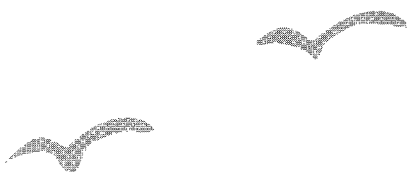
Environment Canada / Environnement Canada

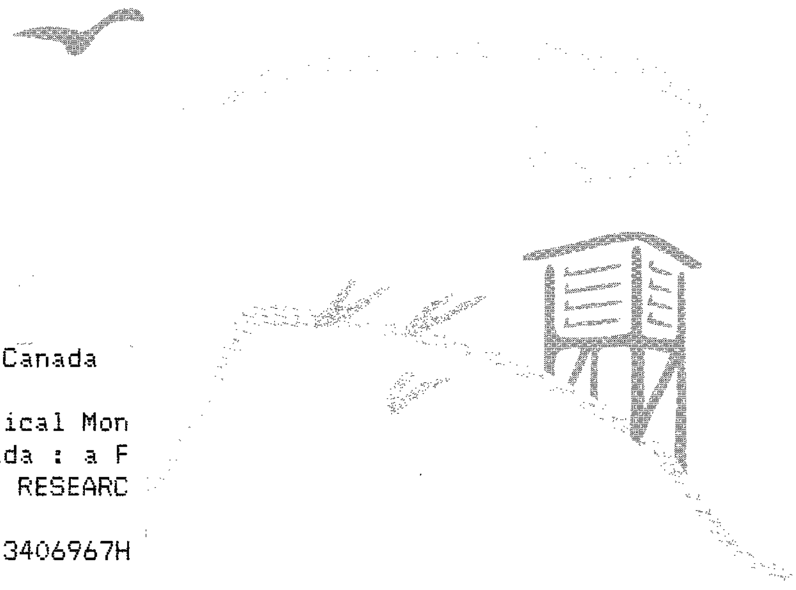
Ecological Monitoring and Research In Atlantic Canada: A Focus on Agricultural Impacts in Prince Edward Island

Workshop Proceedings
Summerside, Prince Edward Island
February 22-24, 1995

Richard D. Elliot and Patrick Chan (Editors)



Environment Canada - Atlantic Region
Occasional Report No. 5



Regional Environmental Monitoring And Research Coordinating Committee

Proceedings of the Workshop on

Ecological Monitoring and Research In Atlantic Canada: A Focus on Agricultural Impacts in Prince Edward Island

Summerside,
Prince Edward Island

February 22-24, 1995

Hosted by:

Bedeque Bay Environmental Management Association - Summerside, PEI
Environmental Training Centre, Holland College, Summerside, PEI
and
Environment Canada - Atlantic Region

Edited by:

Richard D. Elliot - Environment Canada, Atlantic Region, and
Patrick Chan - Environmental Consultant

Environment Canada Atlantic Region, Occasional Report No. 5
1995

This publication should be cited as:
Elliot, Richard D. and Patrick Chan (eds) (1995) Ecological monitoring and research in Atlantic Canada: A focus on agricultural impacts in Prince Edward Island. Workshop Proceedings, Summerside, P.E.I. Environment Canada - Atlantic Region Occasional Report No. 5, Environment Canada, Sackville, New Brunswick, 77 pp.

Copies may be obtained from:

Environmental Conservation Branch
Environment Canada - Atlantic Region
P.O. Box 1590, Sackville, N.B.
E0A 3C0, Canada

Published by Authority of the
Minister of Environment

Catalogue No. CW69-12/5-1995E
ISBN 0-662-23989-X
ISSN 1195-664X

Table of contents

Acknowledgements

This workshop was supported by the Bedeque Bay Environmental Management Association ACAP site (BBEMA) in Summerside, Prince Edward Island, the Environmental Training Centre of Holland College (ETC), also in Summerside, the Ecological Monitoring and Assessment Committee of Environment Canada - Atlantic Region (EC-AR), and the Environmental Monitoring Coordinating Office of Environment Canada (EMCO) in Burlington, Ontario.

In particular, we would like to thank Brenda Penak of BBEMA and Daniel Schulman of ETC who agreed to coordinate the arrangements for the meeting and who are largely responsible for its success, Steve Moore of ETC who proved to be an effective chair of the busy paper sessions, Patricia Roberts-Pichette who represented EMCO at the workshop, and Geoff Howell, Tom Clair and Tom Pollock of EC-AR who helped develop the idea of a Prince Edward Island EMAN site.

We would like to thank the staff of the Loyalist Inn in Summerside for their help in welcoming those who attended the workshop, and to all 64 participants who braved the winter storm to attend, with representatives from all four Atlantic provinces and Ontario. Finally, we wish to express our gratitude to those who presented papers at the workshop and provided manuscripts and summaries for this report.

We would like to close with a final tip of the hat to those who have agreed to sit on the initial ESC coordinating committee, following through with the workshop recommendations to set up an Ecological Science Cooperative in the Bedeque-Malpeque Bay area of Prince Edward Island.

Richard D. Elliot
Environment Canada
Sackville, New Brunswick

Patrick Chan
Environmental Consultant
Cornwall, PEI

November 1995

EXECUTIVE SUMMARY

A workshop was held in Summerside, Prince Edward Island, from 22-24 February 1995, to assess the opportunity to establish a node of the Atlantic Maritime Ecological Science Cooperative in the province, which would address the ecological impacts of agricultural activity on terrestrial and coastal systems. The workshop was hosted by the Bedeque Bay Environmental Management Association, the Environmental Technology Centre of Holland College, and Environment Canada - Atlantic Region, and attracted 64 participants from 23 organisations in Prince Edward Island and Atlantic Canada.

Participants reviewed activities of the Envionmental Monitoring and Assessment Network in Atlantic Canada and other regions of the country, and a range of diverse historical, current and future monitoring and research studies in south-central Prince Edward Island. They then assessed the proposal to set up a P.E.I. ESC node in the context of this review. Representatives of key federal and provincial government agencies, non-government groups, and Holland College agreed to suppport the proposal to establish a node and serve on the initial coordinating committee.

The workshop concluded with the following recomendations to Environment Canada:

1. That a node of the Atlantic Maritime ESC be established in Prince Edward Island, to take advantage of opportunities to build on existing scientific studies and expertise to improve understanding of agriculture-dominated ecosystems in Atlantic Canada, through interdisciplinary ecological research and monitoring, and to work with land-users to provide a scientific base for decision-making to ensure that agro-marine activities are environmentally sustainable.

2. That the node's initial ecological focus concentrate on the following agriculture-related issues: soil erosion by water and wind, ecosystem impacts of the use of agricultural chemicals, effects of terrestrial land-use on adjacent coastal ecosystems, ecological implications of changes in landscape use and composition, and ecological implications of changing socio-economic pressures.

3. That the node's geographical area should include, but not be limited to, terrestrial and coastal/estuarine areas of Bedeque Bay, Malpeque Bay and surrounding areas, with an initial base in Summerside.

4. That Environment Canada support and facillitate the formation of an initial coordinating commmittee for the P.E.I. ESC node, with representatives from key federal, provincial and non-government agencies.

5. That Environment Canada provide core support to undertake such tasks as conducting a scoping exercise to identify important research and monitoring needs, and applying the Atlantic Region EMAN database management system to the P.E.I. ESC node, beginning in 1995-96.

INTRODUCTION

Richard D. Elliot and Patrick Chan

The national Environmental Monitoring and Assessment Network (EMAN) is being set up across Canada to monitor and assess the status of Canada's ecosystems, and to address areas of concern where human-induced stresses have a major negative impact on environmental health. Ecosystem Science Cooperatives (ESCs) have been developed steadily in Atlantic Canada since 1992, with four operational nodes in three provinces operating by the end of 1994.

In reviewing progress in Atlantic Canada, gaps were identified in Labrador, offshore areas of the northwest Atlantic, and in areas within the Atlantic Maritime ecozone which are dominated by agricultural activities. This workshop was organized to assess the opportunity for establishing an ESC node to address the latter need in Prince Edward Island, where agriculture has a major influence on the composition of the landscape, the maintenance of natural biodiversity, and the overall health of the province's ecosystems (see agenda in Appendix 1).

The workshop assessed the potential for a node in south-central Prince Edward Island, and considered options for its the ecological focus and administrative structure, to best address science issues relating to the ecological impacts of agricultural activity on both terrestrial and coastal systems, which are closely linked throughout the province.

Participants were asked to keep in mind the role of ESC nodes in the region. They must capture both broad-based, stressor-related national concerns, as well as local expectations. They must also emphasize and link monitoring - defined here as tracking trends in the magnitude of a parameter over time through repeated measurements - and research - scientific activities focused on determining causes, mechanisms and implications of these levels and changes. And finally, they must consider both environmental stressors, and their ecological effects. Because stressors are primarily a concern because of their ecological impacts, studies must link the two to help understand mechanisms of action and ways to reduce impacts.

The 64 registered participants (Appendix 2) represented the federal government (20 representatives), provincial governments (13), colleges and universities (20), and scientific and environmental non-government organisations (12). They spent most of three productive days considering and refining this proposal. The first day of the workshop began by sharing information on activities under way at current Atlantic Region ESC nodes, to learn from their accomplishments and the approaches. The second day was devoted to contributed papers addressing historical, current and future monitoring and research in the area, to provide the context of scientific information already available. The Atlantic Region ESC Steering Committee, made up of representatives from a variety of provincial and federal government agencies and the regional nodes, also took advantage of the workshop to hold their annual meeting as part of the proceedings.

On the third day, participants focussed on details of the proposed ESC node which they decided should be set up, and formalised their deliberations in five recommendations to go to Environment Canada. The wealth of current information available in the area, and the commitment of those currently involved in related programs in south-central PEI, provided a productive starting point for this new initiative. The support and enthusiasm of the Bedeque Bay Management Association (BBEMA), and the Environmental Technology Centre of Holland College, were particularly important in moving this idea ahead.

We congratulate those with the vision to develop an ESC node in Prince Edward Island, and hope that this workshop has provided a useful impetus in beginning this challenging process.

AN OVERVIEW OF THE ECOLOGICAL MONITORING AND ASSESSMENT NETWORK IN ATLANTIC CANADA

Richard D. Elliot
Chair, Atlantic Region ESC Coordinating Committee
Canadian Wildlife Service - Environmental Conservation Branch
Environment Canada
Sackville, New Brunswick

The Ecological Monitoring and Assessment Network - EMAN

The goal of the national Ecological Monitoring and Assessment Network initiative (EMAN) is to develop an inter-disciplinary network of Ecological Science Cooperatives (ESCs) in each major Canadian ecozone to collect information on the functioning and health or condition of ecosystems, and to provide the results to those assessing, addressing and reporting on the impacts of environmental stresses, in response to national, regional and local priorities.

Each ESC is independent and sets its own research and monitoring agenda, within an evolving national framework, and the organization of individual ESCs varies to reflect regional and local opportunities and constraints. Resources within ESCs are primarily directed to scientific programs, rather than the development of new infrastructure, and most sites evolve from existing centres of scientific activity. Where more than one location is needed to adequately study diverse aspects of the ecozone, an ESC may itself be a network of nodes at which long-term monitoring and associated research is centred. Each node then focuses on selected issues and on the ecological impacts of specific stresses to the functioning of representative ecosystems.

National priorities of EMAN include understanding and protecting the integrity of Canada's ecosystems, monitoring and restoring their natural biological diversity, assessing the impacts of stresses such as climate change, UV-B radiation and toxic chemicals, developing scientifically-based environmental stewardship initiatives, increasing effectiveness by working through scientific partnerships, and contributing to the expertise and knowledge that Canadians need to make environmentally-sound decisions. National coordination is provided by Environment Canada's Ecological Monitoring Coordinating Office (EMCO), based in Burlington, Ontario (*contact:* Dr. Tom Brydges, Ecological Monitoring Coordinating Office, Environment Canada, Canadian Centre for Inland Waters, 867 Lakeshore Road, Burlington, ON L7R 4A6, tel: (906) 336-4401, fax: 905-336-5989).)

Some of the benefits of implementing this network include:

- developing new inter-disciplinary links among non-traditional partners to collect, interpret and apply information about ecosystem functioning and trends in ecosystem health,
- providing a stronger science base for resource management and sustainable development decisions, by evaluating the completeness and utility of existing data, addressing important data gaps through on-site studies, evaluating the impacts of ecological stresses and options for mitigating them, and integrating data-bases to develop a predictive capability for emerging issues,

- increasing the effectiveness of our ecological science by focussing studies in selected areas to develop critical mass and build on long-term data sets and expertise of researchers,
- developing new cooperation among scientists and land-users in addressing environmental issues, and enhancing public awareness of the implications of information gathered through ecological research and monitoring.

The EMAN approach in Atlantic Canada

Most of the Maritime provinces, along with extreme southeastern Quebec, fall in the Atlantic Maritime Ecozone, where three nodes have already been set up. Insular Newfoundland and southeastern Labrador fall in the Boreal Shield, where one node now exists. Central and northern Labrador fall in the Taiga Shield and Arctic Cordillera Ecozones, respectively, and no ESCs have yet been proposed in Atlantic Canada for these ecozones.

The present nodes in Atlantic Canada have evolved from existing research and monitoring programs or sites where interdisciplinary scientific groups are already working cooperatively. Each focuses on different ecosystems, and impacts of different stresses. Selected nodes will be added or expanded to address other important issues, such impacts in marine systems of the northwest Atlantic Ocean. This workshop will consider setting up a new node to address another priority, agricultural land-use impacts in terrestrial and coastal systems, with a focus in Prince Edward Island.

The general administrative approach has been set out in terms of reference developed by the current partners, based on a minimum flexible structure needed to ensure effective coordination and communication. An Atlantic Region ESC Steering Committee links the nodes, coordinating their activities with regional and national priorities, and addressing common organisational and financial concerns. At most nodes, a local Management Committee handles administration, and a Scientific Working Group ensures integration, reporting and application of research projects, with input from other scientists, land-users, municipalities, and NGOs. At some sites, one Coordinating Committee covers both these sets of tasks.

The Atlantic Regional office of Environment Canada provides regional coordination with other partners, ensuring common direction and approaches, and encouraging nodes to reflect both national and local concerns and opportunities. It works with the Ecological Monitoring Coordinating Office in allocating small amounts of funding to maintain each site, and encourage contributions from other partners. The department assists with organization and communications, linking nodes through workshops, e-mail and publications, provides modest resources to help in setting up the network, and developed computer programs to help in database integration and interpretation.

Many other partners contribute to the success of Atlantic sites. Several federal government agencies, including Parks Canada (Heritage Canada), the Canadian Forest Service (Natural Resources Canada), Fisheries and Oceans Canada, the provincial departments of environment and natural resources, many Atlantic Region universities including university-based groups such as the Hunstman Marine Science Centre and TERRAMON, and local environmental non-government groups are all important partners.

EMAN activities in Atlantic Canada have resulted in the following two publications, which are available from Environment Canada, Sackville NB:

Kejimkujik Watershed Studies: Monitoring and Research Five Years after "Keji 88". 1994. J.J. Kerekes (*ed*), Environment Canada-Atlantic Region Occ. Rep. 3, 276 pp. (results of a workshop held 20-21October 1993, at the Kejimkujik ESC node)

Ecological Monitoring and Research in the Coastal Environment of the Atlantic Maritime Ecozone. B.M. MacKinnon and M.D.B. Burt (*eds*), Environment Canada-Atlantic Region Occ. Rep. 4, 264 pp. (proceedings of a workshop held 9-11 March 1994, at the Hunstman Marine Science Centre, to set up the St. Andrews/Passamaquoddy ESC node)

Atlantic Region Nodes

The Fundy ESC Node (Atlantic Maritime Ecozone) - Fundy National Park

The Fundy node is based in Fundy National Park, on the northwest coast of the Bay of Fundy in New Brunswick. The park provides infrastructure and support for the node. A variety of initiatives focus on the functioning of forest ecosystems, and the impacts of forest management activities on them.

Its research activities are linked with the multi-disciplinary Greater Fundy Ecosystem program of Parks Canada, and with the Canadian Forest Service's Fundy Model Forest. Here federal and provincial agencies, together with many Maritime universities and the forest industry, cooperatively investigate and report on the effects of forest management activities on components of the Maritime Acadian Forest.

The park runs a series of ongoing monitoring programs for amphibians, fish, mammals and birds. In addition, CFS monitors forest insects, Environment Canada monitors water quality, stream flows and climate parameters, and monitors acid rain with the New Brunswick Department of the Environment. For further information, contact:

Dr. Doug Clay, Park Ecologist	tel: (506) 887-6000	fax: (506) 887-6011
Harry Beach, Regional Office	tel: (905) 426-6626	fax: (902) 426-2728
Dr. Tom Pollock, Environment Canada	tel: (506) 851-3836	fax: (506) 851-6608

The Kejimkujik ESC Node (Atlantic Maritime Ecozone) - Kejimkujik National Park

The Kejimkujik node is located in the southwestern third of Nova Scotia, with most activities located in and around Kejimkujik National Park, which provides the physical base and infrastructure for the node. A major ecological focus is the impact of atmospheric changes on local ecosystems, particularly aquatic systems. The site has a history of integrated research and monitoring connected with the LRTAP acid rain program, which generated a wealth of information on the characteristics and functioning of these systems.

A second field of focus is the monitoring and assessment of biological diversity. Kejimkujik Park was the first site in Canada to set up permanent plots to monitor forest biodiversity using the protocol of the Smithsonian Institute's Man And Biosphere program. Further work is being done on how to monitor components of local biodiversity at different scales, based on these plots. Related biodiversity initiatives include ongoing programs on the recovery of endangered species, and impacts of river and lake management on their biological components.

The Kejimkujik site was the first to implement the Atlantic Region database to bring together summaries and data-sets of relevant ecological and biophysical information from a variety of sources into an easily accessible database. Its use will range from project planning and data synthesis to report preparation and public interpretation. For further information, contact:

Cliff Drysdale, Park Ecologist	tel: (902) 682-2770	fax: (902) 682-3367
Geoff Howell, Environment Canada	tel: (902) 426-4196	fax: (902) 426-4474

The St. Andrews/Passamaquoddy ESC Node (Atlantic Maritime Ecozone)

The St. Andrews/Passamaquoddy node is based at the Huntsman Maine Science Centre on Passamaquoddy Bay in southwestern New Brunswick. It is led by the HMSC in cooperation with the Department of Fisheries and Oceans station in St. Andrew's, with representatives from the University of New Brunswick, and provincial and federal Environment departments on its coordinating committee. HMSC itself has a membership of many universities and government agencies addressing coastal zone concerns, with links to the St. Croix ACAP community-based environmental management initiative.

The node addresses concerns that arise at the terrestrial-marine interface, with an ecological focus on impacts of human activities on coastal systems, monitoring and assessing marine biodiversity, and the effects of atmospheric pollutants on these systems.

Current concerns include the impacts of aquaculture, resource harvesting and inputs from terrestrial systems on the coastal ecosystem, and the effects of acid precipitation and elevated mercury levels on local biota. The node has also begun efforts into formalising protocols to monitor and detect changes in biological diversity in coastal and marine systems. For further information, contact:

Dr. John Allen, Director HMSC	tel: (506) 529-1200	fax: (506) 529-1212
Dr. Tom Clair, Environment Canada	tel: (506) 364-5070	fax: (506) 364-5062

The Avalon ESC Node (Boreal Shield Ecozone)

The Avalon node is located in the Avalon Peninsula of southeastern Newfoundland, centred on the Salmonier River watershed. It is based on programs initiated by TERRAMON, a network of organisations and agencies concerned with long-term monitoring and research on environmental change in Newfoundland and Labrador, with an office in the Centre for Earth Resources Research at Memorial University.

The node focuses primarily on the functioning of a climatically-stressed boreal ecosystem typical of much of insular Newfoundland, and the potential impacts of human activity on its integrity. A report on the ecology of the Salmonier Basin and initial studies conducted there has recently been published, and studies now underway include the documentation of historical vegetation trends based on bottom cores of headwater ponds, and determination of heavy metal concentrations in lichens consumed by caribou.

The node publishes a newsletter called *TERRAMON News*, and has set up a listserver to distribute announcements, publication references, requests for information, and research discussion topics. For further information, contact:

Dr. Derek Wilton, TERRAMON Coordinator tel: (709) 737-4519 fax: (709) 37-2589
Dr. Tom Clair, Environment Canada tel: (506) 364-5070 fax: (506) 364-5062

APPLICATION OF CONCLUSIONS FROM THE 1995 NATIONAL EMAN CONFERENCE

Richard D. Elliot
Chair, Atlantic Region ESC Coordinating Committee
Canadian Wildlife Service - Environmental Conservation Branch
Environment Canada
Sackville, New Brunswick

Representatives from Atlantic Region ESC nodes joined 250 scientists and managers from across the country at a National EMAN Conference in Burlington Ontario, from 16-19 January 1995, and this workshop briefly considered ideas coming from that meeting. Most stressors considered at the conference were widespread national-level issues and the challenge was to identify the best role of ESCs in addressing them, in relation to local and regional concerns. The major topics of information and discussion were biodiversity, climate change, UV-B radiation, toxic chemicals, and the cumulative effects of these and other stressors.

The consideration of the maintenance and restoration of natural biodiversity in Canada ranged from the broad to the specific, and highlighted the need to focus on key parameters to serve as indicators, and to develop standardized monitoring protocols. The participants pointed to the important role that ESCs could play in developing and implementing these approaches.

Presentations on climate change centred on interpreting climate and physical processes and models, with an attempt to extrapolate to possible ecological effects. One role for ESCs would be to monitor climatic indices, with for example, instrumentation of the type to be installed at Kejimkujik, and to develop ways to link changes in these indices with likely ecological impacts.

As trends in the incidence of UV-B radiation are uncertain in Atlantic Canada, and there is no clear indication as to whether these may have an ecological impact, most concluded that there was no immediate role for Atlantic ESCs in investigating UV-B, and that any studies would likely be linked to those assessing impacts of climate change.

National perspectives on the importance of ecosystem impacts of toxic chemicals were presented, with attention directed at the increasing awareness of threats posed by mercury, now a key concern in Atlantic Canada. While research and monitoring of levels and impacts of acid rain, lead, and mercury will be important at all ESC nodes, the effects of agricultural chemicals will be particularly important to consider in Prince Edward Island.

The cumulative effects of several stressors, demonstrated by the inter-linkages of all the above concerns, have traditionally been recognised but seldom evaluated. However, the conference pointed that these important implications can be best addressed through inter-disciplinary approaches that characterize studies at the ESCs.

SUMMARY OF WORKSHOP DISCUSSIONS

Daniel Shulman, Holland College
Brenda Penak, Bedeque Bay Environmental Management Association, and
Richard Elliot, Environment Canada

After the presentation of the invited papers on recent research and monitoring activities in south-central Prince Edward Island relating to ecological impacts of agricultural activity (next section), workshop participants discussed the value of an ecosystem Science Cooperative in this area. All present quickly agreed that a node of the Atlantic Maritime ESC should be established here to address the impacts of agricultural activities in Prince Edward Island on terrestrial and coastal systems. Participants then concentrated on the following questions:

- what, why, and where? - what should the role of the ESC node be, what should its the ecological focus be, and what area should it cover?
- who and how? - who should be the key participants, and what administrative structure should the node have?
- what recommendations should go to Environment Canada from the workshop?

We report here on the main points and conclusions from the group discussions. Some of these were further modified through discussions at the subsequent planning meeting on 20 April 1990, at which the initial coordinating committee was established.

Role of the PEI-ESC node

The role of the node under consideration was discussed in the context of its local, regional and national needs. Local priorities revolve around the ecological implications of agricultural activities, and relationships of these land-based activities on soil, forested systems, water quality (including streams, wetlands and groundwater), and runoff into adjacent coastal areas. The BBEMA ACAP site has already identified many related local concerns, and has begun community-based initiatives to draw attention to some of them, and to mitigate their impacts through local action. An ESC node should compliment BBEMA, in focussing on scientific data collection to assist in identifying and understanding key local issues, and in finding ways to resolve problems. This unique opportunity was seen as a major strength for both BBEMA and the ESC.

At a regional scale, it was recognised that the node would serve not only as the ESC focus for PEI, but also as the primary site in the region addressing issues in a setting dominated by agriculture. Although some inter-disciplinary scientific work may be conducted in other areas, such as northeastern New Brunswick or the Annnapolis Valley of Nova Scotia, it was felt by the group that the PEI node should attempt to serve as the hub for studies that focus on ecological effects of agriculture in the Maritimes.

The national role of this node was also discussed, recognising that issues identified as concerns across Canada could be considered at this site, although most participants felt that studies of these might have to be funded separately. It was also pointed out that studies initially conducted to address local or regional priorities, such as soil erosion in relation to soil residue, may also have national applicability. These discussions highlighted the needs to communicate national priorities to those at the site, and to broadly communicate the results of studies at the node. The group summarized discussions on the node's role and direction in the following way:

The ESC node in Prince Edward Island should to take advantage of unique opportunities that build on existing scientific studies and expertise in terrestrial and coastal systems of the Bedeque Bay area, to:

- *improve understanding of agriculture-dominated ecosystems in Atlantic Canada through inter-disciplinary ecological research and monitoring, and*

- *work with land-users in providing a scientific base for decision-making to ensure that the use of agro-marine environments is environmentally sustainable.*

Ecological focus

Discussion centred on the application of the concept of addressing the ecological impacts of agricultural activities in Prince Edward Island on terrestrial and coastal systems, considering the role suggested above. It was stressed that a constructive appproach must be taken, building on BBEMA's initiative, in working with farmers and the agricultural community to study impacts and looking for ways to mitigate problems, in a non-confrontational way.

The following aspects were identified as the main ecological issues of concern to those participating in the workshop, for which important data gaps remained. These were all agreed to be fruitful areas for research or monitoring in P.E.I., to support conservation or management action by the responsible agencies or non-government groups such as BBEMA:

- soil erosion by water and wind,
- ecosystem impacts of the use of agricultural chemicals,
- effects of terrestrial land-use on adjacent coastal ecosystems,
- ecological implications of changes in landscape use and composition, and
- ecological implications of changing socio-economic pressures.

It was recognised that the topics covered in the contributed workshop papers represented only part of a wealth of relevant scientific information, and it was recommended that one of the first tasks at the node should be a scoping exercise to summarize all available information and assess the priorities of these and other issues. The ecological focus could then be further refined to target the highest priorities, and projects could then be developed and supported.

Geographic coverage

The multi-faceted roles of the node in the local, regional and national contexts discussed above were borne in mind, as was the conclusion that this would likely be the only ESC node set up in P.E.I. in the foreseeable future. Although the importance of keeping close links with BBEMA was stressed, it was agreed not to limit the ESC node to BBEMA's territory, as described in Brenda Penak's presentation (i.e. the watersheds of the Dunk, Wilmot and Bradshaw Rivers, and the coastal area around the Bedeque Bay, including Summerside).

It was decided that the focus should be on terrestrial and coastal/estuarine areas of Bedeque Bay, Malpeque Bay and the surrounding areas, with an initial base in Summerside. In the spirit of cooperation and building on existing data, it was agreed that firm boundaries should not be drawn, and that studies or monitoring should be supported in adjacent areas of rural P.E.I. where they were considered relevant and appropriate. Thus, while areas closest to the centre of the node would receive the most attention, projects would not be excluded simply on the basis of location.

Participation and administrative structure

The following key agencies were represented at the workshop and agreed that they would participate in setting up the P.E.I. node. The individuals noted below were present at these discussions, and agreed to initially represent their agencies on the coordinating committee:

Environmental Training Centre, Holland College	Daniel Shulman
Bedeque Bay Environmental Management Association	Brenda Penak
P.E.I. Department of Environmental Resources	Bruce Raymond
Agriculture and Agri-food Canada	Linnell Edwards
Environment Canada	Joe Arbour
Environmental Monitoring and Assessment Network	Richard Elliot

It was agreed that several other agencies were particularly important to have as partners in the ESC node, given its focus on agricultural impacts on ecosystems, including the University of Prince Edward Island (including the Atlantic Veterinary College), the P.E.I. Department of Agriculture, Fisheries and Forestry, Fisheries and Oceans Canada, and Cavendish Farms. Several other partners were suggested which could contribute important perspectives and support, including the Atlantic Coastal Zone Information Steering Committee, the P.E.I. Fisherman's Association, the National Farmers Union, the P.E.I. Federation of Agriculture, the Agriculture Federation of Canada, Health Canada, the Université de Moncton (Model Ocean), and Strait Crossing International. The members of the initial coordinating committee are listed in Appendix 3.

It was suggested that the coordinating committee have two co-chairs to spread both the work-load, and the opportunities and contacts, across two agencies. It was also agreed that the initial bases of the node would be at BBEMA and Holland College, recognising the limitations imposed by restrictions in both offices on staff, space, office equipment and financial resources.

Participants recognised that direct funding from Environment Canada would be limited to providing "grease and glue" to get the node started, and to help it continue, rather than as support for specific projects. An important role of the committee will be to consider additional sources of core and program support.

Recommendations to Environment Canada

As a result of the discussions summarized above, the Summerside EMAN workshop respectfully submits the following recommendations to Environment Canada:

1. That a node of the Atlantic Maritime ESC be established in Prince Edward Island, to take advantage of opportunities to build on existing scientific studies and expertise to improve understanding of agriculture-dominated ecosystems in Atlantic Canada, through inter-disciplinary ecological research and monitoring, and to work with land-users to provide a scientific base for decision-making to ensure that agro-marine activities are environmentally sustainable.

2. That the node's initial ecological focus concentrate on the following agriculture-related issues: soil erosion by water and wind, ecosystem impacts of the use of agricultural chemicals, effects of terrestrial land-use on adjacent coastal ecosystems, ecological implications of changes in landscape use and composition, and ecological implications of changing socio-economic pressures.

3. That the node's geographical area should include, but not be limited to, terrestrial and coastal/estuarine areas of Bedeque Bay, Malpeque Bay and surrounding areas, with an initial base in Summerside.

4. That Environment Canada support and facilitate the formation of an initial coordinating committee for the P.E.I. ESC node, with representatives from key federal, provincial and non-government agencies.

5. That Environment Canada provide core support to undertake such tasks as conducting a scoping exercise to identify important research and monitoring needs, and applying the Atlantic Region EMAN database management system to the P.E.I. ESC node, beginning in 1995-96.

WELCOME AND INTRODUCTION TO HOLLAND COLLEGE

Francis Tang
Chair, Renewable Resources Department
Holland College
Summerside, P.E.I.

Holland College, through its Environmental Training Centre, is proud to be a partner, together with the Bedeque Bay Environmental Management Association and Environment Canada, in hosting this conference today.

Our Environmental Training Centre consists of four separated but linked programs. They are: Aquaculture Technology, Environmental Technology, Renewable Resource Management Technology, and Urban and Rural Planning Technology.

We at Holland College not only believe in the importance of research and monitoring relating to the ecological impacts of agricultural activities, but we also firmly believe that in order for us to be an effective trainer in our community, we must have collaborative links with the community. Looking around here today, I see professionals and experts from all over Atlantic Canada and Ontario. I am hopeful that by entering into this partnership, our students will benefit in many ways. If an Ecological Science Cooperative site is established on the Island, our students will then have an opportunity to be involved in a number of monitoring projects, and at the same time gain increased exposure to many different agencies and organizations during their training.

Once more, thank you for this opportunity, and enjoy your conference.

CITIZEN PARTICIPATION IN ECOLOGICAL SCIENCE - THE ATLANTIC COASTAL ACTION PROGRAM

Jim Ellsworth
Environmental Conservation Branch
Environment Canada
Dartmouth, Nova Scotia

Abstract: *This paper briefly explores the process used within the Atlantic Coastal Action Program (ACAP) in facilitating the establishment of functional ecosystem management regimes. The paper further explores the role of citizens in ecological science and the role of ecological science in ecosystem management. Specifically, the paper examines benefits which could be derived from using an ACAP site as an ESC site.*

Background

The Atlantic Coastal Action Program (ACAP) is more of a process than a program. ACAP is now a community-based, consensus-driven approach to ecosystem management. The process assists stakeholders in identifying common environmental, social and economic objectives, the level of environmental quality required to achieve those objectives, and the actions necessary to attain that level of environmental quality.

The ACAP process has proven to be an effective means of facilitating ecosystem management. The boundaries for ecosystem management are set pragmatically, based upon the requirements of the task to be addressed. The boundaries are large enough to effectively deal with the problems at hand yet small enough to enable stakeholders to assume ownership of the state of their environment.

Boundaries for ecosystem science are set by natural characteristics which are common to a geographic area yet distinctive from other areas. Our ecosystem science and ecosystem management regimes can be very different from one another. The information and models generated through ecosystem science serve to assist ecosystem management initiatives and enhance our knowledge of ecosystems.

The issues and questions raised in ecosystem management serve to guide our ecosystem science initiatives. Of course our ecosystem science initiatives are also guided by global issues as well as national, regional, and sectoral priorities.

Ecosystem management depends upon transferring ownership for solving the problems to the stakeholders and assisting them with the process of implementing change. Experts may want to go farther faster, although when experts propose something stakeholders don't like, they will oppose it. Regardless of who creates the solutions, it is up to the stakeholders to implement them.

First, as empowered common clients, and later as capable partners, ACAP organizations weave together the agendas and resources of stakeholders, decision makers and knowledge holders. Nothing short of this powerful combination can facilitate ecosystem management.

The objectives and activities of the 13 sites in Atlantic Canada can be grouped into five broad goals. Each goal represents an opportunity for ecosystem scientists to partner with other knowledge holders, stakeholders, and decision makers.

Goal 1. To restore and maintain water quality in the watershed and coastal area so that it is fit for fish, wildlife, recreation and commercial activities.

Goal 2. To maintain and enhance natural heritage through the conservation and protection of fish and wildlife habitat.

Goal 3. To restore and maintain traditional industries, e.g. shellfish and recreational fin fish fisheries, and assist in the introduction of new sustainable industries, e.g. ecotourism and geomatics.

Goal 4. To promote and demonstrate responsible stewardship in watersheds and adjacent coastal areas.

Goal 5. To develop an agreed upon implementation strategy for the Comprehensive Environmental Management Plan and play an active role in coordinating implementation.

Process Selection

From our experiences in ACAP, and from the lessons learned in other community-based initiatives here in Atlantic Canada and elsewhere, we have the ability to assist stakeholders in analyzing their situation and selecting an appropriate process.

The first stage of this analysis is the identification of stakeholders and a survey of what they perceive to be the issues and what they think should be done to address those issues. The next stage is the presentation of the survey results and the facilitation of a workshop to enable stakeholders to classify their situation and select the appropriate process to address that situation.

Level 1. Stakeholders agree on what the issues are, the causes and what actions need to be taken. The process need only provide a means of levering resources to carry out the appropriate action.

Level 2. Stakeholders agree on what the issues are, however, they disagree on what actions are necessary to address the issues. The process must provide a forum for collaborative decision making and creative solutions.

Level 3. Stakeholders disagree on what the issues are and what should be done to address them. The process must facilitate collective learning by stakeholders. It must also contain the frustration of learning and prevent responsibility avoidance and the premature jumping to solutions.

To successfully deploy the process, stakeholders come to understand and support the purpose of the process. The vision statement of the ACAP organizations should top the existing hierarchy of purposes amongst the participating stakeholders. For example, the sustainable development of an ecosystem is a higher purpose than the education of stakeholders, planning, or action projects. Ecosystem management is the purpose served by these activities. As the prime purpose, the ecosystem management process should set direction for these activities. Success depends upon the ability of participants to unite diverse interests around a common, higher purpose.

Process Deliverables

As with any process, the ACAP process must offer some benefit or return on investment for the individuals and organizations involved. The process has demonstrated that it can align diverse interests around a common cause, lever resources, facilitate partnerships, empower stakeholders, anchor results, address complex and multi-jurisdictional issues and demonstrate the relevance of our science to the issues facing Atlantic Canadians.

For participating communities, the ecosystem science and the opportunity to work with scientists in the generation and dissemination of knowledge are highly valued. For the scientific community, ACAP is an effective vehicle for marketing their knowledge and expertise. As a fundamental principle, ACAP recognizes that decisions are as much values-driven as they are knowledge driven. ACAP addresses these values and creates a receiving environment where scientific information can be quickly and easily plugged into decision-making. In addition, the process integrates scientific, social and economic information to enable decision makers to address problems with a holistic approach.

Many scientists and scientific organizations are presently part of ACAP organizations. Others are working in partnership with ACAP organizations on specific projects. Developing and maintaining this relationship has been frustrating. I can only assume from the contributions that have been made from the scientific community that it has also been very rewarding.

THE BEDEQUE BAY ENVIRONMENTAL MANAGEMENT ASSOCIATION'S VISION AND STRATEGIC PLAN

Brenda Penak
Coordinator
Bedeque Bay Environmental Management Association
Summerside, P.E.I.

SUMMARY

The Bedeque Bay Environmental Management Association (BBEMA) is a non-profit, community-based organization that was established under the auspices of Environment Canada's Atlantic Coastal Action Program (ACAP). The association is governed by a Board of Directors that broadly represent the citizens from within the watershed.

BBEMA's "territory" comprises 450 km^2 in Prince County, in the southwestern part of the province, and includes about one eighth of the area of Prince Edward Island. It includes the watersheds of the Dunk, Wilmot and Bradshaw Rivers, as well as the coastal area around the Bedeque Bay, from Union Corner to Seacow Head including Summerside.

This watershed is characterized by a variety of habitat types - ranging from agricultural and cleared lands, hedgerows, forested areas, freshwater ponds, freshwater and coastal wetlands, streams and estuaries that support a variety of wildlife. About 75% percent of the Bedeque Bay watershed is cleared land, the highest proportion on the Island.

The major activities within this area are potato production, oyster fishing, and livestock farming. The intensive row crop production, combined with fragile, highly erodible soils, has contributed to the prime environmental concern for the watershed - soil erosion. Hence, the association's Vision for a "greener" watershed includes: "keeping the soil on the land", maintaining and enhancing water quality (with particular attention to ground water) and restoring and enhancing natural habitat. One of the key means of addressing this vision will take the form of public awareness and attitude change through activity.

BBEMA's strategic planning session resulted in the development of areas of emphasis, an action plan highlighting goals, activities, tasks, responsibilities and timelines, and a Mission Statement. The Mission of the Bedeque Bay Environmental Management Association is:

"To provide opportunities for the citizen's of the Bedeque Bay Watershed to conserve and enhance their environment through planning, education, projects and partnerships".

Some of the activities and projects the association is involved in include: cover crop management, environmental farm planning, environmental awareness and education, environmental quality assessment and fish habitat assessment. BBEMA's Vision, Mission and many of its projects mesh well with the objectives of an Ecological Sciences Cooperative that would address land use impacts on coastal and terrestrial ecosystems.

HISTORICAL LAND USE CHANGES IN THE BEDEQUE BAY AREA OF PRINCE EDWARD ISLAND

William M. Glen
Forestry Division
Prince Edward Island Department of Agriculture, Fisheries and Forestry
Charlottetown, P.E.I.

Introduction

Monitoring assumes that a current measurement will be compared to a previously obtained one. The difference if any is 'the change', and assessment is the evaluation of the change detected. It is important to know whether this change is part of an on going trend or is a new phenomenon, and to answer this question historical data are of great relevance.

The assumption can be made that if one is monitoring change then one may wish to effect the rate of change in a positive or negative way. If the change is the result of past activity, then it is very difficult to affect the rate of change particularly in long-lived biological systems such as forest stands.

Prince Edward Island has been settled by Europeans since the early 1700s and from then until now great changes have been made to the ecology of the province. Land use has changed the forest cover from 97% forest to a low of 25% and is currently at a level of 48%. The make-up of the forest has also significantly changed.

External influences have caused most changes in land use. Some of the major factors were; the American Revolution in the 1770s, the Napoleonic War in the early 1800s, the railway boom in the 1830-1850s, the American Civil War in the 1860s, the change in ship building in the 1870s and 1880s, the expansion of farming on the Prairies, the two World Wars, mechanization of agriculture and the changing expectations of land owners. It is also likely that the future land use will be influenced by world events such as the General Agreement on Tariffs and Trade (GATT), or the North American Free Trade Agreement (NAFTA).

Choice of Monitoring Site

A site selected in P.E.I. for the Ecological Monitoring and Assessment Network (EMAN) would not reflect the 'average' or typical conditions in the province if located in the Bedeque Bay drainage area, as this area is not representative of most of the province. The land use pattern both historically and currently is far from the provincial normals. The forest cover-type is also not typical.

Monitoring Unit Definition

The use of the watershed as a monitoring unit may be appropriate for aquatic evaluation and for vegetation, where there is a change between watersheds (i.e. elevation differences are such that vegetation is modified). In P.E.I. there is no change in vegetation at the watershed boundaries and animals are also not contained within a watershed.

Townships or 'Lots' as they are more commonly known in P.E.I. have been a standard reporting unit since 1765. Forest area, the type of crops, the number of farms, farm machinery, population etc. have been recorded by this unit. Statistics Canada still uses Lots as a recording unit although often they report at a county level. The large amount of historical information that has been recorded by Lot can not now be re-compiled into watersheds. Therefore it may be more appropriate in P.E.I. to use townships or 'Lots' (or multiples there of) as the monitoring unit.

Land Use Changes 1765 - 1990

The pattern of land use in the province has changed from an almost entirely forest to primarily agricultural and currently it is 49% forest, 40% agriculture and 11% other. Land use is not a constant!

The Bedeque Bay area was subject to the decrease in forest area but has not benefited from the increase since the turn of the century. The three Lots that make up most of the watershed (Lots 25,26,27) were cleared of forest at a faster rate and slightly earlier than the most of the Province and have been less than 30% (15-25%) forested since 1935. Lot 27 has had a very slight increase in forest area since 1935 while the Lots 25 and 26 have had decreases. The suitability of the soils for agriculture and the lack of extreme topography are probably the primary reasons why this part of the province has been so effected.

Forest Cover-type 1980 - 1990

The forest cover-types in the three Lots has also changed with the area of predominately hardwood increasing from 43 to 50%. The softwood species have decreased correspondingly, primarily due to maturity which has allowed the hardwoods to occupy larger areas. This is part of a province-wide trend that has been on going since at least 1946 when hardwood predominated areas were 8% of the forest area. In 1990 the hardwood predominated areas were 29% of the forest.

Cultural Changes 1880 - 1990

There have also been changes in the way in which the farmers in the three Lots have used the land. This can be shown in the number of farms reported in the various censuses. The number of farms have decreased from a high of 550 in 1910 to less than 200 in 1990. This is following the provincial and national trends towards fewer larger farms. Note that agricultural area has been approximately constant since 1935.

The population of the area has not really changed since 1880, which is quite different from the provincial pattern which had a large decrease in the period 1900 to 1930. The provincial population did not reach the 1880 level again until 1970.

Forestry Division Datasets

The Forestry Division has a number of datasets may be of some relevance to the monitoring which is being proposed for this area, or any other area of the province should a more typical area be chosen:

1980 Forest Biomass Inventory

- 196 maps detailing provincial land use
- 900 temporary sample plots (TSP) with data on tree species, size and quality, and understorey woody material >0.3 metres in height

1990 Forest Biomass Inventory

- 212 maps detailing provincial land use (same maps as 1980 with a few coastal changes)
- 1200 temporary sample plots (TSP) with data on tree species, size and quality, understorey woody material >1.3 metres in height, vascular plants, species and abundance, general soil profile description, chemical soil analysis of the 'H' and 'B' horizons, tree cavities, size and use (60 TSPs in the Bedeque Bay area)

Permanent Sample Plots (PSP)

- 400 plots 1/50 ha in size
- all trees tagged and remeasured on a 3 - 5 year cycle, general soil profile description, chemical soil analysis of the 'H' and 'B' horizons (7 PSPs in the Bedeque Bay area)

1935 Forest Cover-type

- General forest cover-types derived from 1935 aerial photography (project now 65% complete)

Aerial photography with provincial coverage

The following series have complete coverage of Prince Edward Island:

Year	Scale	Type	Source of Photos Negatives	Prints
1935	1:14,300	black and white	NAPL	PAPEI
1958	1:15,840	black and white	NAFL	Forestry
1964	1:30,000	black and white	NAFL	Forestry
1968	1:12,000	black and white	NAFL	Forestry
1974	1:10,000	true colour	NSGC	Forestry
1980	1:10,000	black & white	NSGC	Forestry
1980	1:10,000	false colour infrared	NSGC	Forestry
1983	1:60,000	true colour	NAFL	Forestry
1990	1:17,500	false colour infrared	NSGC	Forestry
1994	1:24,000	false colour infrared	NSGC	Forestry

Sources: NAFL - National Air Photo Library, 615 Booth Street, Ottawa, K1A 0E9
NSGC - Nova Scotia Geomatics Centre, 16 Station Street Amherst, N. S., B4H 3E3
PAPEI - Public Archives of Prince Edward Island
Forestry - P.E.I. Forestry Division, Dept of Agriculture Fisheries and Forestry

There are many series with partial coverage, such as those noted below;

Year	Scale	Type	Area
1982	1:18,000	black and white	east of Charlottetown
1987	1:20,000	black and white	west of Charlottetown
1987	various	various	Caledonia/Murray River area

CROP RESIDUE MANAGEMENT AND MONITORING
P.E.I. POTATO PRODUCTION

Ron DeHaan, P.Eng.
Soil and Water Conservation Engineer
Agriculture Division
Prince Edward Island Department of Agriculture, Fisheries and Forestry
Charlottetown, P.E.I.

Residue management in P.E.I. potato production means leaving as much of the previous year's crop as possible on the surface of the soil during the potato year. In P.E.I. this has applicability in two main cropping sequences, potato/grain rotations and potato/grain/hay rotations where the forage has been killed down with a herbicide.

Residue management in the potato/grain rotations starts in the fall as the grain is being harvested. Combines should be equipped with a straw chopper and spreader and the straw should be left on the field to maximize residue levels. Immediately after harvest, there should be one shallow pass with a primary tillage implement like a tandem disc or a chisel plough equipped with a levelling device. This disturbs the soil enough to cover unharvested grain and allows it to germinate, the regrowth providing additional residue for erosion protection during the winter months. The levelling device is considered essential to leave a uniformly disturbed, but level surface without the ridges formed by just a chisel plough alone. Our observations have been that over the winter, the unlevelled ridges become conduits for water, with the resulting run-off leading to excessive rill erosion.

In the spring, tillage consists of a single pass with a primary tillage implement designed for residue management applications. The standard features of these implements are; a gang of cutting coulters, followed by a series of heavy duty S-Tine straight point cultivators or a series of 18 in. sweep points @ 15 in. shank spacing, and finally, a levelling device, either a heavy set of rolling baskets or spike tooth leveller. While there are several variations of this device on the market today, our field trials in 1994 were done using a chisel plough with the modifications mentioned or a Kongsgilde Ress-Till®. Potatoes were planted into the residue, immediately following a pass with either of these implements.

On the three-year rotation, residue management is practiced on forage that has been killed with broad spectrum herbicide such as Glyphosate. The use of herbicide on hayland in potato production has increased dramatically over recent years, primarily for weed control in the subsequent potato crop. Our observations have been that herbicide-treated hayland with traditional tillage practices, i.e. mouldboard plough in fall with disc and harrow passes in the spring, results in soil that has poor aggregate stability, virtually no residue on the soil surface and is extremely vulnerable to soil erosion both during the winter when the field is red and during the following summer with intense summer rainfall events.

Our recommendation for herbicide-treated hayland is that no fall tillage take place. In the spring, a single pass with the aforementioned minimum tillage implement is all that should be required, in most cases. If clods are not sufficiently broken up, some producers may elect to follow with a single pass with a secondary tillage implement (triple-K harrow with rolling baskets). The objective is to plant potatoes into soil with a least 20% of their surface covered with the previous crop residue.

In the fall of 1994, ten well known potato farmers were asked to cooperate on a field scale trial of residue management techniques, with five on potato/grain rotation, five on potato/grain/hay rotation. Soil type and topography were uniform on all trials although potato varieties varied. Each site was split into three distinct treatments:

On the grain sites:

1) fall plough, spring disc and harrow
2) fall residue management, spring disc and harrow
3) residue management in fall and spring.

On the forage sites:

1) fall plough, spring disc and harrow
2) Roundup®, fall plough, spring disc and harrow
3) Roundup®, residue management in spring.

Residue levels for the various sites are shown in Figure 1.

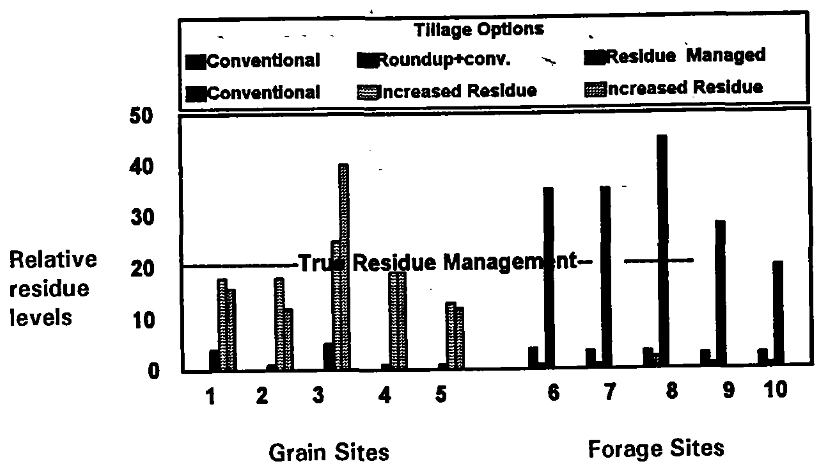


Fig. 1 Residue levels after planting

Rainfall simulation tests conducted on the forage sites after potato planting confirm our assertions regarding the efficacy of the residue in reducing run-off. Results are shown in Figure 2.

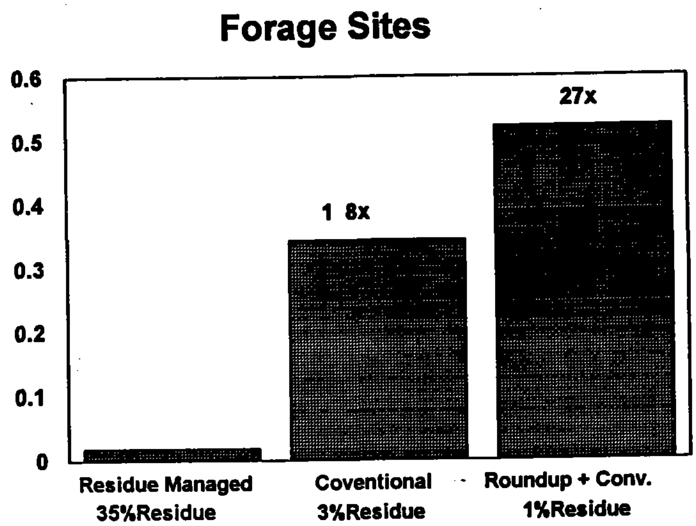


Fig. 2 Comparative erosion rates

Results and Observations on the 1994 Field Trials

Erosion control:

Erosion rates were significantly reduced, with no run-off or rilling between rows even after intense rainfall events. Increased organic matter remained at the soil surface

General crop vigour:

There was earlier emergence in residue-managed sites, and rows filled in quicker in residue-managed sites

Potato tissue nitrogen levels:

Nitrogen stress was more evident in plant tissue samples from potatoes grown in the two-year rotation scenario. Stress appeared more severe on residue-managed sites. On the three-year rotation sites, potato plant tissue nitrogen levels were the lowest on residue-managed sites, but were well above stress levels.

Potato diseases:

No statistically significant increase of the incidence of 2 important potato diseases , common scab *(Streptomyces scabies)* and rhizoctonia *(Rhizoctonia Solani),* was found. Results are presented in Figures 3-6.

Observations from 1994 results

Rot. & Var.	Tillage	% Scab
2 Yr.,Butte	Fall plow	0.36
	Highest Residue	0.27
2 Yr.,Butte	Fall plow	0.04
	Highest Residue	1.44
2 Yr.,R .Burbank	Fall plow	2.01
	Highest Residue	0.71
2 Yr.,Superior	Fall plow	0.89
	Highest Residue	0.71
2 Yr.,Superior	Fall plow	4.61
	Highest Residue	5.07

Fig. 3 Comparison of scab levels with two-year rotation

Observations from 1994 results

Rot. & Var.	Tillage	% Scab
3 Yr.,Shepody	Fall Plow	0.93
	Roundup+fall plow	3.04
	Residue Manage	3.81
3 Yr.,Shepody	Fall Plow	3.27
	Roundup+fall plow	4.73
	Residue Manage	5.09
3 Yr.,R .Burbank	Fall Plow	0.13
	Roundup+fall plow	0.29
	Residue Manage	0.18
3 Yr., Superior	Fall Plow	0.13
	Roundup+fall plow	0.56
	Residue Manage	0.51
3 Yr.,Frontier R .	Fall Plow	2.41
	Roundup+fall plow	6.96
	Residue Manage	6.51

Fig. 4 Comparison of scab levels with three-year rotation

Observations from 1994 results

Rot. & Var.	Tillage	% Rhizoctonia
2 Yr.,Butte	Fall plow	5.58
	Highest Residue	5.01
2 Yr.,Butte	Fall plow	9.31
	Highest Residue	7.93
2 Yr.,R .Burbank	Fall plow	5.96
	Highest Residue	4.22
2 Yr.,Superior	Fall plow	2.51
	Highest Residue	4.91
2 Yr.,Superior	Fall plow	2.33
	Highest Residue	2.02

Fig. 5 Comparison of Rhizoctonia levels with two-year rotation

Observations from 1994 results

Rot. & Var.	Tillage	% Rhizoctonia
3 Yr.,Shepody	Fall Plow	2.56
	Roundup+fall plow	0.6
	Residue Manage	2.67
3 Yr.,Shepody	Fall Plow	3.82
	Roundup+fall plow	4.29
	Residue Manage	0.96
3 Yr.,R .Burbank	Fall Plow	2.31
	Roundup+fall plow	2.8
	Residue Manage	1.53
3 Yr., Superior	Fall Plow	3.69
	Roundup+fall plow	1
	Residue Manage	0.31
3 Yr.,Frontier R .	Fall Plow	2.24
	Roundup+fall plow	4.2
	Residue Manage	1.27

Fig. 6 Comparison of Rhizoctonia levels with three-year rotation

Effect on crop yield of residue management:

The 1994 growing season was characterized by drought conditions, particularly during the latter part of the season. The study areas in the eastern end of the province did receive some effective rainfall. Residue sites in the eastern trial sites displayed a significant yield response to the moisture-conserving properties of the higher residue levels, because there was moisture available. However, in the Bedeque watershed sites no effective rainfall was ever received and thus yield responses were indeterminant. Results are presented in Figures 7-8.

Rot. & Var.	Tillage	Total Yield	% Change
3 Yr.,Russ. Bur.	Conv. (3%)	276	
	Roundup+Conv. (1%)	264	Minus 4.3%
	Residue Managed (35%)	274	Minus 0.7%
2 Yr.,Butte	Fall Plow,Spring Conv.(3%)	210	
	Fall Disc & Chisel,Spring Disc &Triple K or Spring Chisel (18%)	202	Minus 3.8%
2 Yr.,Butte	Fall Plow,Spring Conv.(3%)	234	
	Fall disc & chisel,Spring Disc & triple K or Spring Chisel (18%)	234	

Fig. 7 1994 potato yields in the eastern area

Rot. & Var.	Tillage	Total Yield	% Change
3 Yr., Fron. Russ.	Conv.	274	
	Roundup + Conv.	311	Plus 11.5 %
	Residue Managed	339	Plus 21.5 %
3 Yr., Superior	Conv.	295	
	Roundup + Conv.	306	Plus 3.7%
	Residue Managed	334	Plus 13.2 %
2 Yr., Superior	Fall Plow,Spring Conv.	254	
	Fall Chisel,Spring Harrow (3 Passes)	287	Plus 13.0 %
	Residue Managed	318	Plus 25.2 %

Note: The residue managed treatments had on average 8% more potatoes in > 55 mm size range

Fig. 8 1994 potato yields in the Albany area

Based on the results of the 1994 experiments, some harvester and planter adjustments may be necessary to fully integrate residue management techniques into existing planting and harvesting procedures. Some experimentation with different forage mixes may also be required. Plans are under way to continue with field trials in 1995.

THE ECOSYSTEM SCIENCE COOPERATIVE INFORMATION MANAGEMENT SYSTEM

Geoff Howell
Ecosystem Science Division
Environment Canada
Dartmouth, Nova Scotia

SUMMARY

Ecosystem Science Cooperatives (ESCs) are intended to collect and process information about ecosystem functions such as energy flows, material cycling, population dynamics, and biodiversity. They will become the source of information for local, regional, and national assessments related to a variety of science-based issues. A major goal of the ESCs is to stimulate the development of science activities that have a more integrated ecosystem approach rather than a sectoral science approach. To facilitate this, it was felt that an information management tool was required for each site to assist individual scientists in developing cooperative research initiatives and performing integrated data interpretation. For example, Paul Arp at the University of New Brunswick has used a prototype of the system to retrieve water chemistry and geological data required for the development of forest chemistry flux modelling.

The ESC Information Management System provides for easy access to this source of information. The system acts as an inventory of all types of data available within an ESC and will enable scientists and others to find these data quickly and easily to help facilitate decision making. It is also an easy way to access other software such as geographic information system (GIS) technology, while at the same time providing detailed background information on the geographic data being displayed. The design framework for the ESC system at Kejimkujik National Park can be a guide for the implementation of other ESC information management systems across Canada to ensure a consistent, standardized format.

The system has been developed using ToolBook Visual Authoring software which is a Windows format program that makes use of object-oriented programming and multi-media display to help create a graphical interface which is very user-friendly. From within the system users can start other Windows and DOS programs including SpansMap, IDRISI, Cardfile, and Msplayer. By clicking buttons, custom menu items, and other graphic elements, users can easily navigate their way through the system and use the inventory of data available.

The system has been created as a run-time application which is distributed on six diskettes and can be installed onto computers that don't have ToolBook software loaded by use of a simple setup and installation process. Upon request, copies of the run-time application have been given to interested parties including Ian Church of Canadian Heritage who would like to implement such a system for National Parks in western and northern Canada.

A system description is summarized here, and the main program has several sub-applications, including the following:

- *Contacts* - access to the Windows Cardfile which is similar to a "rolodex" and gives an inventory of contacts established for the ESC,
- *References* - a searchable inventory of reference material pertaining to the ESC,
- *Project Plans* - an inventory of ongoing and future project plans for the ESC,
- *SpansMap* - direct access to this program,
- *GIS Layers* - accesses the Windows Cardfile and loads the inventory of GIS layers stored in SpansMap,
- *GIS Help* - an application to assist with the use of SpansMap,
- *Databases* - information related to the ESC, including climate, water, soils, archaeology, animals, and vegetation, etc.

Other applications complimenting the main ESC system include Water Chemistry Viewer, Meteorological Conditions Viewer, and IDRISI Ortho Module.

The ESC system currently hold a number of contacts, references, project plans, GIS layers, and databases, the majority of which are related to Kejimkujik National Park. The system is being continuously updated. Future developments for the system could include creation of audiovisual files, creating software directly linking the system to spreadsheet programs, creating further complimentary "viewing packages", increasing the data included, and providing for access through Internet.

SEDIMENT MONITORING IN A BEDEQUE BAY WATERSHED

Jack R. Burney
Professor, Department of Agricultural Engineering
Technical University of Nova Scotia
Box 1000, Halifax, Nova Scotia, B3J 2X4

and

Linnell M. Edwards
Adjunct Professor, Department of Agricultural Engineering, TUNS
and
Research Scientist, Agriculture and Agri-Food Canada
Box 1210, Charlottetown, Prince Edward Island, C1A 7M8

Abstract: *Three commercially-farmed watersheds of 140, 203 and 416 ha in the upper reaches of the Wilmot River, which drains into Bedeque Bay, Prince Edward Island, have been instrumented for year-round measurement of discharge and sediment. Adjacent to the outlet of each watershed, three standard erosion plots were set out to measure runoff and sediment from specific agronomic practices, including potatoes as the primary crop. Meteorological instrumentation for monitoring of precipitation, air and soil temperatures, soil moisture, wind travel and evaporation is distributed over the sites. Data is recorded on a central datalogger at each site. Stream discharge is measured using a Parshall flume, and sediment is monitored by use of a specially designed automatic sediment sampler at each watershed outlet and at each plot for one set of erosion plots. At all erosion plots, runoff is collected in volume and sampled for sediment following each runoff event. Stream sediment is monitored at each stream site by use of a turbidimeter. Precipitation is recorded at 2 minute intervals; stream discharge, turbidity and plot runoff at 10 minute intervals; and air and soil temperatures, and soil moisture at hourly intervals. Automated sediment sampling occurs at 17 hour intervals under baseflow conditions, and at 10 minute (summer) or 2 hour (winter) under high flow conditions. Data is stored in original form (1989 to date), calibrated and split into weekly files (1989 to 1994), and partly in event and monthly summary form (December, 1990 to April, 1994), and is used for informational and modelling purposes.*

Introduction

A program aimed at measuring and modelling year-round soil losses under field conditions in Prince Edward Island was initiated in 1986 with support under succeeding Canada/PEI Agri-Food Development Agreements of 1984-89 and 1989-94. The emphasis is on quantifying soil losses under current commercial practices on lands devoted mainly to potato production and on evaluating the effectiveness of alternative, viable, agronomic practices incorporating potatoes as the primary production crop.

The watershed of the Wilmot River (Fig. 1), which discharges into Bedeque Bay, was selected as the study area. The upper 45 km^2 of this watershed has been monitored since

1972 for flow (stage recording at a rated section) and suspended sediment (manual grab sampling) by Environment Canada (Pol, 1988). This data indicates that over half the average annual suspended sediment load occurs in March and April while less than 10% occurs in the period of June through October. No measurement is made of bedload which also may be expected to be most mobile during the high discharge periods of early spring.

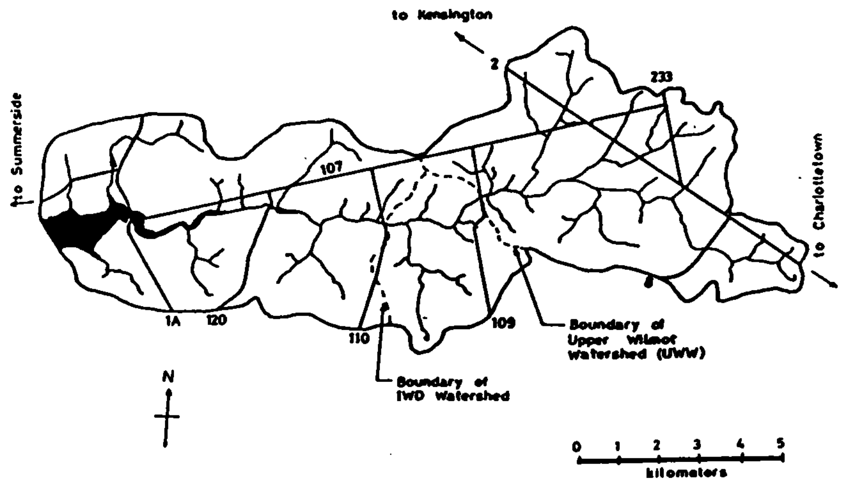


Fig. 1. Wilmot River Watershed with discharge into Bedeque Bay, Prince Edward Island

Within this monitored watershed, and along its steeper eastern boundary, three sub-watersheds, hereafter referred to as watersheds (Fig. 2) were selected on the basis of cropping

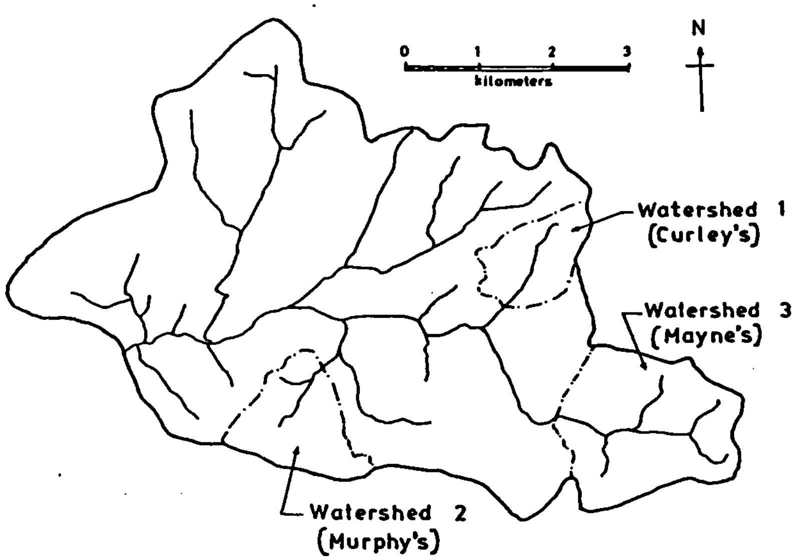


Fig. 2. Location of monitored watersheds in the upper reaches of the Wilmot River watershed

practices and accessibility. The three selected watersheds historically comprise 140 ha of land devoted mainly to potato production (watershed 1), 203 ha of mixed potato and other crops (Watershed 2) and 416 ha of mainly pasture lands (watershed 3). Adjacent to the outlet of each of these watersheds a set of three unit erosion plots (22.1m long down-slope by 4m wide) was established to evaluate soil loss from specific treatment practices. Additionally, the outlet from a terraced field of 4.7 ha adjacent to Watershed 1 was instrumented for soil loss measurement.

Each of the instrumented watersheds (and the terraced field) is farmed commercially and no control is exercised over the cropping practices. A field-by-field inventory of the cropping practices is taken every fall and spring.

Instrumentation

In order to evaluate sediment movement past a specific point it is necessary to measure both discharge and sediment concentration, the product of which gives sediment mass per unit time. Separate instrumentation was installed to measure each of these parameters at the outlets of each of the watersheds, erosion plots and the terrace system. The grouping of a set of three erosion plots adjacent to each watershed monitoring site enables shared use of data recording facilities for discharge and sediment monitoring, as well as for the meteorological instrumentation, as shown for one of the watersheds in Figs. 3 and 4. The terraced field was separately monitored for discharge and sediment only.

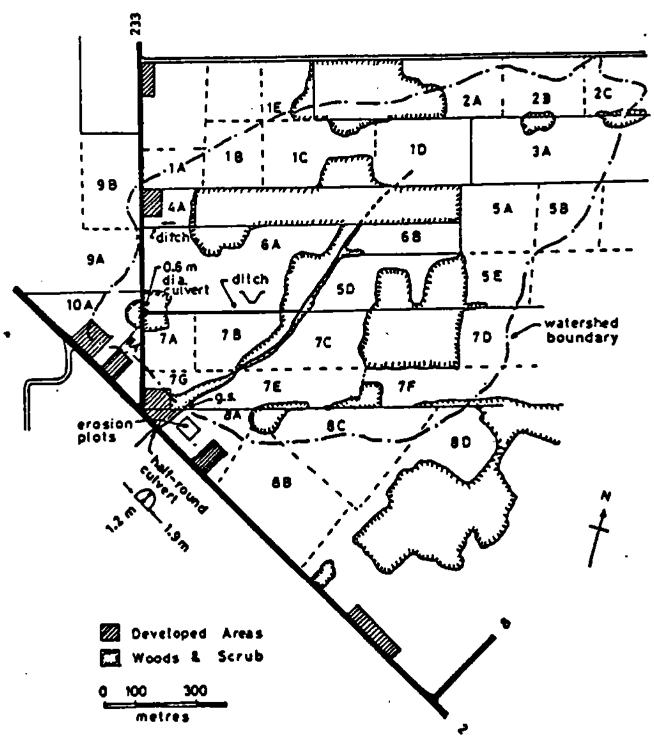


Fig. 3. Watershed 1 (Curley's)

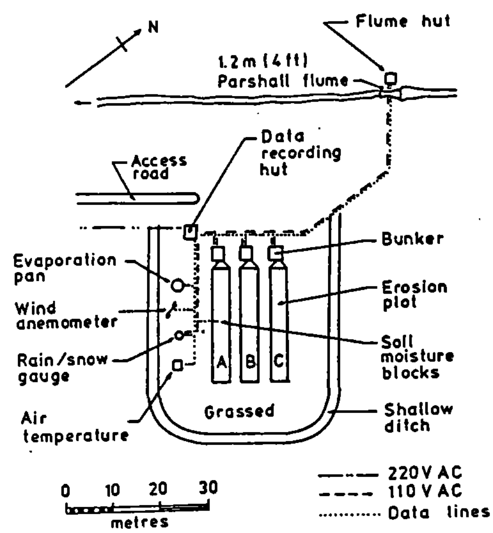


Fig. 4. Recording site for Watershed 1

The following is a summary of the facilities for discharge measurement and sediment sampling. The facilities are presented in detail in Burney and Edwards (1989a; 1989b; 1991) and in summary form in Burney and Edwards (1994a; 1994b).

Discharge Measurement

Flume sections were selected and installed for discharge measurement. These are rated sections which enable discharge to be determined for recorded values of stage (flow depth).

For the watersheds, a Parshall flume (Grant, 1985), a schematic of which is shown in Fig. 5, was selected on the basis of being self-cleansing, allowing natural through-flow, and enabling correction for downstream backwater effects caused by snowbank or debris blockage, or insufficient capacity in downstream culverts during high flows. Additionally, all instrumentation is insulated with provision for electric heating to enable year-round recording. Stream discharge is recorded at 10 minute intervals.

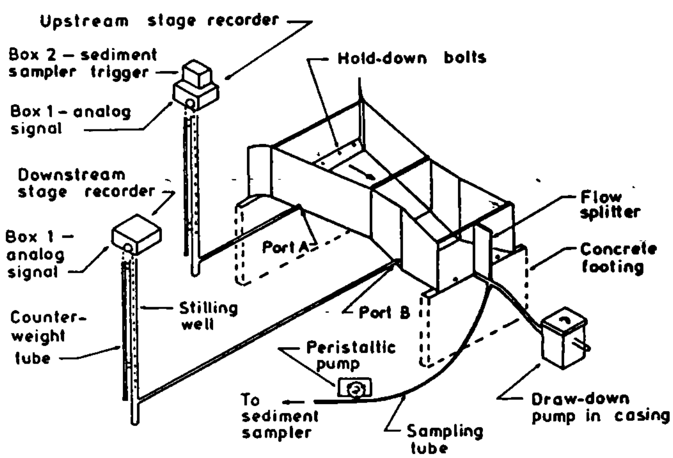


Fig. 5. Parshall flume used for stream discharge monitoring showing stage and sediment instrumentation

For each erosion plot an HS-flume mounted at the end of a flow-concentrating washboard facilitates the recording of the rate of surface runoff (Fig. 6) within a heated and insulated below-ground bunker. Additionally, as shown in Fig. 6, the total runoff from each erosion plot is collected and manually measured in a sequence of three barrels. A larger H-flume, with no storage component, is used on the terrace outlet.

Sediment Measurement

The sediment sampling equipment comprises three sequential components. These are the section from which the sample is drawn, the conveyance and the sediment sampler unit.

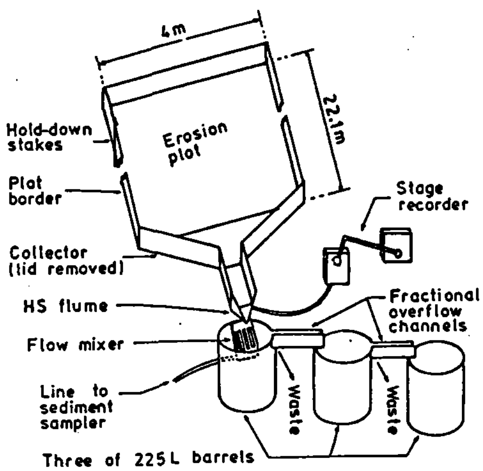


Fig. 6. Standard length (22.1m) USLE erosion plot

As shown for the streams (Fig. 5) samples of flow (which contain bed as well as suspended sediment) are taken at the flume exit. At this point the flow is well mixed following the turbulence created in the throat section. A flow splitter section, mounted centrally on the end of the flume, comprises a 3 mm wide vertical slit facing upstream, and therefore takes a vertically integrated sample of all sediment smaller than this size passing this point. The sampling port is located on the bottom of a pipe attached at the bottom of the flow splitter. Samples are drawn under suction head from a peristaltic pump, from this port through 6 mm I.D. tubing to a sediment sampler unit located in a hut adjacent to the flume. The sediment sampler unit (Fig. 7) was specially designed to work in conjunction with the stage recorder on port A (Fig. 5).

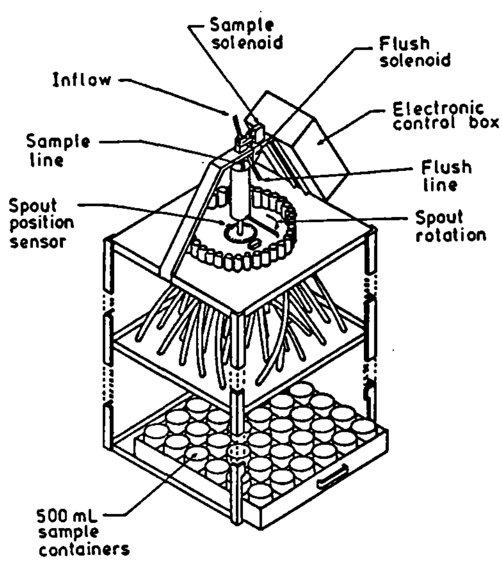


Fig. 7. Automatic sediment sampler unit

Sampling occurs under one of two conditions:

(i) A period of 17 hours since the previous sample (baseflow conditions), or

(ii) The stage at Port A is above a preset threshold level (surface runoff conditions exist) and the time since the last sample at least equals a selectable value. This value is set to 2 hours between samples for the long duration snowmelt induced runoff events of fall to spring, and 10 minutes for the quick runoff events due to storms in the spring to fall period.

In addition to the sediment sampling, a pump attached to the side of the outlet section of the flume feeds a continual flow of stream water through a turbidimeter located in the flume hut. Turbidity readings are recorded on the site datalogger (as voltages representing NTU values) at 10 min intervals.

On the erosion plots and the terrace system sediment samplers are set to trigger whenever runoff occurs, with samples taken at 10 minute intervals.

Sample Data

A sample of recorded data from the original time series and from that presented in consolidated form by PEI Department of Agriculture, Fisheries and Forestry, and Agriculture Canada (1995) is shown in Figures 8 to 10.

Monthly sediment data recorded from watersheds 1 and 3 (also known as Curley's and Mayne's watersheds, respectively) for the period of January, 1991 to April 1993 are shown in Figure 8. This information represents an integration over time for all of the events which occur in the given time period (which in this case is 1 month).

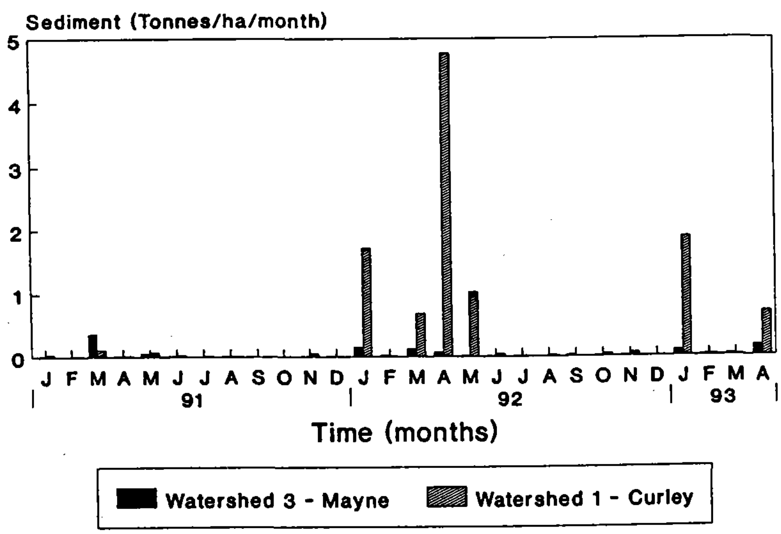


Fig. 8. Monthly sediment recorded at Watershed 1 (Curley's) and Watershed 3 (Mayne's)

up on long slopes causing the substantial rilling observed on many fields left bare over winter. The erosion plots do not show this effects as the length of 22.1m is too short for rilling to occur and hence, although substantial runoff occurs, the flow tends to be relatively low in sediment and therefore does not show as a large soil loss in Fig. 10.

The data generated from recordings in these watersheds have been, and are currently being, used by graduate students in agricultural and geographical sciences (Nova Scotia Agricultural College and the University of Trier, Germany, respectively) and in civil and agricultural engineering (TUNS) in a wide range of research projects. These projects are adding immensely to knowledge of soil loss processes in a cool, temperate maritime climate. Additionally, and more relevant locally, the information gained indicates effective and viable ways to reduce soil loss from farmland, and thereby also mitigate the adverse effects of sediment on watercourses and aquatic life in the Maritime provinces in general, and in Prince Edward Island in particular.

Complementary studies which have been carried out on Charlottetown fine sandy loams (the dominant soil type in the watersheds) include laboratory evaluation of inter-rill erosion (Edwards and Burney, 1989) and of rill erosion (Frame et al, 1992), and measurement of soil erosion using a field rainfall simulator (Parsons et al, 1994).

References

Burney, J.R. and L.M. Edwards, 1989a. Modelling and quantifying soil erosion/soil and water conservation and sediment sources in P.E.I. Part I: Site geography. Proj. Rep., Tech. Dev. Prog., Agriculture Canada, Charlottetown, PEI. 52pp.

Burney, J.R. and L.M. Edwards, 1989b. Modelling and quantifying soil erosion/soil and water conservation and sediment sources in P.E.I. Part II: Instrumentation. Tech. Rep. Dept. of Agricultural Engineering, TUNS, Box 1000, Halifax, NS, B3J 2X4. 106pp.

Burney, J.R. and L.M. Edwards, 1991. Monitoring and modelling soil erosion/conservation in the upper Wilmot River watershed, Prince Edward Island: Data and data analysis. Tech. Rep., Dept. of Agric. Eng., TUNS, Box 1000, Halifax, NS, B3J 2X4. 65pp.

Burney, J.R. and L.M. Edwards, 1994a. Facilities for continuous monitoring of soil erosion in warm and cool seasons in Prince Edward Island, Canada. I. Watersheds. Catina 21: 329-340.

Burney, J.R. and L.M. Edwards, 1994b. Facilities for continuous monitoring of soil erosion in warm and cool seasons in Prince Edward Island, Canada. II. Erosion Plots. Catina 21: 341-355.

Edwards, L.M. and J.R. Burney, 1989. The effect of antecedent freeze-thaw frequency on runoff and soil loss from frozen soil with and without subsoil compaction and vegetative cover. Can. J. Soil Sci. 69: 799-811.

Frame, P.A., J.R. Burney and L.M. Edwards, 1992. Laboratory measurement of freeze/thaw, compaction, residue and slope effects on rill erosion. Can. Agr. Eng. 34(2): 143-149.

Grant, D.M., 1985. Open channel flow measurement handbook (2nd ed.). Isco Inc., Box 82531, Lincoln, NE 68501, USA.

Parsons, T.S., J.R. Burney and L.M. Edwards, 1994. Field measurement of soil-erodibility and cover-management factors in Prince Edward Island using simulated rainfall. Can. Agr. Eng. 36(3): 127-133.

Pol, R.A., 1988. Interpretation of sediment data, 1972-1985, Wilmot River, Prince Edward Island. Rep. No. IW/L-AR-WRB-88-137, Environment Canada, Queen Square, Dartmouth, NS, B2Y 2N6. 67pp.

P.E.I. Department of Agriculture, Fisheries and Forestry, and Agriculture Canada, 1995. NSCP erosion monitoring project. Final Report. Research Centre, Agriculture and Agri-Food Canada, Box 1210, Charlottetown, PEI, C1A 7M8. 191pp.

THE CANADA-P.E.I. WATER QUALITY AGREEMENT AND NUTRIENT LEVELS IN THE BEDEQUE BAY WATERSHED

Bruce Raymond
Water Resources Division
P.E.I. Department of Environmental Resources
Charlottetown, P.E.I.

SUMMARY

The Canada-P.E.I. Water Quality Agreement is a cooperative monitoring program operated by Environment Canada and the P.E.I. Department of Environmental Resources. It has the objective of monitoring long term background water quality in selected watersheds on Prince Edward Island. Watersheds form the primary unit for the program which monitors groundwater, fresh surface water and estuarine water. This program will be incorporated into a new Water Annex Agreement between Environment Canada and the P.E.I. Department of Environmental Resources starting in 1995.

Parameters measured by the program include physical parameters, faecal bacteria, nutrients, chlorophyll, metals and other basic ions. The nutrients monitored are primarily phosphorus and nitrogen due to their limiting effects on primary productivity in fresh and marine environments respectively.

In the Bedeque Bay watershed, there are four sampling stations; the Wilmot River, the Dunk River at Breadalbane, the Dunk River at the Waugh Road, and the Bradshaw River. Inorganic phosphorus levels at the four locations are typical for agricultural areas on P.E.I. This level is higher than other parts of Canada. Total phosphorus levels are similar to dissolved but can be significantly higher during sediment events as the total phosphorus is associated with sediment particles. Phosphorus is not normally a problem for P.E.I. as our freshwater systems are short, small, and shallow with a short residence time.

Concentrations of nitrate at the four stations are also typical for P.E.I. The Breadalbane station has the lowest concentration and the Wilmot River has the highest concentration. Concentrations of total nitrogen are slightly higher and follow similar patterns. Nitrogen can be a problem on P.E.I. when it enters estuaries and causes excessive primary productivity, especially at the head of the estuary. Long-term patterns of nitrate concentrations suggest a general pattern of increase since the mid-1960s when monitoring commenced at a few places on P.E.I. In the Dunk River, the concentration doubled between the late 1960s and the late 1980s. Samples in the last few years are slightly lower but there are insufficient data to determine whether this will become a solid trend. Comparing between watersheds, it appears that those with a higher proportion of cleared land have higher concentrations of nitrate in surface water. This appears to match findings of higher groundwater nitrate concentrations in areas with row crops, manure storage and subdivisions served with septic systems.

GROUNDWATER QUALITY MONITORING IN P.E.I.: NUTRIENTS, BACTERIA & PESTICIDES

George Somers
Water Resources Division
P.E.I. Department of Environmental Resources
Charlottetown, P.E.I.

Introduction

There is considerable interest in establishing the Bedeque Bay area as a node for the long term monitoring of environmental quality. It also appears that this initiative would include a strong focus on agricultural impacts on environmental quality. Over the years the Groundwater Section of the P.E.I. Department of Environmental Resources has collected a significant amount of data on groundwater quality, however it is important to recognize some of the limitations to the value of this data/information, with respect to the goal of measuring environmental quality. Three areas of groundwater quality have been suggested for discussion: bacteria, nutrients and pesticides.

Assessment of Parameters

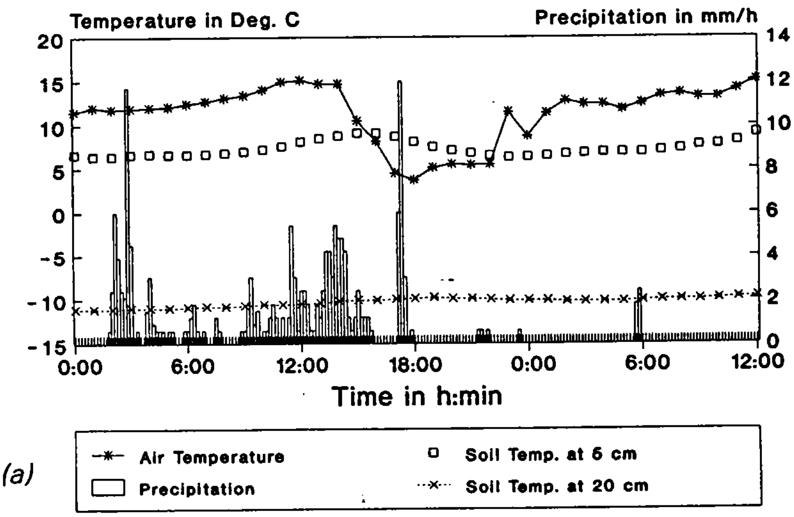
In assessing the value of any source of data/information, a number of factors must be considered, including the use the data is to be put to, the source of the data, the context within which it was collected and finally the manner in which the data was analyzed and any subsequent information or conclusions developed. Often we are faced with the prospect of using data which has been collected for one purpose and applying it to an entirely different purpose. Among other factors, the purpose for which data is collected can create a significant, but not necessarily obvious, bias in a data base. Thus a data base which accumulates results from private enquiries into groundwater quality may be somewhat biased toward "problem" wells, while a data base collected as part of a research program may be biased by the manner sample sites are selected. Each data base may accurately portray the intended sample population, but extrapolation of the results or conclusions from these data bases to other areas of enquiry should be made with caution.

In addition, the key factors responsible for the presence or concentration of a parameter must be considered in assessing the environmental significance of the parameter. In the context of this discussion, parameters that principally reflect the integrity of water supply systems are probably not as valuable as parameters that have a more direct link to the overall state of the natural environment.

The frequency and duration of any departures from "acceptable", "ambient" or "background" groundwater quality also have implications for the usefulness of the parameter as an index of environmental quality. Parameters which are rarely detected are difficult to adopt as indexes because of the statistical difficulties in establishing meaningful trends. Similarly, parameters that exhibit dramatic short term changes in concentration, perhaps

An example of a specific event is presented in Figure 9. Relevant recorded meteorological data is shown in Figure 9a (rainfall, and air and soil temperatures), and the watershed response in terms of discharge and sediment concentration is shown in Figure 9b. This event occurred shortly after snowmelt and, as may be noted, a frost layer still existed in the soil. This is the condition in which soil is most vulnerable to erosion.

(a)



(b)

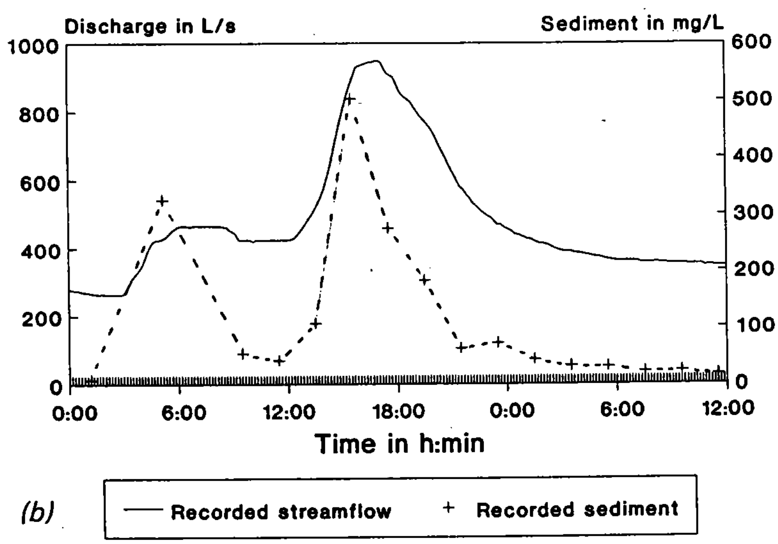


Fig. 9. Runoff event of 22 and 23 April, 1993 on Watershed 3 (Mayne's) showing: (a) meteorological data, and (b) runoff and sediment sampler data

Monthly soil loss data for one of the three erosion plots at Watershed 2 (Murphey's Plot B) is shown in Figure 10. This plot is on a slope of 5.5% and, as for all the erosion plots, has a downslope length of the standard 22.1m (Fig. 6). Three crop years (May through April) of data for a 2-year potato - barley rotation are shown.

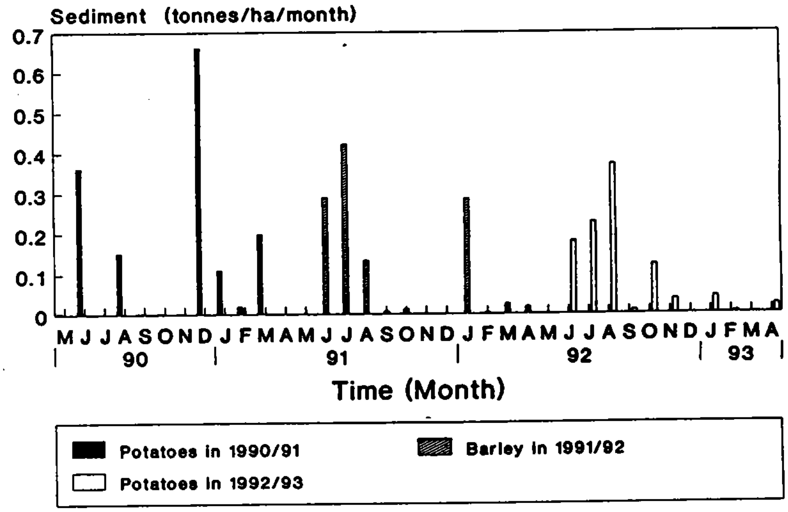


Fig. 10. Monthly soil loss from an erosion plot (Watershed 2, Murphey's, Plot "B")

Discussion

The sediment data recorded in the three watersheds evaluates the monthly and annual soil losses from the farmlands (and therefore reduced productivity) as well as the amount that will eventually deposit downstream and which may adversely affect aquatic life. The sediment in the streams is highly enriched (larger fractions of clay and silt than the original soil). The sediment from the erosion plots, on the other hand, tends to be little enriched for summer events.

It may be noted in particular from Figures 8 (watershed) and 10 (erosion plot) that most of the stream sediment occurs during the fall to spring period, whereas much of the erosion plot sediment occurs in the spring to fall period. In the latter case (erosion plot) the sediment production is dominated by a few high intensity rainfall events which occur mainly in the summer. These are of short duration and therefore only areas very close to a stream contribute sediment to the streamflow. However, large amounts of sediment can move downslope and be redeposited within fields. Erosion losses may therefore be high from individual fields, but the effect downstream is minimal.

During the period of fall to spring, sediment production occurs from snowmelt and from light, long-duration rainfall events. If the soil surface remains frozen, very little sediment is produced although streamflow may be high. The most vulnerable periods are those of substantial thaws when the top soil layers thaw but the subsurface remains frozen. Under these conditions (as illustrated in Fig. 8) infiltration is negligible and surface flow tends to build reflecting short-lived, unique events may not be well suited to tracking long term environmental trends.

Finally, where possible, it is also useful to select a parameter that has significance to other sectors of the environment. On P.E.I., groundwater and surface water resources are closely linked in terms of quantity and presumably quality. Approximately 60-70% of stream flow on the Island originates as groundwater discharge. It reasonable to speculate that at least for some conservative parameters, groundwater quality and surface water quality concerns are linked.

A simple framework, examining the frequency, environmental significance, and time frame for each of these groups of parameters, may be assist in evaluating their relative usefulness in evaluating environmental quality and also illuminate some important data gaps. Table 1 outlines such a framework.

	BACTERIA	NUTRIENTS	PESTICIDES
FREQUENCY of problems	COMMON	INFREQUENT	RARE
KEY FACTORS affecting presence or concentration	WELL CONSTRUCTION, / SERVICING	WELL CONSTRUCTION, LAND USE	WELL CONSTRUCTION, LAND USE , SPILLS?
TIME FRAME	SHORT	UNKNOWN	MODERATE?
IMPLICATIONS FOR SURFACE WATER	NONE	YES	POSSIBLE BUT NOT LIKELY, SPILLS?

Table 1. Possible framework for evaluating groundwater indicators of "Environmental Quality"

Available data

Bacterial contamination of water supplies is probably the most common groundwater concern on P.E.I., or for that matter in most jurisdictions. Bacteria are ubiquitous in the surface environment and soils, and bacterial contamination generally reflects the status of the well or water supply itself, or the influence of near by sewage disposal practices (in rarer cases, manure management practices may be the cause). Assuming the source of the problem is identified and corrected, problems are short lived. Generally, the microbiological quality of groundwater is more of a public health issue than an environmental issue.

On P.E.I., sampling for microbiological quality is initiated for the most part as a result of requests by the home owner, although some systematic surveys of public institutions and municipal water supplies are conducted. The department normally only archives this data for a period of a year because of its highly site-specific nature and short term temporal implications.

There is a considerable amout of data on nitrate concentrations in Island groundwaters. Some of this data is from routine analyses of water, conducted at a home owners request, and some from specifc research studies. Both sources of information contain some biases. While the presence of nitrate in Island groundwater is very common, values in excess of drinking water guidelines are comparitively rare.

The most comprehensive study the Department has conducted involved monthly sampling of 54 wells ditributed across the Island, over a three year period. Sample sites were selected on the basis of land use. Results show that land use in particular, along with other factors such as well depth and casing length, has a strong influence on nitrate concentrations. Temporal changes in nitrate concentrations were generally weak to absent, suggesting that NO_3-N is a relatively stable in our local groundwater environment. Unfortunately, the long term behaviour of nitrates in P.E.I. groundwater is not well understood, and we do not know how long the impact of a given source of nitrate will continue to be manifested by changes in groundwater quality. A summary of the results of this study are presented below in Table 2.

Land use categories:	Mean	Max	Min
All sites	3.98	15.5	<0.2
Row crop areas	5.57	15.0	2.1
Non-row crop areas	3.97	10.5	0.7
On-site manure storage	5.30	13.0	<0.2
Non-cropped areas (pristine areas)	1.15	5.5	<0.2
Subdivisions with on-site sewage disposal	4.25	15.5	<0.2
Subdivisions with central sewage disposal	2.64	6.5	<0.2

Table 2. Nitrate concentrations in different land use categories (mg/L NO_3-N)

Other studies have suggested a correlation between the detection of pesitcide residues and elevated nitrate concentrations. On this basis, the Department will frequently recommend an examination of nitrate concentrations in groundwater prior to a more rigorous investigation of pesticide occurrences, particularly if no specific pesticide application or spill is implicated.

In addition to the information from specific research projects, the Department has a considerable amount of data on nitrates through routine requests for water quality analyses from the public. An examination of results for samples collected in three watersheds in the Bedeque Bay area, in response to routine requests, suggest average nitrate concentration may be somewhat higher here than average values for the Island (see table 3), although there is a wide range of values for each watershed. The relatively high average nitrate concentrations seen in this data base are quite likely a reflection of the intensity of cultivation in this region.

ROUTINE ANALYSES, BEDEQUE BAY ACAP REGION:

Location	No. Samples	Mean+/-S.d.	Max	Min
COASTAL	46	4.7 +/-3.0	17	N.D.
DUNK/BRADSHAW	64	5.6 +/-2.9	14	N.D.
WILMOT	16	5.4 +/-2.4	9	0.02

SAMPLES AT OR ABOVE DRINKING WATER GUIDELINES:

	At Guideline (10 mg/L)	Above Guideline (12mg/L+)
COASTAL AREA	6.5%	4.3%
DUNK/BRADSHAW	9.4%	6.3%
WILMOT	6.3%	0.0%

Table 3. Nitrate concentrations in groundwater (mg/L NO_3-N)

Data on the occurrence of pesticide residues in groundwater come almost entirely from specific studies, with sampling sites chosen in effect to reflect a "worst case" scenario. Normally, sample sites and analytes have been selected on the basis of the use of a specific pesticide in the general vicinity of the well, within a given time frame.

The results this work suggests that most pesticides are only rarely detected in g roundwater, and where normal application practices are followed, and pesticides are detected, observed concentrations are normally an order of magnitude or more below drinking water guideline values.

It is also evident from this work that some pesticides are relatively short lived in groundwater, while others may persist for several years. In addition, pesticide inputs to the environment may tend to be more episodic than nitrates and will vary not only temporally but also in the product being used. Little work has been done on the presence or implications of pesticide metabolites in P.E.I. groundwater, further complicating attempts to characterize their fate in the environment.

While the occurrence of pesticide residues in groundwater is a good indicator selected environmental impacts of agricultural activities, the number of potential candidate parameters to measure and uncertainty/variability in establishing their use patterns makes it difficult to select a discreet compound as an index. In addition the low frequency of detection, variability of persistence, and difficulty/expense of analysis combine to make them less than ideal candidates as index parameters in groundwater.

Conclusions

Several potential groundwater contaminants have been examined with respect to their suitability as indices of environmental quality. The key considerations in this analysis are the availability and source of data, spatial and temporal aspects of the contaminant's behaviour in groundwater and the ease of selecting and analyzing appropriate analytes.

It is suggested here that the microbiological quality of groundwater primarily reflects the status of water and sewer infrastructure and may be of more importance as a public health indicator than an environmental indicator.

Pesticide residues in groundwater may, under some circumstances, be a good indicator of environmental quality. Unfortunately, their variable use pattern, low frequency of detection, analytic costs and uncertainties regarding the environmental fate of the parent compounds and their metabolites may inhibit their usefulness as a long term index of environmental quality.

From this brief review it appears that nitrate may be the most useful groundwater parameter available to measure long term environmental quality. Nitrate is nearly ubiquitous in P.E.I. groundwater, appears to behave in a conservative manner and is easily measured. Furthermore, nitrate concentrations in groundwater appear to show a clear link with land use. While there are a number of potential sources for nitrate in groundwater, with some care it may be possible to adequately account for the most significant of these. Added to these attributes, nitrate also has the benefit that it is also of significance to the health of aquatic ecosystems. This is all the more significant considering the close link between groundwater and surface water systems on P.E.I.

It is hoped that the discussion presented here will contribute to the selection of meaningful indicators of environmental quality.

THE IMPORTANCE OF BEDEQUE BAY TO THE OYSTER FISHERY ON PRINCE EDWARD ISLAND

Leaming Murphy
Resource Specialist
Fisheries and Oceans Canada
Box 1236, Charlottetown, P.E.I. C1A 7M8

SUMMARY

The oyster industry in P.E.I. is comprised of a public fishery and a private lease-hold fishery, employing about 350 fishermen. Bedeque Bay is the source of approximately 65% of the oysters produced in P.E.I. and is one of the most productive oyster areas on the eastern seaboard of North America.

Several constraints limit oyster production in Bedeque Bay. However, periodic bacterial contamination closures result in natural enhancement and actually increase the value of the fishery. Opportunities exist to further enhance the fishery because the shellfish abundance is generally much below the carrying capacity, and the market demand is higher than the available supply of product.

The federal Department of Fisheries and Oceans, the P.E.I. Department of Agriculture, Fisheries, and Forestry, and the P.E.I. Shellfish Association have been actively involved with enhancement activities on Bedeque Bay and other sites in P.E.I. Enhancement usually involves manipulation of the oyster beds by treating the limiting factors, including shell bed relays, shell bed cultivation, separation and moving shell stock, and predator (starfish) and disease control. There is potential for community involvement in these activities.

Despite these activities, production declines were recorded in 1991-93. Several factors including decreased market demand and poor natural sets contributed to the decline. Enhancement activities carried out in 1994 may not produce results for 4-5 years. In the future the shellfish industry will have to become directly involved with funding enhancement projects through levies of "in kind" work on public beds, or public financing will cease. Bedeque Bay is a valuable resource to the oyster fishing industry in P.E.I. Failure of this Bay to produce could result in more than one half of the people involved being forced out of the industry.

THE PAYOFFS AND PITFALLS OF COMMUNITY-BASED ENVIRONMENTAL DATA GATHERING: THE CASE OF THE P.E.I. WATERSHED IMPROVEMENT PROGRAM

David Cairns
Department of Environmental Resources and
Fisheries and Oceans Canada
Box 2000, Charlottetown, P.E.I. C1A 7N8

SUMMARY

The Prince Edward Island Watershed Improvement/Recreational Fisheries Development Program is a federal-provincial cooperative initiative that supports community groups seeking to conserve watersheds. Monitoring of recreational fish and fishing activity is an important part of the program. Most of the data-gathering is done by students and local people, many of whom have no scientific training. Many of those who directly supervise field personnel also have limited scientific training. In many cases, insufficient supervision by trained staff results in poor quality data. Nevertheless, some untrained workers show an aptness for data collection and perform data-collection duties very reliably with little supervision.

It is tempting for scientific organizations to consider community-based data gathering as "free", and therefore all opportunities should be taken up. Such an approach may yield very large quantities of data, but much of these data may never be used because they were not collected properly or because skilled staff do not have time to analyze them. A scientific organization seeking effective means of environmental data gathering should set a maximum ratio of unskilled to skilled workers, and decline any data-gathering opportunities that exceed this limit.

DATA BASE COMPILATION AND MANAGEMENT FOR THE BEDEQUE BAY ENVIRONMENTAL MANAGEMENT ASSOCIATION

Percy Simmonds
Urban and Rural Planning
Holland College
Summerside, P.E.I.

SUMMARY

The purpose of this report is to provide an overview of geographic information of interest to the membership of the Bedeque Bay Environmental Management Association. This information includes both digital and hard copy data sets produced by local, provincial, and federal agencies.

The production of this report was undertaken in the summer of 1994 as a component of Environmental Quality Assessment, Part II; made possible by special project funding under the ACAP (Atlantic Coastal Action Program). An agreement was reached between B.B.E.M.A. and the Urban and Rural Planning Program of Holland College in regard to the storage of data. The program agreed to make its Geographic Information Systems Lab available as the site for housing all the data collected during the course of this project. While investigating sources of information for this report, the Atlantic Coastal Zone Database Directory (ACZDD) was identified as an important reference document. This directory contains a list of data sets which pertain to the Atlantic region of Canada. It was decided that *Geographic Inventory - 94* would serve as a companion document to the ACZDD. The administrators for each of the data bases in the ACZDD were contacted either or in person. A large number of data sets were obtained during a two-day trip to Moncton and Halifax.

The GIS Lab of Holland College's Urban and Rural Planning program was identified as the logical location for the storage of this project's data. The program has the wide variety of computer software and hardware necessary for accessing and examining the project's digital information. All hard-copy data is stored in a series of binders. The lab is located in Room 220 of the College's Harbourside Centre at 298 Water Street in Summerside.

All requests for further information about the currently available 60 databases and/or their use should be made through the B.B.E.M.A. Coordinator, Brenda Penak.

COMPUTER DEMONSTRATION - IFISH DATA COMPILATION

Terry Scott and Mark Bugden
Urban and Rural Planning
Holland College
Summerside, P.E.I.

DEMONSTRATION SUMMARY

We would like to extend a warm welcome on behalf of the Urban & Rural Planning Department of Holland College. We are pleased to participate in the conference and demonstrate the benefit this data can be to our organizations. We will cue the visual displays using SPANS MAP, a desktop mapping package for SPANS GIS. Desktop mapping can provide a quick and relatively simple tool for visualizing and querying geographic information.

Eight students are enrolled in the Urban and Rural Planning Program, including two former Land Registration and Information Services employees, a commercial designer, a Resource Management technician and four-second year Urban and Rural Planning students enrolled in the GIS training course. This collection of students from all provinces in Atlantic Canada provides the course with an interesting exchange of ideas and experiences.

Since 1986, GIS has been a component of the Urban and Rural Planning curriculum, which now offers a specialized year-long training course instructed by Brian Gallant. The program has expanded into a fully-equipped GIS laboratory consisting of five SUN SPARC stations, five high-end PCs and various peripherals such as plotters, printers and a scanner. We use a range of software, such as CARIS, ARCINFO, SPANS GIS, MAPINFO and AUTOCAD.

Project origin

During the summer of 1994, the Bedeque Bay Environmental Management Association acquired and documented various data sets and sources that were relevant to the Bedeque Bay area, including the Integrated Fisheries Information System Habitat or IFISH mapping series. This series was acquired from the Department of Fisheries and Oceans in Moncton, New Brunswick, and covers the Bedeque Bay area in great detail. The map sheets contain data such as land use information, tidal zones, shoreline classification, fish habitat, watershed identification and much more.

The purpose of this project was to recreate the original 16 map sheets of the IFISH series in a digital format, through an educational process.

Project summary

The first step was to identify the study area. It consists of three windows at a scale of 1:100,000, 1:25,000 and 1:6,000. The 1:100,000 and 1:25,000 scale windows are in UTM

Projection and the 1:6,000 is in the PEI stereographic, NAD 27. As the purpose was to recreate the original map sheets, each window was left in its original projection, so the 1:6000 scale data cannot be imposed on the other windows. In future, all IFISH data will be converted to PEI stereographic to be compatible with the present PEI data.

The second step was to digitize all layers of information. Throughout this step, we continually verified the accuracy of the data by laying hard-copy plots over the original sheets on a light table. We then checked the quality of the data and made necessary edits before building the database tables for the various attributes. We finally reclassified the maps based on their attribute tables to produce hard-copy plots.

Conclusion

This project provided the GIS training course with a valuable learning experience, as well as insight into the never-ending technical issues, and ways to solve them and continue learning. The project also provided the Bedeque Bay Environmental Management Association with a data set which may be used in further studies. We look forward to an educational and beneficial future for all the partners in this cooperative site. Please feel free to view our display at any time, and direct any questions to us.

HEDGEROW CLASSIFICATION AND ASSESSMENT IN THE BEDEQUE BAY AREA

Ronald Morrison
Urban and Rural Planning
Holland College
Summerside, P.E.I.

SUMMARY

During BBEMA's environmental quality assessment there was a need for a current assessment of hedgerows in the area, and I was asked to help with data compilation and assessment. I interpreted the 1990 infrared photographs, and identified poor soil conservation practices as well as good examples of soil conservation techniques in relation to hedgerows.

The Forestry Branch of P.E.I. has been planting seedlings since the early 1950s, with a focus on reforestation, and with only large blocks of trees planted. In the last ten years, an average of almost 2,000,000 seedlings per year has been planted, mostly in large groups. Forty-five year old trees are now being cut, and land owners typically leave a row of these trees between their land and the next property as a hedgerow.

The basic definition of a hedgerow is a line of trees separating fields or parts of fields. In order to maintain some consistency, descriptive criteria were established. These qualifiers match those used in the hedgerow award program started by BBEMA. The following criteria were used in describing hedgerows in this study:

- maximum width of 80m,
- minimum length of 80m,
- bounded by field on both sides, and
- hedgerow located in the study area.

I developed classifications and ratings for hedgerows which could be assessed from aerial photographs. I selected 12 classifications including the following important categories:

- width: estimated in tree canopies widths,
- group: divided into 3 classes - softwood, hardwood, and bush,
- soil-conserving hedgerows: divided into 2 categories - water run-off prevention or wind erosion prevention,
- wildlife habitat benefit: rated according to the hedgerow's density, diversity, and location,
- percentage of field: the estimated percentage of field in the photograph, and
- energy conservation: based on the proximity of the hedgerow to buildings.

In general terms, the greatest lack of hedgerows is along the headwaters of the rivers and streams in the study area. Some specific sites with poor conservation practice are parts of the Scales Pond area, and areas south of Central Bedeque, and west of Middletown. The majority of hedgerows were only one tree-canopy in width. The average length of a hedgerow was 370 m, and the longest was 2.153 km in length. The average percentage of field perimeter classified as hedgerow was 65%.

WILDLIFE MONITORING IN PRINCE EDWARD ISLAND

Randy Dibblee
Wildlife Biologist
Fish and Wildlife Division
Prince Edward Island Department of Environmental Resources
Box 2000, Charlottetown, P.E.I. C1A 7N8

SUMMARY

Wildlife monitoring is done to establish baseline data by which future gains or losses may be measured. A requisite to managing any species is the necessity of obtaining the most fundamental of population parameters - *how many?* Monitoring on P.E.I. was considered under three categories:

- wildlife habitat
- wildlife populations, and
- user groups (people).

The advantages of complete censuses as opposed to sampling were discussed. If practical, one should strive to census the entire population. If not, then a representative sample (cross-section) of the population must be obtained as the basis for extrapolation. In all surveys, one should avoid bias and inconsistency, by reducing survey variables as much as possible. In order to achieve this, the following should be considered:

- personnel - keep the same surveyors from year to year,
- methods - use the same techniques in conducting the survey,
- timing - do annual surveys at the same time every year using such indicators as plant phenology and ice breakup to adjust calendar dates, and
- aircraft - in aerial surveys, use the same pilot and aircraft, if possible.

Under habitat monitoring, the P.E.I. wetland inventory was used as an example. The wetland inventory initially conducted in 1984 and completely updated in 1995, identified, delineated, and rated all freshwater wetlands (bogs, marshes, ponds, beaver dams, borrow pits and dugout ponds), brackish marshes, and saltmarshes greater than 0.25 hectares in area. Sand dunes were also included in the inventory. This enabled the establishment of baseline data by which future gains or losses in wetland quantity and quality could be measured.

Under population monitoring, survey and census techniques were discussed. Examples of complete population censuses included cormorant nest counts, mid-winter goose surveys, and aerial beaver surveys. The waterfowl breeding pair and brood survey was used to illustrate a random sampling survey of populations. Indirect trend data used to monitor populations were discussed and included examples such as the small game harvest survey, annual fur harvest data, and nuisance animal permits. Results of several long term wildlife surveys were presented. Direct trend data were obtained from waterfowl banding, including winter Black Duck banding, summer brood banding, and Canada Goose banding.

Monitoring of user groups included discussion of licensing systems such as hunting and trapping licenses. The primary function of a consumptive user licensing system is to serve as the basis for conducting user group surveys, such as those that measure harvest, opinions, economics, etc. Permits to keep waterfowl, destroy nuisance wildlife, possess furbearers after the season, taxidermy permits, etc. were mentioned as examples of monitoring and controlling human uses of wildlife.

ATLANTIC COASTAL ZONE INFORMATION STEERING COMMITTEE UPDATE

Mike Butler
Oceans Institute of Canada
1226 LeMarchant Street
Halifax, N.S. B3H 3P7

SUMMARY

The Atlantic Coastal Zone Information Steering Committee (ACZISC) provides a focus and forum for the development of a regional coastal zone information infrastructure, a prerequisite for integrated coastal zone management. Membership includes federal and Atlantic provinces government, private sector, and academic community representatives.

The ACZISC develops annual workplans. Current major programs being undertaken include:

Atlantic Coastal Zone Database Directory - This database lists and describes databases of relevance to the coastal zone of Atlantic Canada. The majority of these reside within government departments. Version 2 of the directory (April 1994) contains 612 descriptions. The directories have been used by various interest groups for public and private sector applications.

Coastal Information Technology Architecture Plan - The purpose of this plan is to develop a process and protocols that will promote the exchange of data and the inter-operability of the numerous coastal zone information management projects in the region. The development of the plan is ongoing.

East Coast of North America Strategic Assessment Project - This is an 18-month pilot project aimed at demonstrating the capability and value of strategic assessment, both for managing environmental information, and for improving the decision-making process for coastal and marine resource management. This collaborative project between the U.S.A. and Canada began in 1994. Five case study teams are investigating Inshore Coastal Resources, Offshore Resources, Data Access and Distribution, Product Development, and Strategic Environmental Information Database. If successful, the pilot project will be expanded into a five-year program.

Northumberland Strait Coastal Information Management System Report - This project coordinates a number of compatible projects in one geographic area, capitalizes on activities associated with construction of the Fixed Link, and provides an opportunity for the private sector to showcase their coastal zone information management expertise and technologies, particularly with reference to export markets. Several collaborative projects have been identified.

Regional Coastal Mapping Standards - Ongoing workshops recommending mapping standards serve this project.

Coastal Zone Canada '94 Conference - This conference was held in Halifax in September 1994. The theme was *"Cooperation in the Coastal Zone"*, and the program included workshops and round-tables, in addition to technical sessions.

ENVIRONMENTAL MONITORING IN PRINCE EDWARD ISLAND: WHAT ARE WE MISSING?

Daniel Schulman
Environmental Technology
Holland College
Summerside, P.E.I.

Although the title of my talk suggests that I am going to offer a comprehensive catalogue of factors we are not monitoring, I do not pretend to have that kind of knowledge. Instead, I offer some process-related comments intended to ensure that if we undertake coordinated monitoring, we are sure we are getting the best monitoring for our efforts. I suggest that we need a framework on which to base our monitoring and a process to ensure that framework is being comprehensively handled.

The fiscal realities of the times make the prospect of integrating the monitoring efforts of different agencies, institutions and groups more timely than ever. Even such non-traditional partnerships as this community college and the P.E.I. Environment Department, with their widely different objectives, will become beneficial antidotes to the forces of rationalisation and down-sizing. The ESC concept is therefore, a potentially exciting and timely initiative.

One of the big challenges in merging the monitoring efforts of different agencies, institutions and groups will be the reconciliation of the different objectives of each stakeholder. For, as we all know, the objectives of monitoring very often have profound impact on what we monitor and how we design and conduct the monitoring program.

If the establishment of an ESC node in the Bedeque Bay area is pursued, the widely disparate objectives of the various partners will provide an exciting opportunity to take a 'big picture' look at what is currently being monitored. The steering committee will need to consider the full catalogue of factors being monitored in the Bedeque Bay area (everything we have heard about today, from soil erosion to bird migration to groundwater contamination) and ask itself the following question:

> *"Are we obtaining a full understanding of the health of the Bedeque Bay agro-marine ecosystem from the things we are currently monitoring or are there some critical factors we are missing?"*

Of course, there will never be the resources available to monitor everything. So, ultimately, we will have to economize on what it is we monitor. There is much talk today of developing 'indicators' of environmental or ecological integrity. But, for the most part, that talk seems to be highly abstract. We need to move that talk to the practical. I will come back to the business of indicators, but first we have to discuss the issue of monitoring objectives.

As we all know, deciding what we monitor depends on the objectives of our monitoring. The days of monitoring for the sake of monitoring are certainly over. Environmental monitoring can be undertaken for various reasons (Table 1).

1. to help us deal with issues (acid rain, climate change, irrigation..)
2. to assess the absence or presence and/or level of contamination of environmental media (air, water, soil,...)
3. to assess the state/health of particular resources (forests, fish, groundwater...)
4. to assess ecosystem integrity (structures and function relative to 'pristine' state)

Table 1. Reasons for undertaking environmental monitoring

Different partners in the monitoring effort will identify with different objectives. For example, the P.E.I. Department of Agriculture, Forestry and Fisheries will identify mostly with objective number 3 in the above table, while the provincial and federal environment departments will identify more with objectives 1, 2 and 4.

If we are to establish an ESC EMAN node in the Bedeque Bay area with its challenges of coexisting intensive agriculture, recreational fishery and estuarine habitat, what do we form as the objective of our monitoring which can be agreed upon by all partners? Given that resource extraction is so intense in this area, it would seem most reasonable to base our coordinated monitoring effort on the principles of sustainable development. For if we cannot work with our soils, forests, estuaries and marine systems sustainably, we are invariably destined for the same predicament in which the outports of Newfoundland find themselves today. We in Atlantic Canada should know, better than anyone, the perils of postponing a sincere commitment to sustainable development.

First, we need to decide what sustainable development is, and then develop indicators to monitor our progress towards that end. This idea of monitoring our progress is, in fact, provincial government policy through the recently released Renewed Conservation Strategy for Prince Edward Island, *"Stewardship and Sustainability"*, agreed to by all provincial departments in 1994.

These two challenges; an agreed-upon definition of sustainable development and an agreed-upon set of indicators to monitor movement towards or away from the goal of sustainable development are very large indeed. As we all know, once we move beyond the rhetoric, there is much disagreement about what sustainable development is, and there are probably as many definitions of the principle as there are people in this room.

The 1993 Environmental Scan published by CCME offers a list of three important conditions which should form the reasonable basis of any sustainable future (Table 2).

Most people in this room would probably not have a problem with these three conditions, although I could see some debate over the second condition. But we would not have to move very far from the broad rhetoric of these conditions to enter heated debate. For example, condition three holds that pollution and waste generation rates should not exceed assimilation rates. We could probably spend all day debating what is meant by assimilation rates and how

1. The rates of renewable natural resource harvesting must not exceed the rates at which those natural resources are generated.
2. The rates of non-renewable resource extraction must not exceed the rates at which renewable resource substitutes are developed.
3. The rates of pollution and waste generation must not exceed the rates at which they can be assimilated by the environment.

Table 2. Three conditions which must be met to achieve sustainability.
from: *Canadian Council of Ministers of the Environment (1993).*

we would determine them. Even if we expanded this to specify "assimilation without detrimental effect", we would then find ourselves debating what is and is not "detrimental".

Many of us who were excited when sustainable development hit the mainstream are now disillusioned at how the term has become embroiled in rhetoric, with little commitment to move to concrete measurable indices and deliverable objectives. This must occur and I would suggest that if the ESC steering committee for a Bedeque Bay node embraces sustainable development as a basis on which to develop a monitoring program, the first challenge will be to define sustainable development at a concrete level which reaches well beyond rhetoric.

We cannot monitor everything, so we are always faced, explicitly or implicitly with the challenge of identifying indicators. There is much talk about indicators of ecosystem health and environmental quality these days. The U.S. Intergovernmental Task Force on Monitoring Water Quality (1993) defined an indicator as:

> *"...a measurable feature which singly or in combination provides managerially and scientifically useful evidence of ecosystem quality, or reliable evidence of trends in quality."*

To assist in the practical development of indicators, the Council of Great Lakes Research Managers (1991) identified a set of selection criteria to assist in the establishment of managerially and scientifically useful indicators of ecosystem health. It is not intended that indicators satisfy all of these criteria. The list is offered merely as a guideline (Table 3).

Furthermore, this list was developed with the ecosystem health of the Great Lakes in mind. It may well be that it is not fully useful for the Bedeque Bay situation. It may also be that if movement towards or away from agreed upon sustainable development objectives are the basis for our monitoring, these criteria might not fit the bill. I offer it merely as an example of criteria against which indicators could be developed.

Biologically relevant	important in maintaining a balanced biological community
Socially relevant	of obvious value to and observable by shareholders or predictive of a measure that is
Sensitive	to stressors without an all-or-none response or extreme natural variability
Broadly applicable	to many stressors and sites
Diagnostic	of the particular stressor causing the problem
Measurable	capable of being operationally defined and measured, using a standard procedure with documented performance and low measurement error
Interpretable	capable of distinguishing acceptable from unacceptable conditions in a scientifically and legally defensible way
Cost-Effective	inexpensive to measure, providing the maximum amount of information per unit effort
Integrative	summarising information from many unmeasured indicators
Available historical data	to define nominative variability, trends and possibly acceptable and unacceptable conditions
Anticipatory	capable of providing an indication of degradation before serious harm has occurred
Nondestructive	of the ecosystem
Continuity	in measurement over time
Appropriate Scale	for the management problem being addressed
Not redundant with other indicators	providing unique information
Timely	providing information quickly enough to initiate effective management action before unacceptable damage has occurred

Table 4. Selection criteria for ecosystem health indicators.
from: *Council of Great Lakes Research Managers (1991)*

Of utmost importance if we are to develop meaningful indicators of our success or failure at meeting sustainable development objectives, is that we not be bound by our training, our expertise, and the things with which we feel comfortable.

As an example of what I am talking about, lets look at the matter of pesticide use. If we were to sit around the table unconstrained by our personal biases and experience and objectively brainstorm a list of factors which we would want to monitor or evaluate to obtain a full picture of the environmental effects of pesticide use in the Bedeque Bay area, we might come up with a list that looks something like the following (Table 4).

I. Potential Environmental Effects		
- Aquatic	- Lethal	- Acute
		- Chronic
	- Sublethal	- Acute
		- Chronic
- Terrestrial (Above Ground)		
	- Lethal	- Acute
		- Chronic
	- Sublethal	- Acute
		- Chronic
- Terrestrial (in Soil)		
	- Residue ('Contamination')	
	- Organisms	- Lethal
		- Sublethal
2. Potential Human Effects		
- Occupational	- Acute	-Lethal
		- Sublethal
	- Chronic	- Lethal
		- Sublethal
- Environmental	- Food	- Residue ('Contamination')
		- Quality
	- Groundwater	- Point Source ('spills')
		- Normal Use
	- Aerial Drift	

Table 4. Potential environmental effects of pesticide use.

This list is by no means complete. Certainly against a well defined and concrete set of sustainable development objectives, this list of environmental impacts of pesticide use to be monitored might change from that which I have presented. But, nevertheless, the above list is offered to make a point.

It is interesting to go through the list to divide the potential effects into three categories:

- those being monitored, or for which data exists which give a good assessment of the impact.
- those being monitored, or for which data exists which give a partial assessment of the impact.

- those not being monitored, or for which insufficient data exists to give an assessment of the impact.

It would be interesting to put the combined knowledge in this room together to answer these questions. But I couldn't call all of you up before the meeting so I took a very quick stab at the list based on my limited knowledge. And I conclude that of the 20 potential effects listed, we probably are undertaking monitoring or have data to give us a good assessment of three potential effects (acute lethal occupational human exposure effects, food residue levels and groundwater contamination from normal use) and a partial assessment of an additional 4 potential effects (acute lethal aquatic environmental effects, acute lethal above ground terrestrial environmental effects, chronic lethal above ground terrestrial environmental effects and soil residue levels).

I would suggest that the other 13 potential effects listed are not being monitored in any meaningful way because those of us involved in monitoring are either not trained to consider these potential effects or we are not comfortable with the technical difficulties involved in monitoring them. Nevertheless, it should be clear that without monitoring them in some way, we are not fully understanding the potential effects of pesticide use.

Another important consideration with regard to indicator selection is the matter of how an indicator evolves to be viewed by many of us involved in monitoring. We must always remember that an indicator is only a proxy, a signal of the existence of a problem. In other words, it is a symptom, not the problem. Yet, we often become so used to dealing with the indicator, we lose sight of this in our management responses to indicator trends and we treat the indicator as the variable that needs fixing.

Consider the problem of soil erosion. Traditionally, we have used sediment loads in streams as an indicator of soil-related problems upstream. If we confuse stream sediment load as the indicator with stream sediment load as the problem, our management response to increased stream sediment load is to minimise stream sediment load and its impact through activities which include in-stream enhancement and on-land engineering to reduce the physical movement of soil off the land. While these are both very important and valuable management activities, they do not largely deal with the degradation of soil quality which is the ultimate problem that needs fixing. Recognising that it is probably human nature to gradually grow comfortable with indicators as 'the problem', it is very important that the indicators we choose are closely linked with the problem and not the symptoms.

In conclusion, I offer two suggestions for future environmental monitoring in the Bedeque Bay area:

1. Environmental objectives must be established against which indicators will be developed which are agreed to by all partners. Sustainable development would appear to be a logical basis for those objectives but moving beyond rhetoric to mutually agreed upon concrete sustainable development deliverables is a big challenge.

2. A meaningful suite of indicators must be established which, over time, will help us understand how human interaction with the Bedeque Bay area agro-marine ecosystem

is serving or detracting from the goals of sustainable development. The big challenge here will be to avoid restricting ourselves to monitoring only the things we are used to and comfortable with monitoring. If we have to monitor mites, earthworms, soil structure, sublethal effects on aquatic organisms and human community epidemiology, then lets do it!

References

Canadian Council of Ministers of the Environment. 1993. Environmental Scan. Evaluating Our Progress Toward Sustainable Development. CCME-SPC-74E

Council of Great Lakes Research Managers. 1991. A Proposed Framework for Developing Indicators of Ecosystem Health for the Great Lakes Region. International Joint Commission. Windsor, Ontario.

Prince Edward Island Department of Environmental Resources. 1994. Stewardship and Sustainability. A Renewed Conservation Strategy for Prince Edward Island. Charlottetown, P.E.I.

United States Intergovernmental Task Force on Monitoring Water Quality. 1993. Work Products of the Intergovernmental Task Force on Monitoring Water Quality. Environmental Indicators Task Group.

Appendix 1: WORKSHOP AGENDA

Ecological Monitoring and Research In Atlantic Canada: A Focus on Agricultural Impacts in Prince Edward Island

---

22-24 February 1995
Loyalist Inn, Summerside, Prince Edward Island

Hosted by:
Bedeque Bay Environmental Management Association - Summerside, PEI
Environmental Training Centre, Holland College, Summerside, PEI
and
Environment Canada - Atlantic Region

Wednesday, 22 February

Focus: The annual meeting of the Atlantic Region Ecological Science Cooperative Sites

10:00	Welcome and Introduction	Richard Elliot
10:20	Up-dates on Activities at Atlantic ESC Nodes	
	Kejimkujik, NS	Cliff Drysdale
	Fundy, NB	Doug Clay/Graham Forbes
	Passamaqoddy/St. Andrew's, NB	John Alan/Wilf Pilgrim
	Avalon/TERRAMON, Nfld.	Murray Colbo
11:40	Up-dates from Environment Canada	
	The National Perspective	Patricia Roberts-Pichette
	The Atlantic Region	Richard Elliot
12:00	LUNCH	
1:30	Application of results of the national EMAN meeting in the Atlantic Region	Chair: Richard Elliot
3:00	COFFEE	
3:15	Communication and data links	Chair: Tom Clair
	Database of research and monitoring activities	
	Options for news and information exchange	
	Options for exchange of scientific information	

Meeting of the Atlantic Region ESC Steering Committee: participants are invited to attend as observers

7:00 Agenda items: Initiatives to develop new ESC nodes
- agricultural impacts in PEI
- impacts on marine systems of the Northwest Atlantic

Contributions to the Annual Report
Sources and allocation of 1995-96 funding
Implementation of communication and data links
Other business

Thursday, 23 February

Focus: Historical, Current and Future Monitoring in the Bedeque Bay Area

MORNING SESSION: 9:00 AM - Noon Chairperson: Steve Moore

Introductory Remarks - The Ecological Monitoring and Assessment Network (EMAN) - Richard Elliot, Canadian Wildlife Service, Environment Canada and Patricia Roberts-Pichette, Environmental Monitoring Coordinating Office, Ottawa

Welcome - Barry Wicken, P.E.I. Minister of the Environment

Introduction and welcome - *Francis Tang, Holland College*

Citizen participation in ecological scoience - the Atlantic Coastal Action Program - *Jim Ellsworth, Environment Canada*

The Bedeque Bay Management Association's vision and strategic plan - *Brenda Penak, BBEMA*

Historical land use changes in the Bedeque Bay area of Prince Edward Island - *William M. Glen, Dept. Agriculture Fisheries & Food*

Crop residue management and monitoring of P.E.I. potatoe production - *Ron DeHaan, Dept. Agriculture Fisheries & Food*

BREAK: 10:30 - 11:00 "Tool Book" Application Computer Demonstration - *Geoff Howell, Environment Canada*

Sediment Monitoring in a Bedeque Bay Watershed - *Jack R. Burney, Technical University of Nova Scotia, and Linnel M. Edwards - Agriculture and Agri-food Canada*

The Canada - P.E.I. water quality agreement and nutrient levels in the Bedeque Bay watershed - Bruce Raymond, Dept. Environmental Resources

Groundwater monitoring: nutrients, bacteria and pesticides - *George Somers, Dept. Environmental Resources*

LUNCH: 12:00 - 1:00

AFTERNOON SESSION: 1:10-4:30 Chairperson: Steve Moore

The importance of Bedeque Bay to the oyster fishery on Prince Edward Island - *Leaming Murphy, Fisheries and Oceans Canada*

The pay-offs and pitfalls of community-based environmental data gathering: the case of the P.E.I. watershed improvement program - *David Cairns, Dept. Environmental Resources and Fisheries and Oceans Canada*

Data base compilation and manmagement for the Bedeque Bay Environmental Management Association - *Percy Simmonds, Holland College*

Computer demonstration of IFISH data compliation - *Terry Scott and Mark Bugden, Holland College*

BREAK: 2:45-3:15 POSTER AND DISPLAY REVIEW

Hedgerow classification and assessment in the Bedeque Bay area - *Ronald Morison, Holland College*

Wildlife monitoring in Prince Edward Island - *Randy Diblee, Dept. Environmental Resources*

Atlantic Coastal Zone Information Steering Committee update - *Mike Butler, ACZISC*

Environmental monitoring in Prince Edward Island: what are we missing? - *Daniel Shulman, Holland College*

Friday, 24 February

Focus: Development of the ecological focus and structure of an ESC node to address impacts of agricultural activities in PEI

9:00	Objectives of today's session	Richard Elliot
9:15	Current research activities and future direction: A summary of yesterday's presentations	Daniel Shulman
9:45	What, Why, Where? Discussion of the ecological focus of the proposed node	Chair: Richard Elliot
10:45	COFFEE	
11:00	Who? How? Discussion of key participants and structure of the node	Chair: Richard Elliot
12:00	Recommendations to Environment Canada	All
12:30	End of formal workshop	

Appendix 2: WORKSHOP PARTICIPANTS

Dr. Joe Arbour
Environmental Conservation Branch
Environment Canada
45 Alderney Drive
Dartmouth, NS
B2Y 2N6
tel: (902) 426-1701
fax: (902) 426-4457
email: arbourj@ns.doe.ca

Hal Bailey
Environment Conservation Branch
Environment Canada
Environment Science Centre
P.O. Box 23005
Moncton, N.B.
E1A 2S6
tel: (506) 851-6606
fax: (506) 851-6608

Darren Blakney
298 Water Street
Summerside, P.E.I.
C1N 1B8

Dr. Sherman Boates
Wildlife Division, Dept. Natural Resources
Nova Scotia Government
136 Exhibition Street
Kentville, N.S.
B4N 4E5
tel: (902) 679-6091
fax: (902) 679-6176
email: boates@acadiau.ca

Mark Bugden
P.O. Box 66
Portugal Cove, NF
A0A 3K0

Dr. Jack Burney
Department of Agricultural Engineering
Technical University of Nova Scotia
P.O. Box 1000
Halifax, N.S.
B3J 2X4
tel: (902) 420-7627
fax: (902) 423-2423

Dr. Michael D.B. Burt
Huntsman Marine Science Centre
Brandy Cove Road
St. Andrews,
N.B. E0G 2X0
tel: (506) 529-1200
fax: (506) 529-1212

Dr. Mike Butler
Atlantic Coastal Zone Information
Steering Committee
Oceans Institute of Canada
1226 Le Marchant Street
Halifax, N.S.
B3H 3P7

tel: (902) 494-1977
fax: (902) 494-1334
mbutler@ac.dal.ca

Dr. David Cairns
P.E.I. Dept. of Environmental Resources
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7M8

tel: (902) 368-6098
fax: (902) 368-5830
email: dcairns@peinet.pe.ca

Bill Campbell
East Prince Community Development Centre
263 Harbour Drive
Summerside, P.E.I.
C1N 5P1

tel: (902) 888-3793

Pat Chan
Environmental Consultant
P.O. Box 1131
Cornwall, P.E.I.
C0A 1H0

tel. (902) 628-2286
e-mail: pchan@bud.peinet.pe.ca

Genevieve Chicoine
School for Resource and Environmental Studies
Dalhousie University
1312 Robie Street
Halifax, N.S.
B3H 3E2

Dr. Tom Clair
Canadian Wildlife Service
Environmental Conservation Branch
Environment Canada
P.O. Box 1590
Sackville, N.B.
E0A 3C0

tel: (506) 364-5070
fax: (506) 364-5062
email: clairt@ns.doe.ca

Dr. Murray Colbo
School of Graduate Studies
Memorial University
St. John's NF
A1B 3X5

tel: (709) 737-2479
fax: (709) 737-2589

Dorothy E. Collins
Kensington, RR#2
Seaview, P.E.I.
C0B 1M0

Donna Crossland
Canadian Parks Service, Dept. Canadian Heritage
2 Palmers Lane
Charlottetown, P.E.I.
C1A 5V6
tel: (902) 672-6350
fax: (902) 672-6370

Rosemary Curley
Department of the Environment
Fish and Wildlife Division
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7N8
tel: (902) 368-4807

Dr. Jessie Davies
Environment and Sustainable Development
Research Centre
University of New Brunswick
P.O. Box 4400
Fredericton, NB
E3B 5A3
tel: (506) 453-4886
fax: (506) 453-4883
email: enviro@unb.ca

Ron DeHaan
Department of Agriculture, Fisheries and Forestry
P.O. Box 1600
Charlottetown, P.E.I.
C1A 7N3
tel: (902) 368-5642
email: rdehaan@peinet.pe.ca

Randy Dibblee
P.E.I. Department of the Environment
Fish and Wildlife Division
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7M8
tel: (902) 368-4666

Dr. Don Diebel
Ocean Sciences Centre
Memorial University
St. John's NF
A1C 5S7
tel: (709) 737-3708
fax: (709) 737-3220

Cliff Drysdale
Kejimkujik National Park
P.O. Box 236
Maitland Bridge
Annapolis Co., N.S.
B0T 1B0
tel: (902) 682-2770
fax: (902) 682-3367

Tom Duffy
Fish and Wildlife Division
Department of the Environmental Resources
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7N8

tel: (902) 368-4807

Dr. Linnell Edwards
Agriculture Canada
Research Station
P.O. Box 1210
Charlottetown, P.E.I.
C1A 7M8

tel: (902) 566-6871
fax: (902) 566-6821
email: edwards@em.agr.ca

Dr. Richard D. Elliot
Canadian Wildlife Service
Environmental Conservation Branch
Environment Canada
P.O. Box 1590
Sackville, N.B.
E0A 3C0

tel: (506) 364-5014
fax: (506) 364-5062
email: elliotr@ns.doe.ca

Jim Ellsworth
Environmental Conservation Branch
Environment Canada
45 Alderney Drive
Dartmouth, N.S.
B2Y 2N6

tel: (902) 426-2131
fax: (902) 426-4457
email: ellsworthj@ns.doe.ca

Bill Ernst
Environmental Protection Branch
Environment Canada
45 Alderney Drive
Dartmouth, N.S.
B2Y 2N6

tel: (902) 426-5048
fax: (902) 426-4457
email: ernstw@ns.doe.ca

Phil Ferraro
Institute for Bioregional Studies
449 University Avenue, Suite 126
Charlottetown, P.E.I.
C1A 8K3

tel: (902) 892-9578

Brian Gallant
School of Technology
Renewable Resources Dept.
Holland College
Harbourside Centre, 298 Water Street
Summerside, P.E.I.
C1N 1B8

tel: (902) 888-6470
fax: (902) 888-6401

Nev Garrity
Canadian Wildlife Service
Environmental Conservation Branch
Environment Canada
P.O. Box 1590
Sackville, NB
E0A 3C0

tel: (506) 364-5030
fax: (506) 364-5062
email: garrityn@ns.doe.ca

Bill Glenn
Department of Agriculture, Fisheries and Forestry
Forestry Division
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7M8

tel: (902) 368-4703

Alton Glenn
School of Technology
Renewable Resources Dept.
Holland College
Harbourside Centre, 298 Water Street
Summerside, P.E.I.
C1N 1B8

tel: (902) 888-6470
fax: (902) 888-6401

Larry Hildebrand
Environmental Protection Branch
Environment Canada
45 Alderney Drive
Dartmouth, N.S.
B2Y 2N6

tel: (902) 426-9632
fax: (902) 426-8373
email: hildebrandl@ns.doe.ca

Shawn Hill
Department of Environmental Resources
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7M8

tel: (902) 887-3014

Geoff Howell
Environmental Conservation Branch
Environment Canada
45 Alderney Drive
Dartmouth, N.S.
B2Y 2N6

tel: (902) 426-4196
fax: (902) 426-4457
email: howellg@ns.doe.ca

Gary Julien
Environmental Protection Branch
Environment Canada
45 Alderney Drive
Dartmouth, N.S. B
2Y 2N6

tel: (902) 426-4486
fax: (902) 426-4457

Dr. Joseph Kerekes
Canadian Wildlife Service
Environmental Conservation Branch
Environment Canada
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, NS
B2Y 4A2

tel: (902) 426-6356
fax: (902) 426-7209
email: kerekesj@ns.doe.ca

Laurie Ann Knightley
Health and Community Services Agency
Heart Health Division
205 Linden Avenue
Summerside, P.E.I.
C1N 2K4

tel: (902) 888-8159

Claudette Leblanc
Atlantic Coastal Zone Information
Steering Committee
Oceans Institute of Canada
1226 Le Marchant St.
Halifax, N.S.
B3H 3P7

tel:(902) 494-1977
fax: (902) 494-1334

Peter Lewis
Atmospheric Environment Branch
Environment Canada
97 Queen Street
Charlottetown, P.E.I.
C1A 4A9

tel: (902) 566-7042
fax: (902) 566-7279

Graham MacKay
P.O. Box 1384
Summerside, P.E.I.
C1N 4K2

Colin Mckinnon
Canadian Wildlife Service
Environmental Conservation Branch
Environment Canada
P.O. Box 1590
Sackville, N.B.
E0A 3C0

tel: (506) 364-5039
fax: (506) 364-5062
email: mckinnonc@ns.doe.ca

Darlene MacQuarrie
Bonshaw, RR#1
P.E.I.
C0A 1C0

Steve Moore
School of Resource Technology
Renewable Resources Dept.
Holland College
Harbourside Centre, 298 Water Street
Summerside,
P.E.I. C1N 1B8
tel: (902) 888-6470
fax: (902) 888-6401

Ron Morrison
Urban and Rural Planning
Holland College
P.O. Box 198
Summerside, P.E.I.
C1N 4Y8
tel: (902) 888-6461
fax: (902) 888-6401

Leaming Murphy
Department of Fisheries and Oceans
P.O. Box 1236
Charlottetown, P.E.I.
C1A 7M8
tel: (902) 566-7839
fax: (902) 566-7848

Dr. Ory Page
Bedeque Bay Environmental Management Association
205 Prince Street
Summerside, P.E.I.
C1N 1L3
tel: (902) 436-7090
fax: (902) 658-2058

Brenda Penak
Bedeque Bay Environmental Management Association
205 Prince Street
Summerside, P.E.I.
C1N 1L3
tel: (902) 436-7090
fax: (902) 658-2058
email: bpenak@peinet.pe.ca

Dr. Tom Pollock
Environmental Conservation Branch
Environment Canada
P.O. Box 23005
Moncton, N.B.
E1A 2S6
tel: (506) 851-3836
fax: (506) 851-6608
email: pollockt@ns.doe.ca

Bruce Raymond
Department of Environmental Resources
Water Resources Division
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7M8
tel: (902) 368-5054
email: bgraymond@gov.pe.ca

Dr. Patricia Roberts-Pichette
Ecological Monitoring Coordinating Office
Environment Canada
867 Lakeshore Road
Burlington, ON
L7R 4A6
tel: (905) 336-4410
fax: (905) 336-5989

Daniel Schulman
School of Resource Technology
Renewable Resources Dept.
Holland College
Harbourside Centre, 298 Water Street
Summerside, P.E.I.
C1N 1B8
tel: (902) 888-6457
fax: (902) 888-6401
email: schulman@harbour.hc.hollandc.pe.ca

Terry Scott
Cornwall, RR#4
P.E.I.
C0A 1H0

Susan Shaw
Southeast Environmental Association
Box 1500
Montague, P.E.I.
C0A 1R0
tel: (902) 838-2992

Percy Simmonds
School of Technology
Renewable Resources Dept.
Harbourside Centre, 298 Water Street
Summerside, P.E.I.
C1N 1B8
tel: (902) 838-2992
fax: (902) 888-6401

Matt Smith
Department of Agriculture, Fisheries and Forestry
Fisheries and Aquaculture Division
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7M8
tel: (902) 368-5242

George Somers
Water Resources Division
Department of Environmental Resources
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7M8
tel: (902) 368-5046

Trevor Swerdfager
Canadian Wildlife Service
Biodiversity Programme Development
Environmental Conservation Branch
Environment Canada
P.O. Box 1590
Sackville, NB
E0A 3C0

tel: (506) 364-5047
fax: (506) 364-5062
email: swerdfagert@.ns.doe.ca

Francis Tang
Head, Renewable Resources Dept.
Holland College
Harbourside Centre, 298 Water Street
Summerside, P.E.I.
C1N 1B8

tel: (902) 888-6457
fax: (902) 888-6401

Dr. Phil Taylor
Atlantic Cooperative Wildlife Ecology Research Network
Acadia University
Wolfville, NS
B0P 1X0

tel: (902) 542-2200 ext. 1287
fax: (902) 542-3466
e-mail: philip.taylor@acadiau.ca

Gwen Vessey
Department of Agriculture, Fisheries and Forestry
P.O. Box 1600
Charlottetown, P.E.I.
C1A 7N3

tel: (902) 368-5638

Jackie Waddell
Island Nature Trust
P.O. Box 265
Charlottetown, P.E.I.
C1A 7K4

tel: (902) 892-7513
fax: (902) 628-6331

Dave Wallace
RR#2 Linkletter
Summerside, P.E.I.

Brad Wonnacott
#2 - 44 Victory Ave.
Charlottetown, P.E.I.
C1A 5G1

Appendix 2: MEMBERS OF THE INITIAL PEI ESC STEERING COMMITTEE

Co-Chairs

Dr. Jim Bellamy
Atlantic Veterinary College
University of Prince Edward Island
Charlottetown, PEI
tel. (902) 566-0667
email: bellamy@upei.ca

Daniel Schulman
School of Resource Technology
Renewable Resources Dept.
Holland College
Harbourside Centre, 298 Water Street
Summerside, P.E.I.
C1N 1B8
tel: (902) 888-6457
fax: (902) 888-6401
email: schulman@harbour.hc.hollandc.pe.ca

Members

Dr. Joe Arbour
Environmental Conservation Branch
Environment Canada
45 Alderney Drive
Dartmouth, NS
B2Y 2N6
tel: (902) 426-1701
fax: (902) 426-4457
email: arbourj@ns.doe.ca

Dr. David Cairns
P.E.I. Dept. of Environmental Resources
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7M8
tel: (902) 368-6098
fax: (902) 368-5830
email: dcairns@peinet.pe.ca

Dr. Pierre-Yves D'Aoust
Atlantic Veterinary College
University of Prince Edward Island
Charlottetown, PEI
tel. (902) 566-0667
email: daoust@upei.ca

Ron DeHaan
Department of Agriculture, Fisheries and Forestry
P.O. Box 1600
Charlottetown, P.E.I.
C1A 7N3
tel: (902) 368-5642
email: rdehaan@peinet.pe.ca

Dr. Linnell Edwards
Agriculture Canada
Research Station
P.O. Box 1210
Charlottetown, P.E.I.
C1A 7M8
tel: (902) 566-6871
fax: (902) 566-6821
email: edwards@em.agr.ca

Dr. Richard D. Elliot
Canadian Wildlife Service
Environmental Conservation Branch
Environment Canada
P.O. Box 1590
Sackville, N.B.
E0A 3C0

tel: (506) 364-5014
fax: (506) 364-5062
email: elliotr@ns.doe.ca

John Keefe
Environmental Protection Branch
Environment Canada
97 Queen Street
Charlottetown, P.E.I.
C1A 4A9

tel: (902) 566-7042
fax: (902) 566-7279
jkeefe@cpdar.am.doe.ca

Brenda Penak
Bedeque Bay Environmental Management Association
205 Prince Street
Summerside, P.E.I.
C1N 1

tel: (902) 436-7090
fax: (902) 658-2058
email: bpenak@peinet.pe.ca

Bruce Raymond
Department of Environmental Resources
Water Resources Division
P.O. Box 2000
Charlottetown, P.E.I.
C1A 7M8

tel: (902) 368-5054
email: bgraymond@gov.pe.ca