ENVIRONMENT CANADA
ENVIRONMENTAL CONSERVATION BRANCH
ATLANTIC REGION ECOSYSTEM SCIENCE MEETING
DECEMBER 7-8, 1994

SUMMARY OF MEETING

COMPILED AND EDITED BY

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MAY 1995

ENVIRONMENT CANADA, ENVIRONMENTAL CONSERVATION BRANCH

ATLANTIC REGION ECOSYSTEM SCIENCE MEETING, DECEMBER. 7-8, 1994

SUMMARY OF MEETING

TABLE OF CONTENTS **Page**

I CONTEXT, EXPECTATIONS, OPPORTUNITIES

1. Context (G. Finney, E. Hiscock)

1.1 Introduction, Goals of Meeting

The meeting was opened by George Finney. He welcomed the visiting group to Sackville, and expressed his hope that the group would have a productive meeting. The overall goals of the meeting were described as (a) fostering an interchange between participants regarding their programs and possible new directions in research; (b) considering how to organize and plan our ecosystem-based science within the new Branch; (c) updating and discussing our knowledge of key regional conservation issues, and establishing priorities; and (d) preparing for the work planning cycle for FY95-96.

1.2 Environment Canada Resources and Program Review (George Finney)

An overview of the regional resource situation was presented, followed by a description of the current DOE program review, within the context of other current governmental reviews (Science and Technology; government grants and contributions; harmonization). It is clear that our overall program "lines of business" should be science, information for Canadians, the development of policies for "sustainability", and conservation of wildlife and water.

All of the program reviews have implications for our programs and our ways of working, some positive and some negative. Positive ones include Green Plan monies being available for A-base and programs such as ACAP, wildlife science, protected areas, and biodiversity; the ACWERN budget supplementing regional A-base; the opportunity to maximize networking and deploy "collective information"; the opportunity to start modest new programs, aided by the Informatics Group; and the concept of the "data centre". Negative aspects of the program review and other reviews include lost capacity and adaptability amongst staff; possible losses due to the DFO/DOE mandate/responsibilities review; outcome of the DINA review of its Arctic studies; and implications of library reduction/changes to our programs.

1.3 Implications of Changing Jurisdictions of DFO and DOE (E. Hiscock)

The status of the DFO/DOE working committee's progress on the changing mandates of the two departments regarding responsibilities for freshwater (DOE) and oceans (DFO), and the implications for DOE programs and staff, were described. Progress is slow and implications of the negotiations are uncertain at this time (Dec. 1994).

2. Implementing an Ecosystem Approach

2.1 Ecosystem Science-Based Approach (R. Elliot)

An overview of some useful definitions, advantages of the integrated ecosystem approach, dominant themes, and scientific elements of an ecosystem approach to managing a water body, such as the Bay of Fundy, was presented (see Appendix 1). The objective of the ecosystem approach is considered to be "maintenance and restoration of natural biodiversity". Elements of the approach include a number of inventories (physical, biological, stressors), a consideration of system functioning and processes, an assessment of impacts from stressors, a choice of management options, and monitoring. The challenges of starting a comprehensive analysis of the Bay of Fundy, including identifying "partners" and information sources, were described.

2.2 Ecosystem-based Planning Context (G. Howell)

An ecological planning framework for Atlantic Canada was described. It can be used by management groups for deciding issues and priorities. The framework presented was meant primarily as a planning and administrative tool for environmental conservation managers.

3. New Directions

3.1 Ecosystem Science Cooperatives (ESC's) (R. Elliot)

An initiative called ESC's has started, to facilitate multi-partner projects in specific geographic areas. The goals of ESC's are: (a) to coordinate studies and facilitate exchanges across traditional disciplinary boundaries; (b) to increase our effectiveness at protecting and conserving key habitats and ecosystems; (c) to increase regional ecological understanding, particularly addressing information gaps; (d) to focus scientific activity; and (e) to develop new ways to use our scientific information.

The national approach to ESC's is to focus on the functioning of ecosystems, the impacts of stressors, and how and why selected ecosystems change over time. Priority problems include the impacts of climate change, UVb radiation and toxic chemicals, and the need to monitor biodiversity across the country.

The Atlantic program of ESC's is composed of four geographic nodes, representing different ecosystems and stressors. The four nodes are located at: Bay of Fundy; St. Andrews/Passammaquoddy Bay; Kejimkujik Park; and Avalon Peninsula. The Fundy node is hosted by Fundy National Park, concentrates on forestry issues, and is coordinated by Tom Pollock. The St. Andrews/Passammaquoddy node is hosted by the Huntsman Marine Centre, concentrates on coastal issues, and is coordinated by Tom Clair. The Kejimkujik node is hosted by Kejimkujik National Park, concentrates on acid/toxic rain, and is coordinated by Geoff Howell. The Avalon node is hosted by Terramon, a multidisciplinary monitoring group at Memorial University that originated from Earth Sciences; ECB involvement is coordinated by R. Elliot, T. Clair and J. Chardine. There is also the possibility of selecting a site (node) in PEI, hosted by the University of PEI, focussing on agricultural issues.

There will be an Atlantic Region ESC Workshop in February 1995, to select the PEI site, and assess regional priorities and approaches for research and monitoring. This workshop falls after the January EMAN (Environmental Monitoring Area Network) meeting in Burlington, Ont., where national research and monitoring priorities (department-wide) will be discussed.

3.2 ACWERN (Atlantic Cooperative Wildlife Ecology Research Network) (T. Diamond)

This Network is established, with Chairs at University of New Brunswick (UNB, Fredericton), Acadia (Wolfville), and Memorial University (MUN, St. John's). Tony

Diamond is at UNB and Phil Taylor will be at Acadia University shortly. The position at MUN is not yet filled (Dec. 1994).

The Networks' goals are to enhance DOE/university joint research activities in wildlife ecology, to focus on ecological indicators and their use in research and monitoring, to offer advice to governments, to offer opportunities for training assignments for government staff, to enhance practical wildlife training at the graduate level, and to promote cooperative initiatives such as research workshops. The three areas of focus in Atlantic Canada are forest ecology (UNB), marine ecology (MUN), and conservation ecology (Acadia), with leadership and research activities expected at all locations. The Network currently has 5-year joint funding from DOE and NSERC.

Dr. Taylor spoke briefly about his research interests in population ecology and landscape ecology, focussing on insect ecology and their response to landscape structure. He is particularly interested in "deep-system" modelling.

3.3 Environment Canada Laboratories as a Science Resource (P. Hennigar)

The current organizational structure of the Environmental Quality Laboratories (EQL) located in Dartmouth, Moncton and St. John's was described. A brief overview of EQL's chemistry and toxicity expertise and extensive analytical and consultative capabilities was described. Traditional linkages to EPB and ECB programmes and projects were identified. In addition to collaborating on environmental studies with regional clients, the laboratory also is involved in on-going research and development with regional and national scientists, industries, universities, as well as environmental agencies in the USA. Examples of cost-recovery environmental studies (~$300K in FY94-95) are the Gulf of Maine Monitoring Program and the NOAA oil spill remediation studies. The laboratory's integrated chemical and biological approach to ecosystem contaminants and bioeffects monitoring was discussed. It was emphasized that the laboratory's chemical and toxicological expertise is a valuable science asset and ECB resource.

4. Maintaining Biodiversity

4.1 Implementing the Canadian Strategy on Biodiversity (Trevor Swerdfager)

Trevor's talk was meant to foster a discussion of science issues and priorities for ECB. He stated that in the current DOE Program Review, there has been a strong emphasis on ecosystem science, and a stated desire "to move to biodiversity" as an issue. In the Science and Technology Review, the link between science and economic prosperity is emphasized. As part of the federal-provincial harmonization exercise, an environmental management framework is being developed for CCME, and the federal government is being identified as the "science provider", with a focus on regional science.

The presentation considered:
- the needs of ecosystem science (are we doing it? How do we move the ecological planning framework forward?);
- the inventory of priority issues (What are they? Are we doing work on them? Cost implications?);

- the science needed in support of migratory bird management;
- monitoring and data management (Do we know what ecological monitoring is? Do we support the concept of indicators? Are we developing or should we be developing better indicators? Are DOE data bases (which??) appropriate for inventories and monitoring?); and
- biodiversity science roles (what is the nature of our role? How to establish better links to the university community, and others?).

Biodiversity science priorities were discussed. It was suggested that research should focus on key threats or stressors, such as forestry in N.B., agriculture in P.E.I., forestry and agriculture in Nova Scotia, and coastal and pelagic threats to seabirds in coastal Newfoundland. In Trevor's opinion, research should not focus on aquatic and marine habitat issues. This opinion was not shared by many other attendees.

We should also be involved in inventories (protocols and priorities), and monitoring and assessment (data sharing; ecological monitoring theory). "DOE is a science leader, and we should be catalyzing and fostering ecosystem science".

4.2 Implementing the Environment Canada Science Assessment (J.A. Keith)
Tony gave an overview of the Biodiversity Convention, signed at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil, in 1992 and described its implications to work in DOE. He introduced the recently published report "Biodiversity in Canada: A Science Assessment for Environment Canada" (Keith *et al.* 1994), and summarized some of the sections of interest (e.g. toxics).

4.3 Considering Biodiversity - the Fundy Model Forest Example (G. Parker)
Gerry described the recent model forest project in New Brunswick.

II HOW SHOULD ECB-AR ADDRESS SCIENCE-BASED ISSUES?

Overview and need: The prime objective of the Fundy Model Forest is to improve knowledge of ecosystem function and to better understand the responses of that system to forest disturbance, and from that knowledge to improve our ability to develop a multiple resource management plan within the concept of sustained, or enhanced environmental quality. There is an initial need to expand and complete certain data bases for resources within the FMF, and to measure the responses of wildlife resources to specific forest interventions and silviculture practices. Research must concentrate on establishing cause/effect relationships and with those results develop improved forest *ecosystem* management strategies. Single use is being replaced by multiple use within the concept of sustainability. Forest management guidelines must be tested and refined based on data sets generated from specifically designed and scientifically ri8gororus experimentation. It requires cooperation and coordination among biological disciplines and between the scientific and industrial communities.

Objectives: The primary objective of the Hayward Brook study is to measure the responses of aquatic and terrestrial systems to timber removal and subsequent forested stream buffers of various widths.

Hypotheses/questions:

1. Are forested stream buffers capable of supporting viable populations of breeding birds normally associated with larger contiguous stands of similar structure? small mammals? amphibians?
2. Is water quality/quantity impacted by protected forested buffers of 30 m? 60 m? selective removal within buffers?
3. Do forested stream buffers of various widths adequately protect populations of fish?
4. What species of trees do primary cavity nesting bird species select for?
5. Can information from #4 be used to modify present "snag" regulations during forest harvest operations to enhance value of cutting modifications to wildlife?
6. What is the use of forested stream buffers by wildlife in winter?
7. Are mortality rates of wildlife species immediately impacted by the physical process of timber removal? If so, quantify.

5. Three Ecological Issues

5.1 Ecological Impacts of Climate Change (A. Diamond)

Tony started his discussion with a consideration of definitions (global change; climate change; atmospheric change). These are not the same. He then discussed a fundamental problem to defining the scope and implications of climate change, one of ensuring that our measures are the right ones, that we understand what the ecosystem (s) is (are) responding to, and that we know which set of signals of the ecosystem under study should be measured. The example of the flowering plant monitoring system was described.

Tony discussed the example of carbon dioxide production, as a model of climate change effects on biome distributions in Canada. He talked about the need for long-term data sets, such as the 35-year set at the Long Point Observatory, Long Point, Lake Erie, Ontario, on weather patterns and bird migratory patterns. There is the need to understand cause-effect relationships in the field, and to establish possible impacts of climate change on wildlife. In this context, he described the example of the tree swallow, where variation in the weather appears to be a major controlling variable to its distribution, migratory habits/patterns, breeding success, and population numbers.

5.2 Ecological Impacts of UVb. Should we be concerned in Atlantic Canada? (Tom Clair)

Tom gave a brief overview of the UVb problem. He described UVb radiation, its potential effects on ecosystems, and possible ramifications to ecosystems in the Atlantic Provinces. He stated that the effects on ecosystems (terrestrial and aquatic) are largely unknown, but that there are many concerns, not the least of which is the potential of UVb for initiating cancers in exposed organisms. Stratospheric ozone levels, which provide protection from UV radiation, are declining, based on data from 1960 onwards. There is considerable evidence of effects of UVb on terrestrial plants, and on phytoplankton. Primary production can decline as much as 12-15% under UVb exposure. In the field, Chironomida are affected, as are some herbivores. Hydrogen peroxides are produced, and these can be toxic. The aquatic system as a whole is complex and variable in its overall response to UVb.

Implications to habitats in the Atlantic Region appear to be numerous, in terms of the ecosystem health of tidal flats, bogs and marshes. UVb may be implicated in changes in tidal flat sediments, though this is a hypothesis at present. There may be links to changes in humic acids in lakes at Kejimkujik National Park. There are concerns about wetland effects from increased UVb.

Tom described the potential regionally for working on this problem. There is instrumentation and expertise regarding plant ecology and ecophysiology at the Agricultural College, Truro. John Cullen at Dalhousie University conducts research on UVb. As well, Dr. Irena Kasmirsha (Mount Allison), Tony Diamond (UNB), and Kevin Percy (Forestry, Fredericton) all have an interest in UVb.

Why should we be concerned? There is preliminary evidence of effects on plants. Discussion focussed on opportunities for studies in the field on amphibian eggs/embryo masses (as an indicator of extent of effect in region), and the potential to conduct laboratory experiments on UVb effects on diatom starch and implications for tidal marsh sediment changes in composition. The group was asked to think about UVb and its effects, and new projects that could be undertaken.

5.3 Seabird and Marine Ecosystem Priorities: Eastern Canada (D.N. Nettleship)
Marine waters in Arctic and Eastern Canada are influenced by sea ice during at least part of the year and comprise waters of the high arctic, low arctic and boreal oceanic zones. Eco-regions for seabirds separate into seven distinct regions, each with their own specific dynamics, food webs and biogeochemical characteristics: Baffin Bay, Southern Davis and Hudson Straits, Labrador Sea, Gulf of St. Lawrence, East Newfoundland Funk-Fogo Banks and Newfoundland Grand Banks, and Scotian Shelf-Bay of Fundy-Gulf of Maine. Intensive studies of the reproductive ecology of colonially-breeding seabirds and their distributions at sea throughout the year have been performed in each region since 1971. Much of the effort has been directed toward relating the patterns of the occurrence of top-trophic seabird feeders to the physical and biological characteristics of marine environments, particularly in the colder high and low arctic waters of eastern Canada. The drive behind most of these studies has been to learn about the ecological requirements of seabirds and the ecosystems that they occupy. This should enable identifying sources of problems and predicting the effects of human activities such as mineral and petroleum developments and commercial fisheries on the marine bird biota of the wide continental shelves of eastern Canada. This research activity has led to a comprehensive network of baseline study sites in all seven water regions that includes a solid understanding of the structure and energy pathways within these temperate and arctic communities and food webs. Summaries can now be made of major energy flows in the upper trophic levels of coastal and offshore waters.

Seabirds display a marked non-random pattern of distribution in their marine environment. They return to land to reproduce, often forming immense single-species or mixed-species colonies. These breeding places represent compromises between the oceanographic conditions that provide an adequate and predictable food supply and land sites within range of this food source with available nesting sites and few ground predators. Locations meeting these requirements are few. During the non-breeding season, the birds are usually restricted to nutrient-rich waters and/or upwellings and "fronts" or other oceanographic mechanisms that bring food to the surface and concentrate it there. One obvious consequence of this clumped distribution throughout the year is a high risk of exposure of seabird populations to pollution and other hazardous human activities. Major threats in Atlantic Canada include the direct effects (competition for food, human-induced fishery collapses) and indirect effects (by-catch, entanglement and drowning) of commercial fisheries, offshore petroleum developments (e.g., Hibernia), toxic chemical poisoning (e.g., chlorinated hydrocarbons; metals - mercury, cadmium, selenium; plastics), human predation and disturbance (e.g., winter hunting of murres, habitat alteration, tourism, etc.), and climate change. Precisely how these disturbances and environmental stresses affect marine life and ecosystems is by no means clear. But some seabird species are now showing marked changes in population size and status, changes known to be associated with the widespread industrial expansion and marine resource development occurring in all oceanic zones.

The present conservation needs for eastern Canadian seabirds, particularly the more specialized colonially-breeding species, require the total protection of the most important breeding colonies (land and adjacent waters) and key feeding areas both inside and outside the breeding season. Sites used for reproduction require protection from the many sources of human disturbance, both direct and indirect. A regional and national system of enforcement must be developed to ensure that regulations are respected and effective in the attainment of management and concertino objectives. At a systems level, much more multidisciplinary effort is required to increase our knowledge of the important marine processes that determine the temporal and spatial patterns of seabird distribution through the annual cycle and to elucidate links between ecosystem production and organisms in the upper trophic levels. We must develop a more synoptic view of marine ecosystems, and by doing so better understand the factors and processes affecting the distribution and abundance of seabirds in eastern Canadian waters. Only in this way can we expect to succeed in the formulation of a meaningful conservation policy and the identification of processes and actions by which seabird diversity and abundance can be protected and maintained.

6. Workshops

6.1 Assessing and Addressing Science Issues, Priorities, and Needs

The workshops were organized around a number of environmental/conservation issues, and seven questions (presented as given):

(1) How is our issue science-based?
(2) What are the main causes/sources of ecosystem impacts from this stressor?
(3) In which ecozones and ecosystems in the region is this problem most important?
(4) What role should Environment Canada's ecosystem science-based programs play in addressing this issue?
(5) What capacity doe E-Atlantic have to undertake ecosystem-based science programs related to this topic?
(6) Is this issue a regional science priority? Do we direct more or less of our diminishing resources towards it?

(7) What better ways are there within the Branch (ECB) to address this issue from an ecosystem science perspective?

6.2 Workshop One - Agricultural Impacts (G. Howells)

Main agricultural issues that were identified included habitat loss, alteration and fragmentation; waste management; irrigation and other water use, affecting quality of return flows; soil erosion and in-stream siltation; genetic manipulation; pest management, through biological and chemical population control.

The group considered that the Maritime Upland/Lowland and the Northumberland ecological zones would be the predominate areas of agricultural impacts and concerns. Two science goals were identified: a) To evaluate and document current land management options that can be employed to maintain critical habitats, such as riparian zones, buffer strips and vegetated corridors; b) To link land management activities to surface and groundwater quantity and quality.

To accomplish the first goal, there is a need to obtain better landscape level knowledge of agricultural practices and activities. Although the group felt that agriculture was not a growing activity in terms of total acreage, it was probably changing in terms of farm activity (e.g. abandonment, rotation, additions, cropping practices). There is a strong need for a landscape level review of agriculture, identifying both the function and form of the activity.

To accomplish the second goal, there is the need to develop a more intensive study area, such as a research watershed where process level research, monitoring and modelling could be conducted. It would require extensive partnerships to bring together the necessary skills and resources. The Ecological Science Cooperative proposed for PEI could serve as a catalyst for this activity.

The extensive and intensive approaches proposed for studying agricultural impacts on habitat and water quality were not seen to be disconnected activities. A preliminary landscape analysis could precede the intensive work, providing some direction and focus to the intensive research activities. This approach would help to alleviate some of the research design problems of the Fundy Model Forest (described by Gerry Parker). In addition, the group believed that it was necessary to move the results of the intensive study area (Goal two above) back to the landscape level (Goal One above), if management decisions were to be influenced.

6.3 Workshop Two - Forestry Impacts (Gerry Parker)

There was general agreement that the study of forest ecosystems and the impacts of forest management upon those systems is a highly relevant science-based issue in Atlantic Canada. Measuring the responses of terrestrial and aquatic biota to forest disturbances, both natural (Fire, disease) and human induced, and studying ways to mitigate or eliminate adverse impacts of disturbances upon these biota, should be considered a priority. The issue is urgent because other agencies and institutions are not developing a practical research agenda. Changes to forest ecosystems are planned and carried out by people trained in growing trees! They have little understanding of the vast array of other life forms dependent upon the forest environment. Forestry operations are significantly changing landscape biodiversity. Understanding the impacts of those changes on regional biodiversity should be a major input into regional biodiversity strategies for the Branch (ECB).

The impacts of forestry operations on forest ecosystems are perhaps the most obvious of all stressors on environmental systems in the Region. Large clearcuts not only look bad. They also denude large areas of forested habitat. The effects of such rapid deforestation on species, populations and communities dependent upon the complete and undisturbed forest environment are obvious. What is less obvious is the long-term response of biota to loss of mature forested habitats. Do these systems recover over time, and if so, how and over what time periods? Are there long-term negative impacts to ecosystem integrity from multiple short-term harvest rotations?

In which ecozones and ecosystems in the region is this problem most important? There was little discussion on this issue, as the problem of deforestation is widespread throughout most conifer-dominated forest ecosystems in the Atlantic Provinces. Changing technology, where more use is being made of deciduous species, is now threatening the integrity of forest ecosystems once thought to be immune to such intensive forest harvest and management.

Environment Canada should play the lead role in studying the function of forested ecosystems, and the responses of those systems to timber harvest operations. The department should also advise, based on credible science, how provincial forest management guidelines might be modified to ensure the sustainability of all components of forested ecosystems, and to maintain biological diversity in the region.

What capacity does DOE-Atlantic have to undertake ecosystem-based science programs addressing this critical land-use issue? Not a great deal of capacity exists, but DOE does have the framework of expertise on which to build and develop that capability. Ecosystem research must be multi-disciplinary in scope, and it must integrate the capabilities which are found within both the federal and provincial governments, and at the universities. With the addition of the Wildlife Research Coops (ACWERN) at UNB, Acadia and Memorial, our capabilities for involvement have been greatly enhanced. A first step might be a regional workshop to identify major issues and players. The need for tracts of wilderness as outdoor laboratories was identified, for integrated research on the response of forested ecosystems to planned interventions. The need for closer cooperation between government and industry was also apparent.

This issue is certainly a regional science priority, and we should be directing more of our resources towards it.

Are there better ways within the Branch (ECB) to address this issue, from an ecosystem science perspective? Participants again reiterated the need for outdoor "forested laboratories", where the responses of forest ecosystems to planned interventions are measured. These "forest-wildlife experimental stations" would be used as working forests - timber could be extracted in a fashion allowing for rigorous testing of scientific hypotheses. Several of these experimental areas throughout the region would be preferred; each would be administered by integrated management and technical committees. Much of the research could be encouraged and channeled through universities in the Region.

6.4 Workshop Three - Coastal Resource Utilization (P. Hicklin, J. Arbour)

The session on coastal resources opened with the participants agreeing that the focus of discussion would address **stresses on coastal resources.** Identifying stresses on coastal environments is a "knowledge-driven exercise" that requires scientific knowledge of marine ecosystems and their components.

The scope and meaning of the term "coastal zone" was discussed. The group agreed to consider that the coastal zone included the area from the edge of the continental shelf through to the headwaters of watersheds that drain into the coastal waters of eastern Canada.

The group then focussed its attention on the identification of principle stresses on coastal resources. Five categories were identified: pollution sources, resource extraction, climate change, genetic effects and coastal development. Within each category, a number of specific stressors were identified:

a) Pollution sources - land-based sources (point sources, non-point sources and atmospheric deposition); marine-based sources (shipping, oil production, disposal at sea, aquaculture).

b) Resource extraction - minerals (metals, industrial minerals); rockweed and fish harvesting.

c) Climate change - oceanographic variability, global warming, changes in the severity of events.

d) Genetic effects - introduction of non-indigenous species, through ballast water and through losses from aquaculture sites.

e) Coastal development - settlement, industrial activities, coastal engineering, ecotourism.

The working group then identified where these pressures were most dominant in the Atlantic Region. These were summarized by Ecozone (available from the Chair of the Session).

6.5 Workshop Four - Toxic Chemicals (N. Burgess)

This workshop was attended by J. Arbour, N. Burgess (Chair), J. Dublin, P. Hennigar, D. Leger, H. O'Neill and P. Wells.

A long list of sources of toxic substances of concern to the Atlantic Region was identified. These included municipal outfalls and urban stormwater, mining effluents and runoff, other industrial effluents (pulp and paper; petroleum refining), products transported by ship (oils), aquaculture products (pesticides, drugs, wastes), waste crankcase oils (with PAHs), anti-foulants and textile effluents. These were priority substances. Non-priority substances included agricultural and forestry chemicals, urban runoff, and toxics from air-borne sources, both passively carried by the air, and in biological vectors. Specific substances included those on the Priority Substances

List of CEPA, waste crankcase oils, industrial lubricating oils, chlorinated paraffins, and metals such as mercury.

A number of gaps in current work or information were identified. These included current contaminant release data for local industries (end-of-pipe data) rationale to revise, National Pollutants Release Inventory cut-off limits , exposure concerns, the need for hazard assessments regionally, and specific toxics research. Identifying suitable indicators for chlorinated compounds, identifying test cases for hazard assessments, making greater use of biomarkers, and linking research to EEM needs re pulp mills and mines were discussed.

The workshop group worked through a number of toxic chemicals, and concluded that the conduct of a hazard assessment of mercury would be worthwhile, in an Atlantic Canada context. This mercury hazard assessment should begin by drawing together research partners and their existing data. Once the available data is compiled, a workshop would be useful to assemble the partners to work through a screening-level hazard risk assessment. This would demonstrate our ability to conduct ecosystem-based risk assessments of toxic chemicals and would better resolve the potential ecological threat of mercury in regional aquatic ecosystems.

6.6 Workshop Five - Air and Atmospheric Issues (T. Pollock)
This workshop was attended by Tom Pollock (Chair), Peter Eaton, Eric Hiscock, Tom Clair, Geoff Howell and Steve Beauchamp.

Issues fell into two distinct groups: 1)local, such as persistent organic pollutants (POP), volatile elements (Hg,Pb), ground level ozone and acid rain; and 2) global, such as climate change and ozone depleting substances with their attendant increases in UVb radiation at the earth's surface.

The method used in the acid rain program was considered to be an effective model to follow for issue resolution, i.e. choose a sensitive land/seascape, measure effects on suitable indicators, decide on the actions necessary to protect and/or restore those indicators, test those on the landscape under study, then transfer the knowledge to ever larger systems. Such a methodology is based on elucidating and understanding processes. Success in using that methodology in the Atlantic Region is reflected in that we now use chemistry of dilute surface waters and salmonid reproductive success as monitors of the effectiveness of controls on the industrial emissions of SOx and NOx.

Active discussion then focussed on which of the identified issues should displace acidic depositions as "the issue of the day"! The group felt that controls on lead in gasoline have led to a reduction of that element in circulation in the atmosphere, to the extent that it is no longer an acute concern. Mercury, on the other hand, is once again of concern because of reported concentrations in sport fish, snow and feathers of birds of prey. While the ability to measure Hg in air, fish and fish-eating birds exists, our capacity to conduct these measurements is limited, and will require partnerships as well as the judicious use of appropriate modelling.

Group recommendations were that E-AR air and atmospheric issues should be Hg, POP in birds and aquatic organisms, ground level ozone in the Bay of Fundy (together with the Canadian Forestry Service and New Brunswick government), and the effects of UV-B on diatoms (purported to secrete starches contributing to the consistency of the muds and mudflats in the Bay of Fundy). We must also continue to operate the meteorological and hydrometric stations that have been used as monitors for the long term trends of climate change, as well as measure atmospheric CO2 at Sable Island.

The Group recommended that the 'ecosystem planning framework' (see Howells presentation above) be adopted to analyze all of the available information on the above issues. Once the analyses are completed, project teams will have identified the expertise, resources and partners necessary for successful completion of the studies on the priority list.

6.7 Workshop Six - Habitat Loss and Fragmentation (A. Smith)

Habitat loss and fragmentation is a science-based issue. Some points of justification included:

(a) We must focus research on habitat function to determine which important features of habitats are to be protected;

(b) We need better management of protected lands, so that they do not become "islands of green" separate from other habitat pockets; and

(c) Both form and function of habitats are important, as are the characteristic needs of the population of organisms of interest, when assessing habitat loss.

Habitat is more than just a geographic site or location. It has quantifiable features. A habitat can appear still to be intact, however its important qualities may have gone. An example of this phenomenon may be the recent changes to mud flats in the Dorchester Cape area. The mud flat is very much still there; however, due to changes in water content of the flat, it is no longer able to sustain the enormous numbers of *Corophium volutator* that migrating shorebirds rely upon so heavily (Hicklin, pers. comm.).

In order to assess habitat loss and fragmentation, several factors must be considered. These include area, edge, shape, juxtaposition, number, distribution and extent. No single expert can undertake a meaningful analysis of habitat. We must involve several members of a team with complementary fields of expertise. Specifically, the expertise of the habitat biologist should be used to interpret implications of habitat patterns for various attributes of wildlife populations.

Causes of habitat loss and fragmentation include agriculture, forestry, transportation, urbanization, resources extraction, hydro-electric development, land ownership patterns, and natural processes (e.g. fire, erosion). The areas in the Maritimes considered to be most seriously affected by habitat loss and fragmentation are the Northumberland (including Prince Edward Island) and Fundy Ecoregions. These zones were chosen because of the continuing nature of this problem in these coastal areas.

Many current CWS and Branch-wide initiatives were identified as helping to address habitat loss: These include the Atlantic Region Conservation Areas Database, the

Atlantic Conservation data Centre, the monitoring of land use changes, and the Atlantic Coastal Action Plan. Expanding certain aspects of these programs and initiatives would greatly enhance them, through for example increased public involvement, integrating wetlands data into the GIS system, and updating information on coastal islands.

7. Conclusions of the Meeting

Eric Hiscock and Richard Elliot concluded the meeting. Richard expressed the wish that everyone should consider Howell's framework in more depth, and keep the process going of interaction and joint projects of mutual interest.

8. Summary - A Perspective (P.G. Wells)

As environmental scientists, we live and work in extremely challenging times. The number of problems facing the environment and its living resources in Atlantic Canada, as elsewhere, seems to be increasing in number and complexity. Some problems are proving to be extremely difficult to resolve.

To make progress as a new Ecosystem Science group, we will need to be increasingly selective as to the problems we choose to study, and be able to focus and ask critical answerable questions. Hence the workshops above, which were a beginning of this sorting process. In addition, we should practice science, and not be solely the purveyors of scientifically-based information.

In the context of the above meeting, I hope we will have many opportunities to discuss the selection of appropriate methodologies and to consider the resources necessary to conduct research of excellence. The importance of protecting and conserving critical regional habitats and species dictates that we must succeed in this new venture together.

Acknowledgments

Many thanks are due to all of the contributors for their verbal and written presentations, and their notes and comments post-meeting. Since many sections were written from notes taken at the meeting, any errors are to be attributed to the editor, with apologies in advance!

APPENDIX 1 THE ECOSYSTEM SCIENCE - BASED APPROACH (R. Elliot)

IMPLEMENTING OF AN ECOSYSTEM-BASED APPROACH FOR ENVIRONMENT CANADA IN THE ATLANTIC REGION

Richard Elliot - 23 November 1994

Where do we want to go (and why?)

and

How do we get there from here (and what has to change?)

But first:

Where are we now?

WHY DO WE NEED AN ECOSYSTEM-BASED APPROACH: THE BAY OF FUNDY CASE STUDY

The problems:

- changes in distribution and timing of migrating sandpipers
- disappearance of migrating phalaropes from Passamaquoddy Bay
- changes in composition and densities of intertidal invertebrates
- changes in sediment composition of mudflats
- continued shellfish closures
- others: reduced salmon numbers, changed lobster distribution etc.

Possible contributing causes (stressors):

- natural perturbations: 18 year-cycle, climatic changes
- changes in water flow into the bay, and currents within it
- changes in landscape use and chemical inputs into the bay
- local stresses: baitworm harvesting
- broad stresses: increased UV-B, climatic changes

The challenge:

- assessing the relative importance of potential causes and their cumulative impacts
- understanding the mechanism of impacts to develop approaches to mitigate them
- developing and implementing actions that may involve the whole Bay

- these can best be addressed through a broad approach that considers the problems and solutions from an inclusive ecosystem perspective, involving expertise of non-traditional partners

OBJECTIVE OF AN ECOSYSTEM-BASED APPROACH:

"AN INTEGRATED APPROACH TO EVALUATING AND MITIGATING IMPACTS OF STRESSORS ON ECOSYSTEMS, TO MAINTAIN ECOSYSTEM INTEGRITY AND NATURAL BIOLOGICAL DIVERSITY."

An approach that:

- is inclusive in taking a broad view of how ecosystems work, and where their weak links are,
- considers how stressors (e.g. forestry activity, UVB, hunting, pulp mill effluents, aquaculture) interact and affect components and functions, to minimise these impacts
- takes advantage of the breadth of knowledge available, within and outside our department, but requires changes in individual approach
- by providing an ecosystem context with a broad perspective, it helps clearly identify and prioritise issues, and ensure individual activities contribute to common goals
- fulfils sectoral needs more completely, with synergistic benefits from interacting with other sectors

SOME WORKING DEFINITIONS:

Ecosystem:

- *"a dynamic complex of plant and animal communities and their associated non-living environment"*
- no fixed boundaries; parameters set by scientific, management or policy questions being asked

Ecosystem Integrity:

- *"the components of native ecosystem diversity (e.g. species, populations, ecosystems) and the ecological patterns and processes that maintain that diversity"*
- based on complex linkages and inter-related functions, includes abiotic components

Ecosystem Management:

- *"integration of scientific knowledge of ecological relationships within a complex socio-political and values framework, to protect ecosystem integrity in the long-term"*
- combines science with social, cultural, economic perspectives

Biodiversity (Biological diversity):

- *"the variety and variability of living organisms and the ecological complexes in which they occur"*
- includes genetic, species and ecosystem diversity
- species diversity: *"the number and distinctiveness of species in a site or habitat"*
- **goal:** maintaining and restoring our natural biodiversity

DOMINANT THEMES OF ECOSYSTEM MANAGEMENT APPROACHES

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1. Hierarchical Context
- taking a systems perspective combining different hierarchical levels

2. Ecological Boundaries
- using ecologically meaningful boundaries, not political ones

3. Ecological Integrity
- based on components and processes that define natural ecosystems

4. Data Collection
- more information needed, better use of current data

5. Monitoring
- evaluating effects of management actions, information feedback loop

6. Adaptive Management
- scientific knowledge considered provisional, management is iterative learning process

7. Inter-agency Cooperation
- ecological boundaries necessitate inter-agency cooperation and integration of approaches

8. Organisational Change
- requires changes in agency structure and operational approach

9. Humans as Part of the System
- we have fundamental influences on ecological processes, and are in turn affected by them

10. Values
- human values play dominant role in ecosystem management goals

SCIENCE COMPONENTS OF AN ECOSYSTEM APPROACH

1. Inventories of Physical Parameters 2. Inventories of Biological Components 3. Inventories of Ecological Stressors	**MONITORING**
4. Function of Physical Systems 5. Function of Biological Systems 6. Impacts of Stressors on Ecological Systems	**RESEARCH**
7. Management and Conservation Actions	**MANAGEMENT**
8. Assessments of Actions on Ecological Systems	**MONITORING**

CURRENT FOCUS AND EXAMPLES OF ECOSYSTEM-RELATED SCIENTIFIC ACTIVITIES BY EC-AR BRANCHES

	Monitoring	Research	Management
1. Inventories of Physical Parameters	**AEB** - weather, climate, hydrology **ECB** - water quality		
2. Inventories of Biological Components	**ECB** - birds, habitats, landscape change		
3. Inventories of Ecological Stressors	**AEB** - LRTAP, UVB **EPB** - industrial effluents, air emissions **ECB** - oiled birds, LRTAP, habitat loss, forestry		
4. Function of Physical Systems		AEB - hydrological cycles, air flow models ECB-PS - LRTAP,	
5. Function of Biological Systems		**ECB** - migratory bird systems, habitat functions EPB -shellfish, indicator species	
6. Impacts of Stressors on Ecological Systems		**ECB** - LRTAP, toxics, integration/modelling EPB - industrial effluents, toxics AEB - LRTAP?	
7. Management and Conservation Actions			**ECB** - species and habitat management **EPB** - industrial impact advice and regulations AEB - ?
8. Assessments of Actions on Ecological Systems	**EPB** - industrial compliance, effects, effluents ECB - monitoring managed populations, habitats	ECB - evaluation of management options	

CHANGING PRIORITIES OF EC-AR ECOSYSTEM-RELATED SCIENTIFIC ACTIVITIES

	Monitoring	Research	Management
1. Inventories of Physical Parameters	**Current** - major, emphasis on water and weather **Future** - reduce, focus on selected areas or priorities		
2. Inventories of Biological Components	**Current** - moderate, focused on birds **Future** - increase?, broaden to biological diversity, with partners		
3. Inventories of Ecological Stressors	**Current** - moderate **Future** - re-orient to changing priorities, involve partners (ESCs)		
4. Function of Physical Systems		**Current** - minor **Future** - re-orient to ecosystem functioning	
5. Function of Biological Systems		**Current** - minor, bird focus **Future** - increase, broaden to ecosystem functioning (use ESCs)	
6. Impacts of Stressors on Ecological Systems		**Current** - moderate **Future** - increase, broaden to address cumulative impacts (use ESCs)	
7. Management and Conservation Actions			**Current** - major, focused on single issues or species **Future** - broaden to reduce cumulative ecosystem effects
8. Assessments of Actions on Ecological Systems	**Current** - moderate, focused on single issues **Future** - re-orient to address cumulative effects, involve others	**Current** - minor, focused on single issues **Future** - re-orient to consider cumulative effects	

DEVELOPING MANAGEMENT OPTIONS USING THE ECOSYSTEM APPROACH:
THE BAY OF FUNDY EXAMPLE

	Agencies Involved
Physical Inventories and Trends	
• sediment composition	ECB, AGC
• tides and currents	DFO, AGC
• river discharges and inputs	AEB, ECB
Biological Inventories and Trends	
• shorebird counts and changes in numbers	ECB, Acadia
• changes mudflat invertebrate composition	ECB, Acadia
• planktonic invertebrate composition and changes	ECB, DFO
Inventories and Trends of Stressors	
• shoreline management, barrages	municip./provinces
• toxic chemicals, water quality	EPB, ECB, DFO, AgC, provinces
• UV-B	AEB, universities
• baitworm harvesting	Acadia, ECB
Functioning of Physical Systems	
• sediment erosion, transport and deposition	AGC, Acadia, ECB, AgC
• role of river inputs	ECB, AEB
Function of Biological Systems	
• biological components of mudflat systems	ECB
• biological components of water column	ECB, DFO, Huntsman
Assessing the Impacts and Inter-actions of Stressors	
• impacts of toxics on sediment-dwelling organism	EPB, ECB, universities
• UV-induced mortality of diatoms or invertebrates	ECB, universities
• baitworm harvesting on mudflats	Acadia, ECB
• eco-tourism	ECB, NSDNR
• barrages, currents and sediment dynamics	AGC, DFO, universities

Developing Management Options

- following an assessment of impacts and options for mitigation

IF WE'RE COMMITTED TO AN ECOSYSTEM BASED APPROACH FOR EC-AR,

ARE WE READY TO:

- apply the approach to planning and operations **in every Branch**?
- implement the planning approach for **1995-96?**
- explain it to our staff and **involve them in changes** needed to make it work?
- **develop ecosystem-based and issue-based teams**, and assign our staff and managers to lead and participate in them **this year**?
- **assign managers to decide the key issues** EC should address, their relative priority, and consequent management objectives?
- **reduce the priority to some of our current operations** if they don't rank high on an ecosystem-based scale?
- **identify new skills** and expertise needed to make the approach work, and decide how to **find them** through staffing, re-training and partners?

APPENDIX II PARTICIPANTS

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