

CLIMATE CHANGE: Impacts, Adaptation and Networking

Proceedings of a Workshop

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by

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Foreword

Natural Resources Canada, Environment Canada, and the Climate Change Action Fund have sponsored a series of workshops across Canada as the first step in the planning of a National Climate Change Impacts and Adaptation Research Network. This Network is expected to be largely made up of a series of regional centres and networks of research scientists. On 18 May 2000 a workshop was held at Mount Allison University, Sackville, New Brunswick to alert the research community in the Atlantic provinces that this network was being planned and to determine the level of interest in the Atlantic provinces in establishing a regional climate change impacts and adaptation network that would be part of a similar national network. The workshop was attended by 53 researchers, research managers and other interested parties from the federal and provincial governments, universities, non-governmental organizations and the private sector. After several background papers were presented, the workshop broke up into three discussion groups, each of which addressed four questions pertinent to the aims of the workshop. This report is a summary of the workshop proceedings.

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1. Workshop Opening

George Finney, Regional Director, Environmental Conservation, Environment Canada-Atlantic Region, welcomed the participants to the workshop and stated that it was one of a series of regional workshops whose purpose is:

1. To alert the research community, governments, resource managers and other stakeholders that a national climate change impacts and adaptation research network is being planned.
2. To determine the level of interest in Atlantic Canada of establishing a regional climate change impacts and adaptation research network that would be part of a similar national network.

As would be brought out later in the workshop, the Atlantic region, whose economy is largely resource-based, is especially sensitive to climate change. Although efforts are being made through the Kyoto Protocol to reduce the effects of climate change, some impacts of climate change may be inevitable and we may need to be prepared to adapt to them.

At the same time, researchers in the region are scattered geographically and suffer from a lack of funding. There is also a need for the research to be applicable to public policy. A regional network would be science-based but would hopefully reach out to those beyond the scientific community. In closing, Dr. Finney wished the participants success and said that he looked forward to learning the level of interest among various regional institutions and universities in a Atlantic Canada Climate Change Impacts and Adaptation Research Network.

Gary Lines, the workshop convenor, then stated that the workshop was divided into two main parts:

- a) As a background to the group discussions in the afternoon, several presentations would be made in the morning about:
 - i. the present status of funding for climate change projects, and organizational changes within Environment Canada related to climate change;
 - ii. the future of climate change impacts and adaptation research in Canada;
 - iii. the provision of climate change scenarios for impact and adaptation research in Canada;
 - iv. a concept paper about the proposed Atlantic Environmental Research Network and;
 - v. impacts of climate change on vulnerable sectors in the Atlantic region.
- b) In the afternoon, the workshop would be broken up into three working groups to address a set of questions related to the possible establishment of an Atlantic Canada Impacts and Adaptation Research Network.

Sections 2 and 3 of this document summarizes Part a) above of the Workshop, and Sections 4 and 5 summarize the deliberations of the three working groups in Part b). Material provided by three presenters in Part a) is shown in Appendices C to E.

2. Background for the Work Group Discussions

1. Environment Canada Funding and Organizational Structure for Climate Change Projects (Dave Wartman, Environment Canada – Atlantic Region)

Dave Wartman outlined the latest situation with respect to possible funding for climate change work, based upon the current state of knowledge from the recent federal budget. There are significant funds available for climate change work but much of it is not accessible for research in climate change impacts and adaptation.

There is one primary source of funding that is of interest to impacts and adaptation researchers: a continuation of the Climate Change Action Fund (CCAF). The CCAF was originally established to operate over a period of three years, ending in March 2001. In the recent federal budget, the CCAF was extended for an additional three years (to March 2004), maintaining the current funding levels of \$150 million. The specific allocation of funding for each component (Technology, Science Impacts and Adaptation, and Public Education and Outreach) is not clear. However, funding similar to past levels is expected. This means that there is approximately \$5 million per year for the next three years for research in Science Impacts and Adaptation.

The Canadian Foundation for Climate and Atmospheric Science has been established with a total funding of 60 million dollars over a period of six years. The Canadian Meteorological and Oceanographic Society has been given the task of organizing the Foundation; a technical committee and board are now being selected. The Foundation will be funding research in three sectors: air quality, climate change and extreme weather. It is unlikely that there will be significant funding for impacts and adaptation.

With respect to organizational aspects, Environment Canada and Natural Resources Canada are the lead agencies for work in climate change. Dave Wartman stated that, in the Atlantic Region, a new Climate Change Division headed by him and consisting of six people has been established in Environment Canada. The Division hopes to establish links with universities.

2.2 A National Perspective on the Future of Impacts and Adaptation Research in Canada (Pam Kertland, Climate Change Action Fund Adaptation Liaison Office, Natural Resources Canada)

Pam Kertland of the Climate Change Action Fund (CCAF) Adaptation Liaison Office, Natural Resources Canada, Ottawa, provided an overview of the national activities relating to climate change and in particular, the impacts and adaptation aspect of the issue. The Office, which sponsored the workshop, is responsible for managing the process of calling for proposals by which the CCAF disburses money for climate change

impacts and adaptation research as well as other activities such as the development of a national impacts and adaptation research network.

She reminded participants that at Kyoto, Canada agreed to a 6% reduction in greenhouse gas emissions from 1990 levels by 2008-2012. However, there are other obligations for participating countries, such as monitoring greenhouse gas sources and sinks, and developing a better understanding of the risks of a changing climate. Even if fully implemented, the Kyoto Protocol will slow but not forestall climate change; our work on adapting to these unavoidable effects must start now.

The development of a national implementation strategy on climate change and the role of research in impacts and adaptation were then briefly described. The National Climate Change Process, a joint federal-provincial endeavour, established 16 Issue Tables to examine the impacts, costs and benefits of implementing the Kyoto Protocol, and to analyze the various options open to Canada for implementing a climate change strategy. One Issue Table dealt with Science (climate science), Impacts and Adaptation and produced an Options Report which contained four recommendations with respect to impacts and adaptation:

- a. An impacts and adaptation research program should be implemented.
 - b. A Canadian Climate Impacts and Adaptation Network (C-CIARN) should be established with regional and sectoral composition.
 - c. A significant investment in analytical capacity and a targeted research program should be made now, to enhance scientific capacity in impacts and adaptation.
- d) An appropriate governance structure should be established for dealing with impacts and adaptation results because implementation of adaptation measures will involve governments at all levels as well as the private sector and individuals.

The result of this and other work has been the inclusion of impacts and adaptation in the national climate change strategy and the requirement by Energy and Environment Ministers that adaptation to climate change be included in the strategies being developed for "mitigation" sectors (e.g. industry, transportation etc.).

Ms. Kertland stated that the C-CIARN was required because of the growing demand for information on impacts and adaptation research, the need to provide a focus for the work, the need to involve all stakeholders, and the need to coordinate assessment activities and to reduce overlaps and duplication in research. An interim steering committee has been set up to guide development of the network. Further information on the Science, Impacts and Adaptation Issue Table may be found at: www.nccp.ca.

Ms. Kertland said that this workshop was one of series being held to establish regional and sectoral nodes of the network. It was important to determine the level of interest among the participants in an Atlantic Canada node in the C-CIARN, and to hear their ideas on the function and form of the Atlantic node. She also noted that this was just the first step of a process and that after the report of this workshop was received, the

Adaptation Liaison Office would continue to work with a smaller group of representatives to establish the Atlantic node, if it was seen as desirable.

2.3 Scenarios and Adaptation Science: National and International Perspectives (Roger Street, Environment Canada)

(Note: a summary of the PowerPoint presentation by Mr. Street may be found in Appendix C.)

Researchers in impacts and adaptation require scenarios of regional climatic change as input for their work. Roger Street stated that, even if emissions of greenhouse gases were to go to zero today, there would still be impacts from past emissions due to the inertia of the atmosphere-earth-ocean system. Even now, we are not perfectly adapted to our environment. He then went on to describe the processes involved in producing scenarios of climate change. It is important to realize that scenarios are not predictions *per se*; rather they are plausible futures based upon reasonable assumptions. Scenarios may be incremental in nature, spatial and temporal analogues, extrapolations of present-day trends, expert opinions, or outputs from climate models.

These scenarios should include not only mean values but also information on variability and extremes because impact scientists must assess our sensitivity to uncertainties in our future. Because scenarios are projections of plausible future states, there are many assumptions that go into them, and uncertainties associated with them. It is important that impact scientists be aware of and take into consideration both these assumptions and the uncertainties.

Roger Street listed six cardinal variables in climate change scenarios that would be of use to impact researchers: maximum temperature, minimum temperature, precipitation, solar radiation, relative humidity and wind speed. A central issue is the spatial and temporal scales that would make the scenarios useful. Selection of these scales would require a balance between the availability of data and the availability of using model results at the given scales.

Mr. Street then went on to describe the activities of the Canadian Climate Impacts and Scenarios (CCIS) Project of the Canadian Institute for Climate Studies at the University of Victoria. The aims of this project are:

- the provision of basic national climate change scenarios, advice and related information to the Canadian impacts and adaptation communities;
- the development of a nationally consistent framework within which sector- and region-specific climate change scenarios will be developed through engagement of the respective impacts and adaptation research communities;
- the development and maintenance of a capacity within the Canadian impacts and adaptation research communities to develop nationally-consistent climate change

scenarios to support climate impacts and adaptation research and assessments, and

- the engagement of the university research community and scenario users in the further development of the young and growing science of climate change scenarios.

The spatial resolution of the scenarios is 3.75 degrees latitude/longitude. Change fields can be produced with a spatial resolution of 0.5 degrees latitude/longitude. The base climate is averaged between 1960-1990, and scenarios are available for the 2020s, 2050s and 2080s. Monthly, annual and seasonal values can be produced. The variables in the scenarios are maximum temperature, minimum temperature, relative humidity, wind speed, cloud cover and incident solar radiation. Further information on the CCIS Project may be found at www.cics.uvic.ca/scenarios/.

What is adaptation? Mr. Street described it as actions taken in response to a projected or actual change in the climate. The actions aim to minimize the adverse effects and to maximize the positive effects. Adaptation may be spontaneous or planned, and may take place on local, national and international scales. Adaptation falls into five broad categories:

- Prevent the loss – adopt measures that reduce vulnerability to climate change.
- Tolerate the loss – do nothing to reduce the vulnerability, and absorb the cost of the losses as they occur.
- Spread or share the loss – do not reduce vulnerability, but spread the burden of the losses over different systems or populations (this is how insurance works).
- Change the affected activity – stop doing things that cannot cope with changes in climate, and substitute other activities.
- Change the location of the activity – move the activity or system to a more favourable location.

In closing, Mr. Street said that carefully planned adaptive measures will be more effective than last-minute panic reactions to climate change. If the population at large is involved in planning adaptive measures, they will be more accepted and more effective. "Win-win" measures such as increasing the efficiencies of and eliminating leaks in our water system should be encouraged. We must give ourselves "environmental headroom" by measures such as better management of existing protected areas including our parks. We must look for "triggers" of climate change such as significant changes in the fresh water input into the Gulf Stream. Finally, scenario analysis will give us insight into the sensitivities of our physical, biological and human environments to climate change, and help us to devise more effective adaptive measures.

2.4 The Proposed Atlantic Environmental Research Network (Alex Bielak, Environment Canada – Atlantic Region)

(Note: a summary of the PowerPoint presentation by Dr. Bielak may be found in Appendix D.)

Dr. Bielak summarized a concept paper on the proposed Atlantic Environmental Research Network (AERN). This concept paper has been endorsed in principle by Environment Canada's Regional Science Coordinating Committee and Regional Management Committee, and the Management Board of the Atlantic Cooperative Wildlife Ecology Research Network (ACWERN). The proposed AERN uses the model of the ACWERN, which is considered to be a success, unique to Atlantic Canada, now in its sixth year. ACWERN has added to the region's wildlife research expertise by bringing together research chairs at the University of New Brunswick, Acadia University and Memorial University of Newfoundland. ACWERN operates on an annual research budget of \$900 000 (not including salaries) within the framework of a strategic plan, and its operation is overseen by a management board comprised of deans from the participating universities and senior officials of Environment Canada – Atlantic Region.

The success of the ACWERN has been the basis for the proposed AERN which would have three fundamental objectives:

- to undertake high quality relevant fundamental and applied research within specified areas of interest,
- to provide mechanisms to ensure effective linkages among the researchers and the supporting agencies which are faced with practical environmental management and conservation decisions and,
- to provide a vehicle for enhanced education and training of students and interchange among institutions.

AERN would be a network of research cooperatives, each dealing with a theme. Three potential themes are:

Wildlife ecology and biological diversity, through a re-oriented and expanded ACWERN

Freshwater and estuarine ecosystems

Adaptation and response to climate change impacts

Dr. Bielak noted that the third theme fits in closely with what is being discussed at this workshop. Some of the impacts of climate change that would be addressed by this theme are:

- The impacts of sea level rise on coastal areas, including storm surges, the flooding of low-lying areas and erosion,
- Impacts on the Acadian forest, which is a transitional zone between boreal and deciduous forests,
- Uncertain but likely far-reaching impacts of changes to ocean currents, such as the Labrador Current and the Gulf Stream,
- Impacts of projected changes in the frequency and intensity of extreme weather events such as hurricanes,
- An analysis of the regional aspects of historical climate parameters to improve our understanding of how the climate is changing in Atlantic Canada, and what the regional sensitivities are to climate and climate change,
- Impacts of climate change on people, aquatic systems and terrestrial systems in Labrador, and
- Impacts of climate change on the dynamics of regional water resources, including streamflow, snow melt and winter ice regimes.

It is noteworthy that several of the above impacts (on forests, water resources and coastal zones) will be addressed in Section 3 to follow, and by the discussion groups. Dr. Bielak pointed out that AERN has many of the same potential benefits as the proposed Atlantic Canada Impacts and Adaptation Research Network: it would provide a critical mass of researchers; it would foster interaction and cooperation among researchers; and it would provide a focus. He noted that participation in AERN would require some tangible contribution. Governments would be expected to provide funding while universities would be expected to provide tangible support for CFI proposals, or dedication of Canada Chairs, as well as the development of strategic plans including a focus on the environment.

Dr. Bielak ended by saying that the AERN proposal continues to be discussed with potential interested parties in government and academia.

3. Impacts of Climate Change on Vulnerable Sectors

The workshop then heard from several scientists working in aspects of climate change that were deemed to be of interest both for the proposed Atlantic Environmental Research Network (AERN) and the topic of this workshop (the Atlantic Canada Impacts and Adaptation Research Network). These are: forests, water resources and wildlife, and coastal zones.

3.1 Forestry (Roger Cox, University of New Brunswick)

Roger Cox stated that some of the projected changes in regional climate and forest processes are:

- warmer winters and cooler summers;
- warmer springs which would lengthen the growing season;
- changes in the radiation budget due to changes in cloudiness;
- increased atmospheric carbon dioxide concentrations possibly leading to increased carbon assimilation by the forests;
- changes in water availability due to changes in the hydrological regime;
- improved water use efficiency due to the changes in carbon dioxide concentrations (reduced stomatal conductance); and
- changes in nutrient availability (Warmer soils would lead to faster nutrient cycling and changes in the availability of the nutrients which are dependent on species root periodicity.).

He then listed several possible responses of forests to climate change:

- Changes in growth rates
- Changes in forest extent
- Changes in the relationships between carbon sources and sinks
- Species composition and rates of migration
- Disturbance regimes (e.g., fire, browsers and pests)

Dr. Cox said that he did not expect forest extent to change much in the foreseeable future. At the present time, the forests are near equilibrium in regard to mean source-sink relationships; however, carbon storage might be affected by increased decomposition rates. He also said that, apart from climate change, other global change factors such as air pollution might also affect forests. In addition, market forces including competition for exports will affect forestry practices including the species planted.

With respect to species composition, forests might change from a boreal to a more mixed temperate regime. The forest behaviour during the transition to a warmer climate would depend upon the adaptability of the current species.

It is now possible to model the rate of forest migration. New competition factors might arise from increased atmospheric CO₂ concentrations. An important factor in the Atlantic region is that coastlines pose real physical barriers to forest migration.

Future changes in the disturbance regimes could include:

- Increases in storm damage (We are salvaging blowdowns now but more effort, new plantings and coordination may be needed in the future.),

- Increases in browser activity (Milder winters with less snow would allow deer to be more mobile.),
- Encroachment on forest lands due to increased human population (extension of farmland and industrial areas),
- The area affected by forest fires could increase or decrease depending upon the location,
- Increases in some types of insect damage due to the northward movement of the climatological limits of some pests, and
- Increased frequencies of winter thaws might lead to increased dieback of some species, notably the birch species. Thawing and subsequent re-freezing of the roots and stems of yellow birch have resulted in an inability to refill the air embolisms in their stems that accumulates over winter, leading to dieback and decline.

3.2 Hydrology and Wildlife (Tom Clair and Richard Elliot, Environment Canada – Atlantic Region)

Tom Clair stated that possible changes in the general circulation of the atmosphere could lead to changes in rainfall and winter temperatures. These factors could lead to earlier breakups of the winter ice cover in rivers, and lower summer flows. Indeed, the frequency of mild days in January and February has increased since the 1920s. In the Saint John River, the ice breakups have occurred earlier in the springtime, and peak daily flows in the spring have been greater. Modelling of the Churchill River using expected changes in climatic factors as input indicates earlier and higher peak flows in the springtime, and earlier and lower low flows in the summer. Dr. Clair ended by saying that these changes could have significant effects on those parts of the human and natural environment that are geared to the present flow regime, including the generation of hydro-electric power.

Richard Elliot then discussed some of the effects of climate change on wildlife. Many species of wildlife are affected by the temperature and precipitation regime of their habitat, not only the actual magnitudes, but the seasonal distribution as well. The length of daylight also affects them. If there is a climatic warming, events in the lifetime of a species that respond to temperature might occur earlier, but those linked to the length of daylight might not. Therefore, there could be a de-coupling of important links in the life cycle of the species, which might be disruptive.

In spatial terms, a given species of wildlife might be able to migrate with the climatic regime that is favourable to it, but another species upon which it depends for food, etc. might not. This could lead to dire consequences for the first species. Species that have narrow climatic ranges would be more vulnerable to climate change. Dr. Elliot cited the example of polar bears, many of which are in poor condition. In recent years there has

been a lack of ice floes near the shore; the polar bears rely upon these floes as platforms from which to hunt seals for food.

Dr. Elliot ended by saying that wildlife may take a long time to adapt to climate change; this must be taken into account when designing adaptive measures.

3.3 Coastal Zone and Sea Level Rise (John Belbin, Clean Annapolis River Project)

John Belbin stated that there are many coastal areas in the Atlantic region that are at risk from sea level rise and additional effects such as spring tides and storm surges. He said that measurements at several locations in Nova Scotia show that sea levels are slowly rising; the Bay of Fundy is rising at about 40 cm per century. At the same time, much of the land in Nova Scotia is sinking, at a rate of several 10s of cm during the past few decades. In the future, additional sea level rise and increased frequency of storms from climate change could pose an additional risk.

Annapolis Royal, Nova Scotia was used as an example; already this town has suffered flooding with high tides, sea level rise coupled with a storm surge could result in the town being cut in two by high water. Mr. Belbin ended by saying that the type of study that had been done at Annapolis Royal should be done at other places in the region.

Appendix E shows a map of the potential flooding in Annapolis Royal that could result from increases in water levels of 4 and 6 metres, and several photographs of incidents of high water that have already occurred in the town.

4. Deliberations of the Breakout Groups

4.1 Breakout Group Structure and Questions Addressed

The workshop broke up into three groups with Richard Elliot, John Jacobs and Roger Cox acting as facilitators. Each group was to address the following four questions:

a) Is there a need for an Atlantic Canada node in a national Climate Change Impacts and Adaptation Research Network?

b) From your perspective, what would be the prime function(s) of a regional Climate Change Impacts and Adaptation Network?

c) Whom should the regional Network serve?

d) What steps need to be taken to implement the Atlantic Canada Climate Change Impacts and Adaptation Research Network?

4.2 Results of the Breakout Group Discussions

The responses of the breakout groups to each of the above four questions are summarized below.

a) Is there a need for an Atlantic Canada node in a national Climate Change Impacts and Adaptation Research Network?

All three groups agreed that there was a need for such a network. The reasons given were as follows:

- It is obvious that we must reduce as much as possible the future potential impacts of climate change. However, it is now recognized that, because of the inertia of the atmosphere-ocean-earth system, some impacts of climate change are inevitable in the future and that adaptation to these changes will be needed.
- Because the impacts of climate change will vary from region to region, a regional perspective is needed in impacts and adaptation research. The Atlantic Region, with its largely resource-based economy, is at considerable risk from climate change. In particular, the environmental sectors highlighted in this workshop (forests, water resources and wildlife, and coastal zones) could suffer considerable damage from changes in climatic factors such as temperature and precipitation, both in amount and in timing throughout the year. As pointed out in Section 3 above, forests are at risk from damage from more frequent storms, increased winter browser activity, forest fires, insects and diebacks from more frequent freeze-thaw cycles in the winter. Climate change may disrupt the hydrologic cycle and the natural ecosystems and human activities (such as power generation) that depend upon it. Wildlife species may be able to adapt to climate change by migrating, but parts of the food chain upon which it depend may not be able to due to barriers such as coastlines. Much of the Atlantic coastline is at possible risk from flooding from a combination in rising sea levels and increased frequency of storm surges.
- Resources for carrying out research in climate change, including possible impacts and adaptive measures, are limited. For this reason, it is essential that priorities for research be carefully set. This is especially important because researchers in the Atlantic region are geographically dispersed.
- Once priorities have been set, resources must be obtained to carry out the work. At present much of the dialogue in impact research and adaptive measures is carried out by natural scientists working for the federal government and universities. There is a need to more fully engage groups in provincial and municipal governments, and non-governmental organizations, as well as social scientists, in a multi-disciplinary, holistic approach to the issue of impacts and adaptation. More resources might then be attracted to the region if proposals for funding were submitted by coordinated groups of researchers in both the natural

and social sciences working with various levels of governments, universities and non-governmental organizations, rather than by isolated individuals. If it can be shown that a particular research effort will benefit several sectors instead of just one, proposals are more likely to be accepted by funders.

- There is a need to facilitate better information exchange among scientists within the region as well as between regional scientists and those in other regions and in national programmes.
- One group made the point that the average age of researchers is increasing and that there are many approaching retirement; there is therefore a need to attract new researchers.
- It is desirable, if not essential, for research in climate change impacts and adaptive measures to be useful for guiding public policy. It is important to involve policymakers in both the planning and review stages of the research to increase its benefit to the public. One group even suggested that the word "applications" as well as "research" be part of the name of any network, to emphasize the need for the research to be applicable to public policy.

b) From your perspective, what would be the prime function(s) of a regional Climate Change Impacts and Adaptation Network?

The responses of the groups to this question can be grouped in several categories.

i) Improve communication

- The Network could act as an information and data exchange for the benefit of impact and adaptation researchers in the region. This could include a directory of the researchers, how they can be contacted, the nature of their work and interests, and a description of their research results. It may not be necessary for the Network to actually archive databases, but rather to serve as a clearinghouse to enable those looking for a particular type of data to find the source. The Network should also identify funding sources.
- It is important that there be good communication between those identifying impacts and those examining adaptation. It was also brought out in the discussion that the Network could ensure that scenarios of regional changes in climatic elements such as temperature and precipitation are available to researchers in the Atlantic region.
- By being a focal point, a network would also facilitate better communication among various disciplines, including social and natural scientists, policymakers, and the public. One breakout group made the point that, within the Atlantic region, the representation of Newfoundland and Labrador interests needs to be improved.

- Another benefit of the Network being a focal point is that it could serve to improve communication between regional scientists and those in other regions and in national programmes.

ii) Better set research priorities and stimulate further research on priority issues

- A network, by fostering better communication among various groups in society, could facilitate a more efficient setting of priorities for work in impacts and adaptation, and the choice of special themes for the work. This is especially important considering the limited resources available. One breakout group stressed that the community at large must define what impacts of climate change are unacceptable.
- As described in Section 3, the Workshop discussed several possible themes upon which future work may be based (forestry, water resources and wildlife, and sea level rise), but there may be other candidates as well.

iii) Allow researchers in the Atlantic region to make better use of limited resources

- An Atlantic Canada Impacts and Adaptation Research Network could increase the chance of researchers knowing where possible funding sources are located. It could also help potential collaborators seek out one another and combine forces in a synergistic way in the development of proposals that make better use of talent and funding. This would attract more funding to the region.
- By making researchers aware of who is doing what in the region, and by fostering better coordination, a Climate Change Impacts and Adaptation Research Network could reduce the possibility of needless duplication, and identify gaps.

iv) Allow the Atlantic region to more fully participate in the national network on impacts and adaptation

- If they were part of a Regional Network, researchers in the region could better interact with counterparts in other regions and with national programmes as a coordinated group rather than as individuals. Conversely, it would be easier for the national program to communicate with the regional program via the Atlantic network acting as a regional focal point, rather than trying to communicate with a large number of individuals.
- By acting as a united regional voice, an Atlantic regional network would have more influence on the national program. For example, research results from the Atlantic region would have a better chance of influencing national policy.

c) Whom should the regional Network serve?

- All groups agreed that the regional network should attempt to serve all groups in the region involved in research in climate change impacts and adaptation. This would include those setting the priorities in research, those actually carrying out the research, those applying it to public policy and those (i.e., the public) who will be affected by policies. Therefore, as discussed in Question a) above, the network should serve not only the researchers themselves, but other groups such as policymakers in various levels of government, non-governmental organizations and the public.
- Following on the above, it is essential that the Network be inclusive and open to all those interested in impacts and adaptation.

d) What steps need to be taken to implement the Atlantic Canada Climate Change Impacts and Adaptation Research Network (AIARN)?

The breakout groups made many suggestions about possible steps:

- i. Various existing means of research coordination could be examined and assessed for their applicability. These could include EMAN and the proposed Atlantic Environmental Research Network (AERN). It is possible that the AIARN could be part of both a national impacts and adaptation research network and the AERN.
- ii. The workshop participants agreed that the last thing that was needed was a duplication of existing management structures. Existing structures should be used as much as possible. However, it was felt that consideration should be given to having a coordinator and/or a secretariat.
- iii. The communication links could be established via a Web site that would include inventories of researchers, research activities, and where the associated research results including databases could be found. A bulletin board could foster dialogue among researchers.
- iv. Use could be made of the Millennium Chairs that are being set up at various universities in the region. The Chairs could be encouraged to coordinate activities to benefit impacts and adaptation research in the region.
- v. An assessment could be made of the "state of the art" of research into climate change impacts and adaptation in the region. This might reveal gaps and overlaps and help to identify future priorities. An assessment might be done by holding a workshop or by contracting a party to carry out such an assessment. More focused workshops could then follow.
- vi. All interested parties in various levels of government, academia and the public should be involved in the setting up of the Network.
- vii. Some funding would be needed to support the establishment of the Network.

5. Wrap-up of the Workshop

Pam Kertland, Adaptation Liaison, Natural Resources Canada, reviewed thoroughly the points that were brought up in the workshop. These have been summarized in Section 4 above. The ensuing discussion brought up the following additional points:

- Membership in an Atlantic Canada Climate Change Impacts and Adaptation Research Network would bring responsibilities; members would be expected to take on some active role.
- It is important to take a long-term view in planning and carrying out research in impacts and adaptation.
- Research funds would need to be distributed in a fair manner.
- Funding for the coordination of the Network, including the establishment of a Web site, is currently expected to be \$50 000 per year for the next three years.
- There was considerable discussion about the relationship between regional nodes for multi-sector research and national nodes for research in a single sector, i.e., forestry or coastal zones, etc. Some participants felt that the regional node could fulfill the function of coordinating sectoral research and that the national sectoral nodes were not needed. On the other hand, Roger Street made the point that, without national nodes for a single sector, there was a danger either of duplication of effort, or of leaving gaps in the research. Regional nodes could also limit the number of sectors that could be examined.
- The suggestion was made that there may be a need for a Canadian Foundation for Studies in Climate Change Impacts and Adaptation Research.

In closing, Gary Lines, the Workshop convenor, stated that the Workshop was only the first step in a process, and thanked the participants for their contributions.

Appendix A: Workshop Agenda

0800 Sign-In

0830 Greeting and review of administrative items.

0840 Welcome to the Workshop. (George Finney, Environment Canada-Atlantic)

0850 A briefing to inform participants of the status of funding for Climate Change projects. Also some information on recent organization changes at Environment Canada related to Climate Change. (Dave Wartman, Environment Canada-Atlantic)

0900 A national perspective on the future of impacts and adaptation research in Canada. (Pam Kertland, Adaptation Liaison, Natural Resources Canada)

0930 Scenarios and Adaptation Science: national and international perspectives.

(Roger Street, Environment Canada)

1000 Coffee

1030 Presentation on the Atlantic Environmental Research Network Concept Paper.

(Alex Bielak, Environment Canada-Atlantic)

1100 Presentations concerning impacts on vulnerable sectors.

- Forestry – (Roger Cox, University of New Brunswick)
- Hydrology and Wildlife – (Tom Clair and Richard Elliot, Environment Canada)
- Coastal Zone - Sea Level Rise – (John Belbin, Clean Annapolis River Project, Nova Scotia)

1145 Break-out groups to discuss questions concerning regional network. (Focus questions to be provided by moderator)

1200 Lunch

1300 Break-out groups continue...(Coffee available at 1445)

1500 Presentation by break-out groups and review of the conclusions

1545 Wrap-up of session and a summary of next steps. (Pam Kertland, Natural Resources Canada)

1615 Adjourn

Appendix B: Workshop Participants

Name	Affiliation
Allen, Darren	Student, University of New Brunswick
Beersing, Anil	Dept. of Environment and Labour, Newfoundland and Labrador
Belbin, John	Clean Annapolis River Project (CARP)
Benjamin, Cheryl	Student, Dalhousie University
Berube, Dominique	New Brunswick- Dept. of Natural Resources and Environment
Bielak, Alex	Environment Canada, Environmental Conservation Branch, Dartmouth NS
Bliss, Doug	Canadian Wildlife Service, Sackville NB
Bourque, Charles	Dept. of Forestry, University of New Brunswick
Boyce, David	Southeast Environmental Association, Prince Edward Island
Breau, Jacques	Student, Mount Allison University
Brun, George	PWMG
Burrell, Brian	New Brunswick Dept. of Environment and Local Governments
Cain, Maria	Clean Nova Scotia
Caissie, Daniel	Dept. of Fisheries and Oceans, Moncton NB
Clair, Tom	Environment Canada, Environmental Conservation Branch – Sackville NB
Coon, David	Conservation Council of New Brunswick
Côté, Ray	Dalhousie University

Cox, Roger	University of New Brunswick
Daborn, Graham	Acadia University
Deveau, Jean-Guy	Environment Canada, Moncton NB
Diamond, Tony	University of New Brunswick
El Jabi, Nassir	Université de Moncton
Elliot, Richard	Environment Canada, Environmental Conservation Branch – Sackville NB
Fairchild, Gordon	Soil Water Conservation Centre, Université de Moncton
Finney, George	Environment Canada, Sackville NB
Foote, George	Dept. of Natural Resources Nova Scotia
Forbes, Don	Dept. of Fisheries and Oceans, Bedford Institute of Oceanography
Fraser, Todd	Dept. of Technology & Environment, Prince Edward Island
Howells, Alison	New Brunswick Lung Association
Jacobs, John	Memorial University of Newfoundland
Jordan, Paul	Mt. Allison University
Kennedy, Katherine	Student, Mt. Allison University
Kertland, Pam	Natural Resources Canada
Kirkpatrick, Anna	Student, Mount Allison University
Lavigne, Mike	Canadian Forestry Service, Fredericton NB
LeBlon, Brigitte	Dept. of Forestry, University of New Brunswick
Lines, Gary	Climate Change Div. Environment Canada -Atlantic

Major, John	Canadian Forestry Service, Fredericton NB
Meng, Fan-Rui	Dept. of Forestry, University of New Brunswick
Ollerhead, Jeff	Mt. Allison University
O'Neill, Des	Donmec Consultants Inc.
Parrish, Christopher	Ocean Sciences Centre, Memorial University of Newfoundland
Patterson, Gary	Agriculture Canada
Pettipas-Deir, Cathy	Student, Mt. Allison University
Reekie, Edward	Acadia University
Robichaud, André	Université de Moncton
Sanderson, Brian	Agriculture & Food Canada
Shaw, John	Dept. of Fisheries and Oceans, Bedford Institute of Oceanography
Shaw, Rod	Rodshaw Environmental Consulting Inc.
Street, Roger	Environment Canada, Downsview ON
Sutherland, Karen	Climate Change Div. Environment Canada -Atlantic
Szabo, Steve	Climate Change Div. Environment Canada -Atlantic
Wartman, Dave	Climate Change Div. Environment Canada -Atlantic

Appendix C:

Summary of a PowerPoint presentation

Scenarios and Adaptation Science: National and International Perspectives

by

Roger B. Street
Director, Adaptation and Impacts Research Group
Meteorological Service of Canada

1. Why Do Impacts Studies?

- The first step in developing adaptation responses is to identify and assess key impacts of climate change and then identify where implementing adaptation responses is most urgent
- There is a need to define "dangerous anthropogenic interference with the climate system" (UNFCCC, Article 2)

2. What are Impact Studies?

a) Sensitivity studies:

- identify the effects of climate (variability, including extremes) on an "exposure unit"
- isolate the direct effects of climate
- are an essential first step in identifying impacts of climate change
- are also useful for identifying thresholds

b) Considerations in impact studies:

- exposure units when responding to climate change (or any stimuli) adapt naturally - need to include autonomous adaptation

- there is a need to consider the indirect impacts of climate change (i.e., the impact of changes in other components of the related system to changes in the climate)
- there is a need to consider the impacts of changes in non-climate factors (socio-economic plausible futures)

3. Climate Change Impact Studies

When assessing the impacts of projected changes in climate, there is a need to consider "scenarios" which are:

- plausible futures
 - neither predictions nor forecasts of future conditions
- descriptions of alternative plausible futures that conform to sets of circumstances or constraints within which they occur
- meant to illuminate uncertainty as they aid in determining the possible ramifications of climate change

Scenarios for Climate Impacts

- A "climate scenario" refers to a plausible future climate that has been constructed for explicit use in investigating the potential consequences of both human-induced climate change and natural climate variability/change.
- A "climate projection" is a description of the response of the climate system to a scenario of greenhouse gas and aerosol emissions as simulated by a climate model. It rarely provides sufficient information to estimate the impacts of climate change but must be manipulated and combined with the current climate to be useable for impact studies.

a. Issues associated with climate scenarios:

- Six cardinal variables - maximum and minimum temperature, precipitation, incident solar radiation, relative humidity and wind speed - actual needs depend on the sensitivities
 - The central issue is spatial and temporal scales
 - scales at which variables can sensibly be provided must be a balance between the availability and advisability of using climate model results at a particular scale, and the requirements of the impact study
- Scenarios should also provide adequate quantitative measures of uncertainty - cannot rely on one scenario but should use a number of scenarios (at least two) which include a range of projected climate futures

b) Types of climate scenarios:

- incremental scenarios for sensitivity studies (e.g., $\Delta T = \pm 10\%$)
- spatial or temporal analogues (historical or geographical)
- extrapolation of existing trends
- expert judgment
- scenarios based on outputs from climate models

5. The Canadian Climate Impacts Scenarios (CCIS) Project

a. Project Outline

CCIS Project will provide:

- climate change scenarios for Canada; and
- advice on scenario generation, applications, limitations, uncertainties, downscaling techniques, interpretation of global climate model (GCM) and regional climate model (RCM) results for Canada.

b) CCIS Scenarios

- Climate change scenarios for Canada from the latest Canadian GCM experiments
- At original GCM resolution $\sim 3.75^\circ$ lat./long
- Changes with respect to 1961-1990 for the 2020s, 2050s and 2080s
- Monthly, seasonal and annual values
- Monthly time series for 1961-1990, 2010-2039, 2040-2069, 2070-2099

c) Climate variables, minimum data set:

- mean, minimum and maximum temperature, precipitation, a radiation variable, a humidity variable, wind speed

d) Simple interpolation of change fields to 0.5° latitude/longitude resolution

e) Core scenarios

- Variables available: minimum, mean and maximum temperature, precipitation, specific humidity, wind speed, cloud cover, total incident solar radiation
- Variables being added: sea level, skin temperature (for sea surface temperature), snow water content, sea level pressure, sea ice, evaporation and soil moisture
- variables to be derived: vapour pressure, relative humidity, potential evapotranspiration, diurnal temperature range

6. What is Adaptation?

- Any action taken to adjust to projected or actual changing climatic conditions - can be spontaneous or planned, and can be carried out in response to or in anticipation of changes
- Process through which the adverse effects of climate on health and well-being are minimized, and opportunities afforded by the climate are maximized
 - When done correctly, the process should be consistent with sustainable development objectives
 - Not an alternative to mitigation but part of a balanced response portfolio

7. Adaptation Responses

a) Preventing the loss

b) Tolerating the loss

c) Spreading/Sharing the loss

d) Changing use or activity

e) Relocation

f) Research and monitoring

g) Education

a) Preventing the loss

- social, economic and environmental loss/harm is avoided, reduced or managed
- environmental impact assessments should include effects of climate change
- coastal zone management plans
- building codes and standards
- disaster contingency planning

b) Tolerating the Loss

- adverse impacts are accepted in the short term because they can be absorbed without long-term damage
- environmental management legislation
- integrated water resource management

c) Spreading or Sharing the loss

- distribute the burden of impact over a larger region or population beyond those directly affected
 - use economic instruments
- **national flood insurance and reinsurance schemes**
- **grants for flood and coastal protection**
- **increased funding for infrastructure upgrading and maintenance in high risk areas**
- **insurance schemes for disaster assistance**

d) Changing Use or Activity

- change of activity or resource used to adjust to the adverse as well as the positive consequences of climate change
- principally accomplished by exercising control over land and resource use, development plans/activities

e) Relocation

(Note: preservation of the activity is considered more important than its location, and migration occurs to areas that are more suitable)

- migration and retreat from areas affected by rising sea level and increased extreme weather events
- economic instruments that establish a funding mechanism to assist with costs associated with relocation

8. Why Adaptation Now?

- Being prepared - mitigation will not prevent climate change
- Anticipatory and precautionary adaptation actions are more effective and less costly than forced, last minute actions
 - Immediate benefits of taking adaptive actions:
 - **resilience to current climate variability and extremes**
- **removal of maladaptation policies and practices**

9. Adaptation Strategies - based on State of Knowledge

a) Better understanding the sensitivities of physical, biological and human systems:

- **characterization of the climate system; and**
- **impacts modelling and other approaches.**

b) Identifying possible future impacts:

- **climate and socio-economic scenarios; and analytical and methodological procedures.**

c) Periodic and strategic national syntheses of impacts

e) Need to improve processes for identifying and evaluating the viability of adaptation options:

- Research on the adaptation process and on adaptation capacity - forms, stimulants, and impediments - related to natural and socio-economic systems
- Periodic and strategic national syntheses of adaptation research results, including identification and evaluations of adaptive options

Appendix D:

Summary of a PowerPoint presentation

AERN - A Proposal for an Atlantic Environmental Research Network

by

Dr. Alex Bielak
Environment Canada - Atlantic Region

and the
pro tem AERN Council

1. Environmental Concerns in Atlantic Canada

- regional environmental concerns require sound science to answer questions, *e.g.*
- depleted populations of birds, fish, and loss of forest and marine biodiversity
- loss and degradation of terrestrial, marine and freshwater habitats
- pollution from acid rain, smog, contaminated sites, agriculture and industries
- loss of ecosystem integrity in coastal areas

1. Atlantic Region Resource Constraints

- regional science capacity limited by:
- resource reductions in government agencies
- many research institutes located outside region
- provinces lack individual capacity
- academic research capacity high quality, but dispersed among region's small universities
- regional gaps in key disciplines
- reduced funds from granting councils to universities

1. Emerging Opportunities

a. *increasing federal focus on universities - e.g:*

o Canadian Foundation for Innovation (CFI)

o 2000 new Canada Research Program (Millennium) Chairs

University of New Brunswick (18) Mount Allison University (5) Université de Montréal (7) University of Prince Edward Island (5?) Acadia University (7) Dalhousie University (4-6?) St. Mary's University (8)

Others (?)

o *National Centres of Excellence Competition - Meeting Environmental Challenges for*

Clean Water (indications that Atlantic region component desired)

Two LOIs - (1) Canadian Water Network (University of Waterloo) and (2) résEAU-WETnet (McGill University)

a. *increasing federal focus on environment, (including 2000 budget):*

• Environment Canada - Species at Risk Act (SARA)

- Environment Canada - climate change science initiatives
- Environment Canada - increased regional interest from National Water Research Institute
- Parks Canada - renewed priority for science of protected areas
- related science priorities in Dept. of Fisheries and Oceans, Canadian Forestry Service, etc.

1. The ACWERN Model

- **Atlantic Cooperative Wildlife Ecology Research Network (ACWERN) - begun in 1994**
- ACWERN research chairs at Acadia University, University of New Brunswick, Memorial University are university faculty positions
- Environment Canada \$200K core funding matched by National Science and Engineering Research Council (NSERC) Industrial Research Chairs program

- overseen by board of 2 deans from each site, 2 senior Canadian Wildlife Service managers, chaired by CWS
- Secretariat support by Environment Canada - considerable effort
- operates within framework of a strategic plan

1. The Operation of ACWERN

- focus in areas of interest to Environment Canada-Canadian Wildlife Service (EC-CWS):
- impacts of forest harvesting on birds
- seabirds as indicators of marine health
- landscape approach to habitat concerns
- projects selected by chairs with EC input
- one third of current projects at each University:
- directly address CWS conservation concerns
- indirectly address related concerns
- address other conservation questions

6. ACWERN Achievements

- ACWERN has been successful in:
- multiplying \$200K core funds to a \$900K annual research budget, plus salaries
- linking university research with Canadian Wildlife Service (HRAs, adjuncts, hiring 2 ACWERN graduates)
- linking three universities together (AGM)
- enrollment of 24 students, over 25 alumni
- 40 projects, >50% with the Canadian Wildlife Service
- increasing university confidence in Canadian Wildlife Service at all levels from students to Vice-Presidents
- *ACWERN is considered to be a sound basis for a broader initiative*

7. A Vision for the Atlantic Environmental Research Network (AERN)

- AERN is being proposed to provide critical mass in Atlantic Canada, to:
- advance the capacity, efficiency and application of environmental science
- establish a broad, interactive network of government agencies and universities

- **implement coordinated environmental science strategies, and**
- **capitalize on funding and partnership opportunities**

8. Objectives of the AERN

1. to undertake high-quality relevant fundamental and applied research,
2. ensure effective links between researchers and supporting agencies to address conservation questions, and
 1. enhance education and practical training of students, and interchange among partners.

9. AERN will be a Network of Networks

- AERN - an over-arching network structure with several constituent cooperatives
- will be overseen by senior management council
- **membership: contributing federal and provincial agencies and universities**
- **role: oversee development and operations of network, coordination of member cooperatives**
- *pro tem* council was struck in March 2000

10. Characteristics of Cooperatives

- each cooperative would have:
 - **a research strategy and formal agreement**
 - **Management Board to oversee direction**
 - **partners would make tangible contributions:**
 - **universities with relevant research priorities**
 - **agencies with long-term funding commitments**
 - **other needs**, such as one university to lead, one agency to provide a coordinator, etc.
 - **Recognition that this endeavour will entail very substantial effort**

11. Initial Themes for AERN Cooperatives

- 3 themes selected on the basis of:
 - regional Environment Canada priorities and science needs
 - resource and partnership opportunities
 - a) Wildlife and biodiversity (an evolution of present ACWERN)
 - b) Freshwater and estuarine issues
 - c) Impacts of climate change
 - Other themes/interlinkages possible

a. Wildlife and Biodiversity (ACWERN)

Themes: Species at risk, protected areas, natural resource management

Universities: University of New Brunswick (UNB), Acadia University, Memorial University University of Prince Edward Island (UPEI), Université de Moncton?, Mount Allison University?, Dalhousie University, Others?

Government partners: Environment Canada-Canadian Wildlife Service (incl. NWRC), Parks Canada, Canadian Forestry Service (CFS), Dept. of Fisheries and Oceans (DFO), Others?

Funding partners: Canadian Wildlife Service, (CWS) National Science and Engineering Research Council (NSERC), CFI

Industry/private partners: AC-CDC, forestry companies, fishing industry

b) Freshwater and Estuaries

Themes: water quality, degradation of rivers and estuaries, impacts of pollutants

Universities: UNB, Acadia, UPEI, Mount Allison?, U de Moncton?, Dalhousie? Others?

Government partners: EC-NWRI, EC-CWS, Canadian Forest Service, DFO, Others?

Funding partners: EC-NWRI, NSERC (NCE), CFI

Industry/private partners: forestry companies, agriculture, municipalities

c) Climate Change Impacts

Themes: Coastal processes and marine currents, species and habitats at risk, Other?

Universities: Acadia?, Memorial?, Mount Allison?, Dalhousie?, UNB? Others?

Government partners: Environment Canada – Meteorological Service of Canada (EC-MS) EC-CWS, DFO, NRCan (CFS, Geological Survey), Others?

Funding partners: EC-MS, NSERC, CFI, CCAF, federal climate change initiatives

Industry/private partners: transportation sector, AC-CDC, forestry sector, fishing industry etc.

13. Purpose of This Meeting

- Is an opportunity to build on Meteorological Service of Canada initiatives e.g. AEPRI, Centre for Marine Environmental Prediction...
- Climate Change Impacts and Adaptation Network - an Atlantic Node of AERN?
- DFO Workshop (last week)
- Climate Change Action Fund

14. Status of AERN Proposal (as of mid May 2000)

- Concept developed, reviewed and supported by Environment Canada-Atlantic Region Regional Science Coordinating Committee and Regional Management Committee
- reviewed and supported by ACWERN Management Board and member universities (Acadia, UNB, Memorial)
- presentations and preliminary positive reactions from: Mount Allison, UPEI, U de Moncton and Dalhousie
- (awaiting further feedback)
- EC National Science & Technology Management Committee provided encouraging and supportive feedback

Concept builds on Friedman report (Strengthening Environmental Research in Canada) and is consistent with EC Science & Technology Advisory Board discussion.

- Science Policy Branch will assist with synopsis of NSERC, CFI, Millennial Chairs etc. program opportunities
- NWRI and NWRC confirm that they are supportive of the concept and willing to become actively involved
- Atlantic Provincial Wildlife Directors advised of initiative

- Deputy and Minister Briefed
- Letters to Cabinet and Caucus colleagues in the Region drafted to raise their awareness of the initiative
- Presented to Climate Change Workshop: Impacts, Adaptation and Networking

15. Next Steps for the AERN

- Continue to discuss with potential university partners , five national resources group of federal agencies (May - June)
- Consider funding options...
- approach NSERC to:
- **explore flexibility in allocation of millennium chairs to networks (the "6%")**
- **explore other network support programs**
- The Holy Grail - rumoured Atlantic Research Fund - a possible \$10-20M opportunity

16. For more information:

- On overall proposal:
 - **Dr. George Finney (506-364-5011)**
 - **Dr. Alex Bielak (902-426-6314)**
- On wildlife and biodiversity network, or on ACWERN:
 - **Dr. Richard Elliot (506-364-5014)**
- On proposed freshwater and estuarine network:
 - **Dr. Alex T. Bielak (902-426-6314)**
- On proposed climate change network, or on AEPRI:
 - **Mr. Dave Wartman (902-426-9132)**