest management is one thing - understanding the complexities of interactions is another. Agreeing to working within a local level indicators framework, an essential component of CCFM's SFM framework, also meant tracking temporal performance indicators and setting thresholds for variability in indicator performance. Newfoundlanders and Labradorians now had to examine the gaps in their resource knowledge base and begin being accountable for their resource management decisions.

The Challenge of the SFM Process

Industry, government, and community organizations had to become more unified to take on the new challenges of resource management. In 1992, the Western Newfoundland Model Forest (WNMF) was formed as part of the national model forest network. Its diverse range of partners set the stage for formulating approaches to SFM in light of limited resources, both financial and knowledge-based. A community-based stakeholder organization has the ability to cut through red tape and leverage resources from a number of agencies and programs. The number one priority of the WNMF has been to develop a framework to help evaluate the effects of long-term forest management activities on forest structure, ecosystem diversity and a select set of wildlife species. This unified approach to address the challenges of SFM has been called the Biodiversity Assessment Project (BAP) (Duinker, P. N.; Doyon, F.; Morash, R.; Van Damme, L.; MacLeod, H. L.; Rudy, A. 2000). BAP is the focus of this paper.

Process Inclusiveness

BAP provides an opportunity for those with an academic and management interest in forest connectivity and fragmentation, species utilization of habitat, and natural forest succession to come together as a community to assist managers in resolving the ecological challenges confronting them. Striving to achieve SFM requires forecasting and monitoring the effects of present day and future management activities on suites of indicators. The approach BAP adopted was to use local level indicators of biodiversity in monitoring and forecasting ecological impacts.

In defining SFM, Criteria and Indicators (CIs) are divided into two separate components.

Ecological CIs are illustrated under the following titles:

1. Conservation of Biological Diversity;

2. Maintenance and Enhancement of Forest Ecosystem Condition and Productivity;

3. Conservation of Soil and Water; and

4. Forest Ecosystem Contributions to Global Ecological Cycles

Socio-economic CIs focus on the last two titles:

1. Multiple Benefits to Society; and

2. Accepting Society's Responsibility for Sustainable Development (CCFM, 1995).

BAP concentrates on the first and second criterions of SFM. WNMF is working on integrating several other complementary approaches with BAP to address the remaining criteria.

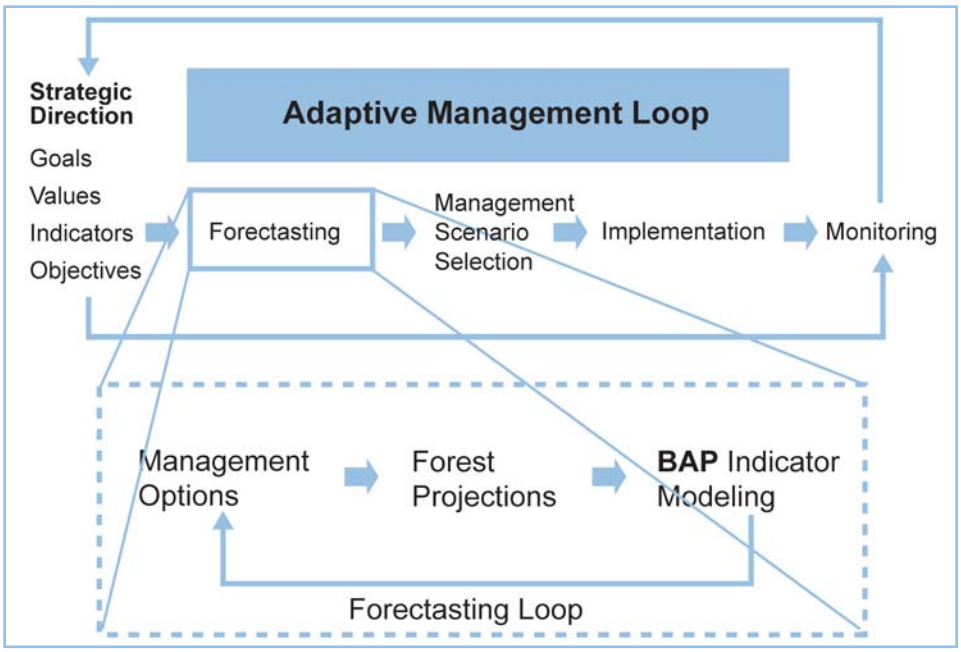
The complex, multi-faceted nature of biodiversity brings about the need to better address our limited knowledge of resource processes and their associated bio-indicators. BAP must be flexible and adaptive in order to integrate what we do know about ecological processes with what we need to find out.

MWFP of Alberta first approached a team of scientists to create a system that anticipates the complexities of forest systems at a landscape scale. BAP-Alberta was a multi-million dollar project with 29 specific habitat suitability models. According to Starfield and Bleloch (1986), models are tools which "help us to (1) define our problems, (2) organize our thoughts, (3) understand our data, (4) communicate and test that understanding, and (5) make predictions." Therefore, models are learning tools that can help determine the impacts of any external perturbation on the entire system (Higgelke 1994).

WNMF partners liked the way MWFP approached the complexities of biodiversity assessment and brought that process to western Newfoundland but WNMF had a different perspective on the implementation of this project. WNMF partners applied adaptive ecosystem management principles to develop BAP. The adaptive process "maximizes the manager's learning about the system, and is consequently a safe approach to initiating management in complex systems" (Baskerville 1985). In designing forest management goals and associated actions, the measurement of progress is carried out in a manner that allows the manager to learn about the complex system from his/her management of it. The BAP allows one to forecast management actions in a well-defined feedback loop, as illustrated in Figure 1, and track the resulting effects for a variety of management actions. BAP users are forced to recognize errors in their proposed assumptions, thus allowing for continuous learning from system performance.

Ecologists, biologists, foresters, and research scientists all have a role to play in integrating their knowledge into a common, integrated framework to assess impacts of forest management activities.

Figure 1. Adaptive Management Loop (Doyon 1999)



Partnerships

The WNMF partnership includes a multitude of various agencies and organizations, existing resource databases, and facilities to broaden the ownership of such an initiative. The WNMF partnership is comprised of federal, provincial and municipal government agencies, industry organizations, economic development associations, environmental organizations, academic institutions and a commercial trapping group. Partners agreed that the BAP should be a tool utilized by all sectors of resource management, not just industry. The partnership was the catalyst for transferring BAP to WNMF. A team of resource planners, managers, ecologists, biologists and computer specialists from a multitude of different organizations was struck to manage the development of WNMF's BAP toolbox. They formed the Biodiversity Assessment Project Working Group (BAPWG), which is directed by the following partners:

Industry

- Corner Brook Pulp and Paper Limited - Chair of BAPWG
- Abitibi Consolidated Company of Canada

Federal Government

- Natural Resources Canada, Canadian Forest Service
- Parks Canada, Gros Morne National Park

Provincial Government

- College of the North Atlantic, Geospatial Research Facility (GRF)
- Department of Environment and Conservation, Inland Fish and Wildlife Division (IFWD)
- Department of Environment and Conservation, Water Resources Division
- Department of Natural Resources, Forestry Services Branch (FRB)

Community

- Western Newfoundland Model Forest

Working on behalf of the BAPWG is a technical sub-committee guided by the original researchers involved with MWFP. Partners work cooperatively to transfer BAP-Alberta models to the WNMF.

Public Participation

Accountability is the cornerstone of the WNMF partnership and the BAP. Public participation and input into forest management has two direct avenues. Public associations and individuals have direct access to WNMF resources and will be provided access to working groups if they agree to the ground rules of consensus decision-making. BAPWG has an open chair policy for organizations to participate in the development process of a specific initiative.

The second avenue addresses the implementation stage of the BAP. The Forestry Services Branch of the Provincial Government's Department of Natural Resources manages the forests of this province. They are responsible for ensuring that forest management districts prepare management plans in consultation with public and community stakeholders. Local planning teams prepare strategic documents and five-year operating plans that incorporate both timber and non-timber forest values. A major area of concern for planning teams is the ability to forecast the impacts of future management directives. BAP assists in ensuring some level of confidence in their decision-making abilities.

Capacity Building

The future application of BAP is dependent on the relationship between the inventory agencies, research community, forest resource managers, and planning teams. The outcome of forest management decisions is a result of trade-offs between user groups and biophysical indicators. BAP can provide participants with a number of scenarios, thus building capacity to assess the biodiversity outcomes of virtual scenarios.

BAP Process Overview

BAPWG is running analyses on four scenarios using the output of the wood supply projection models - Woodstock and Stanley (Remsoft):

1. Business as usual – if management was to stay as presently practiced with the current annual allowable cut;
2. Business as usual: Fragmented – if the average five-year harvest block was to stay at 50 ha in size with a variability between 10 and 100 ha. A green-up delay of five years would be imposed for harvesting adjacent blocks.
3. Business as usual: Aggregated - if the average five-year harvest block was to stay at 300 ha in size with a variability between 100 and 800 ha. There would be no green-up delay for harvesting adjacent blocks.
4. Marten Friendly – This scenario respects the landscape thresholds set by the Recovery Team for Newfoundland marten. There will be no mean block size but a minimum of 10 ha and no maximum limit. Tree height would have to be maintained at greater than 6.5m with no green-up delay.

A landscape simulator that incorporates the natural disturbance regime of the WNMF study area is also running concurrently. Through a series of applied research projects on insect disturbed forest areas, Dr. Yves Jardon of the Institut Québécois d'Aménagement de la Forêt Feuillue (IQAFF) has produced historical outbreak data with LANDIS. LANDIS is a commercial landscape simulator model capable of producing a future forest scenario void of anthropogenic disturbances and based on projecting only natural forest succession processes. This natural disturbance regime scenario gauges the natural range of variability of the bio-physical indicators, setting minimum and maximum thresholds.

BAP has three levels at which these scenarios will be assessed:

1. ecosystem;
2. landscape; and
3. species specific.

Coarse-Filter Biodiversity Analyses

At a coarse level of bio-indicators, ecosystem diversity and landscape configuration are targeted (Doyon and MacLeod 2000). The following set of bio-indicators broadly considers the basic habitat requirements of forest-dwelling, vertebrate species (Rudy 2000).

Ecosystem Diversity – Three bio-indicators used in the analysis of ecosystem diversity are:

- Area-weighted Stand Age;
- Tree Species Distribution
    - Species distribution by broad habitat type;
    - Species presence;
- Species dominance; and
- Habitat Diversity

These indicators enable BAP to track the changes in forest composition due to management practices.

Landscape Configuration – Bio-indicators used in the analysis of landscape configuration are chosen for their sensitivity for gauging the impact on connectivity. These bioindicators are:

- Average patch size and shape;
- Average edge contrast/Edge length;
- Patch core area;
- Adjacency; and
- Nearest neighbour

Fine-Filter Biodiversity Analyses

At a fine-filter level of assessment, habitat supply models were developed for specific wildlife species. As of August 2004, the BAPWG has models for Newfoundland pine marten *(Martes americana atrata)*, woodland caribou *(Rangifer tarandus)*, and boreal owl *(Aegolius funereus)*. All models follow the same format and utilize harvest projection inventory tables produced by each scenario.

Species Specific - In a forest management context, some wildlife species need to be analyzed separately (Doyon 1999) and cannot be generalized into core wildlife groups. A species status as an indicator or keystone species may determine their priority for modeling in BAP.

BAP Flow

Figure 2 attempts to illustrate how BAP fits into interdisciplinary research and decision-making in Newfoundland and Labrador.

The BAPWG is responsible for the transfer and development of BAP tools. Once the prototype has been developed and accepted, BAPWG partners will be responsible for further refinements and implementation. As Figure 2 illustrates, BAP is dependent on many sources of input. Once the forest inventory specialists have provided the basis for the projections in the province's wood supply projection models, Woodstock and Stanley, and researchers have provided further information on other ecosystem components, BAP can generate a stand attributes table for assessment. The assessment is filtered through the coarse stream for ecosystem and landscape analyses once the habitat reclassification is done. Concurrently, the bio-indicators will be filtered through the fine stream where the habitat requirements to select which species will be assessed.

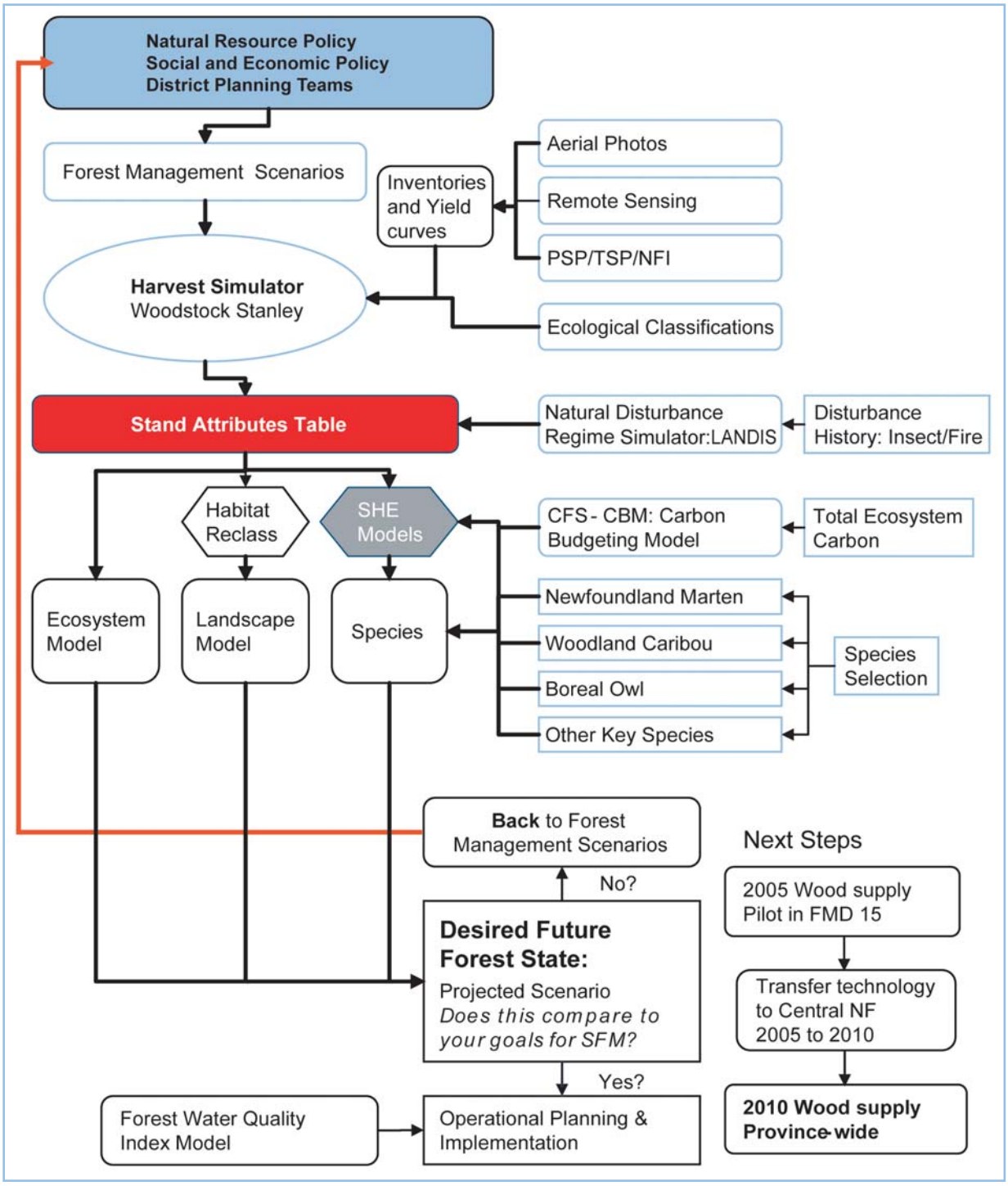
Decision Making

BAP is designed as a decision support system for both the public consultation process and the provincial wood supply analysis. Once integrated into the provincial forest management planning process, each district planning team will be responsible for setting the constraints for different management scenarios. After the bio-indicators for each management strategy are analyzed, compared and evaluated, the planners and planning teams will receive an opportunity to decide if the outcome of the projection compares with their goals for SFM. If they do not, re-testing of management scenarios occurs until an acceptable management strategy is achieved (Newfoundland Forest Service 2003).

Conclusion

The Western Newfoundland Model Forest is committed to seeing the BAP process through to its adoption as a formal mechanism for protecting the biodiversity of Newfoundland and Labrador forests. Balance of ecological integrity, economic sustainability, and social rights and freedoms is always considered when developing decision support systems for forest management. Process transparency, access to information, and providing the opportunity for community participation will ensure the success of the Biodiversity Assessment Project and its incorporation into the public consultation process for decisions on forest management planning in Newfoundland and Labrador.

Figure 2: BAP Process



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The Ontario Benthos Biomonitoring Network

By Chris Jones , Brian Craig, and Nicole Dmytrow

Abstract

Canada's Ontario Ministry of the Environment and Environment Canada (Ecological Monitoring and Assessment Network) are developing an aquatic macro-invertebrate biomonitoring network for Ontario's lakes, streams, and wetlands. The Ontario Benthos Biomonitoring Network (OBBN) is based on the principles of partnership, free data sharing, and standardization. This paper discusses the importance of biomonitoring, describes why benthos are commonly used as indicators of aquatic ecosystem condition, explains the complementarity of biological and chemical assessments, details OBBN components, and lists research needs. The paper is framed by several themes: inclusiveness, partnerships, capacity building, and creating effective links between monitoring and decision-making.

Traditionally there has been an individualistic approach to biomonitoring in Ontario, with little communication between practitioners. This lack of coordination has limited the application of biomonitoring, chiefly due to an inability to share data, and a lack of consistent training. Based on approaches used in the United Kingdom, Australia, and the United States, the OBBN aims to standardize methods (while maintaining limited options that recognize differences in partner expertise and financial resources), enable data sharing between partners, automate assessments, and provide training.

Biological criteria for evaluating aquatic ecosystem condition are generally not available. The OBBN uses a reference-condition approach (RCA) to define biocriteria: samples from minimally impacted (reference) sites define an expectation (i.e., the normal range) of biological condition at a test site. Assessments evaluate whether a test site's biological condition is within the normal range. The OBBN's automated analytical tools and a protocol that balances flexibility with standardization will allow citizen scientists and university academics alike to do reliable bioassessments. New partnerships, and the ability to generate local information on aquatic ecosystem condition, will build capacity for adaptive water management and enhance the link between science and decision making in Ontario.

Introduction

The Ontario Benthos Biomonitoring Network (OBBN) was co-founded by the Ontario Ministry of the Environment (MOE) and Environment Canada's Ecological Monitoring and Assessment Network Coordinating Office (EMAN CO). Once fully implemented, the OBBN will allow partners to evaluate aquatic ecosystem condition using the reference-condition approach and shallow-water benthos as indicators of environmental quality.

The purpose of this paper is to explain our vision of the OBBN within the context of a complex mosaic of Canadian initiatives that together result in capacity for adaptive environmental management and informed local decision-making. The common thread through this mosaic is a commitment to the fundamentals (e.g., Jones and others 2002): building partnerships, and providing information on ecosystem condition and management performance to local decision makers. We begin by discussing the importance of biomonitoring, explaining why benthos are commonly used as indicators of aquatic ecosystem condition, and highlighting the complementarity of biological and chemical assessments. We then describe the components of the OBBN and their roles in adaptive, community-based ecosystem management. The paper concludes with a list of research needs related to implementation.

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Importance of Aquatic Biomonitoring

Monitoring supports adaptive water management; it provides feedback on the status of aquatic resources and the performance of policies, programs, and legislation (Jones and others 2002). Biomonitoring—the process of sampling, evaluating, and reporting on ecosystem condition using biological indicators—is an important part of aquatic ecosystem management. This is because management end-points are often biological (e.g., protection of aquatic biota and their habitats), and because laws and policies typically stress the protection of aquatic biota.

Ontario's legislative basis for biomonitoring includes the Ontario Water Resources Act (Government of Ontario 1990a), which has a clearly biological definition of *impairment*. It states "the quality of water shall be deemed … impaired if … the material discharged … causes or may cause injury to any person, animal, bird or other living thing …". Similarly, Ontario's Environmental Protection Act (Government of Ontario 1990b) has clearly biological elements of its definition of *adverse impact*, including: (a) impairment of the quality of the natural environment for any use that can be made of it, (b) injury or damage to property or to plant or animal life, (d) an adverse effect on the health of any person; and (f) rendering any property or plant or animal life unfit for human use. Canada's federal Fisheries Act (Government of Canada 1985) provides further impetus for biomonitoring by stating that "no person shall carry on any work or undertaking that results in the harmful alteration, disruption, or destruction of fish habitat" (i.e., spawning grounds; nursery, rearing, and migration areas; and food supply).

Ontario's policies also suggest a need for biomonitoring. The document, "Water Management: Policies Guidelines Provincial Water Quality Objectives of the Ministry of Environment and Energy [sic]" (Ontario Ministry of Environment and Energy 1994) states, "With respect to surface water quality, the goal is to ensure that … water quality is satisfactory for aquatic life…" Similarly, Ontario's Provincial Policy Statement (PPS; Government of Ontario 1997), an extension of the Planning Act, states, "the quality and quantity of ground water and surface water and the function of sensitive ground water recharge/discharge areas, aquifers, and headwaters will be protected or enhanced". The PPS further states that development and site alteration is only permitted in significant habitats if no negative impacts on the natural features or the ecological functions will result.

Similar legislation- and policy-based justifications for biomonitoring exist in many countries. For example, in the European Union, the EU Water Framework Directive requires both good ecological status (based on the reference condition approach, see below) and good chemical status of surface water (EU Commission 2003); in the U.S., the concept of biological integrity has been included in water legislation (i.e., the Water Pollution Control Act) since 1972 and "is now an integral component of water resource programs at state and federal levels" (U.S. EPA 2002).

Benthos as Indicators

Benthos are large, bottom dwelling insects, crustaceans, worms, mollusks and related aquatic animals. They are good indicators of aquatic ecosystem health because they are sedentary, their life cycles range in length from months to years (compares well with typical 1-3 year business planning and budgeting horizons typically applied in environmental management), they are easy to collect and identify, they are responsive to changes in water and sediment quality, they are ubiquitous, and they are not typically seen as an economic or recreational resource themselves (Mackie, 2001). Benthos have been used extensively to assess water quality in streams and lakes (Rosenberg and Resh 1993 and 1996).

Complementarity of Biological and Physical-Chemical Monitoring

Physical-chemical (stressor-based) and biological (effect-based) monitoring approaches are complementary (Table 1).

Table 1: Attributes of stressor- and effect-based aquatic monitoring[1].

	Stressor-based Approach	Effect-based Approach
Monitoring focus	Stressors causing environmental change, i.e., chemical and physical inputs	Effects (responses) of natural and/or anthropogenic disturbances, e.g., changes in the structure and function of biological communities
Management focus	Water quality regulation: controlling stressors through regulations	Aquatic ecosystem protection: managing ecological integrity
Primary indicators	Chemical and physical habitat variables, e.g., pH, dissolved oxygen, copper concentration	Structural and functional biological attributes (e.g., relative taxa abundances, frequency of deformities)
Assessment end points	Degree of compliance with a set criterion or discharge standard	Degree of deviation from a benchmark or desired biological condition

[1]adapted from Roux et al. (1999)

An example of a stressor-based index is a water chemistry analyte, a surrogate for the toxicity of water to fish. An example of an effect-based index is age class abundance of smallmouth bass, a surrogate for reproductive success and mortality of fish exposed to a chemical stressor. We use chemical (Figure 1) and biological (Figure 2) data from the Pretty River (Collingwood, Ontario) to illustrate this complementarity.

Figure 1: Zinc and Phosphorus concentrations in the Pretty River, Collingwood Ontario. The central 50% of the data is shown as the box; vertical bars extend to the maximum (upper) and minimum (lower) values. Solid horizontal lines indicate Provincial Water Quality Objectives for Ontario. Unpublished data.

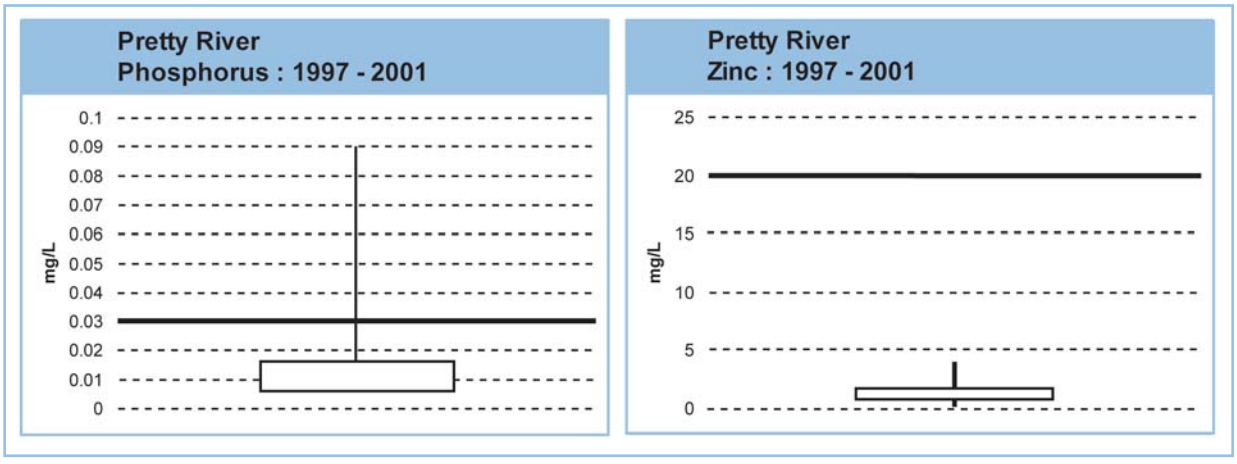
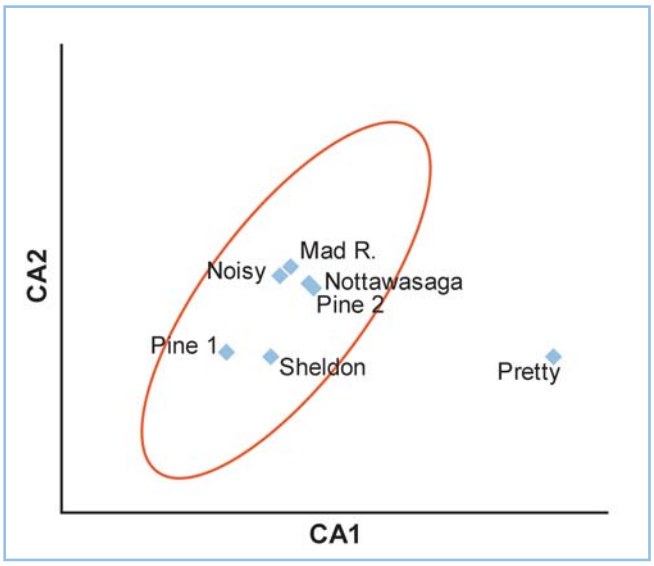


Figure 2: Correspondence analysis ordination of site-by-taxa matrix associated with benthos data from Pretty River (Collingwood, Ontario) and a set of minimally impacted reference sites. The red ellipse denotes the 95% confidence boundary of the reference group. Unpublished data, courtesy of Nottawasaga Valley Conservation Authority.



The majority of the distribution of data for phosphorus and zinc (stressor-based indicators; Figure 1) were well below Provincial Water Quality Objectives (e.g., MOEE 1994), suggesting good water quality conditions; however, the site was biologically unusual in relation to regional reference sites (Figure 2). In this case, seemingly contradictory water chemistry and biological monitoring results can be combined to make a more complete assessment of aquatic ecosystem condition than either approach could on its own; in other words, to conclude that water quality is good but that biota are suppressed (perhaps by habitat degradation).

Ontario Benthos Biomonitoring Network Vision

The application of benthos biomonitoring has not been widespread in Ontario, largely due to several technical factors. Although regulatory guidelines for water chemistry are available, no analogous biocriteria exist for biomonitoring. In addition, bioassessment is complex: biota respond to factors other than water quality, no standard sampling protocol exists, benthos identification requires special expertise, experts disagree on interpretation, and traditional methods are costly.

A historical patchwork approach to biomonitoring in Ontario has created three main barriers to wider application: no standard protocol, no mechanism for sharing data, and no consistent training. The OBBN aims to remove these barriers by specifying standard methods, enabling data sharing between partners, automating analysis using a reference-condition approach, and providing training. With the direction of a multi-partner Technical Advisory Committee, we are developing the network according to the principles of partnership, free data sharing, and standardization. The OBBN is a pilot project for a Canada-wide aquatic biomonitoring program that is accessible to volunteer "citizen scientists" and professional research scientists alike.

The OBBN has 4 objectives:

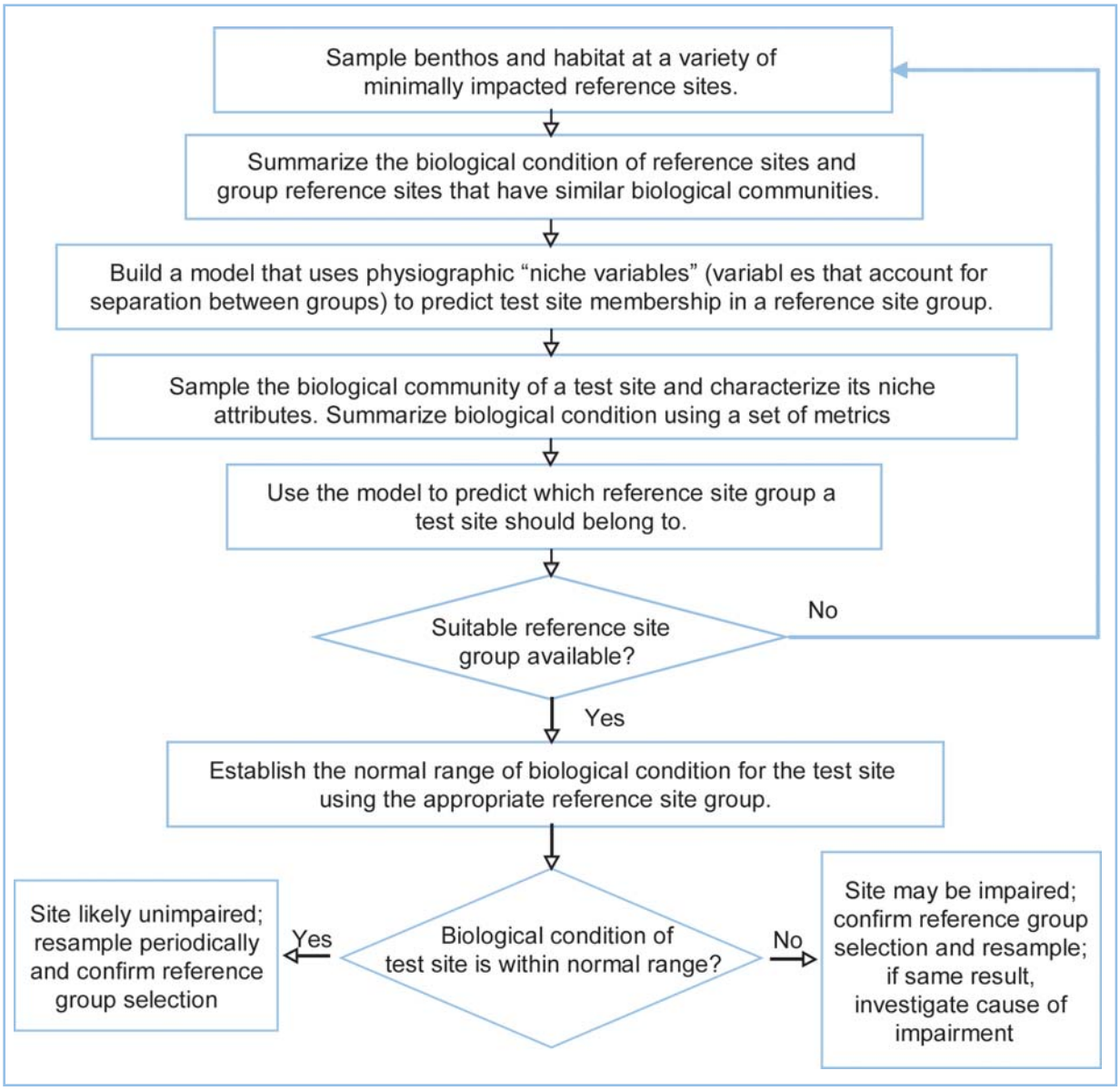
1. To enable the assessment of lakes, streams, and wetlands using benthic macro-invertebrates as indicators of aquatic ecosystem condition
2. To provide a biological performance measure related to management of aquatic ecosystems
3. To provide a biological complement to Ontario's provincial surface water chemistry monitoring program
4. To facilitate a reference condition approach to bioassessment in which minimally impacted sites are used to derive a community expectation for a test site

The target date for full implementation of the OBBN is 2005. Coordinating partners, MOE and EMAN CO, provide scientific guidance and limited sampling equipment. Partners (federal, provincial, and local governments; conservation authorities [Ontario's watershed-based quasi-governmental water management agencies]; universities; non-governmental groups; and volunteers) sample lakes, streams, and wetlands, use and report information according to their own mandates, and participate in collaborative research to refine protocols and analytical methods.

Reference Condition Approach

The OBBN uses a reference condition approach (RCA) to bioassessment (figure 3), in which minimally impacted reference sites are used to define "normal" and set an expectation for community composition at test sites where water and habitat quality are in question (e.g., Wright and others 2000, Bailey and others 2004). Using the RCA, the OBBN considers test sites unusual if their communities fall outside of the normal range. Unusual sites warrant further study to determine if human activities are responsible for the deviant community composition.

Figure 3: Steps in the reference-condition approach to bioassessment.



The first step in the RCA is to sample reference sites. Because no objective, quantitative criteria for "minimally impacted" exist, the OBBN asks partners to sample sites that are not obviously exposed to any human impacts (such as point-source contamination, regulation of water level, water impoundment, deforestation, habitat alteration, development, agriculture, or acidification), and that represent best local conditions. Test site sampling will commence once a reasonable amount of reference site data is available.

OBBN Protocol

Providing standard operating procedures is vital to wide implementation of aquatic benthos biomonitoring in Ontario. A degree of standardization is important to ensure comparability of results over time and across jurisdictions, and this is particularly true when using a reference condition approach (but see Diamond and others 1996); however the OBBN protocol (Jones and others 2004) also recognizes that some degree of flexibility is equally vital in a program that is founded on partnerships. OBBN partners differ with respect to their financial resources and expertise, and standard methods must have options that can accommodate these differences (Table 2).

Table 1: Summary of OBBN protocol recommendations.

Biomonitoring Component	Recommendation
Benthos Collection Method	Traveling kick and sweep (other optional methods are available for special studies or atypical habitats)
Mesh Size	500 mm
Time of Year	Any season; assessment comparisons are made using data from the same season
Picking	In lab (preferred) or in field (optional); preserved (preferred) or live (optional), microscope (preferred) or visually unaided (optional); random sub-sampling to provide a fixed count per sample
Taxonomic Level	Mix of 27 Phyla, Classes, Orders and Families (minimum detail); more detailed identifications are optional and are recommended for reference sites
Analysis	Reference condition approach: community composition summarized using a variety of user-defined indices and hypothesis testing based on generalized distance (Bowman and Somers 2004)

Approximately 400 sites have been sampled to-date in Ontario using these protocols.

OBBN Database and Automated Analytical Tools

The OBBN includes an internet-accessible database for storing and sharing reference site and test site data. The database is being jointly developed by EMAN CO and the National Water Research Institute of Environment Canada and will be integrated with a proposed national biomonitoring program. Several automated analytical database modules are under development: a test site and reference site selection utility, a mapping utility, a summary metrics calculator, and a statistical module for hypothesis testing. These modules are critical to the success of the program because they will simplify the analyses associated with bioassessments, allowing volunteer citizen scientists and professional research scientists alike to generate readable, custom, nearly instantaneous assessment reports. Such reports will represent a considerable increase in available information for local community-based decision making in Ontario.

Generating a custom report with the automated analytical tools requires an OBBN partner to proceed through six steps:

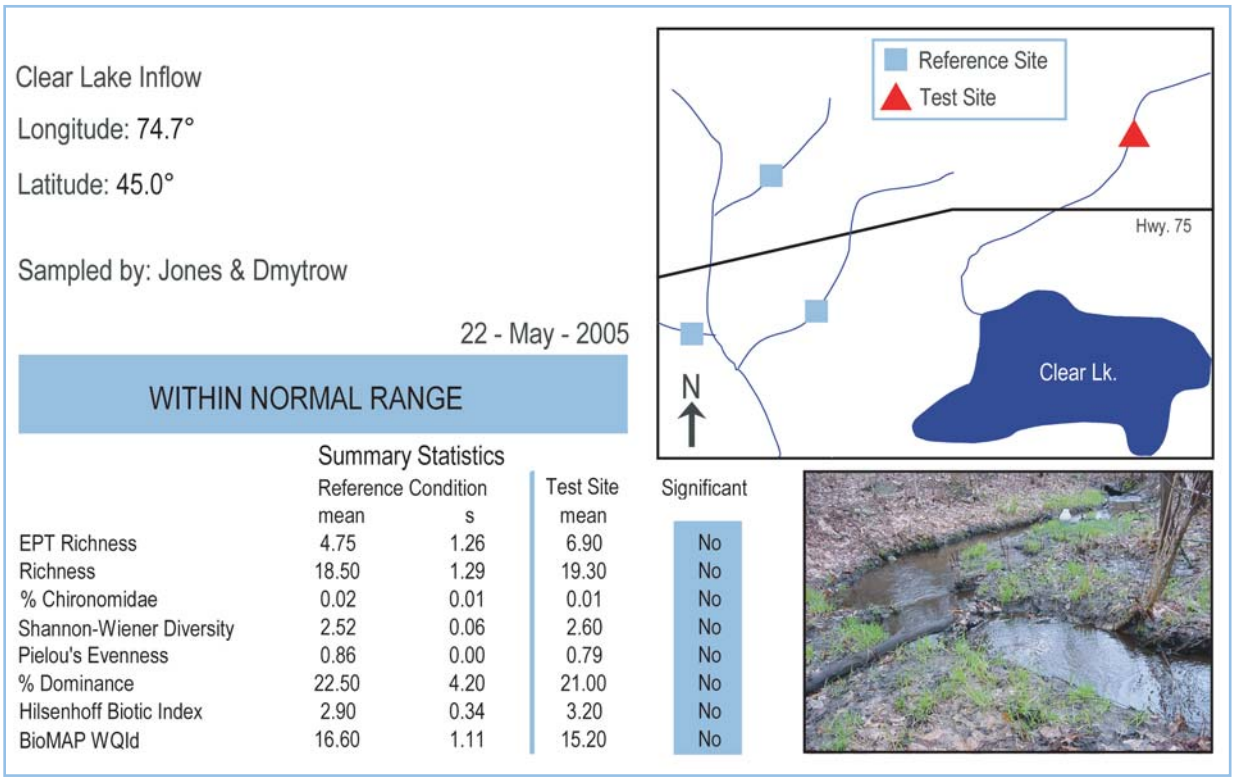
1. Log-in to the database with a client password (passwords are coded to training certification level and effectively limit data entry fields and forms a user has access to based on training received).
2. Enter test site location, and benthos and habitat data.
3. Execute the reference site selection tool (runs a predictive model that predicts a test site's reference site group membership based on site- and catchment-scale physiographic information, and queries the database for records associated with reference sites in the predicted group).

4. Execute the Metrics Calculator (calculates a user-defined set of benthos community summary metrics for both the test site and reference sites).

5. Execute the hypothesis-testing tool (automates the statistical calculations associated with a multivariate t-test, which determines if the test site is within or outside the normal range considering all summary metrics [and redundancies among metrics] simultaneously).

6. Execute the reporting tool (which compiles products from each of the above modules into a simple output; Figure 4).

Figure 4: OBBN sample report from automated analytical software (hypothetical data).



Summary Statistics

	Reference Condition mean	Reference Condition s	Test Site mean	Significant
EPT Richness	4.75	1.26	6.90	No
Richness	18.50	1.29	19.30	No
% Chironomidae	0.02	0.01	0.01	No
Shannon-Wiener Diversity	2.52	0.06	2.60	No
Pielou's Evenness	0.86	0.00	0.79	No
% Dominance	22.50	4.20	21.00	No
Hilsenhoff Biotic Index	2.90	0.34	3.20	No
BioMAP WQId	16.60	1.11	15.20	No

Training

Training is a critical component of the OBBN for two reasons. First, it ensures that protocols are followed correctly so that partners have confidence in the quality of reference and test site data shared through the network. Second, it fosters interest in monitoring and better use of monitoring information in the environmental decision making process.

The large number of OBBN participants and relatively few full-time staff administering the network (one government scientist and one recent graduate intern) necessitated a train-the-trainer approach, which is still under development. To-date, training has been offered at a series of multi-day courses that cover all aspects of the program, with emphasis on the reference condition approach, sample collection and processing procedures, and benthos identification. To ensure deficiencies in OBBN methods can be corrected, training workshops will be augmented with short protocol-audit workshops, in which exercises will determine if participants are applying techniques as written and if difficulties are arising.

To-date, several hundred partners have attended training courses and their feedback will enable refinements to the training program. A future training focus will be benthos identification. Rather than developing a unique taxonomic certification for Ontario, we plan to implement the North American Benthological Society Taxonomic Certification Program, which is still under development (e.g., North American Benthological Society 2003).

Collaborative Research

The OBBN includes a collaborative research component that is aligned with program implementation, principally the refinement of methods. Collaborative research opportunities ensure efficiency, assist with the delivery of information, and provide opportunities for partners to get involved in the science of monitoring. Studies investigating high priority questions related to collection methods and timing of benthos sampling are underway. These studies will determine where optional methods can be applied, if sufficient numbers of animals are collected, and whether different collection methods yield similar relative abundance estimates for a site. A temporal stream study is investigating seasonal patterns of benthos community composition and may allow us to refine sampling windows specified in our protocol manual.

The OBBN is undertaking to answer the following research questions in priority sequence with results being reported using media such as peer reviewed literature and government technical bulletins.

- Is the reference site mean plus/minus 2 standard deviations a reasonable definition of the normal range? Does this definition reflect what we consider to be an ecologically significant effect, in other words, the minimum effect size we wish to detect?
- How many groups of reference sites are there? How many sites are required to define a group? How minimally impacted must a site be to be considered a reference site? Does this threshold change depending on location in the province?
- How accurately can we predict a test site's reference group membership? What are the best attributes on which to build our predictive model?
- What is the ideal ratio of reference sites to number of metrics used in the analysis?
- Does the detail of benthos identification (for example. Order-level vs. Genus-level) affect the sensitivity of a bioassessment and the amount of diagnostic information provided? Does the selection of a sampling method affect sensitivity or diagnostic resolution? Can we use "response signatures" to identify certain types of impairment? Which indices contribute the most information to bioassessments in different parts of Ontario?

  How many samples are enough for whole lake, whole river, or whole wetland assessments?

  How much variability in bioassessment outcomes is introduced by crew-specific sampling biases?

Conclusion

Community based monitoring is important to adaptive environmental management because it provides feedback to managers on the status of resources and the performance of management activities. Biomonitoring is required to support legislative and policy direction in many jurisdictions, and provides effect-based results that are relevant in management schemes that aim to protect biota. Benthos possess many traits that make them excellent indicators of aquatic ecosystem condition.

The OBBN will enable partners, ranging from volunteers to research scientists, to reliably conduct benthos bioassessments on lakes, streams, and wetlands. The result will be a marked increase in the amount of locally available information on aquatic ecosystem condition for consideration in environmental management decisions. The OBBN has five components that have been built specifically to promote comprehensive bioassessment coverage of the province: a database that enables reference and test site data sharing, a standard protocol (which contains options so procedures can be tailored to partners' expertise and financial resources), training, automated analytical tools, and a research program. The network is scheduled to be fully implemented by 2005 on the principles of partnership, free data sharing and standardization. It is part of a mosaic of Canadian programs that is delivering effective information to local environmental decision makers.

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