

International Air Issues Workshop

*Waterton Lakes National Park
June 5-8, 1995*



Sponsored by Parks Canada / U.S. National Park Service





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Executive Summary	3
Acknowledgments	7
Introduction	9
Status of U.S. Acid Rain Program and Current Assessment Activities	11
Canadian Environmental Legislation Relating to Air Quality	15
Air Quality Management in Alberta	19
Smoke Management and Visibility Protection: Two Major Initiatives of the British Columbia Ministry of Environment, Lands & Parks Air Resources Program	33
Montana Air Quality Issues	45
The U.S.–Canada Air Quality Agreement	49
Canada–U.S. Air Quality Agreement	53
Activities of the International Air Quality Advisory Board	57
U.S. National Park Service Roles and Responsibilities	65
Air Quality Issues, Monitoring and Management in Canadian National Parks	75
The Northeast Regional Air Quality Committee (NERAQC) – A First Adventure Into Cross-Border Cooperative Action on Air Issues and Protected Areas	95
U.S. Fish & Wildlife Service Air Quality Roles and Responsibilities	107
International Air Issues Workshop, U.S. Forest Service Roles and Responsibilities	111
Air Quality Monitoring in U.S. National Parks	117

Shenandoah National Park Case Study	127
Grand Canyon National Park Case Study	137
Canadian Air Quality Monitoring Program	143
Integrated Ecological Monitoring and Atmospheric Issues in Kejimikukik National Park . .	169
Jasper National Park – Particulate and PAH Studies	185
Discussions: Questions and Results	195
Commentary and Recommendations: U.S. National Park Service Perspective	203
Recommendations for Parks Canada	205
Workshop Commentary from Environment Canada	207
Participants	209
Narratives	215
Selected Air Quality Publications and Videos	229



Executive Summary

The workshop was triggered by the 1991 Canada-U.S. Air Quality Agreement which recognizes that transboundary flows of polluted air affect national parks and wildernesses. Sixty scientists and resource managers came from American and Canadian park services and sister agencies to discuss air pollution, its impacts on parks and visitors, and how to improve air quality through international partnerships. The first day consisted of presentations outlining park service roles, legislation and programmes at federal, state and provincial levels, transboundary activities, and monitoring programmes and case studies in each country. These presentations were captured on video and will be made available to parks staff in each nation. Submitted papers or transcripts of the videos were used to create the body of this proceedings volume. The second and third days were devoted to discussion groups and the presentation of their results to a plenary session. The recommendations from these discussions will provide direction to ongoing and planned park programmes related to improving or maintaining air quality. Here are a few highlights from the presentations.

- U.S. sulphur dioxide (SO₂) emission decreases are greater than expected under their Clean Air Act, but the benefits may not be fully realized due to the unexpected role of nitrogen. Nitrogen oxide (NO_x) emission targets may have to be lowered further.
- The Canadian Environmental Protection Act provides for the setting of ambient air quality objectives at three levels, maximum desirable levels (almost natural), maximum acceptable, and maximum tolerable beyond which immediate measures are to be taken. SO₂ and NO_x are not considered toxic substances under the act, but could be made so.
- Industrial and urban emissions of SO₂, NO_x and carbon dioxide are the major national and international air emission concerns. However, parks and other rural areas are also strongly affected by “burning issues”, to quote one speaker, such as prescribed forest fires, house heating, land clearing burns, and burning of waste and stubble.
- The Air Quality Agreement set the stage for park service involvement in air quality politics. The North American Commission on Environmental Cooperation, linking Mexico with the U.S. and Canada, and the International Air Quality Advisory Board of the International

Joint Commission, may both provide opportunities for further recognition of protected area values in setting air quality objectives.

- The Northeast Regional Air Quality Committee links protected areas in Atlantic Canada and New England in coordinating air quality reviews, monitoring programmes and coordinating regulations. The committee has started by contracting for a regional air quality assessment.
- Prescribed burns may produce one half to one twentieth of the smoke of a wildfire. Ironically, though, a prescribed burn must fit the relevant emissions cap.
- A study of wood burning at a park campsite showed that in 1992, 50% of the days studied had total suspended particulate (TSP) in excess of $120\mu\text{g}/\text{m}^3$, i.e. the maximum acceptable federal standard even though the campsite was at less than full occupancy. Following the introduction of smoke talks to visitors, and switching from free to sold wood, TSP levels fell to a maximum of $90\mu\text{g}/\text{m}^3$, with few days over $50\mu\text{g}/\text{m}^3$, even though occupancy increased.

The two concurrent discussion groups each considered the same themes, and in general reached very similar conclusions about each one.

Air issues. They rated the top air quality threats to parks as acidifying agents, toxic substances and visibility impairment from fine particulate (e.g., sulphate). This selection is based on impacts to ecosystem health, visitor expectations of clean air and long views, and the extent of the stress (global to local).

Education. Five audiences were prioritised in terms of the likely effectiveness of national parks education programmes in improving in-situ air quality. They are decision makers, appropriate stakeholders, the media, environmental non-government organizations and parks staff. Significant returns on effort can be expected through staff training, especially at the management level, and through partnerships that include opportunities for stress identification and mitigation.

Best practices. Parks can help to improve air quality through visitor education and demonstrating best practices, such as energy conservation through building retrofits and smoke management at campsites. They should also promote reduction of emissions by lobbying fleet managers and the public to reduce vehicle idling and switch to less polluting fuels, and through the greater use of shuttle buses for visitor access.

Bilateral air quality ventures. Once Parks Canada identifies a national lead for air quality issues, several liaison mechanisms can be considered, including a joint air quality newsletter, a bilateral air quality committee, adding some Canadian sites to the IMPROVE network and the U.S. Interagency Monitoring of Protected Visual Environments.

Regional air quality partnerships. RAQPs are a highly promising strategy to promote improved air quality in the airsheds that affect protected areas. However, no national or bilateral lead is required to lead or coordinate transboundary regional air quality partnerships. Experience to date shows that national efforts to promote the concept fall on fertile ground, and the local to

regional agencies readily cooperate to develop partnerships which suit their particular problems and opportunities. RAQPs should be led by a board of air quality specialists and park managers from regional and field levels. The board would produce strategic plans for their agencies, and create issue teams to assess specific air quality issues and quantify goals. Individual parks may need to form their own air quality working groups to direct their contribution to an RAQP and to develop an air quality management plan.

Visibility monitoring cameras. Parks Canada received an offer of visibility monitoring equipment from the US National Park Service. These cameras record visibility events that can be paired with particulate samplers to provide a powerful interpretive tool for the public and park staff to appreciate the loss of amenity that is associated with smog, plumes and other anthropogenic haze.

“The medium is the message,” said Marshall McLuhan. We met to discuss one medium, air, but the message sent by another, water, was loud and clear. Rain began during the first night and continued all next day. It combined with spring runoff, causing Waterton Lake to top its banks. Puddles stretched from curb to curb. That night the lake entered ground floor bedrooms, forcing occupants to the second floor. The parking lot joined the lake, so we moved cars across the street. Some power went out and phone service ceased. By morning of the 7th, 220 mm of rain had fallen and the hotel was an island. We cancelled field trips and the barbecue. We drove cars across a bridge 50 cm under water to high ground, returning on park trucks like refugees.

The Superintendent declared an emergency and we decided to evacuate Waterton. Thirty-five brave souls elected to continue in Lethbridge, about 160 km away. We contacted a hotel with conference facilities and enough bedrooms for the survivors. Only two routes were still open, many communities were flooded, thousands of sheep and cattle were lost, some bridges were destroyed, and the main highway to Calgary was impassable. To our amazement, though, we reconvened in Lethbridge, continued discussions that evening and the next morning, finishing by noon on the 8th. Our regrets at missing the field trips, the barbecue and the park scenery were compensated by memories of a remarkable natural event, the adaptability of delegates, and the tremendous logistical support given by park and hotel staff alike.



Acknowledgments

On behalf of the Parks Canada and the U.S. National Park Service, we extend a sincere vote of thanks to all participants for agreeing so readily to attend this inter-agency and international workshop. This readiness to join our workshop is testimony to the concern and interest that many people and institutions share in improving air quality and protecting park ecosystems. We redouble our thanks to the speakers, especially to those slated for the later part of the afternoon and the evening. The non-stop torrential rain of that day kept us cooped up in the conference centre, unable to enjoy the scenic wonders of Waterton and unable to refresh our minds during 21 presentations. So, full marks to all participants for their contributions during a long and intense day. Our moderator, Joe Carriero of the U.S. Fish and Wildlife Service, must take a great deal of credit for keeping us on time and focused on the business at hand. His humour and wit at the start of each segment guaranteed a timely return to our seats and attentive minds.

The floods that forced us to migrate from Waterton Park to Lethbridge also closed many roads in southern Alberta and northern Montana. Many participants were forced to depart early to avoid the risk of being unable to attend other events. We give additional thanks, though, to those who did make it to Lethbridge to contribute to the discussion groups. From the United States they are Robert Breen, John Bunyak, Joe Carriero, Diane Ewell, Miguel Flores, Brace Hayden, Bill Malm, Bill Michels, Jack Oelfke, Jim Renfro, Judith Rocchio, Shelley Sparhawk, Julie Thomas, Kathy Tonnessen and Janet Wise. From Canada they are Harry Beach, Patricia Benson, Barbara Bertch, Ian Church, Wayne Draper, Cliff Drysdale, Luc Foisy, Joe Kozak, Brian Levitt, Andrew McElheran, Lori McLeod, Gary Moulard, Neil Munro, Al Stendie, Kevin Van Tighem and Brian Weller.

The discussion groups succeeded in good measure by the efforts of their leaders, namely Neil Munro, chair, Judy Rocchio, rapporteur and Brian Levitt, recording secretary, for one group, and Janet Wise and Ian Church, co-chairs, Bob Breen, rapporteur and Lori McLeod, recording secretary for the other. Thanks to them for keeping the groups animated, on topic and on time.

Even a normal workshop depends heavily on the efforts of local staff to arrange facilities, special and social events. Thanks go to Dave Mihalic and Merv Syroteuk, the superintendents of Glacier and Waterton Lakes National Parks for inviting us to come to Waterton-Glacier International Peace Park and allowing us to make such heavy demands upon their staff. In particular

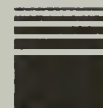
we thank interpreters Locke Marshall of Waterton Lakes and Bill Hayden of Glacier for their informative, entertaining and musical introduction to the parks' nature and history. Thanks to Keith McDougall of Waterton Lakes for videotaping the entire day of presentations. The resulting videos provided us with a transcript to help produce these proceedings, and will also provide supporting material for in-service training of resource management specialists. Waterton Lakes National Park also gave us the services of four summer employees, Brian Levitt, Lori McLeod, Deb Remnant, Lisa Staal, to help with registration and recording the group deliberations.

We also recognize the valiant efforts of the staff of the Bayshore Inn to keep services going while relocating evacuated guests, sandbagging and pumping various locations, moving cars and relocating their own ground floor office equipment and store inventory. They kept the conference rooms and catering services fully operational right up until our departure to Lethbridge. Thanks also to the staff of the Lethbridge Lodge for responding at only 3-4 hours notice to accommodate 35 people and provide 3 meeting rooms at very reasonable rates. We salute Kevin Van Tighem and Brent Kozachenko, Waterton Lakes wardens, for providing valuable liaison between the workshop and park staff during the emergency situation, and Bill Dolan, Chief Park Warden, for allowing Kevin to remain with the workshop.

Finally, we thank our colleagues on the organizing committee for their unstinting efforts to make the workshop a success.

- Patricia Benson, Parks Canada Alberta Region, responsible for arranging the discussion groups and registration.
- Bill Dolan, Waterton Lakes National Park, responsible for arranging hotel and conference facilities, field trips, opening session and the social programme. As well as causing Bill to spend the night supervising the evacuation of a campground, the deluge led to the cancellation of some of Bill's work, the barbecue and field trips.
- Karen McDonald, Environment Canada Western and Northern Region, provided liaison with Environment Canada air quality specialists across Canada.
- Bill Michels, Glacier National Park, provided local liaison and produced the workshop brochure.
- Brace Hayden, Glacier National Park, provided local liaison and assisted with editing the proceedings.
- Andrew McElheran, University of Calgary, corralled speakers' papers or transcribed presentations from videos to give us a complete proceedings. He also assisted with registration.

Erik Hauge and David Welch, co-chairs
Denver, 12 October 1995



Introduction

*Erik R. Hauge
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Concern about transboundary air pollution and its impacts in Canada and the United States led to the March 13, 1991, Canada-U.S. Air Quality Agreement. Among its many provisions, the agreement called for the establishment of programs in Canada similar to the Prevention of Significant Deterioration and visibility monitoring programs established under the U.S. Clean Air Act. The U.S. National Park Service (NPS) established its Air Resources Division (ARD) in 1978 in response to those same requirements. Over the next several years, the ARD has developed a multi-faceted program of air quality, visibility, and acid rain monitoring; effects research; permit and regulatory review; and public information.

A casual conversation with Neil Munro, Parks Canada Atlantic Region, at a park science conference in November 1990 led to an invitation for me to attend an international science conference the following May at Acadia University in Nova Scotia. There I gave a presentation on the NPS air quality program. The idea that a land managing agency could conduct its own substantial air quality program (instead of relying on regulatory agencies) intrigued the Parks Canada conference attendees, and the dialogue which followed my presentation has led to permanent ties between our two agencies' natural resources programs.

One result of this new relationship was the First International Air Issues Workshop, co-chaired by Neil Munro and I, held in June 1993 at Roosevelt Campobello International Park, New Brunswick. There representatives of the NPS ARD, Parks Canada, the U.S. Fish and Wildlife Service, Environment Canada, and Roosevelt Campobello Park gave presentations on air quality programs conducted at national parks. A field trip to nearby Acadia National Park highlighted the workshop, since Acadia has one of the most outstanding air quality programs in the NPS.

The workshop recommendations included continued and enhanced bi-lateral cooperation and coordination. Exchanges of data, instruments and even personnel between the agencies were discussed. The major recommendation was to hold a second workshop in the west, where many of the parks and other protected areas were located, and to invite participation by representatives of U.S. and Canadian Federal, state, and provincial air regulatory agencies, land managing agencies,

and Indian tribes. Waterton Glacier International Peace Park was chosen as the site. David Welch of Parks Canada headquarters and I were selected co-chairs.

Once the location of the workshop was decided, an Organizing Committee was established with representatives from Waterton Lakes National Park (Bill Dolan), Glacier National Park (Brace Hayden, Bill Michels), Parks Canada Alberta Region (Patricia Benson), and Environment Canada Prairie and Northern Region (Karen McDonald).

The Organizing Committee decided the goal of this workshop was to “foster dialogue and management recommendations on air issues in national parks and other protected areas in North America.” The major workshop themes included: acts, policies, and agreements related to protected area air quality management; air quality issues and monitoring; improving air quality through exemplary practices, public education, national and international cooperation; and Waterton Glacier air quality issues and management. The two major objectives were to exchange information and to develop cooperative efforts. The information exchange was to be accomplished through the agency presentations at the workshop as well as the subsequent publication and distribution of these proceedings. The development of cooperative efforts was to begin during the group and plenary discussions, and result in specific recommendations for enhancing present and encouraging future actions.

Preparation for the workshop was thorough. Conference and meeting rooms were reserved, as were sufficient motel rooms for the steering committee, participants, and volunteer staff during the beginning of the summer tourist season. Group meals and a barbecue were arranged, as were a field trip and a post-workshop hike in the parks.

The flooding caused the cancellation of the field trip, barbeque, and post-workshop hikes, but did not stop the workshop. The individual presentations were made, the discussion groups met, considered the seven major themes, and made excellent recommendations.

I invite you now to read these proceedings, including the individual presentations and the group discussions. Use the recommendations to enhance information exchanges and develop cooperative efforts to better protect our national parks and other significant lands from the adverse impacts of air pollution.



Status of U.S. Acid Rain Program and Current Assessment Activities

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This discussion will focus on three distinct areas:

- 1). Key elements of the structure of the U.S. Acid Rain Program and the EPA's mandate
- 2). The current status of the program and of acidifying emissions in the USA
- 3). The program's relationship to sensitive & protected areas, using the results of a study focusing on sensitive regions

U.S. ACID RAIN PROGRAM — STRUCTURE AND MANDATE

The United States Acid Rain Program was established under Title IV of the U.S. Clean Air Act as amended in 1990. The implementation and compliance with the Program is currently being tracked. The first complete year of emissions data has been collected, and will be of interest to policy-makers and the scientific community in both the United States and Canada. Acid Rain programs in Canada and the United States make up the first annex of the 1991 Canada-U.S. Air Quality Agreement; developments in either country's program are of relevance and interest to both countries, particularly activities which begin to assess the effectiveness of the control programs.

The U.S. Acid Rain Program calls for a 10-million ton reduction in sulphur dioxide (SO₂) emissions from 1980 levels; the primary source of SO₂ in the USA are coal-fired electric utility plants. The program also mandates a 2-million ton reduction in nitrogen oxide (NO_x) emissions.

There are two phases to the program. Phase 1 which began in 1995 affects 110 larger, higher emitting electric utilities, concentrated in the Ohio Valley and the northeast. Phase 2 which

begins in the year 2000 affects an additional 780 sources covering the rest of the country. The program encompasses many innovative elements. Three that will be discussed include:

- 1). flexibility of the program;
- 2). allowance trading; and
- 3). emissions monitoring.

Flexibility

Compliance strategy flexibility is an integral part of the Acid Rain Program's permitting requirements. The regulations under Title IV of the Clean Air Act (Acid Rain title) do not dictate how units must comply with emission reduction; units are free to meet the emission reduction requirements how they wish. Some examples of these options include switching to a lower-sulphur coal, installing scrubbers in their stacks, conservation or renewable energy technologies or by purchasing SO₂ emission allowances. Utilities are free to choose the most cost-effective method.

Allowance Trading

The Acid Rain Program introduces an SO₂ allowance trading system that uses the incentives of the free market to reduce pollution. Allowance trading follows a prescribed formula: 1 ton of SO₂ emission equals 1 allowance. The EPA allocates these allowances based on a broad emission reduction formula. Allowances are a commodity: they can be purchased, sold, traded, or banked. Some utilities will meet their emission reduction requirements through this method. At the end of each year, each source must hold enough allowances to cover each unit's emissions for the year.

Emissions Monitoring

Under the Acid Rain Program, each source must install continuous emissions monitoring (CEM). The CEM system is critical to the program. It instills confidence in allowance transactions by certifying the existence and quantity of the commodity being traded. CEMs are also a very accurate method to ensure that emissions reduction goals are met.

SUMMARY OF OVERHEADS

U.S. Acid Rain Program – Current Status

Overheads 1 & 2: *U.S. Acid Rain Program – Current Status*

Overhead 3: *Options Selected for Phase 1 Compliance*

- Overhead 4: *Geographic Distribution of Utility Plants Under Phases 1 & 2*
- Overhead 5: *Results Under Phase 1 Regulations (1994 data)*
- Overhead 6: *Projected Annual Emissions in Phase 1*
- Overhead 7: *States With Largest Projected Extra Emissions Reductions in Phase 1*

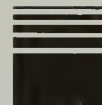
U.S. Acid Rain Program – Relationship to Sensitive & Protected Areas

- Overhead 8: *Acid Deposition Standard Feasibility Study: Report to Congress*
- Overheads 9-12: *Acid Deposition Standard Feasibility Study: Scope*
- Overhead 13-15: *Acid Deposition Standard Feasibility Study: Key Conclusions*

- of note is the fact that the bulk of acid rain research in the 1980s focused on sulphur; there is a great deal of research ongoing about the effects of nitrogen on acid depositions, and many unknowns remain
- it would have been useful if the U.S. Congress provided guidance regarding the desirable level of protection (eg. protect 95% of sensitive resources, protect 95% of all resources, etc.)

- Overhead 16: *Impact of Title IV SO₂ Allowance Trading*

Overhead materials were not submitted by the author for publication.



Canadian Environmental Legislation Relating to Air Quality

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Note. The figures of the overheads were submitted by the author, but the narrative was paraphrased from the video transcript of the workshop by the editors. It has not been reviewed for accuracy by the author.

Introduction

I would like to present a few highlights and key aspects of Canadian legislation related to air quality. There has been a major shift in the nature of Canadian federal legislation in the last decade. There is no longer a Canadian Clean Air Act, Clean Water Act or Environmental Contaminants Act. We now have a multi-media approach, whereby air pollution is dealt with in an ecosystem context.

Jurisdiction. See Figure 1

The provincial governments have most of the authority to assess projects, to regulate and control emissions, and to issue permits. There is no central control as there is in the United States. The federal government can get involved if there is a significant transboundary aspect, be it international or interprovincial. An example is the eastern Canada acid rain programme of the seven eastern provinces and the federal government. Second, the federal government can also be involved if a substance is declared toxic under the Canadian Environmental Protection Act. A situation could be one where there is a significant threat to human or environmental health, e.g. from lead or mercury. Then the federal government can act and regulate. A third category is if national measures are appropriate, e.g. automobile emissions or consumer products that contain solvents or organic compounds that contribute to ozone formation. Usually there would be a federal-provincial agreement for this. Fourth, if there is a need for national harmonization, the federal government

and provinces can agree to do so, usually for a given source sector. The federal government would then coordinate the development of the national norm or control, and provinces would convert this to their own legislation.

Federal legislation. See Figure 2

There are four key acts, and I will deal with one of them in more detail later. These are 1) the Canadian Environmental Protection Act; 2) the Motor Vehicle Safety Act administered by Transport Canada; 3) the Pest Control Products Act which deals with pesticides such as persistent organic pollutants; and 4) the Canadian Environmental Assessment Act.

Plans and Policies. See Figure 3

Canada is less legalistic and legislative than the US. We are more policy and cooperation oriented, whereby the provinces will implement plans, policies and strategies that they agree to.

For example, the Toxic Substances Management Policy was announced just a few days before this workshop. Its main feature is a virtual elimination approach. Persistent, bioaccumulative, toxic and anthropogenic substances are put on a virtual elimination track, by-passing environmental assessment hold-ups. About a dozen substances have been put on this track. Other substances are to undergo risk assessment to determine a programme of action, e.g. ones that are not mainly anthropogenic. An example is mercury of which much is of natural origin. We would never be able to “virtually eliminate” mercury from the environment.

Another example is the Canadian Acid Rain Programme. This goes back to a 1985 formal agreement between Canada and the seven eastern provinces. It set a cap on emissions by 1994 which has been achieved. By 1997 there will be a long term acid rain management strategy to determine how we will manage acid rain beyond the year 2000. It will cover SO₂ and NO_x, the health effects of acid aerosols, sulphate particulate and visibility impairment, etc.. It will also address what US emission reductions would be needed to meet Canadian goals.

A third example is the NO_x/VOC Management Plan. This is a domestic programme for smog and ground-level ozone management. Federal and provincial ministers approved a plan in 1990 calling for reduction measures to be put in place. Phase 2 is under development. This will target the main ozone areas, the Windsor-Quebec corridor and lower Fraser Valley. Transboundary ozone management will be looked at under the Canada/US Air Quality Agreement, especially the Windsor-Quebec corridor and the neighboring US states. The next steps are to be determined by the end of 1996.

Canadian Environmental Protection Act (CEPA). See Figure 4

CEPA provides for the setting of ambient air quality objectives. These are based on three levels, the maximum desirable, the maximum acceptable and the maximum tolerable. Maximum

desirable levels are equivalent to, or not too far above, natural background levels, i.e. almost pristine. The maximum acceptable level allows some degradation but is still acceptable for health protection. This is the level used for policy setting, e.g. the ozone level of 82 ppb/hour. The maximum tolerable is higher. It calls for immediate measures to be taken because of serious threats to health. CEPA differs in approach from the US Prevention of Significant Deterioration and visibility approach. We look for areas to keep pristine and want to do an environmental assessment, and would push for something close to the maximum desirable level. This approach should help remote, pristine areas.

CEPA allows us to set national codes and guidelines. The codes relate to emissions but they have no legal force. They are developed in consultation with the provinces who may then actually legislate.

Part Five of CEPA deals with international air. The Minister is obligated to regulate if emissions pollute in another country or violate an international agreement. The Minister must first determine if the problem can be resolved provincially, and whether the provinces are willing to take action. Therefore consultations are required, and the minister must demonstrate his/her inability to get the provinces to act. A current review will attempt to tighten up this section. Another limitation is that the polluted country must have granted Canada essentially the same rights. Other provisions deal with equivalent provincial regulatory authority, and the authority of the minister to collect information related to pollution going into another country.

The information provisions of CEPA give the federal government the authority to seek information on pollutant releases, either on an individual project basis or a generic basis, e.g. for pulp and paper mills. CEPA also calls for the publication of the National Pollutant Release Inventory. The first annual report has now been released. Industrial sources are required to report their emissions annually. One hundred and seventy eight substances are listed, and must be reported over a certain level. Prior to this, no/one knew how different companies rated.

Canadian Environmental Assessment Act. See Figure 5

This Act has an international provision. If the minister feels that there is probable transboundary emissions, he/she may set up an environmental assessment panel, and the other country may request a panel to be set up.

**CANADIAN
ENVIRONMENTAL
LEGISLATION
relating to
AIR QUALITY**

Figure 1

JURISDICTION

- Mainly Provincial
- Federal Involvement if:
 - transboundary
 - substance declared toxic
 - national measures most appropriate
 - need for national harmonization

Figure 2

FEDERAL LEGISLATION

- Canadian Environmental Protection Act (CEPA)
- Motor Vehicle Safety Act
- Pest Control Products Act
- Canadian Environmental Assessment Act (CEAA)

NATIONAL PLANS AND POLICIES

- Toxic Substances Management Policy
- Acid Rain Program
- NOX/VOC Management Plan

Figure 3

FEATURES OF CEPA

- Ambient Air Quality Objectives
 - Maximum Desirable
 - Maximum Acceptable
 - Maximum Tolerable
- Regulation of Toxics⁴⁰
- Codes and Guidelines
- International Air Provisions
- Information Provisions
 - National Pollutant Release Inventory (NPRI)

Figure 4

FEATURES OF CEAA

- Assessment of Major New Products
- Access of Other Nations to Assessment Process

Figure 5



Air Quality Management in Alberta

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This paper will discuss the two major components to Alberta's Air Quality program:

- 1). Alberta's traditional regulatory program for industrial air quality management
- 2). the new strategic component: the Clean Air Strategy for Alberta which has become the Clean Air Strategic Alliance

SUMMARY OF OVERHEADS

Industrial Air Quality Management

Overhead 1: *Air Quality Management in Alberta*

Overhead 2: *Overview of Industrial Air Quality Management System*

- note: industrial operators must report their emissions to the government, both at the source and in the ambient atmosphere, monthly, annually, and immediately in the case of an emergency or upset

Overhead 3: *Industrial Air Quality Management System for SO₂*

Overhead 4: *Source Emission Control Criteria*

- great deal of sulphur processed in Alberta
- small sources required to recover 70%, large sources required to recover 99.8%; on average, sources in Alberta recover 98.5% of their sulphur

Overhead 5: *Alberta Ambient Air Quality Guidelines*

Overhead 6: *Monitoring*

Overhead 7: *Enforcement*

Overhead 8: *Sulphur Dioxide Emissions in Alberta*

- increases in emissions from thermal power plants due to increased utilization

Overhead 9: *Environmental Assessment Process*

Overhead 10: *Continuous and Intermittent Air Quality Stations*

Overhead 11: *Static and Precipitation Quality Stations*

Clean Air Strategic Alliance

The Clean Air Strategic Alliance (CASA) was initiated out of the 1991 Clean Air Strategy for Alberta. Global issues with respect to air quality were starting to emerge that were not well-handled using the traditional industrial management system which dealt in the first with sulphur. The departments of Environmental Protection and Energy, in a joint effort, conducted 18 months of public consultations, designed to develop a strategy for managing all air quality issues. The provincial government ultimately decided to implement the recommendations of the report through the creation of a not-for-profit Crown Corporation.

Overhead 12: *Clean Air Strategic Alliance: Strategy*

- the illustrated strategic management approach was ultimately the recommendation stemming from the public consultations

Overhead 13: *Clean Air Strategic Alliance: Vision*

Overhead 14: *Clean Air Strategic Alliance: The Management System*

Overhead 15: *Clean Air Strategic Alliance: Shared Responsibility*

- the role of government has changed; the partnership paradigm forms the premise for CASA

Overhead 16: *Clean Air Strategic Alliance: Shared Responsibility*

- note: this list represents the issues for which the CASA corporation is responsible

Overhead 17: *Clean Air Strategic Alliance: Stakeholder Partnership*

- the listed stakeholders make up the 18-member Board of Directors of the corporation
- stakeholders include government, industry, and the public agencies

Overhead 18: *Alliance Accountability*

- the Board is responsible for corporate decisions, and is responsible to its stakeholders, as well as to the Ministers of Environmental Protection and Energy who have delegated responsibility to the Board
- most CASA's operations are conducted by the multi-stakeholder project teams

Overhead 19: *CASA Strategic Overview*

- inner rings on the graphic represent information; sectors represent issue-specific project
- note: one recent development is the establishment of a Regional Air Quality Project team, recognizing that if a problem is focused in one area, it is more efficient to deal with it in that area rather than on a system-wide basis

Overhead 20: *Affected Areas*

- the highlighted areas are areas where Regional Air Quality Management plans are in place

Overhead 21: *West Central Airshed Management Zone*

- this zone was created due to concerns expressed about the high concentration of farming and oil & gas activity in the same vicinity
- an extensive monitoring program is being set up, including biological monitoring and air quality monitoring; it is funded entirely by industry
- industrial sources with a good compliance record on emissions are permitted to divert funds spent on that monitoring to this project
- a Clean Air Strategic Alliance project at work

AIR QUALITY MANAGEMENT IN ALBERTA

Operational

- Environmental Protection and Enhancement Act (1993) (replaced Clean Air Act 1971)
 - Industrial Air Quality Management System
 - Environmental Assessment

Strategic

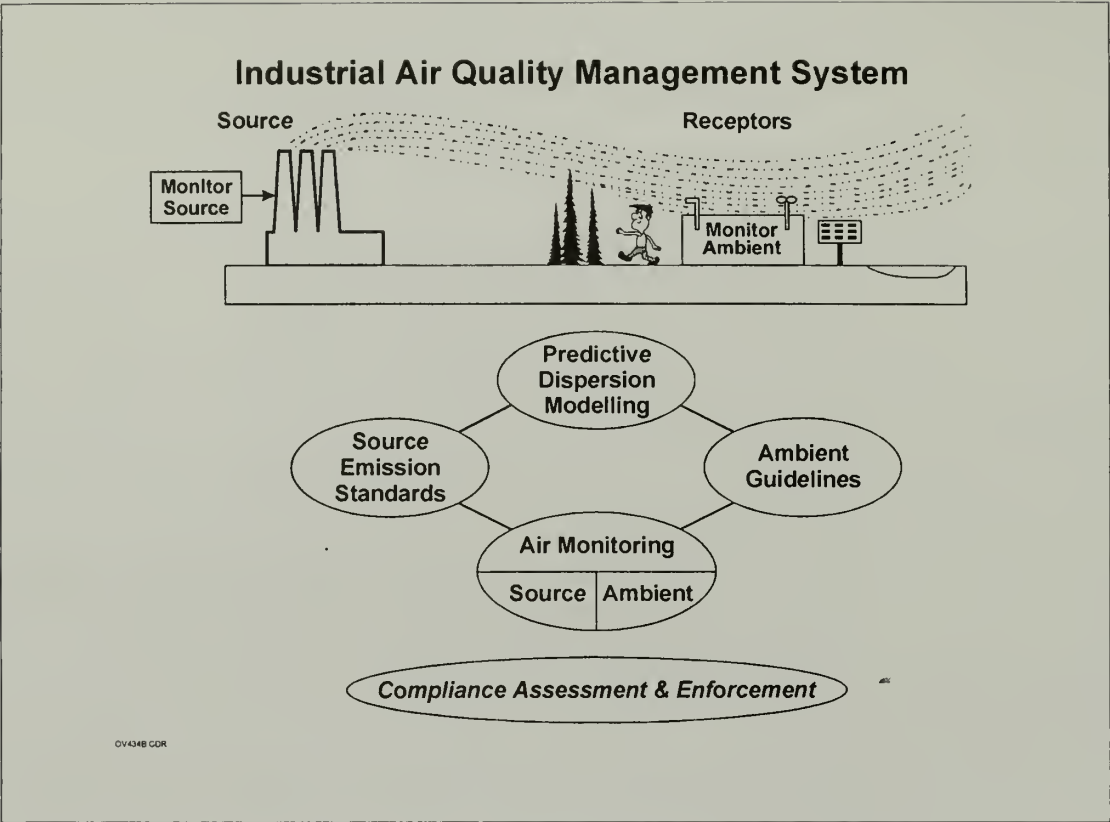
- Clean Air Strategy for Alberta (1991)
- Clean Air Strategic Alliance (1994)

Overhead 1

OVERVIEW OF INDUSTRIAL AIR QUALITY MANAGEMENT SYSTEM

- Emissions minimized using best available demonstrated technology (BADT) — economically achievable
- Residual emissions dispersed to keep ambient concentrations below Alberta Air Quality Guidelines
- Industrial operators must monitor emissions and report to government
- Cumulative emissions considered with respect to ambient guidelines and regional air pollutant deposition

Overhead 2



Overhead 3

SOURCE EMISSION CONTROL CRITERIA	
Industrial Sector	Source Emission Control Criteria
Pulp and Paper	US-EPA NSPS
Fertilizer	Fertilizer Plant Guidelines
Sour Gas Processing	Sulphur Recovery Guidelines
Oil Sands	Sulphur Recovery Guidelines – Sulphur Recovery Unit Only
Coal-Fired Power Generation	Alberta Thermal Power Plant Guidelines
Refineries	Sulphur Recovery Guidelines

Overhead 4

ENVIRONMENTAL PROTECTION AND ENHANCEMENT ACT

Table 1
Alberta Ambient Air Quality Guidelines

Air Quality Parameter	Guideline
Sulphur Dioxide ¹	<ul style="list-style-type: none"> • 450 micrograms per cubic metre as a 1-hour average concentration • 150 micrograms per cubic metre as a 24-hour average concentration • 30 micrograms per cubic metre as an annual arithmetic mean
Hydrogen Sulphide ¹	<ul style="list-style-type: none"> • 14 micrograms per cubic metre as a 1-hour average concentration • 4 micrograms per cubic metre as a 24-hour average concentration
Nitrogen Dioxide ¹	<ul style="list-style-type: none"> • 400 micrograms per cubic metre as a 1-hour average concentration • 200 micrograms per cubic metre as a 24-hour average concentration • 60 micrograms per cubic metre as an annual arithmetic mean
Carbon Monoxide ¹	<ul style="list-style-type: none"> • 15 milligrams per cubic metre as a 1-hour average concentration • 6 milligrams per cubic metre as an 8-hour average concentration
Ground Level Ozone ¹	<ul style="list-style-type: none"> • 160 micrograms per cubic metre as a 1-hour average concentration • 50 micrograms per cubic metre as a 24-hour average concentration
Suspended Particulates ¹	<ul style="list-style-type: none"> • 100 micrograms per cubic metre as a 24-hour average concentration • 60 micrograms per cubic metre as an annual geometric mean
Dustfall ¹	<ul style="list-style-type: none"> • 53 milligrams per hundred square centimetres per 30 days in residential and recreation areas • 158 milligrams per hundred square centimetres per 30 days in commercial and industrial areas
Coefficient of Haze	<ul style="list-style-type: none"> • 90% of the readings per month shall be less than 1.0 COH unit
Ammonia ²	<ul style="list-style-type: none"> • 2.0 pm as a 1-hour average concentration
Static Total Sulphation ³	<ul style="list-style-type: none"> • 0.50 mg SO₃ equivalent/day/100 sq cm as a 1-month accumulated loading
Static Hydrogen Sulphide ³	<ul style="list-style-type: none"> • 0.10 mg SO₃ equivalent/day/100 sq cm as a 1-month accumulated loading
Static Fluorides ³	<ul style="list-style-type: none"> • 40 ug water soluble fluorides/100 sq cm/30 days

Reference:

1. Clean Air (Maximum Levels) Regulation (218/75).
2. Guidelines for Limiting Contaminant Emissions to the Atmosphere from Fertilizer Plants and Related Industries in Alberta.
3. Air Monitoring Directive, Alberta Environmental Protection.

September 1994



Overhead 5

MONITORING

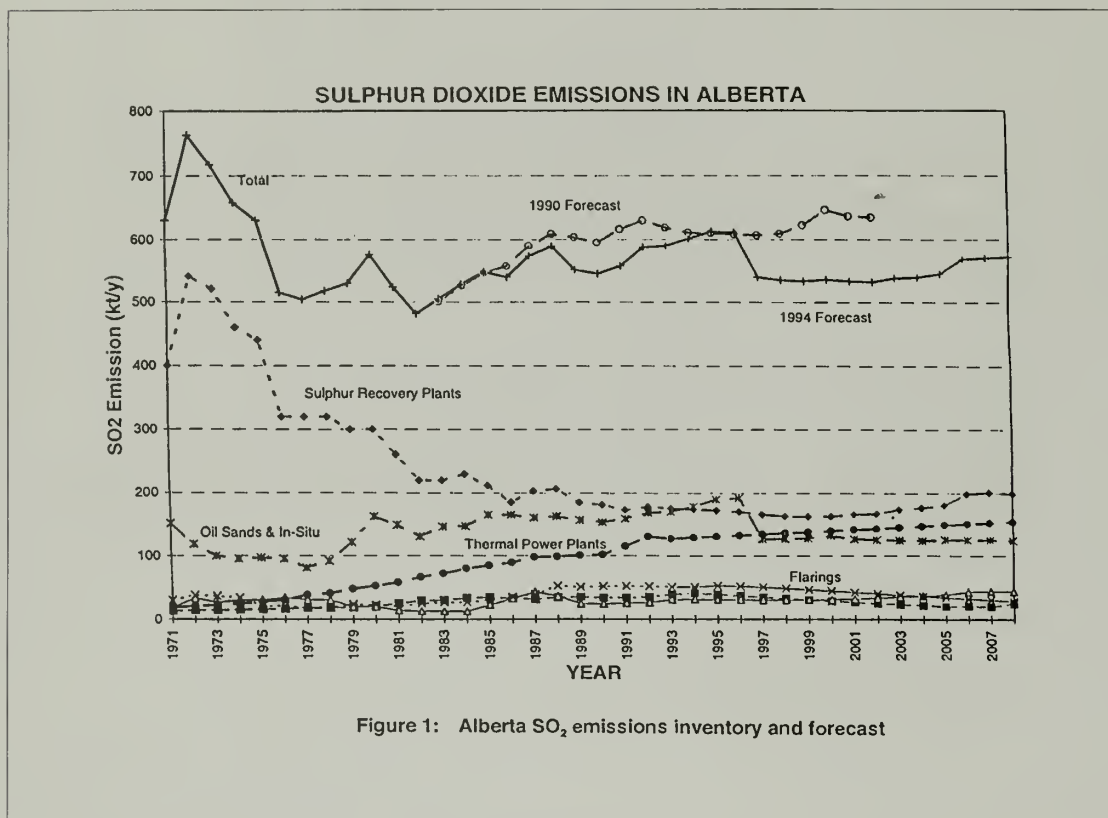
- General
 - Industry Self-monitoring (Polluter Pays)
 - Air Monitoring Directive (AMD)
 - Spot Checks/Audits by Department
- Source
 - Manual Stack Surveys – 138/year
 - Stack sampling code
 - Continuous Emission Monitoring Systems – 91
 - Draft guidelines
- Ambient
 - Air Monitoring Directive
 - Continuous monitors – 90
 - Static/exposure stations – 1,504
 - Soil monitoring – 33

Overhead 6

ENFORCEMENT

- Firm but fair enforcement of the environmental legislation in a timely and consistent manner
- Options
 - Warning letters
 - Orders
 - Prosecutions
 - Court Orders

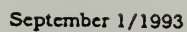
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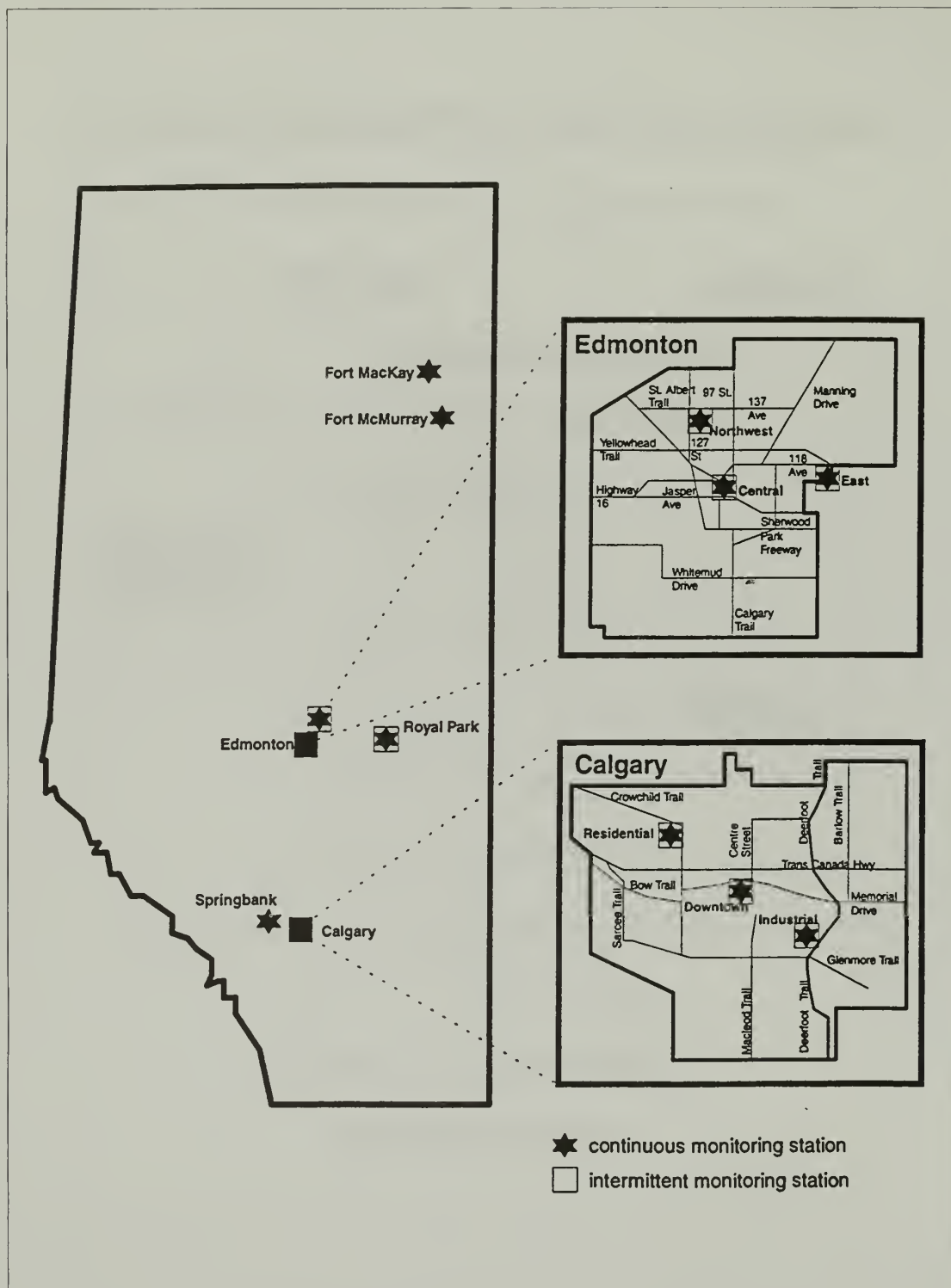


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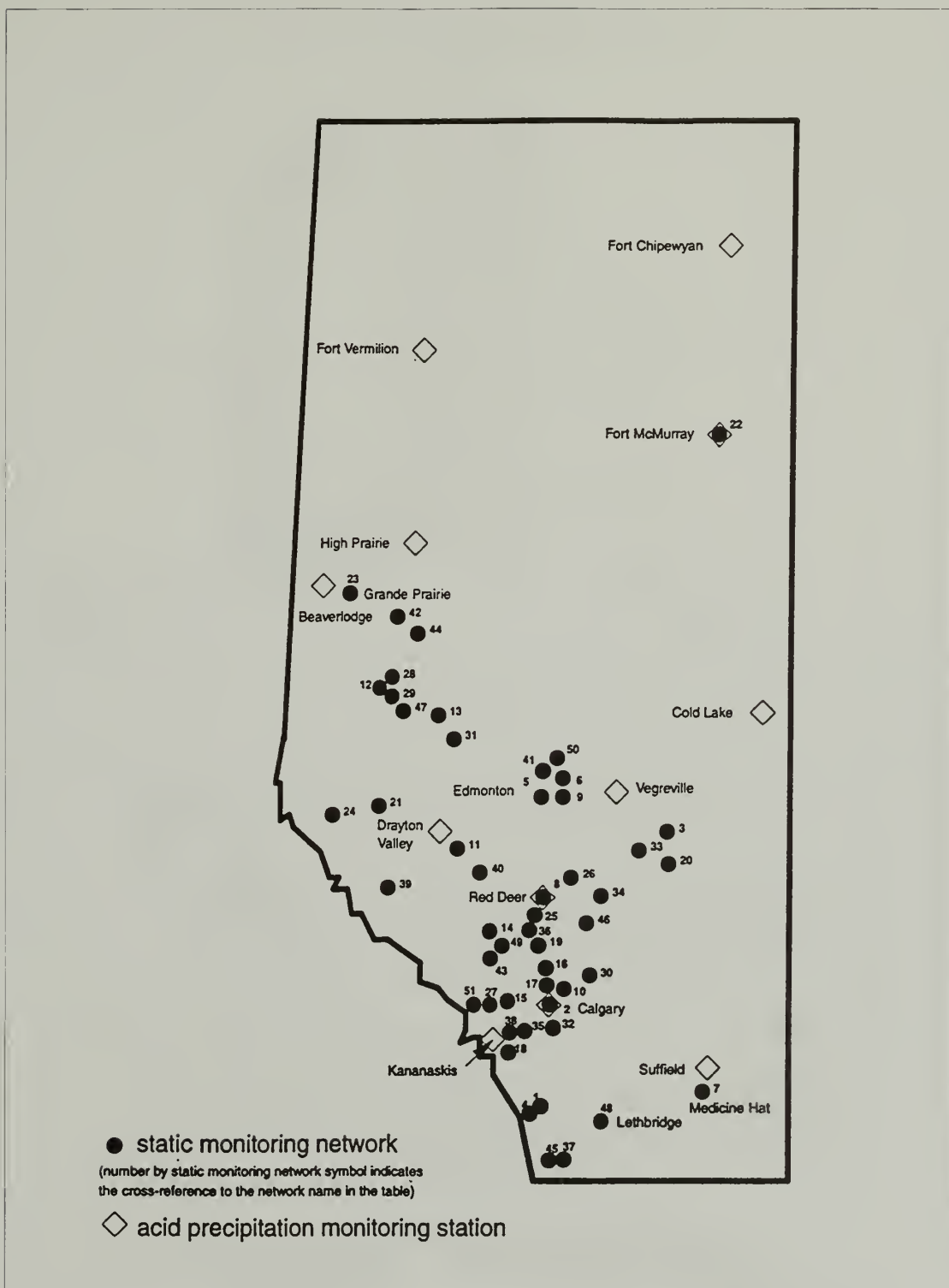
MANDATORY ACTIVITIES

EXEMPTED ACTIVITIES

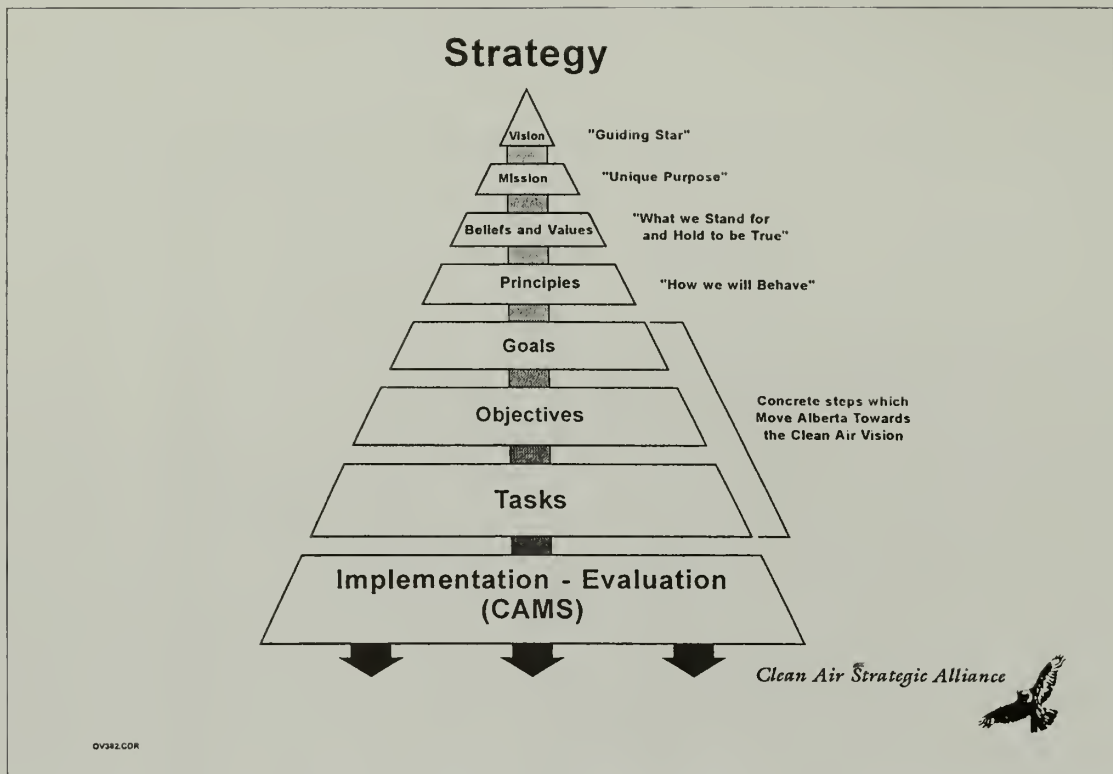




Overhead 10



Overhead 11



Overhead 12

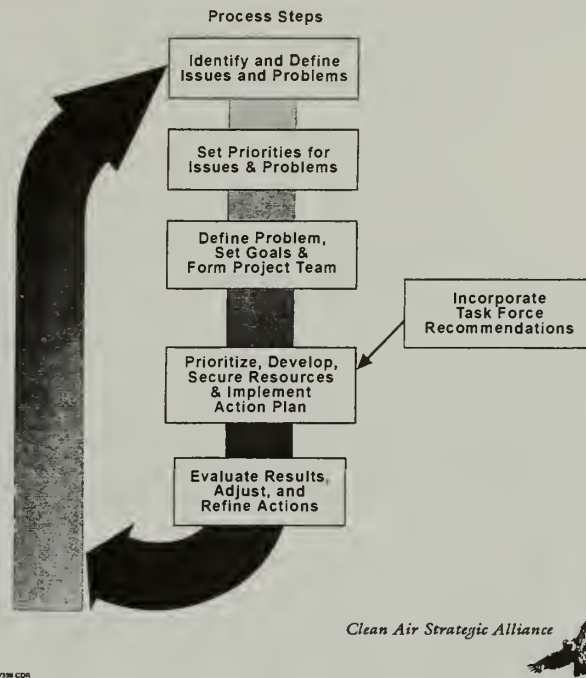
Vision

The air will be odourless, tasteless, look clear and have no measurable short- or long-term adverse effects on people, animals or the environment.

OV247.COR

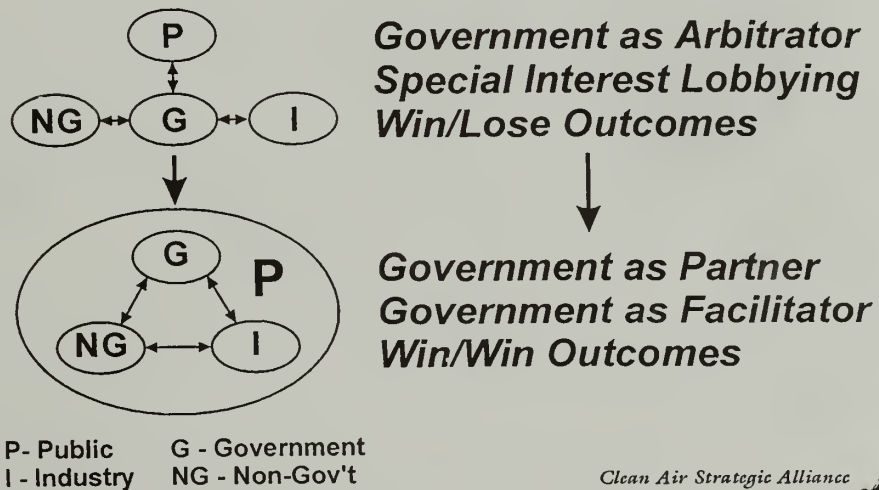
Overhead 13

The Management System



Overhead 14

Shared Responsibility



Clean Air Strategic Alliance



OV330 CDR

Overhead 15

SHARED RESPONSIBILITY

- Defining Problems
- Setting Priorities
- Developing Plans
- Securing Resources
- Taking Action
- Measuring Results

Clean Air Strategic Alliance



Overhead 16

Stakeholder Partnership

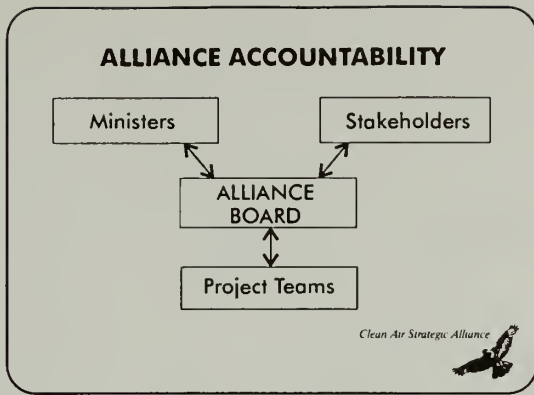


Clean Air Strategic Alliance

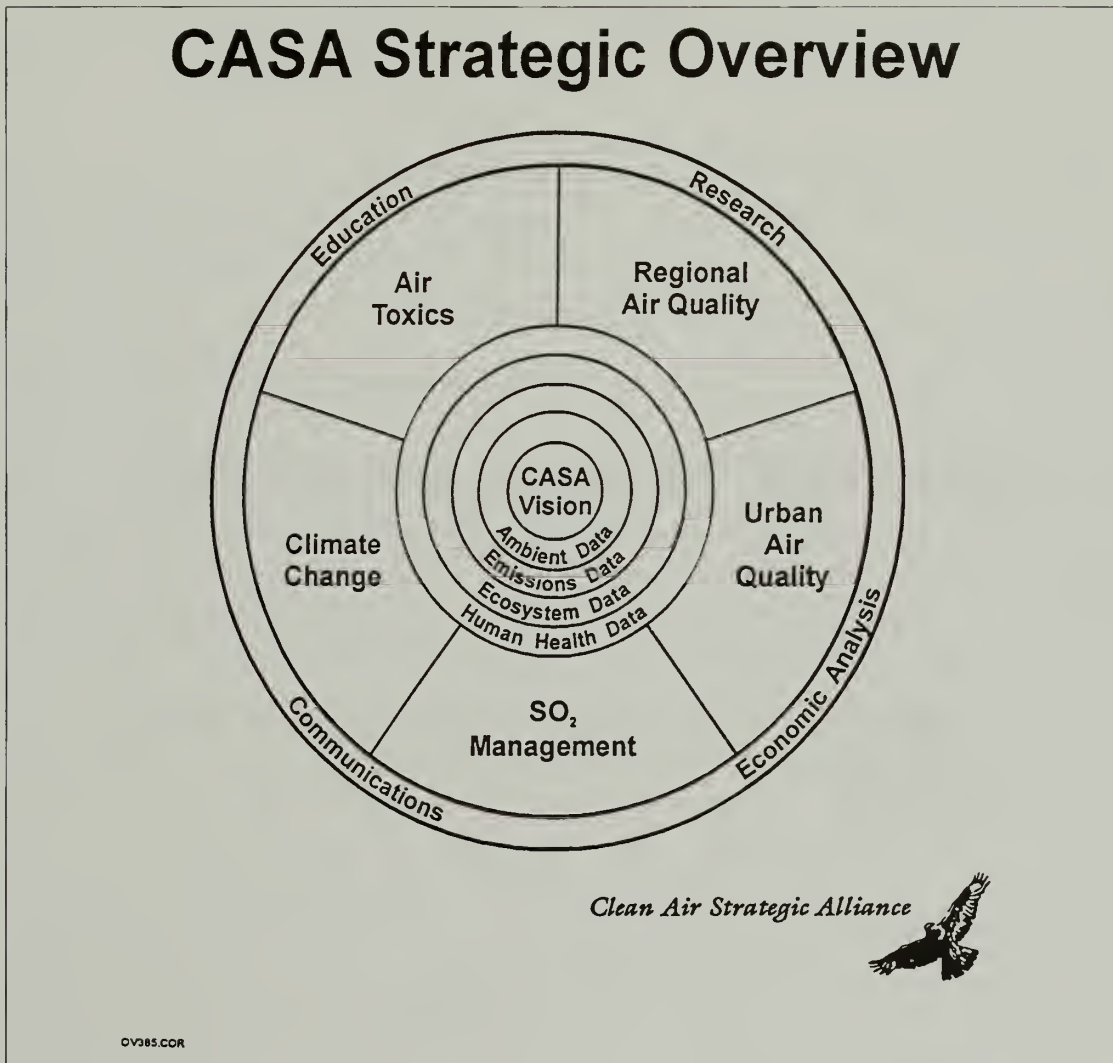


OV318 CDR

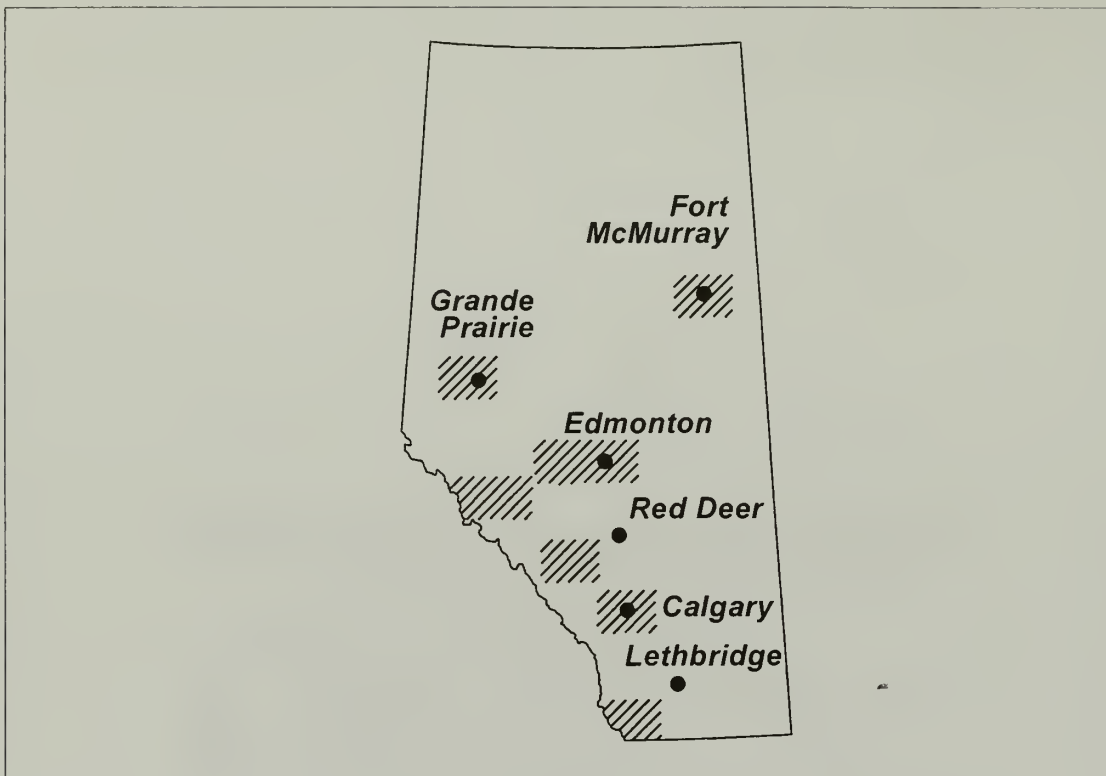
Overhead 17



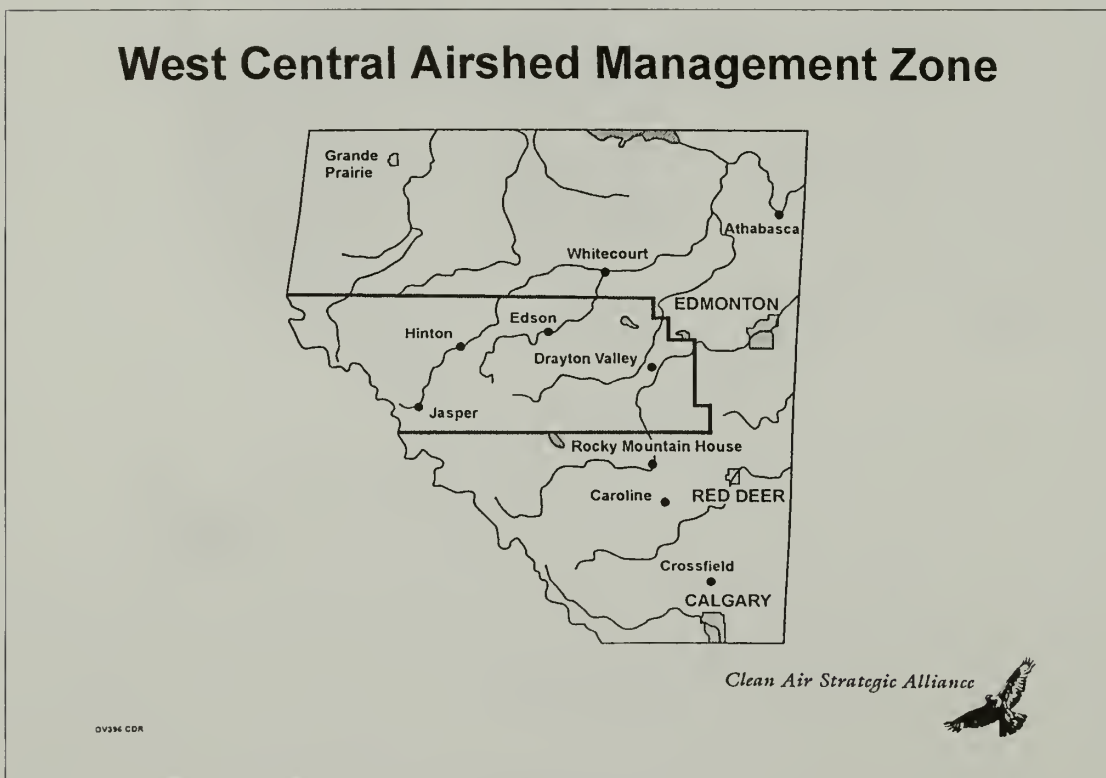
Overhead 18



Overhead 19



Overhead 20



Overhead 21



Smoke Management and Visibility Protection: Two Major Initiatives of the British Columbia Ministry of Environment, Lands & Parks Air Resources Program

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SECTION 1: SMOKE MANAGEMENT

Historically, the most pervasive air quality problem in British Columbia stemmed from one ubiquitous human activity: the burning of biomass. In the mid '80s BC Environment fielded more complaints related to “woodsmoke” than any other air pollutant. Examples include: home heating with wood burning appliances, the burning of yard refuse, sawmill waste incineration, prescribed burning of logging debris, fires set to enhance wildlife habitat, fire hazard abatement burns, land clearing debris burns, traditional agricultural burns, and fires set to reduce bulk at remote landfills.

The negative human health and aesthetics impacts stem from poor burning practices. This burning is often poorly managed. Combustion is very inefficient and often deleterious materials are burned. Burns are often in residential areas. There is little regulatory consideration of air quality.

Recognizing the need to better manage these activities, the province of British Columbia embarked on an ambitious program to review virtually all burning practices, and propose appropriate changes. The Discussion Paper “Smoke Management For The ‘90s” kicked off this process. Commissioned by the Clean Air Policy Steering Committee, (a multi-Ministry advisory group), it was released in the Spring of 1992.

“Smoke Management For The ‘90s” presents the reader with a historical perspective on four general types of burning (Prescribed Burning, Open Burning of Land Clearing Debris, Residue Burning in the Forest Products Industry, Urban & Agricultural Burning, & Residential Wood Burning), and details how they are presently regulated. It also examines what, where, when and how

biomass is burned. The benefits of the present practices are explored, as are the negative environmental impacts. Each section closes with a list of recommendations.

The follow up to the release of the Discussion Paper acted as a catalyst to promote a paradigm shift with regards to burning in BC. The Paper challenged the reader to discard the notion that woodsmoke is natural and therefore good, and this biomass is ‘waste’. Instead the paper presented woodsmoke as a complex mixture of harmful pollutants and portrayed ‘wood waste’ as a rich resource waiting to be utilized.

Central to the whole Smoke Management initiative is the premise that *all* burning practices must be reassessed on the basis of cost vs benefit to society as a whole. Regulating one type of burning while ignoring others is not only unfair, it fails to impress upon *all* those who burn the need to collectively manage emissions. All too often the benefits accrue to the party burning (cheap waste disposal) while the costs are borne by those living nearby (impacted health, degraded aesthetic values).

PRESCRIBED BURNING OF LOGGING RESIDUES

Prescribed burning is done mainly for silvicultural purposes (site preparation for planting), but is also used to enhance wildlife habitat, improve cattle range, and reduce wildfire hazard. It is a low cost form of silvicultural site preparation. It was at one time ‘over prescribed’ and under regulated from an air quality perspective.

From a resource management perspective, eliminating all prescribed burning is not a practical option. The amounts burned can be reduced, and burning practices better managed. For example, the amount of wood residue from logging can be decreased, leading to less burning. Alternative site-preparation techniques can be used instead of slash burning.

Some of this woody residue can be used for power generation. Emissions can be reduced by strategically timing prescribed burns for periods of good atmospheric dispersion. There are new burning methods that ensure rapid consumption of target residues. Smoke Management for the ‘90s recommended the following to reduce smoke from prescribed burning:

- Develop BC Environment and Ministry of Forests policies that will encourage the maximum use of wood residue throughout the forest industry. This should include minimizing on-site debris and, where possible, transporting residue to energy recovery facilities.
 - Some aspects of this recommendation have been implemented. Problems remain with energy recovery.
- Support research into fire behavior and the site impacts of burning compared with the alternative of mechanical site preparation.
 - 5-year S.P.E.M. program did just this.

- Continue to improve the management of prescribed burning to reduce public exposure to particulates and air toxics, and minimize regional haze.
 - Area prescribed burned in B.C. down dramatically.
 - Complaints related to smoke from these burns down dramatically.
- Increase air quality monitoring. Expand continuous monitoring of fine particulate mass (PM₁₀) so that long-term changes can be effectively assessed and the data can be used as a regulatory tool.
 - BC now runs more continuous pm₁₀ monitors than any other province.

Burning of Land Clearing Debris

Burning to remove land-clearing residue causes special problems. Frequently, the woody debris left from land clearing was burned with noncombustible materials. Tires were used as fire accelerants. Very noxious emissions were often released. Smoke Management for the '90s recommended the following to reduce smoke from land clearing burning:

- Immediately stop the practice of using tires in land-clearing fires, throughout British Columbia.
 - Implemented in 1994.
- Develop and promote methods and procedures to stop land-clearing fires in areas where the potential for human health impacts are unacceptable.
 - Open burn smoke control regulation passed in 1993.

Waste Burning at Sawmills

Wood residue burning by sawmills is a long standing waste management problem. Most sawmills are still permitted to burn woody residues in inefficient teepee burners. These emissions lead to health problems in many small B.C. communities and are a visual blight.

Nearly half of the sawmill wood residue in the province is burned with no energy or resource recovery. Most of the surplus could be used for thermal electrical generation, as a feedstock for the chemical industry, or as raw materials for pulp mills and fibreboard mills. Smoke Management for the '90s recommended the following to reduce smoke from wood residue burning at sawmills:

- BC Environment should develop BACT/BART (best available control technology/best available retrofit technology) emission control objectives for existing incinerators, and amend all existing incinerator permits to require BACT/BART within 5 years.
 - Some new emission criteria developed.
- BC Environment should eliminate all teepee or olive burners in urban centres and smoke-sensitive areas. Require state-of-the art incineration, or divert these wood residues to electrical generation facilities and/or other uses.
 - 1997 set as date to phase-out most tee pee burners in smoke sensitive areas. the rest phased out by 2000.
- BC Environment should phase out open burning of sawmill residues as a waste management option except for small, remote operations.
 - Much of this burning has been eliminated.
- Energy policy in British Columbia presents a formidable barrier to achieving optimum energy utilization of waste wood from the forest products industries. A mechanism should be established whereby the social costs of all energy sources are incorporated into energy development decisions.
 - Under discussion

Urban and Agricultural Burning

A wide variety of organic materials are burned within urban areas as a means of waste disposal. These include; 1) back-yard and garden residues, 2) construction debris, 3) landfill fires, and 4) agricultural burns.

These fires have a high potential to cause human health impacts due to their close proximity to dwellings and business areas. Burning takes place under a variety of meteorological conditions, and often the material is wet etc... leading to poor combustion. Synthetic materials are often added to the fires. Smoke Management for the '90s recommended the following to reduce smoke from urban and agricultural burning:

- Municipalities should be encouraged to put an end to all burns of backyard and garden residues. These materials should either be composted or otherwise managed (not landfilled).
 - Yard burning banned in many large municipalities.
 - Model burning by-law being developed for smaller communities.

- Municipalities should be encouraged to put an end to on-site burning of land development and construction debris.
 - Now regulated under open burn smoke control regulation.
- New policies should be developed to curtail the burning of municipal domestic and light industrial waste in municipal landfill operations.
 - Implemented over much of the province.
- The exemption under which most agricultural burning occurs should be repealed. Where fire is essential to combat an outbreak of pests and/or disease a one-time burn approval can be issued.
 - Exemption not repealed in 1992.
 - Renewed pressure to repeal exemption started.

Residential Wood Burning

In many BC communities wood burning for home heating causes a marked decline in urban air quality. Unlike natural gas or oil, burning wood releases substantial particulate emissions and other products of incomplete combustion which negatively impact human health.

Inefficient woodstoves and poor burning practices by woodstove operators are a major part of the problem. As BC has not set emission standards for wood burning appliances, it is likely that a minority of woodstoves achieve the emission rates required in other jurisdictions in the Pacific Northwest. Smoke Management for the '90s recommended the following to reduce smoke from residential wood burning:

- Implement a BC woodstove standard identical to the EPA standard and/or the Oregon standard. Make the standard a requirement for any new stove sold, and include it in BC building codes for new homes or renovations.
 - Implemented
- To assist Municipalities, BC Environment should develop model emission reduction programs similar to those in Puget Sound, Juneau, Missoula etc... These include components such as issuing burning advisories, mandatory burn bans, and various incentive programs to improve or eliminate emissions.
 - Model program under development.
 - Advisories issued in a half dozen communities.

- To assist municipalities, BC Environment should provide the expertise to identify problem areas, design air quality monitoring networks and help implement air quality indices in affected communities.
 - Every region now has air quality professionals providing such services.
- To assist Municipalities, the Atmospheric Environment Service should make available regional air stagnation forecasts on an as-needed basis.
 - The ‘venting index’ is now available through a 1-900 number, and is widely available to regional offices.
- The Government should support a substantial Public Information initiative to inform and educate the public about the hazards associated with exposure to ambient levels of smoke from woodstoves.
 - New pamphlets and a wood stove video released.
 - Regional staff elevating this issue through a media campaign each winter.

Conclusion

In BC a variety of techniques to minimize the impact of wood burning have been brought to bear on this multi-faceted issue. Diverting some of this residue to electrical generation facilities requires massive changes to energy pricing policies and the electrical generation infrastructure, and have yet to happen. Other changes simply require more public information, or the changing of a by-law. Many of these changes have occurred.

SECTION 2: VISIBILITY PROTECTION

There has always been an awareness in British Columbia that good visibility is an important air quality value. Crystal clear vistas are a perennial theme in tourism promotions. Public complaints about air quality peak whenever smoke or smog are readily observable. However, it is only recently that air quality regulators have attempted to manage this important aspect of air quality.

In the early 1990s, BC Environment released several discussion papers addressing smoke and haze concerns. *Smoke Management for the '90s* examines the harmful impacts of the various sources of wood smoke in the province — of greatest importance are the negative effects that very fine particulate matter has on both lung function and the scattering of visible light. The discussion paper, *Ensuring Clean Air*, also stresses the importance of visibility. In addition, the City of Vancouver's 1990 report, called *Clouds of Change*, and the Greater Vancouver Regional District's *Let's Clear the Air* discussion papers (1992) emphasize the importance of managing fine particulates to preserve visibility.

Common to all these reports is the concept that natural vistas possess considerable aesthetic and economic value for residents and tourists alike.

In 1991, Canada and the United States signed the *Canada–U.S. Air Quality Accord*. Both countries agreed to address shared concerns regarding “sources that could cause significant transboundary air pollution.” Annex 1, part 4 of the accord addresses “prevention of air quality deterioration, and visibility protection.” The sources of concern are generally taken to be permitted point sources within 100 km of the Canada/U.S. border emitting over 100 tons per year, or very large but more distant sources. This 100-kilometre-wide swath of land encompasses about 15% of B.C.’s land mass, and most of British Columbia’s population centres and permitted emission sources.

Because of the growing interest in the Visibility issue BC Environment staff were directed to examine the visibility issue in more depth. In mid-1992, the branch released an issue paper entitled *Visibility Protection for British Columbia*, which presents the science behind light scattering by fine particles, measurement techniques and assessment methods. This Issue Paper sets out a rationale for protecting visibility and makes seven recommendations. The first was to create a Task Force to examine the issues surrounding Visibility Protection in British Columbia.

BC Visibility Task Force

Goals:

- To develop and rationalize the principle of visibility protection in British Columbia.
- To identify stakeholder requirements — including provincial and federal agencies, the public and special interest groups — for protection of visibility.
- To identify visibility sensitive areas in British Columbia and to recommend establishment of visibility protection areas.
- To recommend to Air Resources Branch, short-term and long-term management actions and strategies to protect or enhance visibility in visibility sensitive areas and to satisfy requirements of the Canada – United States Air Quality Accord.
- To develop and coordinate inter-agency cooperation in monitoring visibility and in implementing visibility management strategies.
- To liaise with visibility interests in adjoining jurisdictions.
- To seek Task Force representation on the IMPROVE* Steering Committee (*Interagency Monitoring of Protected Visual Environments).
- To identify specific needs for conferences, workshops, and public consultations on visibility protection issues for British Columbia.

Membership:

BC Environment
Atmospheric Environment Service
Parks Canada
BC Parks
BC Ministry of Forests
BC Ministry of Tourism
Greater Vancouver Regional District

Mentors:

WESTAR (Western States Air Resources council)
Washington State Department of Ecology
CARE (Centre for Atmospheric Research Experiments)
U.S. National Park Service
U.S. Environmental Protection Agency
IMPROVE Steering Committee
University of British Columbia (Dept. of Geography)
Air Resource Specialists Inc.
Desert Research Institute

What is Visibility, Visual Air Quality and Visibility Protection?

- **Visibility** often means “how far you can see.” or the ‘visual range’, but sometimes it’s taken to mean ‘visual air quality’.
- **Visual Range [VR]** (or Meteorological Range [MR]) is a quantitative measure of the maximum distance at which a large black object is just barely distinguishable from the background sky.
- **Visual Air Quality [VAQ]** is the effect that the atmosphere has on our outdoor visual experience. VAQ is a somewhat personal, subjective interpretation of how color, clarity and borders (plumes or layers) affect the experience of a person viewing an outdoor scene.
- **Aerosols** are very fine particulate matter of natural or anthropogenic origin. The smallest of these are very efficient scatterers of visible light. When discussing VAQ we are really speaking of the visual effect that aerosols have on image forming light traversing the distance between an object, say a distant mountain, and our eyes (USEPA, 1979).
- **Visibility Protection** (in the U.S.) is taken to mean “any actions or plans which insure significant, reasonable progress towards achievement of the National Visibility Goal of protecting and improving the visual resource of the Nation’s Class 1 Wilderness and National Park Lands” (Core, 1986).

The **National Visibility Goal** was established by Congress in 1977 to correct and prevent pollution-related visibility impairment affecting large national parks and wilderness areas (USEPA, 1979). Specifically, the goal is:

The prevention of any future, and the remedying of any existing impairment of visibility from man made air pollution.

A Proposed Visibility Protection Goal For British Columbia

Whereas clean, clear air is a strong indicator of the overall health of British Columbia's atmospheric environment and, by extension, the quality of life in the province, and

Whereas all British Columbians, through resource and energy use, are sources of air pollutants and thus responsible for impairing visual air quality, and

Whereas human settlement patterns, the location of geographic features, and the distribution of tourism and recreation facilities predispose some regions to being "visually important areas," and

Whereas the movement of air pollutants, once emitted, are dictated by natural forces and thus freely traverse political boundaries,

The adoption of the following Visibility Protection Goal by the Government of British Columbia is recommended:

The Province of British Columbia is committed to preventing significant impairment of, and remedying existing impairment of, visual air quality in designated visually important areas. This commitment extends to all direct or indirect anthropogenic sources of air pollution within the province, regardless of in which jurisdiction these visually important areas lie.

Benefits of an Effective Visibility Protection Program

Good visibility is a publicly recognized indicator that our air quality management efforts are succeeding.

If the frequency of photochemical smog or regional haze declines over the next few decades it will reverse a long standing trend in the public's mind that air quality is steadily worsening. Improving VAQ reflects well on the Government's stewardship.

Good Visibility = Healthy People.

Recent studies have firmly established a link between low to moderate concentrations of fine particulate matter and substantial health impacts. These are the same particles which

impair visibility. Managing them more effectively improves visibility, and by extension, improves health. Good VAQ means healthy air.

Solutions which protect visibility also benefit other air quality management efforts.

Emission reduction programs and visibility protection are inextricably linked. Adopting the visibility protection goal add weights to such programs as NOX/VOC Management, Smoke Management, AirCare, Emissions Trading etc.. Any new initiatives spawned by a visibility protection program will also benefit these existing emission reduction efforts.

An Effective Visibility Protection Plan ensures BC meets its transboundary obligations under the Canada\US Air Quality Accord.

It presents us with an opportunity to form alliances with adjoining Canadian and U.S. jurisdictions with respect to the long-range transport of pollutants, particularly woodsmoke, nitrates and sulphates. By adopting similar VAQ standards, we ensure a level playing field concerning transboundary pollutants.

Recommendations of the BC Visibility Task Force

Immediate Actions

■ Establish a Visibility Management Steering Group

A multi-agency Visibility Management Steering Group must be created to succeed the Visibility Task Force. Its primary goals will be to oversee the implementation of task force recommendations, continue to stay informed of developments in the field, and further develop the concept of *visibility protection* in the province. The steering group's goals would be to:

- promote consensual resolution of visual air quality issues;
- address economic/ecological issues related to visual air quality management;
- advance cooperative management strategies regarding visual air quality;
- coordinate education and implementation; and
- promote the establishment of local/regional management groups to address local/regional concerns.

■ Announce the Provincial Government's Commitment to the British Columbia Visual Air Quality Goal

By adopting the *British Columbia Visual Air Quality Goal*, the provincial government will communicate to the public a strong commitment to protecting visual air quality. Publicly declaring the *Goal* will also show a commitment to the transboundary concerns raised in the *Canada-U.S. Air Quality Accord*.

- Sponsor an International Workshop on Managing Natural and Anthropogenic Emissions

One of the Visibility Management Steering Groups first tasks would be to sponsor a workshop to resolve the ethical issues surrounding the management of emissions from virtually all sources. Forging consensus on a common, underlying philosophy will eliminate roadblocks to effectively managing visual air quality in the future.

- Adopt the IMPROVE Protocol for All Visibility and Aerosol Monitoring in B.C.

It is recommended that British Columbia adopt the monitoring protocols developed by the Interagency Monitoring of Protected Visual Environments (IMPROVE). This includes standards for optical, scene and aerosol monitoring related to visual air quality. Adopting the IMPROVE protocol wholesale will facilitate the comparison of data between jurisdictions, and ensure B.C. keeps abreast of the latest advances in the field.

- Adopt Deciview (*dv*) as the Standard Visual Index for B.C.

It is recommended that the Deciview (*dv*) Standard Visual Index be adopted as the reporting standard for visibility in British Columbia. Using *dv* will also facilitate comparison with work being done in the U.S. and abroad.

- Develop a Public-Education and Communications Plan

One of the first tasks of the Visibility Management Steering Group would be to develop a joint public education and communications plan to promote visibility protection province wide. A communication and public-education plan will better define the problem and communicate the provincial government's anti-degradation/remediation goal.

Actions Following Further Research

- Develop a Joint Program Plan for Visibility Monitoring, Data Analysis and Reporting

It is recommended that, before any agency initiates a visibility monitoring program, a multiagency program plan be developed to ensure integration and eliminate duplication of effort. This includes the acquisition of aerosol mass (PM_{2.5}), chemistry (IMPROVE), extinction (nephelometer, transmissiometer), and scene (camera) data.

- The plan will include the rationale for monitoring (where, when, why, how), the analysis details (analytical protocols, costs, analyzing agency, QA/QC), and reporting procedures. Developing a plan must be a high priority for the Visibility Management Steering Group.

- Implement Visibility Standards following Health and Economic Valuation Studies

Visibility-based standards should be implemented Province-wide as a means of protecting human health and ensuring the preservation of scenic resources. Before this is done, human health and economic valuation studies must be completed.

Aerosols and gases that impair visibility also affect human health. As such, monitoring aerosols and gases for visibility studies will also be valuable for health-related studies. This is especially relevant for very fine particulates (PM_{2.5}) — more and more regarded as potentially the most harmful for humans. Having other data available (bext) will facilitate research into the links between human health and visual air quality.

In addition, access to visibility monitoring data will make it possible to use the latest valuation techniques to assess 1) the public's willingness to pay for visibility protection, 2) the economic benefits of good visibility, and 3) the potential collective loss from poor visibility (tourism, health). This will make it possible to properly account for the intangible benefits of an effective visibility protection program — usually summed up as “quality of life.”

■ Designate Visually Important Areas (VIAs)

The Visibility Management Steering Group should further develop the concept of protecting visibility in B.C. by designating Visually Important Areas (VIAs), as put forward in the *British Columbia Visual Air Quality Goal*.

Rather than adopting one rigid set of criteria to define all VIAs (as did the U.S.), each VIA would be a discrete unit with unique visibility criteria. The guidelines for determining the criteria would be firm, and visual air quality criteria would reflect the level of overall concern, background conditions, climate, physiography and other factors.

Conclusions

The final report of the Visibility Task Force was submitted to the Ministry Executive in November of 1994 and is under consideration now. Some of the recommendations have worked their way into a document outlining the Air Resources Programs Atmospheric Monitoring Strategy. Since a Visibility Protection program is such a departure from the existing program (and expensive) it may take some innovation to implement the recommendations in the current fiscal environment.



Montana Air Quality Issues

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The Department of Health and Environmental Sciences' Air Quality Division (AQD) has worked cooperatively with the National Park Service (NPS) and the U.S. Forest Service (USFS) in conducting ambient air monitoring. My first experience working cooperatively with the NPS and the USFS was coordinating ambient air monitoring during the wildfires of 1988. This was an example of four agencies working together, the NPS, the USFS, the Environmental Protection Agency (EPA) and the Montana State Department of Health and Environmental Sciences (DHES) to respond to public health concerns. The project involved locating available monitoring equipment, deploying it in areas impacted by wildfire smoke, teaching local USFS or NPS employees to operate the equipment, and in Gardiner for the Yellowstone fires, providing lab equipment and training to USFS personnel to determine particulate levels on-site. This was an ambitious project that was successful due to the participation and cooperation of all the agencies.

Currently the DHES is cooperating with the NPS in a carbon monoxide (CO) study in West Yellowstone. The DHES performed the audits on the equipment and assisted with siting the monitors. The DHES is also assisting the USFS with particulate monitoring in the Bitterroot. The DHES helped identify monitoring sites, trained USFS personnel in the operation of the equipment and performed equipment maintenance. These sites are being used to measure the smoke impacts from Wilderness areas.

The DHES has an ambient monitoring network throughout the state, measuring PM-10, sulfur dioxide (SO₂), and CO in many communities. In addition some companies are also required to operate ambient monitoring sites as a condition of their permit. These monitoring activities identify areas of the state that exceed the ambient standards and need to have control plans developed to bring them back into compliance with the standards.

Currently the DHES is evaluating adding a PM-10 background site for the Northwest part of the state and determining exactly where a representative background concentration should be measured. In the past, $8 \mu\text{g}/\text{m}^3$ was used as the background PM-10 concentration. This number was generated from TSP data that was gathered in Glacier National Park a number of years ago

which was converted to PM-10. However a site recently established outside of Whitefish showed background PM-10 levels of $30 \mu\text{g}/\text{m}^3$. This is of concern since the background level makes a significant difference in the emissions increases that can be permitted and the amount of control needed for nonattainment areas.

Montana has particulate nonattainment areas in the Western part of the state where communities located in mountain valleys are affected during the winter by inversions. The major sources contributing to the particulate problem have been identified as residential wood burning and re-entrained road dust as well as emissions from the stationary sources located in the communities. However, one of our nonattainment communities, Whitefish, does not have a stationary source.

The PM-10 nonattainment areas in the state are: Libby, Kalispell, Columbia Falls, Whitefish, Thompson Falls, Butte, Missoula, Lake Deer and Ronan. Missoula is also a CO non-attainment area due to motor vehicles, Billings is an SO₂ nonattainment area due to industrial facilities and E. Helena is a lead and SO₂ nonattainment area due to the ASARCO lead smelter. Control plans have either been implemented in these areas or negotiations are underway to develop the control plans.

One source of particulate that individuals in nonattainment areas always identify, but which is very difficult to identify through the studies and difficult to establish control strategies for, is smoke from prescribed burning. Montana issues permits to the major open burners and operates a smoke management program in the fall. The NPS, U.S. Fish and Wildlife Service and the USFS are all major open burners participating in this program. The months of September, October and November experience changeable weather conditions providing good days for burning and days when inversions exist and smoke would immediately impact local communities. Therefore during those months, weather balloons are released daily from Libby, Kalispell, Missoula and Butte and the information is relayed to a monitoring unit in Missoula where a meteorologist decides if burning can occur. Local airshed coordinators, usually USFS personnel, work with local health offices to make sure any fires won't have an adverse impact on nonattainment areas.

The most important program in addressing air quality impacts from industrial facilities is the preconstruction permitting program. Montana recognized that there were public health concerns from industrial facilities and passed their Clean Air Act before the federal Clean Air Act was passed. Montana has a minor new source review program where any stationary source that has the potential to emit more than 25 tons per year must obtain an air quality permit prior to construction. Permitting is considered a significant action and an environmental assessment must be done for each permit. In addition, best available control technology (BACT) must be applied and dispersion modeling must be done to show that the project will not cause or contribute to a violation of any ambient standard. When a facility makes a change that causes an increase in emissions, they must get an alteration to their permit and go through BACT, modeling and an environmental review for the new project.

Montana has delegation for the Prevention of Significant Deterioration (PSD) and New Source Review (NSR) programs which are the federal permitting programs. This program only applies to major facilities which are facilities that have the potential to emit 250 tons per year or which are listed sources that have the potential to emit 100 tons per year.

The PSD program restricts increases in concentrations of pollutants over a baseline amount to specific levels. This is called the ambient air increment and companies need to model their emissions to show that the increment is not exceeded. In addition they must show that they don't cause or contribute to a violation of the ambient standard.

For a PSD permit, premonitoring must be done for a year prior to submitting an application to establish the background levels to ensure that the additional emissions from the facility will not violate an ambient standard. The DHES can then require post monitoring to determine the actual effect of the emissions on the air quality in the area. BACT must be applied.

Additional impact analyses are required to assess impairment to visibility, soils and vegetation. This analysis must include not only the impacts of the source but of any general commercial, residential or other growth associated with the source. Montana has specific rules to address visibility impacts on Class I areas.

The PSD/NSR program designated certain areas as Class I or pristine areas. When a permit application is submitted that is within 100 kilometers of a Class I area, a copy is sent to the federal land managers of the areas for review and evaluation of the air quality related values or AQRVs. If the federal land manager makes a demonstration of adverse impacts from the proposal and the DHES concurs with the demonstration, then the DHES will not issue the permit. There is nothing in the Montana regulations which require the DHES to deny a permit based on AQRV impacts, however, Montana has always provided the federal land managers with the opportunity to work with the facilities to resolve the issues.

Major sources that make modifications to their facilities with an increase in emissions above certain specified significance levels are subject to PSD permitting. However, if the increase in emissions is less than the significance level, the facility is only subject to state permitting requirements. The federal program allows for what Montana calls "emissions creep."

In the future, Montana will be implementing the federal acid rain program. There are only four Phase II facilities in the state: Montana Power Company's Colstrip units in the southeast part of the state, Montana Power Company's Corette plant in Billings and the Montana-Dakota Utilities facility in Sidney, in the extreme eastern part of the state.

Finally Montana will also be developing an air toxics program which will consist of ambient monitoring and permitting for sources of the 189 hazardous air pollutants listed in the federal Clean Air Act.

Montana's cooperation with Canada has included the monitoring project related to the Canadian power plant north of Scobey where extensive air quality and water quality monitoring was done due to public concerns about the facility. A recent issue has arisen that involves public concerns about a hazardous waste incinerator that is proposed to be located just across the border. However, the site currently being assessed is north of North Dakota.

This provides a brief overview of Montana's air quality program and the relationship with the National Park Service and Canada.



The U.S.–Canada Air Quality Agreement

(with Keith Puckett of Environment Canada)

Molly Ross
*Special Assistant to the Assistant Secretary for Fish and Wildlife and Parks
U.S. Department of the Interior
Washington, D.C., United States*

This paper will examine the U.S.–Canada Air Quality Agreement and selected policy issues relating chiefly to protected areas. The accompanying paper by Keith Puckett of Environment Canada will discuss the scientific and technical activities under the Agreement and the information exchange that is occurring between the two countries.

National parks can be a compelling argument within each country for better air pollution controls and for a greater scientific understanding of air pollution. National parks protect natural and cultural heritage, and provide enjoyment to present and future visitors. The quality of the air and the quality of visibility within parks is obviously important and relevant. Together, the existence of parks and other protected areas in Canada and the United States present a strong argument for both countries to make the Air Quality Agreement work well, and to establish and maintain the tools necessary to protect park resources in both countries from the adverse affects of air pollution. The problem is mutual; air pollution is sourced in both countries and affects both countries, although the amounts of pollution and the kinds of problems it causes may be different in each country. The Air Quality Agreement helps to provide the tools that will allow some of these transboundary problems to be solved.

BACKGROUND TO THE AIR QUALITY AGREEMENT

Agreements between Canada and the United States with respect to **water** go back historically to 1909, to the Boundary Waters Treaty. Agreements dealing with air took longer to complete. During the 1970s, a great deal of research was conducted in both countries on the effects of acid rain; by the end of the decade the United States Congress was presented with a number of acid rain bills for discussion. The accession of the Reagan administration put a halt to consideration of acid rain as a problem at the political level, but scientific research continued.

1985 marked a turning point, when both countries appointed special envoys to examine the issue of acid rain. Drew Lewis was appointed by the USA, and William Davis was appointed by Canada. Their report which was issued in 1986 concluded that acid rain **was** a problem, a transboundary problem among others. A greater turning point occurred, from the United States' perspective, in 1988 with the election of George Bush. Early in the Bush administration, the President threw his support behind certain amendments to the U.S. Clean Air Act, which would become law. This change in political orientation led to new discussions about what could be accomplished by a transboundary agreement on air quality, which would build on earlier memorandums of intent signed by the two countries.

Negotiations between the two states began in 1989, and took a more serious turn in 1990, leading to the Air Quality Agreement which was signed by the President of the United States and the Prime Minister of Canada on March 13, 1991. Political agreements, certainly international political agreements, are very difficult to achieve. They require the convergence of a number of different factors and circumstances. In this case, however, the Air Quality Agreement was also based on scientific research, and on an understanding by Canadian and American officials of the air pollution problems that ultimately required political solutions.

THE AIR QUALITY AGREEMENT

There are certain asymmetries in the agreement as it is written. The United States came into the negotiation process with the Clean Air Act amendments of 1990 having been signed and acted into law as of November 1990. Much, or all, of what the U.S. government committed itself to do during the negotiations was what it was requiring itself to do already under these new amendments. The agreement in many places requires the U.S. only to follow its existing laws. In contrast, Canada in at least three circumstances was asked to develop specific programs. Two examples of this include establishing a national cap on sulphur dioxide (SO₂) emissions, and implementing a program of continuous emissions monitoring. Canada committed to meeting both of these requirements by 1995.

Annex 1 of the agreement relates to the prevention of air quality deterioration and visibility protection. To meet the requirements of this section, the United States agreed to maintain the activities it undertakes under Part C of the Clean Air Act to prevent significant air quality deterioration and protect visibility. Canada committed to developing and implementing means of affording levels of protection comparable to those under the U.S. program, also by 1995. Although the agreement is much broader in scope than the annex being discussed, it is particularly relevant to protected areas and to those who manage them.

Officials right now are in the process of preparing a comprehensive assessment of how well the agreement has worked in its first five years of existence, and what will require future discussion. This assessment is required under the terms of the agreement.

The Assessment Notification & Mitigation provisions of the accord (Article 5) are one example of an area that will require further discussion. In essence, there is a disagreement between the two countries. Canadian officials have expressed their belief that they are taking more action in

this area than their counterparts in the United States are willing to take. However, this is an example of another asymmetry in the agreement; it can be argued that the current U.S. programs are adequate and thus no new action is required by the United States. Transboundary assessment, notification, and mitigation is one area of special interest to those who are concerned with protected areas.

PREVENTION OF SIGNIFICANT DETERIORATION (PSD) / VISIBILITY PROTECTION

When considering this clause of the agreement, it is very difficult to compare the two countries' systems. For U.S. officials, when looking at Canadian federal legislation only, it is hard to be assured that there is adequate protection for the air quality resources, including visibility, that are explicitly protected in federal law in the United States. Further to this, it is not clear to U.S. officials whether this kind of protective legislation has been enacted by all of the provinces. Canada's position is that through its environmental assessment program and the permitting programs of both the federal and the provincial governments, Canada is providing comparable levels of protection to those provided by the USA, where PSD is concerned.

U.S. laws with respect to PSD are very strong in giving a role to the federal land manager, in promising to err "on the side of the resource" by ensuring that air quality-related values are protected, and in giving the federal government a role in permitting processes. This last point sometimes involves the federal government persuading permitting authorities to deny permits. With respect to protection of visibility, the goal is to remedy any existing and prevent any future man-made impairment of visibility in parks and wilderness areas classified as Class 1 areas. A regulatory scheme requires the meeting of this goal through reasonable progress and best available retrofit technology. In the United States, regulations currently address "reasonably attributable" pollution — pollution that can be attributed back to a source or group of sources. The Environmental Protection Agency will be drafting regulations to address regional haze before the year 2000.

CONCLUSION

The Prevention of Significant Deterioration provision can be read symmetrically. If both governments initiated identical programs on either side of the border, the PSD clause would be so strong where protection of air quality is concerned, that there would be undeniable benefits to protected areas. However, the provision can also be read asymmetrically, to suggest that Canada must provide evidence of the prevention of significant air quality deterioration to the United States, regardless of whether the United States provides similar evidence to Canada. If this second approach is taken for correct, it suggests that Canada should develop and implement a specific program to deal with air quality and visibility.

Likely this issue will be discussed at a political and a legal level in the future, but the problems themselves, particularly as they relate to parks, can be discussed without going to that extreme. Parks managers and scientists on both sides of the border should use their knowledge and their information to push for better protection of air quality.



Canada-U.S. Air Quality Agreement

(with Molly Ross of the U.S. Department of the Interior)

Keith Puckett
Atmospheric Environment Service
Environment Canada
Downsview, Ontario – Canada

This paper will discuss the scientific aspects of the Air Quality Agreement. The roles and responsibilities of each country with respect to scientific issues are found in Annex 2 of the agreement. An examination of Annex 2 is helpful in identifying other opportunities for collaborative work to meet the information requirements of the agreement. In general, it would seem that the accord's information exchange provisions are working reasonably well. There are four parts to the annex:

AIR POLLUTANT CONCENTRATIONS AND DEPOSITION

1. "For the purpose of determining and reporting on air pollutant concentrations and deposition, the Parties agree to coordinate their air pollutant monitoring activities through:
 - (a) coordination of existing networks;
 - (b) additions to monitoring tasks of existing networks of those air pollutants that the Parties agree should be monitored for the purpose of the Agreement;
 - (c) addition of stations or networks where no existing monitoring facility can perform a necessary function for purposes of this Agreement;
 - (d) the use of compatible data management procedures, formats and methods; and
 - (e) the exchange of monitoring data."

Note that section 1(b) means simply that if the parties are not measuring something that is relevant, they should be doing so.

AIR EMISSIONS LEVELS

2. "For the purpose of determining and reporting air emissions levels, historical trends, and projections with respect to the achievement of the general and specific objectives set forth in this Agreement, the Parties agree to coordinate their activities through:
 - (a) identification of such air emissions information that the Parties agree should be exchanged for the purposes of this Agreement;
 - (b) the use of measurement and estimation procedures of comparable effectiveness;
 - (c) the use of compatible data management procedures, formats, and methods; and
 - (d) the exchange of air emission information."

INFORMATION EXCHANGES

3. "The Parties agree to cooperate and exchange information with respect to:
 - (a) their monitoring of the effects of changes in air pollutant concentrations and deposition with respect to changes in various effects categories, e.g., aquatic ecosystems, visibility, and forests;
 - (b) their determination of any effects of atmospheric pollution on human health and ecosystems, e.g., research on health effects of acid aerosols, research on the long-term effects of low concentrations of air pollutants on ecosystems, possibly in a critical loads framework;
 - (c) their development and refinement of atmospheric models for purposes of determining source receptor relationships and transboundary transport and deposition of air pollutants;
 - (d) their development and demonstration of technologies and measures for controlling emissions of air pollutants, in particular acidic deposition precursors, subject to their respective laws, regulations and policies;
 - (e) their analysis of market-based mechanisms, including emission trading; and
 - (f) any other scientific and technical activities or economic research that the Parties may agree upon for purposes of supporting the general and specific objectives of this Agreement."

Note that section 3(a) means that the parties agree to share information about any changes in the impacts of air pollution as emissions change. Section 3(b) refers to the parties agreeing to share any information about new impacts of air pollution that may be discovered.

ACIDIC DEPOSITION

4. “The Parties further agree to consult on approaches to, and share information and results of research on, methods to mitigate the impacts of acidic deposition, including the environmental effects and economic aspects of such methods.”

The annex has been implemented in large part through the establishment of a committee to promote scientific cooperation between federal, state, and provincial government agencies. The committee has acted as an umbrella organization to foster existing cooperative efforts, and has at times initiated its own research efforts. For example, the committee conducted the analysis and interpretation on the causes and effects of acid rain which formed the bulk of the 1994 progress report on the Air Quality Agreement. The contents of the next progress report are currently under discussion.

CONCLUSION

The Air Quality Agreement must be reviewed by its fifth year of existence, which will be 1996. Annex 2 will certainly be reviewed, likely with respect to the direction currently being given to the scientific communities in both countries and whether this direction is clear enough. One question that should be answered is whether Annex 2 provides sufficient direction and mandate with respect to defining the effects of air pollution on protected areas.



Activities of the International Air Quality Advisory Board

*Kathy A. Tonnessen
Leader, National Air Quality Program
National Biological Service
Denver, Colorado – United States*

At the **International Air Issues Workshop** we investigated available avenues to protect air quality and resources on both sides of the border. One of the ways to do this is to involve the governments and the regulatory agencies that set regulations to control air pollutants. There are a number of bilateral agreement and treaties currently in force that could be used to influence governments to protect parks and protected areas from air pollution damage. We can use provisions of the U.S./Canada Air Quality Agreement to effect this protection (this Air Quality Accord is addressed by other speakers at the Workshop). Another bilateral avenue is via the International Joint Commission, which I will discuss in this paper. The most recent addition to the array of international organizations concerned with environmental quality in North America is the North American Commission on Environmental Cooperation (NACEC), the body charged with implementing the North American Agreement on Environmental Cooperation, the environmental side agreement to the North American Free Trade Agreement.

In this paper I will specifically outline the roles, responsibilities, and activities of the International Air Quality Advisory Board (IAQAB), organized by the International Joint Commission as its technical advisory body on issues related to air quality in the U.S./Canada border region.

INTERNATIONAL JOINT COMMISSION

I first want to describe the International Joint Commission (IJC) and its activities related to air quality protection. The IJC is a bi-national organization established by the Boundary Waters Treaty of 1909 (its first meeting was not until 1912), with three members appointed by the President of the United States and three appointed by the Governor-in-Council in Canada. The IJC has offices in Ottawa, Windsor (ONT), and Washington, D.C. The Commissioners rely on a number of advisory boards and task forces to provide them with technical input concerning water quality and

quantity issues along the border, especially in the Great Lakes basin, and on the subject of air quality and its effects on human health and ecosystem integrity in the border region.

The IJC was organized to deal with disputes along the border, primarily those dealing with water quantity and quality. Much of the early work of the Commission concerned the obstruction or diversion of waters that flow along, and in certain cases across, the boundary. Since the passage of the Great Lakes Water Quality Agreement of 1972, the IJC has been engaged in numerous studies and deliberations to restore and maintain the chemical, physical, and biological integrity of the Great Lakes Basin Ecosystem. The Commission encourages public participation in these issues, and is required to provide interested parties with a “convenient opportunity to be heard” on matters under consideration. The IJC involves and educates the public on transboundary issues at the Biennial Meeting, the next to be held in Duluth, Minnesota in September 1995.

Current members of the IJC include:

Canadian Commissioners: three new Canadian commissioners were recently appointed.

United States Commissioners: Tom Baldini, Susan Bayh, and Alice Chamberlin

The Canadian Commissioners were just appointed by the government in Ottawa. Their names are not available at this time; U.S. Commissioners were appointed within the last two years by President Clinton.

The IJC involvement in air quality issues began as early as 1928 when it became involved in the Trail Smelter dispute. In this case the State of Washington requested relief from emissions generated by a smelter located over the border in British Columbia. Under a 1966 Reference the Governments asked the IJC to keep them informed of air pollution problems along the Canada-United States boundary. Under this Reference the Commission established the International Air Quality Advisory Board (IAQAB), to work on air quality issues. In 1988 the IJC specifically instructed the IAQAB to investigate the hazards of emissions in the Detroit/Windsor-Port Huron/Sarnia Region. Since that time the IAQAB has considerably expanded its scope to include research and education on the important regional air pollutants (including toxics, acid deposition, particulate matter, ozone, and greenhouse gases) in both urban and rural locations (including parks and protected areas).

INTERNATIONAL AIR QUALITY ADVISORY BOARD

The IAQAB is made up of an equal number of representatives from the United States and Canada. These members serve as advisers to the Commission; the Board fills an important education function on air quality issues for the Commissioners and the public. To accomplish its mission the IAQAB sponsors workshops, conducts analyses, publishes reports, and writes public information articles and brochures. One such brochure is titled “Winds of Chance, the Effects of Air Pollution on the Great Lakes”, which discusses the concept of a transboundary “airshed”. The Board members also review documents and reports for technical content and communicates this information to the

Commissioners. The IAQAB satisfies its “education and alerting” function to the IJC in two ways: (1) by presenting semi-annual reports to the IJC during its meetings in Ottawa and Washington, D.C., and (2) by writing special reports, providing a more in-depth discussion of a current topic.

The IAQAB has evolved to include technical experts in the areas of meteorology, control technologies, atmospheric chemistry, and ecosystem science. The current members of the IAQAB are:

United States:

Gary Foley (U.S. Chair)
EPA, Research Triangle Park, NC

Rick Artz
NOAA, Silver Spring, MD

Harold Garabedian
Vermont Environmental Conservation Dept., Waterbury, VT

Paul Lioy
Environmental Health Sciences Institute, Piscataway, NJ

Kathy Tonnessen
National Biological Service, Denver, CO

Canada:

James Young (Canadian Chair)
SCENES Consulting Inc., Toronto

Dave Besner
New Brunswick Dept. of Environment, Fredericton, NB

Wayne Draper
Environment Canada, Air Issues Branch, Ottawa

Edward Piche
Ontario Ministry of Environment, Toronto

CURRENT ISSUES DISCUSSED BY THE IAQAB

The IAQAB has investigated a number of issues related to transboundary air pollution and its effects, some at the request of the Commissioners and some based on current controversies. Some of the most recent topics of discussion and analysis are mentioned here.

Redesignation of Detroit for Ozone Attainment: The State of Michigan petitioned the EPA to reclassify the Detroit area as being in compliance with the National Ambient Air Quality Standard (NAAQS) for ozone pollution. This reconsideration did not take into account the transport of ozone generated in the Detroit area across the border into Canada. Based on the Board's recommendation, the IJC wrote a letter to the U.S. government requesting that the redesignation not be granted.

Health Impacts of Ozone and Particles: The Board wrote a special report to the IJC on the new scientific information generated by health researchers on the injury to human lung function due to these two regional air pollutants. The Board recommended that this new information be considered in the review of the U.S. NAAQS for ozone and particles.

Nitrogen and Sulfur Deposition to the Lake Superior Basin: The Board wrote an information article for a recent semi-annual report on the current knowledge of sulfur and nitrogen in wet deposition within the Lake Superior Basin, including the Keweenaw Peninsula of Michigan and Isle Royale National Park. It reported the recent reduction in sulfate concentrations in rain and snow, then discussed the increase in nitrogen deposition and the implications for ecosystem function.

Visibility and AQRV Protection in Parks and Preserves: The Board has been bringing the Commissioners up-to-date on the issues associated with protection of visibility and air-quality related values in parks and protected areas in the boundary region. The IJC was briefed about the research, monitoring, and regulatory programs existing in both the U.S. and Canada.

Results of Windsor Air Quality Study: With the threat of construction of a waste incinerator in the Detroit area, the Ontario Ministry of Environment and Energy sponsored a comprehensive study of levels of toxic metals and organics that are present in the Windsor, Ontario area, both indoors and outdoors. This study also looked at the health risks to Windsor citizens due to these airborne toxics. The Board received a special briefing from Ontario researchers on the findings of that study.

IAQAB: CURRENT PLANS AND PROJECTS

The IAQAB is required to hold an annual public meeting to inform interested citizens about the Board's projects, and to get information from the public on their concerns about air quality in the border area. This year's meeting will be held in Toronto, Ontario in July 1995. Another opportunity for the public to hear about Board activities will come on September 24, 1995 in Duluth, Minnesota during the IJC's 1995 Biennial Meeting on Great Lakes Water Quality. This meeting is an opportunity for citizens, government officials, agency representatives, scientists, policy makers, special interest groups and the media to meet and discuss issues of concern in the Great Lakes basin. This year's meeting will focus on the concerns for air and water quality in the Lake Superior Basin and is titled "Our Lakes, Our Health, Our Future". At this meeting the IAQAB will present a workshop on toxic deposition to the Great Lakes Basin.

The Commissioners have requested that the IAQAB organize a “fact-finding” workshop to determine the important regional air quality issues and possible international strategies to deal with these issues in the Pacific Coastal region of Washington State and British Columbia. We are now planning for a two-day workshop in Vancouver, B.C. to be held November 1-2, 1995. We will bring together technical experts and policy people from the state, provincial, and federal agencies, along with land managers, public interest and environmental groups, to focus on the regional pollutants of concern in the region west of the Cascade Mountains: ozone, particles, and deposition of nutrients and toxics. One of the air quality issues of regional concern is the effects of prescribed and wild fires on visibility and human health. There have been field studies carried out in both British Columbia and Washington State that indicate the importance of biomass burning, vehicle emissions, and stationary air pollution sources in contributing to visibility degradation in parks and protected areas along the border (e.g. Mount Rainier and North Cascades NPs in Washington State).

The IAQAB has commissioned a study by a consultant to estimate the mass flux of toxics (using lead and cadmium in the initial calculations) to the Gulf of Maine watershed. A workshop to discuss findings in the interim report “Atmospheric Deposition to the Gulf of Maine” was held in summer 1994 in New Brunswick. We expect to receive a final report of this study in summer 1995. The Gulf of Maine Council has expressed an interest incorporating this approach into its ongoing program to protect water quality in the Gulf of Maine.

The Board is now preparing a special report to the IJC on the “Harmonization of Air Quality Standards”. This is a current topic of interest since the U.S. and Canada do not share common air quality standards or objectives. For example, the U.S. National Ambient Air Quality Standard for ozone is 120 ppb, while the Canadian National Objective for ozone is 82 ppb. At present the U.S. Environmental Protection Agency is reviewing both the national ozone and the particle standards.

The Board is also preparing a special report on Air Quality Issues in Protected Areas, based on a series of articles that appeared in the IAQAB semi-annual reports. As a result of these reports the IJC has expressed its willingness to communicate concerns to the two governments on the protection of air-quality related values (AQRVs) in parks, preserves, and wilderness areas in both the U.S. and Canada. These recommendations will include:

- Encourage the protection of visibility and other AQRVs,
- Emphasize the connection among regional air pollutants,
- Make the link between health effects and effects on AQRVs,
- Commission should identify transboundary “hotspots” of visibility degradation,
- Urge governments to develop regional haze regulations,
- Recommend harmonization of Prevention of Significant Deterioration programs under the U.S./Canada Air Quality Agreement,
- Call on Governments to coordinate monitoring and inventory program for AQRVs,
- Urge Governments to devise regional plans and regulations to reverse effects on AQRVs, and,

- Recommend regular exchange of information, technology, and personnel between Parks Canada and the National Park Service to monitor and
- Perform research on air quality and AQRVs in parks and preserves.

ACTIVITIES OF THE INTERNATIONAL AIR QUALITY ADVISORY BOARD

Kathy A. Tannessen

U.S. Department of Interior
National Biological Service
National Air Quality Research Program

Overhead 1

IJC/IAQAB ROLES

- IJC is a binational organization
- Created by Boundary Waters Treaty in 1909
- Investigates and reports on air and water quality
- Three commissioners from U.S./Canada
- First addressed air quality in 1928
- Created IAQAB in 1966
- IAQAB provides notice and advice

Overhead 2

MEMBERS OF THE IAQAB

UNITED STATES:

- Gary Foley (U.S. Chair): EPA, Research Triangle Park, NC
- Rick Artz: NOAA, Silver Spring, MD
- Harold Garabedian: VT Environmental Conservation Department, Waterbury, VT
- Paul Liroy: Environmental Health Sciences Institute, Piscataway, NJ
- Kathy Tannessen: National Biological Service, Denver, CO

Overhead 3

MEMBERS OF THE IAQAB

CANADA:

- James Young (Co-Chair): SENES Consultants, Toronto
- Hans Martin (CANADIAN CHAIR): Atmospheric Environment Service, Downsview, ONT
- Dave Besner: New Brunswick Dept. of Environment, Fredericton, NB
- Wayne Draper: Environment Canada, Air Issues Branch, Ottawa
- Edward Piche: Ontario Ministry of Environment, Toronto

Overhead 4

INTERNATIONAL JOINT COMMISSION

Canadian Commissioners:

- Claude Lanthier
- Gordon Walker
- James MacCaulay

United States Commissioners:

- Thomas Baldini
- Susan Bayh
- Alice Chamberlin

Overhead 5

IJC/IAQAB FUNCTIONS

- Advise IJC Commissioners on air issues
- Provide technical review and information
- Semi-annual reporting on air issues
- Clipping service for education
- Cooperate with other boards, especially water quality
- Organize technical workshops
- Issue special reports
- Write articles and pamphlets for public information

Overhead 6

RECENT ISSUES

- Redesignation of Detroit for Ozone
- Health Impacts of Ozone and Particles
- N, S, and Toxics Deposition to Lake Superior
- Deposition to the Gulf of Maine region
- Visibility and AQRV Protection in Parks and Preserves
- Results of Windsor Air Quality Study
- Status of Mercury Deposition
- Status of Monitoring Networks and Emission Inventories

Overhead 7

RECOMMENDATIONS TO GOVERNMENTS AQRV'S IN PARKS AND PROTECTED AREAS

- Recommend harmonization of PSD programs under the U.S./Canada Air Quality Agreement
- Call on Governments to devise a coordinated monitoring and inventory program for AQRVs
- Urge Governments to devise regional plans and regulations to reverse effects on AQRVs
- Recommend regular exchange of information, technology, and personnel between Parks Canada and NPS to monitor and protect AQRVs

Overhead 8

RECOMMENDATIONS TO GOVERNMENTS AQRV'S IN PARKS AND PROTECTED AREAS (continued)

- Encourage the protection of visibility and other AQRVs
- Emphasize the connection among regional air pollutants
- Make the link between health effects and effects on AQRVs
- Commission should identify transboundary "hotspots" of visibility degradation
- Develop regional haze regulations

Overhead 9

CURRENT PLANS AND PROJECTS OF THE IAQAB

- IAQAB Public Meeting, Toronto — July '95
- Session at IJC Biennial Meeting, Duluth — September '95
- PNW Air Issues Workshop, Vancouver — October '95
- Analysis of Deposition to Gulf of Maine
- Special Report of Harmonization of Standards
- Special Report on Air Quality Issues in Protected Areas

Overhead 10



U.S. National Park Service Roles and Responsibilities

*John Christiano
Chief, Air Resources Division
U.S. National Park Service
Denver, Colorado – United States*

The U.S. National Park Service is currently in a transition phase due to extensive restructuring, but its mandate — protecting and preserving park resources in the United States — remains the same. The National Park Service Air Quality Division also depends on partnerships to fulfill its mandate, with organizations such as the Environmental Protection Agency and the Fish and Wildlife Service, to name two. Partnership arrangements such as the Interagency Workgroup on Air Quality Models (IWAQM) and the Interagency Monitoring of Protected Visual Environments (IMPROVE) are extremely beneficial to all of the agencies involved. In addition, the Air Quality Division is involved in several regional arrangements such as the Southern Appalachian Mountains Initiative (SAMI), and is hoping to expand its involvement in international partnerships (including ones with Canada).

SUMMARY OF OVERHEADS

Overhead 1: *The National Park Service: Legislative Mandate*

- the National Park Service (NPS) was created by the Organic Act of 1916. The legislative points raised on this page suggest that the NPS is mandated to protect parks from air pollution based on prior legislation. In fact, this responsibility did not come into effect until the passage of Clean Air Act amendments in 1977

Overhead 2: *Clean Air Act Section 165(d)(2)(B)*

- these amendments gave a role for the first time to the Federal Land Manager

Overhead 3: *Clean Air Act Section 169A(a)(1): National Visibility Goal*

- this section of the Act is a special goal for visibility which applies to the National Park Service, the Fish and Wildlife Service, and other agencies
- based on these amendments, the NPS Air Quality Division was created in the 1970s

Overhead 4: *Proposed National Park Service Organization*

- restructuring began early in the Clinton administration, and has continued following the recent Congressional elections

Overhead 5: *National Park Service Air Quality Division*

- likely the structure shown will not be the final structure
- the National Biological Service is shown due to its former involvement as part of the Air Quality Division
- the Fish and Wildlife Service and the National Park Service are co-located, and assist each other in fulfilling Clean Air Act responsibilities

Overhead 6: *Government Structure*

Overhead 7: *Air Quality Division: Research Branch*

Overhead 8: *Air Quality Division: Monitoring and Data Analysis Branch*

Overhead 9: *Air Quality Division: Policy, Planning, and Permit Review Branch*

- this branch relies on the information collected by the other two branches when conducting permit reviews of emission sources that are to locate near national parks

Overhead 10: *AQ Program Head Office Because:*

- note: there are 369 park units in the USA; having employees with certain specialized skills in a central office is seen to be more efficient
- decentralized operations could also lead to inconsistencies in decision-making; some of these decisions could set negative precedents for other park areas if they were not made by some central authority

Overhead 11: *AQD Role*

Overhead 12: *Regional Role*

- will of necessity change, as the regional offices have been removed from the current organizational structure

Overhead 13: *Park Role*

- most of the NPS's monitoring data is collected in the parks themselves

Overhead 14: *Air Quality Division*

- Fiscal Year 1995 Budget Distribution

Overhead 15: *Air Quality Division*

- Budget History in Current Year Dollars
- planned increase for 1996 is due mostly to capital replacement needs

Overhead 16: *Air Quality Division*

- Budget History in Constant 1982 Dollars
- the NPS's buying power is lower today than it was in 1982

THE NATIONAL PARK SERVICE

“... shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purpose of said parks, monuments, and reservations, ***which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.***” (16 USC 1; 1916)

“... these areas, though distinct in character, are united through their interrelated purposes and resources into one National Park System as cumulative expressions of a single national heritage; that, ***individually and collectively, these areas derive increased national dignity and recognition of their superb environmental quality through their inclusion jointly with each other in one national park system preserved and managed for the benefit and inspiration of all the people.*** . . .” (16 USC 1a-1; 1970)

“The authorization of activities shall be construed and ***the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established,*** except as may have been or shall be directly and specifically provided by Congress.” (16 USC 1a-1; 1978)



Overhead 1

CLEAN AIR ACT SECTION 165(d)(2)(B)

"The Federal Land Manager and the Federal official charged with direct responsibility for management of such lands shall have an affirmative responsibility to protect the air quality related values (including visibility) of any such lands within a class I area and to consider, in consultation with the Administrator, whether a proposed major emitting facility will have an adverse impact on such values."

42 U.S.C. Sec. 7475(d)(2)(B)

Overhead 2

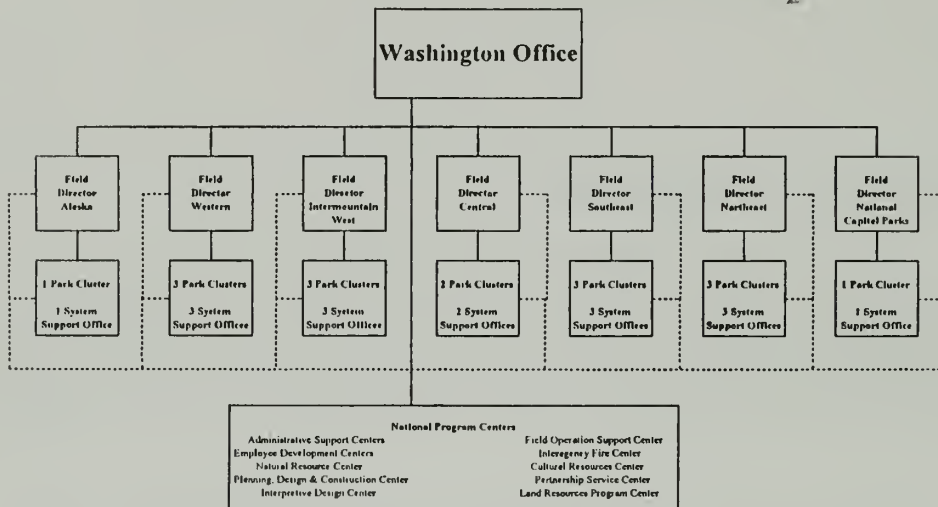
CLEAN AIR ACT SECTION 165(d)(2)(B)

"Congress hereby declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory class I Federal areas which impairment results from manmade air pollution."

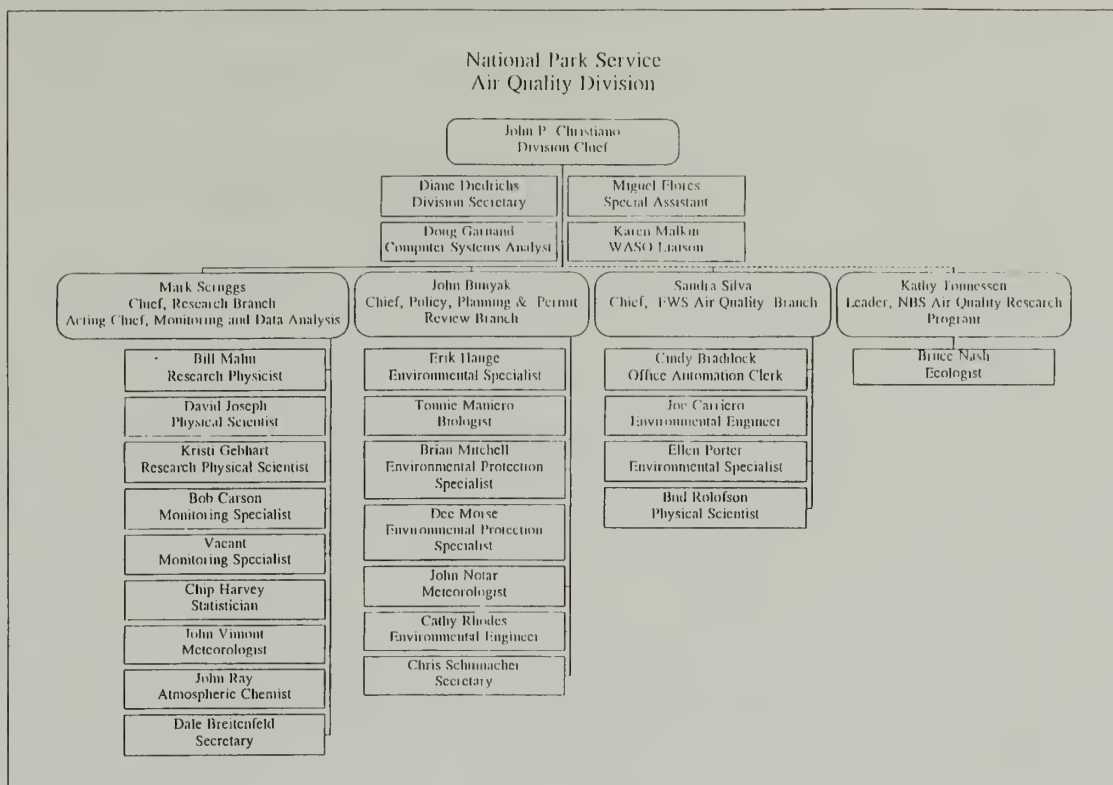
42 U.S.C. Sec. 7491A(a)(1)

Overhead 3

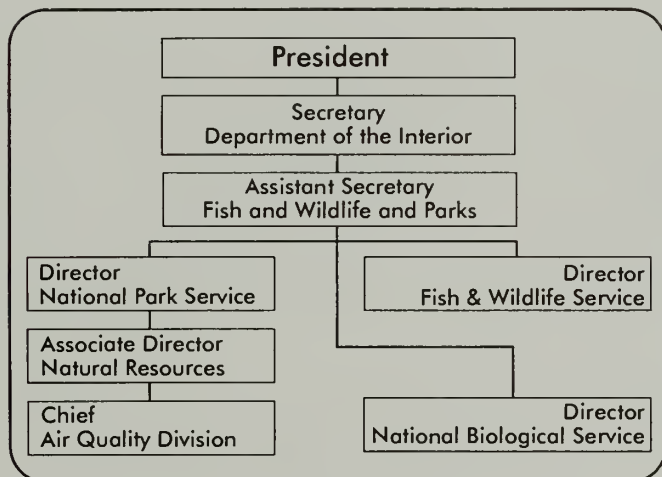
PROPOSED NATIONAL PARK SERVICE ORGANIZATION



Overhead 4



Overhead 5



Overhead 6

RESEARCH BRANCH

- VISIBILITY EFFECTS RESEARCH AND MONITORING
 - Develop and evaluate visibility monitoring methods
 - Deploy and maintain a servicewide monitoring network to collect visibility and particle data to assess current visibility conditions and determine spatial and temporal trends
 - Develop and apply analytical methods to determine causes and sources of impairment
 - Conduct research on human perception of an reaction to visibility impairment
 - Participate in multilateral coalitions to conduct and assess studies on the cause of visibility impairment and to identify remedial strategies to reduce documented impairment
 - Participate in multilateral, cooperative monitoring programs
- ECOLOGICAL EFFECTS RESEARCH
 - Synthesize existing data on the effects of air pollution on terrestrial and aquatic ecosystems in parks
 - Characterize the sensitivities of elements in the terrestrial and aquatic ecosystems with respect to air pollution
 - Evaluate research and biological monitoring to develop models to predict ecosystems changes that might result from increases in pollution stress
 - Communicate National Park Service research needs to the National Biological Service
- MODELING/METHODS DEVELOPMENT
 - Develop, evaluate, and apply techniques for predicting air pollutant concentrations resulting from proposed new sources
 - Develop and apply methods for assessing the visibility impact of new sources
 - Develop and apply methods for assessing the impact on regional air quality and visibility of single or multiple sources
 - Participate in multilateral groups established to resolve model development, application, and interpretation issues

Overhead 7

MONITORING AND DATA ANALYSIS BRANCH

- Gaseous Pollutant & Wet Deposition Monitoring
 - Acquire baseline and trend data
 - Develop & evaluate methods for NPS units
 - SOPs and training
- Information Management & Data Analysis
 - Maintain data bases
 - Periodic reporting
 - Statistical analysis
 - ADP support
 - Support to other branches
- Quality assurance

Overhead 8

POLICY, PLANNING, AND PERMIT REVIEW BRANCH

- **NEW SOURCE PERMIT REVIEW**
 - Review air quality construction permit applications for effects on NPS units
 - Provide guidance for potential permit applicants
- **LEGISLATION**
 - Monitor legislation at federal level for NPS concerns
 - Develop NPS position and supporting technical analysis for legislation impact on NPS concerns
- **FEDERAL REGULATORY DEVELOPMENT**
 - Coordinate with federal agencies to assure NPS concerns are addressed in regulatory development
 - Prepare comments on other agencies EIS actions
 - Develop policies for addressing problems for which there is no regulatory solution
- **STATE INTERACTION**
 - Work with states to assure their programs adequately protect NPS units
- **PLANNING, TRAINING, AND INTERPRETATION**
 - Work with parks and regions to prepare planning documents
 - Develop air quality interpretive materials

Overhead 9

AQ PROGRAM HQ OFFICE BECAUSE:

- Varied and Specialized Skills
- Complex Regulatory System
 - National Standards
 - Many Actors
- Issues Arise Sporadically
- Nationwide Consistency

Overhead 10

AQD ROLE

- Programmatic Responsibility
- Support to Director and Secretary
- Technical Assistance to Parks & Regions
- Research and Monitoring
- Allocating Funds
- Policy/Regulatory/Legislative Analysis
- Training
- Interpretation

Overhead 11

REGIONAL ROLE

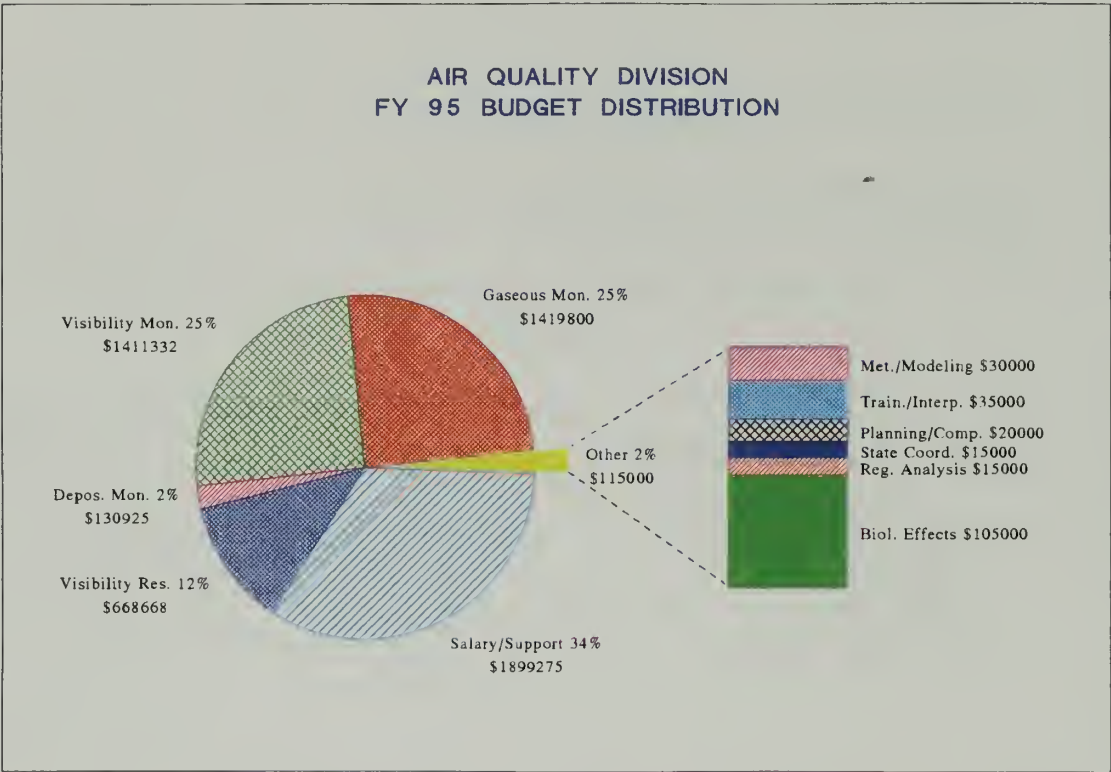
- Coordination with Parks & AQD
- Compile Ranked Project Lists
- Review Planning Documents
- RD Signoff
- Prepare/Present Testimony
- Advisory Board

Overhead 12

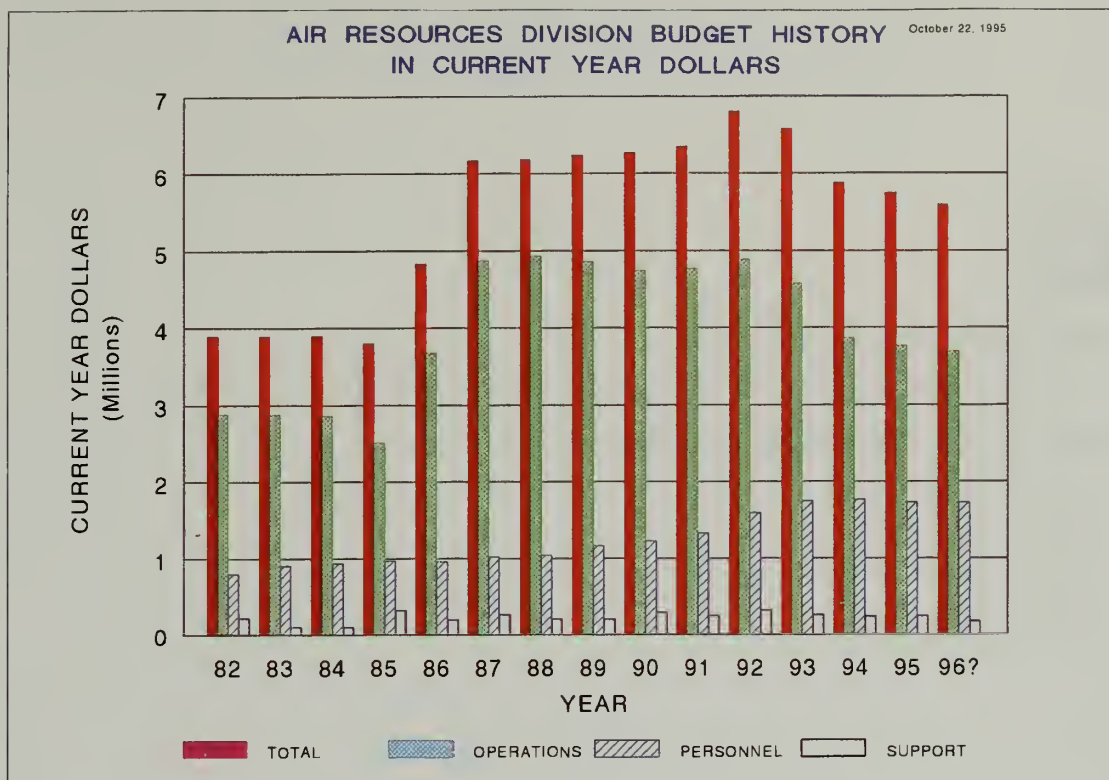
PARK ROLE

- Awareness of Local AQ
- Knowledge of AQRV's and Effects
- Monitoring
- Awareness of Local Sources
- Early Warning
- AQ Planning
- Develop Funding Requests
- Interpretive Programs
- Present Testimony
- Trained Staff

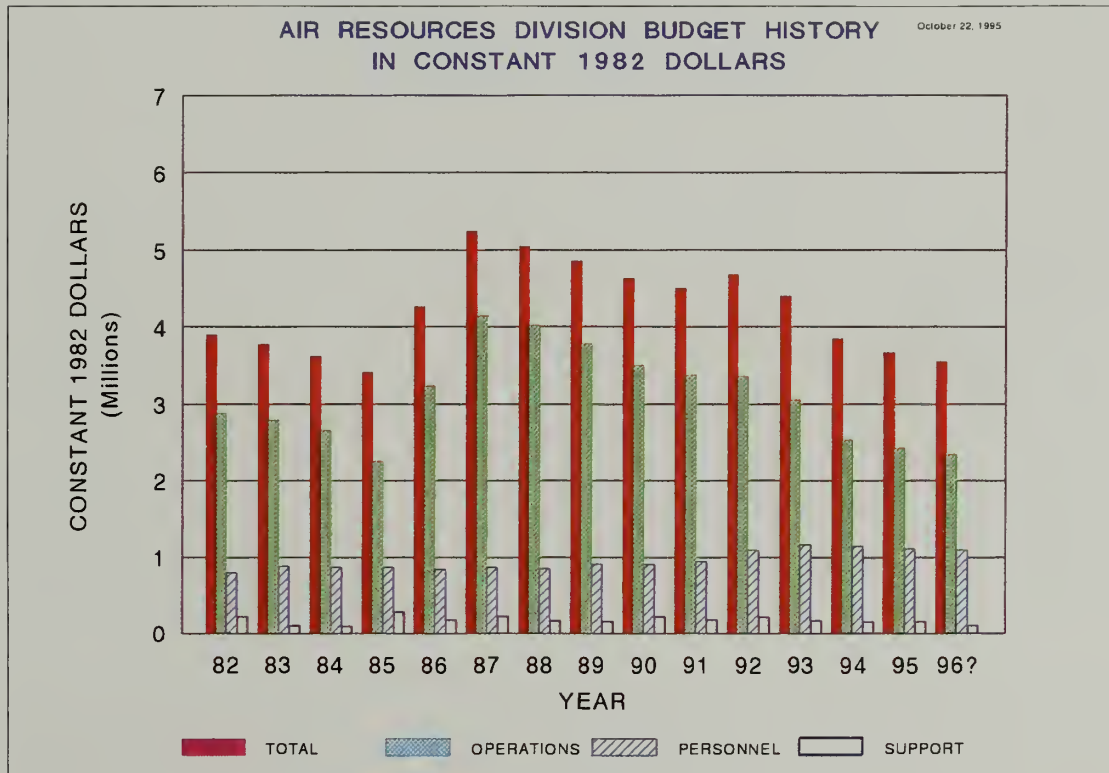
Overhead 13



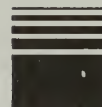
Overhead 14



Overhead 15



Overhead 16



Air Quality Issues, Monitoring and Management in Canadian National Parks

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ABSTRACT

So far our only assessment of stresses upon national parks is based on the perceptions and knowledge of expert groups at each park. Of 28 stresses recognized as significant, acid precipitation ranks 8th and climate change 23rd. Petrochemicals, 17th, pesticides, 18th and heavy-metals, 21st, may be partly of airborne origin. Given the nature of other stresses, such as the impacts of commercial tourism infrastructure and regional habitat loss through commercial forestry and highway construction, it is unlikely that the relative rank of air quality stresses will increase. Nevertheless, Parks Canada is concerned about their potential effects upon ecosystems, human health and visitor enjoyment. National park air issues include smoke from campfires and planned ignition prescribed forest fires, vehicle emissions from park and through traffic, airborne pesticides and fertilizing chemicals, particulate emissions causing visibility reduction, acid precipitation, organochlorines, ground-level ozone, ultra-violet B radiation and climate change. In 1994-95 there were 74 air measurement programmes among 36 national parks. These include 24 parks with air and climate stations, 13 with forest fire weather systems, 14 with avalanche weather and/or snow stations, and 10 related to acid precipitation or its effects. The other 13 are miscellaneous programmes, such as an organochlorine study, visibility monitoring and ground level ozone monitoring. The National Parks Act contains ample authority to regulate air emissions occurring within national parks, but no such regulations have been established.

There are 5 strategies that Parks Canada could follow in order to improve air quality in national parks: 1) increase the number of air quality monitoring stations to help understand ecosystems and air quality impacts; 2) foster public awareness of air issues through interpretation and outreach programmes; 3) influence neighboring agencies through planning, regional ecosystem and other management processes; 4) observe all federal and provincial regulations governing air

quality; and 5) demonstrate best-practices over and above regulatory requirements. Parks Canada and the United States National Park Service should maintain links in relation to air quality management by: 1) maintaining coordination mechanisms such as bilateral committees and workshops; 2) building air science capacity through U.S. NPS training of Parks Canada staff; and 3) developing more joint programmes such as the regional air quality management plan being developed for New England and Atlantic Canada national parks, or such as formal membership in joint air quality monitoring networks.

CANADIAN NATIONAL PARKS, STRESSES AND AIR ISSUES

The National Parks

Canada's 36 national parks cover 196,651 km², or 1.97% of Canada's land and freshwater area. They range in size from the 8.7 km² of Saint Lawrence Islands to 44,802 km² of Wood Buffalo. They are established under federal jurisdiction to protect representative areas of Canada's 39 natural regions and to allow for their appreciation and enjoyment by present and future generations of Canadians. All geographic extremes of Canada are included in the system, from the high Arctic to hardwood forests of the southern Great Lakes, from alpine glaciers to prairie grasslands (Figure 1). Well known parks such as Banff and Prince Edward Island are accessible by road and receive millions of visits each year. Others, like Ellesmere or Ivvavik in the Arctic, can only be reached by chartered aircraft, and see only hundreds of visits annually. Only 23 natural regions are so far represented by a national park, so new ones are still being added. For example, an area of 22,252 km² on north Baffin Island will form the 37th national park. These parks are distributed throughout both highly populated and remote regions, giving Canada a network of natural areas with opportunities to study regional and continental baseline conditions, changes and human impacts. They are also prime destinations for the public and provide opportunities to educate and influence public attitudes on ecosystem management, sustainable development and environmental health issues.

Current Stresses and Air Issues

The establishment of a national park protects what is there from logging, agriculture, urbanization and other direct uses of the land. However, many parks inherit the legacies of prior human occupation, such as townsites, agriculture and forestry. Sometimes they continue for a limited time as part of the agreement to change the area's jurisdiction and land use regime. Examples have included duck hunting and commercial and domestic wood harvesting. Any roads and railways across parks continue in use today. All parks remain subject to certain stresses arising from local, regional, continental and global factors such as tourism and resorts, long range transport of air pollution, loss of habitats for migratory birds and stratospheric ozone depletion.

A study of stresses facing our national parks in 1992 identified 28 significant stresses on national parks (Table 1). By significant we mean having a definite ecological impact, affecting more than 1 km² and not diminishing over time. Most of these stresses were identified on the basis of local knowledge and formal studies either in the park or in the surrounding ecosystems. Others, however, were extrapolated from a general knowledge of environmental degradation at regional,

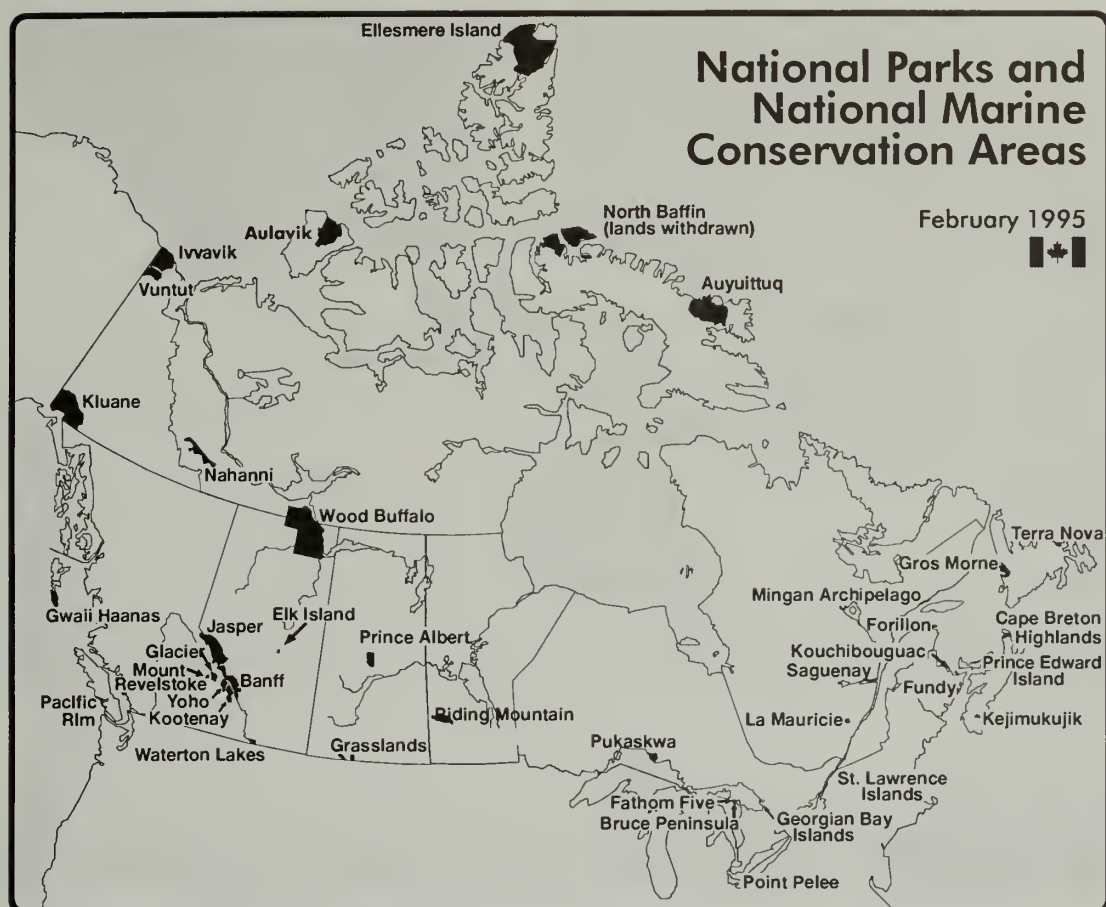


Figure 1. National Parks and National Marine Conservation Areas of Canada

Table 1. National Parks Reporting Significant Stresses, 1992			
Stress	No. reporting	Stress	No. reporting
Visitor/tourism facilities	22	Commercial fishing	10
Exotic vegetation	19	Mining (external)	10
Utility corridors	19	Petrochemical pollution	10
Dams	18	Pesticides	9
Forestry (external)	18	Poaching	8
Urbanization	17	Exotic invertebrates	7
Agriculture (external)	15	Heavy-metal pollution	7
Acidic precipitation	14	Park infrastructure	6
Exotic mammals	14	Climate change	4
Park management practices	13	Human disturbance	4
Sport fishing	13	Sewage	4
Sport hunting (external)	13	Solid waste	4
Exotic birds	12	Vehicle/animal collisions	4
Exotic fish	10	Exotic micro-organisms	3
Total = 34 national parks. Source: Parks Canada 1995, p. 36.			

continental and global scales. Acid precipitation fits both statements, and climate change mainly the latter. The assessment of significance was based on the perceptions of the park managers and resource experts who participated in the study. So, for example, the threat posed by high levels of tropospheric ozone, as now suspect in Fundy National Park, was not rated significant at the time. Similarly, national parks may be under threat from atmospheric nitrate deposition and volatile organic compounds. Many of the cases of petrochemical and pesticide threats no doubt stem from airborne sources, although some may reach the park via water courses.

To date, though, we have no formal assessment of the degree of air-related threats relative to others such as habitat loss, terrestrial and aquatic pollution, hunting and exotic species. Whatever the absolute levels of threat they pose, they will likely remain relatively low in the overall ranking of threats to the ecological integrity of national parks. We must emphasize also that the stress study did not consider threats to human health and amenity. So, in another example, we did not address issues like campfire smoke and breathing standards studied in Kouchibouguac, La Mauricie and Jasper (see the paper by Renata Bailey in this workshop), or visibility now being measured at Waterton Lakes and Kootenay. Table 2 presents the possible scope of air quality issues facing Canadian national parks. The table is an educated guess based on discussions with Environment Canada and U.S. NPS staff, and general literature, mainly secondary journals and public information documents.

Table 2. Probable Air-Related Stresses and Responses in Canadian National Parks

Stress, from local to global	Responses
Campfire smoke and BaP	Respiratory problems for visitors
Smoke from prescribed fires	Reduced visibility for residents Some toxic stresses
Vehicle emissions from park traffic	All the above
Airborne pesticides	Selected flora and microfauna mortality
Particulate emissions	Reduced visibility for visitors
Acid precipitation, including rain, snow, fog, dry deposition and acid shock in spring	Reduced fish populations Reduced tree vigour
Nitrate deposition	Possible eutrophication of soils
Organochlorines (DDT, PCB)	Wildlife deformities Recruitment failure in some birds
Ground-level ozone	Foliar damage Respiratory problems
Ultra-violet B radiation	Reduced amphibian populations Cancers in animals Foliar damage Effects on primary producers, e.g. plankton
Climate change – seasonality and norms	Fire régimes in fire-adapted ecosystems Permafrost – accelerated melting River régimes – riparian habitat changes
BaP = Benzene(a)Pyrene; DDT = Dichloro-diphenyl-trichloroethane; PCB = Polychlorinated biphenyl.	

CASE HISTORIES

Acid Rain and Integrated Monitoring at Kejimikujik National Park

Kejimikujik contains mixed wood forest on glacial deposits of low local relief, set in a region of productive and idle woodland and a few farms. There are no local urban or industrial areas. However, it is downwind of the industrial heart of North America and so is strongly influenced by acid rain and other air pollutants. The park is therefore an ideal site for monitoring such regional and continental scale phenomena. Limnology and climate studies began in 1964. Continuous recording of weather, fire weather, water quantity and water quality began in 1966. Systematic sampling of streams, lakes, terrestrial vegetation and precipitation began in 1979 (Kerekes 1992). Data from a calibrated watershed and air quality monitoring instruments have been collected since 1980. Biological components of selected lakes have also been monitored since 1980. Other biological monitoring programmes were added in 1988, including turtles, fungi, coyotes and flying squirrels. Monitoring of microclimate, radiation, ozone and other air pollutants begins in 1995. Other agencies and universities conduct most of these programmes. They are coordinated through annual workshops to exchange results, discuss concerns and plan continuing activities. The park ecologist, wardens and general works staff support scientific programmes, help maintain facilities, and conduct some biological work.

The integration of many disciplines and studies at one site has produced some important results, both as part of national networks to study acid rain and as contributions to understanding the park's ecosystem. For example, low pH levels have been associated with decreased reproductive success of brook trout and with a consequent reduction in angling success. Sulphate deposition is believed to have caused the disappearance of Atlantic salmon. Reductions of fish biomass are in turn thought to lead to decreased reproduction of loons. Wetland areas are sensitive to the leaching of aluminum, iron, sodium and potassium minerals essential for fen plants such as sedges and shrubs. The loss of these nutrients favors Sphagnum and Kalmia species that are more characteristic of bog conditions.

The Northeast Regional Air Quality Management Plan

A regional air quality management plan (RAQMP) is an action plan for a U.S. national park in response to air problems identified in its resource management plan. While park organizations have little direct sway over air quality, they can contribute to improved regional air quality through

- i) data collection to help in understanding problems and documenting improvements
- ii) increasing public and employee understanding of the issues and opportunities
- iii) developing support for air quality improvement goals from other agencies, and
- iv) leading in air pollution prevention by example (U.S. NPS 1993).

In 1994 several federal, state and provincial agencies in Canada and the United States joined to form a regional air quality partnership (RAQP) for the national parks and certain other protected areas in New England and Atlantic Canada. An RAQMP is one possible outcome of the partnership. This initiative is described in detail by Kozak *et al* in this workshop.

Campfires, Smoke and Health Risk, Jasper, La Mauricie and Kouchibouguac

Overnight camping is a treasured experience for many visitors to national parks. Some people strike out on their own in search of isolation in the backcountry, but for most, a drive-in, designated campground is their home for the night. An open fire for cooking and socializing is an essential part of this experience. Campfires produce smoke particles which are small enough to enter the respiratory tract and lead to pulmonary and cardiovascular diseases in sensitive people such as the young and the elderly. Inversions are often witnessed over national parks. They result in campground smoke being trapped near the surface. In Jasper, town residents and visitors are concerned about the apparent health effects of campfire smoke and reduced visibility on the road around the main campground. This prompted a study to monitor total suspended particles (TSP) and to determine whether they were above the national 24 hour acceptable level of $120 \mu\text{g}/\text{m}^3$ (Bailey, this workshop, and Bailey and Stendie 1993). During one week in October 1992, TSP peaked at $170 \mu\text{g}/\text{m}^3$ and exceeded 120 on half the days, even though only 413 of 781 camping sites were occupied. A full campground might push the level over $400 \mu\text{g}/\text{m}^3$, a level at which the federal government is committed to taking immediate action in order to protect human health. By comparison, an assessment of visibility in southwest British Columbia, during the summer of 1993, reported mean aerosol concentrations at Pacific Rim National Park of $5.67 \mu\text{g}/\text{m}^3$, ranging from 1.56 to $11.00 \mu\text{g}/\text{m}^3$ (B.C. Environment 1994).

The Jasper study prompted other national parks to study smoke. In 1993, La Mauricie examined smoke emissions at one campground. The study measured suspended particles under 10 microns diameter and one of the polycyclic aromatic hydrocarbons, Benzene(a)Pyrene (BaP), during the peak visitor period (Quenneville 1994). Concentrations of suspended particles over 24 hour periods varied between zero and $45 \mu\text{g}/\text{m}^3$, well below the $120 \mu\text{g}/\text{m}^3$ acceptable level. However, no inversions occurred during this study. BaP values ranged from 0.1 to 3.66 nanogrammes per cubic metre. They were in the same range as the Montréal and Sept-Îles urban areas, but far less than in the aluminum smelter town of Jonquière, where the average value during the winter of 1990 was $126.2 \text{ ng}/\text{m}^3$. La Mauricie does not have a critical problem requiring radical actions, nevertheless visitors with pulmonary ailments may experience temporary illness.

The La Mauricie study spawned similar ones at Forillon and Kouchibouguac. At Kouchibouguac, a change in firewood supply policy was introduced in 1994 to improve ecosystem management practices, rather than to reduce smoke production *per se*. The concern is that in main campgrounds, most firewood is burnt for enjoyment, rather than cooking as at backcountry sites and kitchen shelters. Comparisons among 4 eastern national parks show that where firewood is free, wood consumption is about 10 times greater than where it is purchased (Tremblay 1993). Since burning 1 kg of wood produces about 1.5 kg of CO_2 , this policy will also greatly reduce the exposure of visitors to the gas, and marginally help our cost-recovery efforts. The park has established 25 vegetation monitoring plots around the campground in order to assess the impact of visitors who may now scrounge for litter and live branches for their recreational combustion. A two-day sampling of emissions showed that even during periods without inversions, BaP levels exceeded Ontario and Dutch norms (Bergeron and Laurence 1994). Given that these and other norms are set for industrial work places, such levels are of serious concern in the outdoors in a national park.

Greenhouse Gases, Organochlorines and Nitrogen Cycling Studies at Point Pelee

Point Pelee National Park is central to the Great Lakes industrial heartland of northeastern United States and central Canada. Concerns over air and water pollution have precipitated several studies linking pollution with ecological effects (Gary Moulard, Point Pelee National Park, personal communication). While they focus on water sampling, many pollutants are probably of airborne origin. Several species of the park's herptiles have been extirpated in recent years, so the Canada Centre for Inland Waters (CCIW) has been studying marsh water and groundwater quality for possible causes. DDT has been found at significant levels in the park sediments and in some fox snakes. Early results show, however, that DDT is no longer entering the park from external sources. PCB results are still awaited. Significant levels of phosphorous and nitrogen have been detected in some ponds of the Pelee Marsh. In one, it was 25 times the expected level, causing a hyper-eutrophic situation. This eutrophication has no doubt affected the biodiversity of the marsh. The CCIW study indicates that septic systems may be the cause through many years of cumulative input to the closed systems of Pelee marshes. This work is now linked to a University of Western Ontario of greenhouse gases to give an overall picture of nutrient processes in the marshes.

Biomass Burning: Where There's Fire, There's Smoke

Whether smoke from biomass burning in fire-adapted ecosystems fits the definition of air pollution is debatable. Evidence of fire in the form of fusain exists in sediments dating from the Carboniferous Period. In the Quaternary period, lightning and human-caused fire structured ecosystems on every continent except Antarctica. Parks Canada recognizes fire as an important ecosystem process, and has provided policy and direction for its continued presence in national parks (Heathcott, Natural Resources Branch, personal communication). Indeed, the exclusion of fire from most park ecosystems may not only be unwarranted but unattainable.

The burning of wildland fuels releases large quantities of smoke containing a complex mixture of particles, liquids and gases. Smoke particles consist of many organic compounds, with particle size concentrated in the range of 0.1-10 micrometres. Gases include carbon monoxide, carbon dioxide, methane, nitrogen oxides and various organic compounds. Condensed liquids occur with particles, and in high concentration in the gas phase. These constituents of smoke are of concern to human health and safety, visibility, climate change and other ecosystem health issues.

Smoke management is considered by Parks Canada in every phase of fire management planning, with many actions carried out in response to smoke issues. The reliance on planned ignition prescribed fire versus wildfire or lightning-ignited prescribed fire enhances options for fire management. For instance, implementation of planned ignition prescribed fires can reduce the amount of biomass consumed and hence smoke emissions. This is achieved by selecting appropriate fuel moisture conditions, ignition technique and pattern. Enhanced smoke dispersal and dilution may be achieved through the selection of suitable atmospheric conditions during planned ignition prescribed fires. The ability to schedule planned ignition prescribed fire is generally lacking for wildfire and naturally ignited prescribed fire. These events often occur during periods of relatively high fuel moisture, resulting in increased smoke. Such fires also burn for lengthy periods, increasing the probability of poor smoke dispersal and dilution.

In sum, planned ignition prescribed fire is one means of mitigating the effects of smoke from fire. However, land management agencies, while meeting ecological objectives, must also be sensitive to public concern due to smoke from wildland fire. Public awareness and education is required to ensure the continuation of active fire management.

Visibility Monitoring at Waterton Lakes and Kootenay National Parks

Most parks have weather stations and many have monitoring programmes related to fire and avalanche management and acid precipitation. Our concerns are now spreading to other aspects of air quality such as visibility. In Canada, British Columbia (B.C.) took a lead role in visibility protection because of concerns over impacts to tourism caused by degraded visibility. Sawmill waste burners, open burning of wood debris, emissions from pulp mills and domestic woodstoves are the main concerns (Geoff Clarke, Jasper National Park, personal communication). To address these issues, B.C. set up a Visibility Task Force, of which Parks Canada is a member. See the paper by Peter Reid at this workshop. One outcome has been for Environment Canada to install particle samplers and nephelometers, to measure light scattering, in 1993 in Waterton Lakes and 1994 in Kootenay. The Waterton Lakes nephelometer will provide a comparison to visibility measurements on the other side of the Rocky Mountains in Glacier National Park, Montana. The Kootenay site also has a camera system to provide a photographic record to use in addressing visibility concerns with local and regional agencies and industry (Alan Dibb, Kootenay National Park, personal communication).

Combustion Emissions in Yoho National Park

The town of Field is inside, and governed by, Yoho National Park. In 1993 a study of energy supply and demand problems for Field also estimated emissions of carbon dioxide (CO₂), sulphur dioxide and nitrogen oxides (Table 3; Ian Church, Yoho National Park, personal communication). The total CO₂ was 64,090 tonnes/year, or 128 tonnes for each of the 500 residents, compared to 4.4 tonnes per capita for Canada! Twenty-one percent stems from commercial traffic along the Trans-Canada Highway, 3% from automobiles and 71% from railway traffic. The remaining 5% is attributed to home heating and electricity generation, bringing park residents more or less in line with the national average. The estimate of railway emissions is probably low, since it doesn't take into account idling locomotives in the Field railway yards. As many as 21 units have been observed there as they await crews or snow clearing of tracks.

Air emission problems are compounded in places like Yoho which have narrow mountain passes susceptible to air inversions. Westerly air flows are blocked by high passes, and the absence of morning sunlight in narrow valleys reduces diurnal mixing. The problem will also worsen over the next few years because commercial road and rail traffic is increasing. The park is monitoring air conditions, and will encourage CP Rail to better manage their yards and to turn off engines while yarded. The outlook remains dim, however.

Table 3. Estimated Emissions from Combustion in Yoho National Park

Source	Sulphur dioxide	Nitrogen oxide tonnes/year %	Carbon dioxide	Carbon dioxide
Railway	290	860	45,600	71
Trucks	90	250	13,200	21
Automobiles	1.5	50	2,250	3
Propane heating	0.1	—	1,050	2
Wood heating	—	—	760	2
Field diesel generator	8	23	1,230	2
Total	389.6	1,183	64,090	100

Avalanche Control in Glacier National Park, British Columbia

Although avalanche control is not an air quality issue, this programme is included as a rare example of an air monitoring programme operated by Parks Canada for its own management purposes. The Rogers Pass avalanche defense operation is one of the largest such programmes in the world (Scheiss 1989). It protects 40 km of Trans-Canada Highway and Canadian Pacific Railway. Heavy snowfall and steep terrain combine to make this an area of extreme avalanche activity. Mount Fidelity is in the control area. It receives the greatest average yearly snowfall in Canada, 1503 cm (1966-1986). The snow pack reached 493 cm in the winter of 1971-72. One hundred and thirty-four avalanche paths affect this corridor. Countermeasures include snow sheds, trigger zone defense structures, diversion dikes, mounds, retaining benches and public information signs. For the years 1962-88, the number of control actions ranged from 18 to 60 per winter and lasted from one hour to five days. Artillery fire was staged from 18 locations using a 105 mm Howitzer to engage 170 targets. Annual ammunition usage varied from 350 to 1,900 rounds.

Avalanche hazard situations are analyzed and forecast from weather and snow pack information obtained at two continuously manned stations, four secondary stations and three telemetry stations. The data collected varies somewhat between sites, but includes humidity, snowfall, snow pack depth, snow courses, wind speed and direction, and sky conditions. Avalanche patrols and supplementary snow pack observations throughout the control area provide additional data. Test sites are used for test skiing, testing of slopes with hand charges, measuring snow drifts and studying shell impacts, and more. The park uses both the Swiss method of snow profile evaluation and the American ten point meteorological forecasting system. However, the scale of the Rogers Pass operation required additional techniques to obtain objective data on weather and snow pack instability from remote high elevation locations to avalanche forecasters stationed at the highway level. A shear test method was developed for field use which measures snow blocks for shear planes and their depths, weight above shear planes, shear strength and shear speed.

Aerosols and Source Attribution, Pacific Rim National Park

The 1993 study of visibility in southwest British Columbia, referred to above in the discussion on campfire smoke, also collected data on the composition of aerosols and used principal components analysis to determine their sources. Although Long Beach, Pacific Rim National Park is considered to be a 'remote or "clean" location' (B.C. Environment 1994, p.11), four statistically significant groupings of aerosol components were noted (Pryor and Steyn 1994, p.25), as follows.

1. Aluminum, calcium and silicon from soil and road dust.
2. Sodium from sea water, and iron, potassium, sodium and vanadium, possibly from particulate emissions from the processing of vegetation soaked in sea water.
3. Sulphur, representing secondary aerosols.
4. Nickel, lead and zinc, probably from refuse incineration and vehicle emissions and occurring together because of collocation of sources.

This study demonstrates the ability to determine natural and artificial air components, either from local or long range sources. The same study also recorded an extreme event of vanadium and nickel concentrations, at Pacific Rim and other sites, which suggested "a plume from a source burning crude oil" (Ibid p.15). This event is believed to result from crude oil combustion at Cherry Point in Washington State which generated an aerosol layer of 300-400 m northwards.

AIR-RELATED MONITORING, CURRENT AND FUTURE

Current Programmes

Table 4 summarizes the present and planned air monitoring programmes at Canada's 36 national parks. Water quality monitoring programmes are noted for comparison, and because some of them monitor water conditions as an adjunct to air pollution and climate change studies. Most of the 74 current air monitoring programmes are meteorological, albeit adapted for seasonal phenomena like forest fire or avalanches. The number of air monitoring programmes at a park is largely a function of its age. The 4 parks with no air monitoring are recently established or yet to be fully declared. The number of programmes then increases with park age up to about 4 to 6 after 25 years.

Future Monitoring

Ninety-six monitoring programmes are planned in addition to the present total of 594. Of these, 7 are air related. National park monitoring will increase 16% by this measure, whereas air monitoring will increase by only 8%. Six of the 7 programmes will be either weather stations or concentrated at the integrated monitoring site at Kejimikujik National Park. Since collecting the information for Table 4, Environment Canada and Parks Canada have agreed to install under-canopy bio-climate stations at Kejimikujik, La Mauricie and Yoho National Parks.'

Table 4. Air Related Monitoring in Canadian National Parks, 1994-95

In place/planned additions							
National Park	Weather and/or climate surveys	Forest and fire weather related	Avalanche weather &/or snow	Acid precipitation	Other air quality	Water quality	None
Aulavik						1/-	
Auyuittuq	1/-					-/1	
Banff	2/-	1/-	1/-			2/-	
Bruce Peninsula	1/-	1/-					
Cape Breton Highlands	1/1	1/-		1/-		1/-	
Elk Island	2/-				1/-	1/-	
Ellesmere						-/1	
Forillon		1/-	1/-			-/1	
Fundy	1/-			1/-	1/-	1/-	
Georgian Bay Islands	1/-	1/-				1/-	
Glacier			2/-			1/-	
Grasslands	1/-						
Gros Morne	1/-		1/-	2/-		2/-	
Gwaii Haanas							✓
Ivvavik	-/1						
Jasper		2/-	1/-		4/-	3/-	
Kejimikujik	1/1	1/-		1/-	-/3	1/-	
Kluane			1/-			1/-	
Kootenay			1/-		1/-	2/-	
Kouchibouguac	1/-		1/-	1/-		-/1	
La Mauricie		1/-		1/-		1/-	
Mingan Archipelago							✓
Mount Revelstoke	1/-					1/-	
Nahanni	1/-					1/-	
Pacific Rim							✓
Point Pelee					4/1	1/-	
Prince Albert			2/-	1/-		2/-	
Prince Edward Island	1/-					1/-	
Pukaskwa	1/-			1/-		2/-	
Riding Mountain	1/-	1/-	1/-			2/-	
Saint Lawrence Islands	1/-						✓
Terra Nova	1/-	1/-		1/-		2/-	
Vuntut							
Waterton Lakes	2/-	1/-	1/-		1/-	1/-	
Wood Buffalo		1/-				1/-	
Yoho	1/-		1/-		1/-	2/-	
Total of 36 units	24/3	13/-	14/-	10/-	13/4	34/4	5

ACTS, POLICIES AND AGREEMENTS

The National Parks Act and Ecological Integrity Monitoring

The National Parks Act (Parks Canada 1988, section 4.5(1.2)) states that “maintenance of ecological integrity through the protection of natural resources shall be the first priority when considering park zoning and visitor use in a management plan.” It also states (Parks Canada 1988, 4.5(1.5)) that “the Minister shall report to Parliament every two years on the state of the parks . . .” Both of these revisions arose during the parliamentary committee examination of the Act, rather than from a proposal within Parks Canada. As a result, Parks Canada is still developing a stable concept for what a State of the Parks Report should contain. These two citations, though, imply that the report should monitor the state of ecological integrity in each national park. Parks Canada has adopted a stress-response approach to ecological integrity monitoring which will include water and air measures, such as weather and climate, snow pack, air quality and visibility, as measures of stress and for ecosystem analysis.

The recognition that maintaining and, where necessary, restoring the integrity of whole ecosystems is our prime mandate has spurred efforts in cooperative management of natural resources extending into neighbouring jurisdictions and land holdings. Many parks are now developing the so-called greater park ecosystem concept, and establishing local and regional advisory boards to advise on joint management goals, practices, data sharing, etc. In this vein, several parks are members of the model forest programme, and others have become member sites in Environment Canada’s ecological monitoring and assessment network.

Based on information provided by parks to headquarters by survey, Fall 1994. The terms weather and climate may be used interchangeably by parks staff. Most water quality monitoring is done in relation to maintenance of drinking and bathing standards in the face of waste disposal and inflowing water contaminants from industry, for example, not air quality issues as such. The column for other air quality monitoring is for: Elk Island atmospheric nitrogen deposition; Fundy ground level ozone; Jasper toxic monitoring related to a pulp mill, regional air quality, organochlorine and campground smoke; Kejimikujik radiation, microclimate, particle collection and ozone; Kootenay and Waterton Lakes visibility and particulates; Point Pelee organic and inorganic precipitation sampling, greenhouse gas studies, and nitrogen cycling; and Yoho unspecified airborne contaminants. Source: Rissling and Welch 1995.

The National Parks Act and Regulatory Authority for Emission Control

There are no national park regulations specifically related to air quality, but the legal powers to create and enforce them exist. The National Parks Act contains broad authority to fine individuals who “discharge or deposit within a park . . . any substance capable of degrading the natural environment, injuring the flora or fauna or endangering human health” or to direct those individuals to take “reasonable measures to prevent any degradation of the environment and any danger to the flora or fauna or to persons resulting therefrom” (Parks Canada 1988, section 8.1.4. The maximum fine is \$2,000 (Ibid 8.1). The Act authorizes the recovery of costs from responsible individuals (Ibid 1.5 – 1.7).

The Act also contains authority to develop regulations for “the protection of the flora, soil, waters, fossils, natural features, air quality and cultural, historical and archaeological resources” (Ibid 7.1.b). Regulations could, therefore, be developed to govern emissions from, for example, pesticides, campfires, generators, automobiles, recreational vehicles, commercial vehicles, locomotives, boats, boilers, forest fires, or even elk flatulence! These authorities under the National Parks Act could only be exercised where the infractions occur within a national park. While national parks jurisdiction extends downwards to include groundwater, minerals, oil and gas, etc., it does not extend into the air column, except for regulations controlling aircraft landing and take-off. That is to say, while Parks Canada could regulate locomotive emissions under the National Parks Act, it cannot do so for aircraft at any elevation and would have to apply other federal statutes.

Since 1992 Parks Canada has included the following clauses in all leases, licenses of occupation, concession agreements and right of way agreements, in addition to requirements to observe the National Parks Act. “The Lessee covenants and agrees that all activities on the land shall be conducted in compliance with all applicable statutes, regulations, by-laws, rules, declarations, directives and orders concerned with environmental . . . protection . . . (and) The Lessee covenants and agrees to ensure that no contaminants, pollutants, or toxic, dangerous or hazardous substances or materials . . . shall be used, emitted, discharged, stored or disposed of except in strict compliance with such statutes . . .” Further clauses impel the lessee to disclose and correct any such environmental impact, and allow the Crown to inspect and correct such impacts and charge for the cost of doing so. These clauses apply equally to residential and business properties.

Parks Canada’s Guiding Principles and Operating Policies

This is the principal document which translates the National Parks Act into prescriptions for management. It contains several directions for the management of ecosystems to be based on comprehensive monitoring. The section called Guiding Principles, Number 6, on research and science, states:

“Management decisions are based on the best available knowledge, supported by a wide range of research, including a commitment to integrated scientific monitoring. (Parks Canada) requires applied and basic research and monitoring activities to make responsible decisions in its management, planning and operating practices, as well as to broaden scientific understanding” (Parks Canada 1994, p.18).

Part II of the full document contains distinct chapters for national parks, national marine conservation areas (formerly national marine parks) and other categories of protected areas and sites falling under that Act, such as historic sites and federal heritage buildings. In the chapter on National Parks Policy, section 3.2 concerns ecosystem based management. It includes three paragraphs (Parks Canada 1994 p. 35):

“3.2.6. An integrated data base will be developed and kept up to date for each national park to provide, along with research and environmental monitoring, the baseline information required to protect and maintain park ecosystems and contribute to state of the parks reporting to Parliament. In defining information needs, the spatial and temporal dimensions of park ecosystems and

ecosystem processes will be a primary consideration. Therefore, data requirements will regularly extend beyond park boundaries.

“3.2.7. Parks Canada will work with other government agencies, universities and conservation organizations involved in conservation biology and environmental monitoring to develop integrated programs for the collection, storage, analysis and interpretation of data.

3.2.8. Parks Canada will actively promote national parks as sites for scientific research that will contribute to the long-term protection and better public understanding of ecosystems. Parks Canada will initiate project or cooperate in programs sponsored by other government agencies and the scientific community to ensure that benchmark research areas are established and maintained in national parks to better understand the effects of human activity on ecosystems both inside and outside national parks.”

The Strategic Plan

Some time frames for the above policy statements come from our Strategic Plan (Parks Canada 1990). “. . . by the year 2000, (Parks Canada) will have strengthened its scientific capacity to provide adequate protection to natural ecosystems . . .” (p. 3). Parks Canada will “strengthen (its) scientific capability to support planning and decision-making” (p. 9) and will “base interpretation programmes on solid facts derived from a scientific research foundation . . .” (p. 12). “Additional resources will be committed for scientific research to improve the organization’s ability to protect major elements of our . . . natural heritage” (p. 9). The plan lays out several strategic directions for enhanced protection through science, including: “use parks and sites as models of environmental quality and benchmarks for integrated monitoring and research into environmental conservation problems and solutions” (p. 10). The Strategic Plan also says that we will “encourage partners to use parks and sites as laboratories for the advancement of environmental science” (Parks Canada 1990, p. 16).

The Strategic Framework to Sustain the Integrity of Ecosystems

This document says that we will “protect and manage park ecosystems through the application of a rigorous scientific approach by enhancing the (Parks Canada) scientific capacity both in-house and in partnership with others” (Parks Canada 1992, p. 12), “assess the significance of . . . internal and external threats to parks by . . . developing the appropriate integrated natural resource management and monitoring programs” (Ibid., Part II, Table 1.1), “develop procedures for and implement natural resource monitoring programs, adapted to each park, to ensure on-going evaluation of ecosystems and their components to support (State of the Environment/State of Parks) reporting requirements” (Part II, Table 1.3), “enter into agreements with sister agencies . . . to initiate regional baseline and monitoring programs” (Part II, Table 1.3), and establish and maintain data bases in all parks” (Part II, Table 4.3).

United States – Canada Air Quality Agreement

This 1991 agreement established the principle that the two countries are responsible for the effects of their air pollution upon one another, committed them to various consultation and reporting procedures, and provided mechanisms for public hearings and the resolution of disputes concerning transboundary air pollution (Air Quality Committee 1994). It also set caps and schedules for SO₂ and NO_x emissions. It contains a section of specific relevance to national parks (Ibid., p. 62).

“4. Prevention of Air Quality Deterioration and Visibility Protection

Recognizing the importance of preventing significant air quality deterioration and protecting visibility, particularly for international parks, national, state and provincial parks, and designated wilderness areas:

A. For the United States:

Requirement that the United States maintain means for preventing significant air quality deterioration and protecting visibility, to the extent required by Part C of Title I of the Clean Air Act, with respect to sources that could cause significant transboundary air pollution.

B. For Canada:

Requirements that Canada, by January 1, 1995, develop and implement means affording levels of prevention of significant air quality deterioration and protection of visibility comparable to those in paragraph A above, with respect to sources that could cause significant transboundary air pollution.

C. For Both Parties:

The Parties shall consult, as appropriate, concerning the implementation of the above."

Canada has established a federal-provincial National Prevention of Significant Deterioration (PSD) / Visibility Working Group to define Canada's response to the above. However, Parks Canada's particular obligations and opportunities in this matter have yet to be defined. Indeed, this is one of the objectives of this workshop, the second Canada-U.S. national parks air quality meeting. The previous meeting, in June 1993 at Roosevelt-Campobello International Park, was an informal affair involving only a handful of representatives from the two parks services and one or two other agencies such as Environment Canada. It served to inform Parks Canada about air quality issues and programmes of the U.S. National Park Service. The need for this more formal workshop and proceedings was developed at that time. Another outcome was the proposal for the bi-lateral Northeast RAQP referred to above. The current workshop will also promulgate ideas for other transboundary RAQPs.

The Agreement does not specify actions on the part of either national park service. Regarding obligations *in sensu strictu* for Parks Canada, there may be none. Under clause 4.b, for example, it is unlikely that human activities within national parks have significant air quality impacts on US protected areas. The only possible exception might be the periodic (annual to decadal) and short term (days) plumes from planned ignition prescribed fires in aid of vegetation management. Under clause 4.c, while bi-national consultation takes place under the aegis of the Air Quality Committee, the parks services have no such obligation in a legal sense. However, accords like the Air Quality Agreement, and the desire to share experiences in protecting national parks, foster a willingness to hold workshops, like this one, that contribute to the spirit of clause 4.c. The Agreement also adds a rationale for actions in support of our legislative and policy requirements for ecological integrity conservation and monitoring.

Clause 4.a places an onus on the United States to prevent air quality and visibility deterioration in Canadian national parks. Deterioration, or improvement for that matter, could only be proven to occur if a spatially significant sampling of national parks had air quality monitoring stations within them or nearby. By spatially significant we mean a network of monitoring sites that would allow reliable extrapolation over parks and their greater ecosystems, and also represent all major ecological zones and airsheds in Canada. Such stations would also benefit Parks Canada by yielding some of the data requirements for ecological integrity monitoring, noted above.

CONCLUSIONS

Summary of Air Quality Issues in Canadian National Parks

Parks Canada recognizes air quality deterioration as a significant stress on the national park system, particularly in the form of acid precipitation and climate change. However, air quality deterioration is not perceived to be as extreme as, say, regional habitat losses and fragmentation, the impact of visitor activities and facilities, the loss of native species and the introduction of exotic ones. Recent legislation and international agreements have led to an increased awareness of air-related problems. Various parks have commissioned or been part of studies on the emissions from campfires, visibility, the uptake by soils of airborne nutrients, ground-level ozone levels and aerosols from industrial activity. Eventually, reports on the state of parks' ecological integrity could include assessments of air quality changes. The Canada-U.S. Air Quality Agreement has generated a project to develop a regional air quality management plan for the national parks and certain other protected areas in New England and Atlantic Canada.

Summary of Air Quality Monitoring in Canadian National Parks

Twenty-four national parks have at least one weather or climate station. Those that don't have only recently been established or are yet to be fully declared. Nineteen have specialized forest fire or avalanche weather monitoring systems in place, and 15 have some kind of air quality monitoring in place. Parks Canada is in the process of developing a strategy for ecological integrity monitoring and State of the Parks Reporting, and air quality is seen as a component of common measures across all parks. So, although the primary concerns of park protection are focused on

other stresses, air quality will remain on the agenda for incorporation into systematic park monitoring.

Possible Roles for Canadian National Parks in Air Quality Improvement

The suggestions in the rest of the paper are the authors' opinions and should not be considered official policy. We envisage 5 ways in which Parks Canada should continue or increase its involvement in air quality management. Our proposals recognize that Parks Canada has no atmospheric science programme of its own, and has looked to Environment Canada in that regard.

1. Continued and increased participation in air quality monitoring networks.

Parks Canada should continue to welcome the installation of air quality stations in national parks. The benefits to other agencies are chiefly the provision of accessible and natural yet protected benchmark sites for long-term studies, and the availability of park staff to support routine maintenance of stations. The prime benefit to Parks Canada will be the provision of air quality information to help understand ecological trends and assess air quality stresses on protected ecosystems. A benefit to Canada will be to assess the impact of U.S. originated air pollution on Canadian protected areas as referred to in the Air Quality Agreement. Parks Canada would also benefit from the contribution of air quality data to ecological monitoring systems.

2. Fostering public awareness. Like other national park organizations, part of our prime mandate is to communicate park values to the general public, both those that visit in person and those that visit vicariously through television, travel books, and interest group publications, and so on. Air quality and visibility deterioration can be communicated to the public in this way and through in-park interpretive programmes, real-time health advisories (e.g. on ozone levels or campfire smoke emissions), costing and documenting amenity loss (e.g. through reduced visibility), and assessing the ecological impacts of airborne toxics, nutrients, greenhouse gas emissions, etc.. Other vehicles for air quality reporting might include ecosystem conservation plans and park management plans, interagency initiatives such as regional air quality management plans, briefing notes and news releases about pollution events, and, of course, state of the park reports.

3. Influencing neighbour agencies. Various elements of policy bring Parks Canada into contact with surrounding land managers and communities. These include private owners, other provincial and federal governments, timber companies, school boards, volunteer organizations and chambers of commerce. These contacts mostly take place during consultation for management planning, on advisory bodies for ecosystem management, and during park science, parks days and other public events. Multi-agency regional planning is becoming an important part of Parks Canada's business. Examples include greater park ecosystem studies and consultation, and the aforementioned regional air quality management plans. Provided that sound data is collected which describes air quality in national parks, Parks Canada could also intervene in environmental assessments involving transboundary air pollution.

4. Full observance of existing standards. In terms of its own operations, Parks Canada increasingly applies existing standards, e.g. for human health, emission controls and waste disposal. This effort should continue for all management, concessionaire and visitor activities which are subject to Parks Canada regulation. These include domestic, vehicle and campfire emissions which affect air quality at campgrounds and bus parking lots at popular viewing sites. In an increasingly litigious society, Parks Canada should be careful to avoid health risks from non-natural sources, at least to humans. Voluntary observance by Parks Canada, its licensees and visitors may be preferable to regulated observance. Nevertheless, regulations should be imposed where voluntary compliance fails to achieve predetermined air quality standards.

5. Demonstrate best practices. As a high profile agency in environmental protection, Parks Canada is ideally placed to adopt and demonstrate best practices in many fields, not least being to minimize park-originated pollution. Parks Canada can go beyond meeting regulatory standards, as noted above, to incorporating new technologies or eliminating polluting activities. Indeed, some of this already takes place in Canada and elsewhere, as exemplified by the “pack-in, pack-out” philosophy applied to hikers’ supplies and waste in high use or sensitive wilderness areas.

Suggestions for Links Between Parks Canada and the US National Parks Service

1. Coordination. Common interests in general and the Canada–U.S. Air Quality Agreement in particular justify ongoing meetings to exchange information, develop and maintain professional contacts, assess the state of air quality in North American national parks, and perhaps to coordinate common monitoring programmes. These meetings could take place in various forms, as ad hoc or standing committees, technical and policy workshops (like this one) or mini-conferences focusing on the results of research and monitoring of air quality and ecological effects. None of these fora need be large, elaborate affairs. It is more important that minutes or proceedings be distributed among park professionals and managers in a timely manner. A hindrance to bilateral meetings is the limit to international travel affecting Parks Canada staff. Like the previous bilateral air quality meeting, this is why this workshop, albeit held at an international park, takes place on Canadian soil.

2. Capacity building. If ever Parks Canada develops an air quality assessment capacity of our own, we would have to develop expertise in source apportionment and ecological effects. The U.S. NPS may be able to supply training in these areas. There may be subjects other than air quality for which Parks Canada could also offer capacity building.

3. Joint programmes. Two obvious candidates come to mind. First, regional air quality management plans could be developed for other boundary areas apart from New England-Atlantic Canada. At one extreme there could be groupings of contiguous or nearby national parks, such as Waterton Lakes and Glacier. At the other we might envisage common concerns for all the protected areas of the Great Lakes Basin. Discussions at this workshop will, hopefully, consider suitable scales of such regions and which parks might

be encompassed by such plans. RAQPs incorporate the unilateral actions noted above such as demonstrating best practices and interpretive messages to transboundary audiences. Second, Parks Canada, with the help of Environment Canada, should consider joining the national park air quality network operated in the United States.

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The Northeast Regional Air Quality Committee (NERAQC) – A First Adventure Into Cross-Border Cooperative Action on Air Issues and Protected Areas

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ABSTRACT

This paper describes a new organization – THE NORTHEAST REGIONAL AIR QUALITY COMMITTEE (NERAQC) operating in Eastern North America that is attempting to work across jurisdictional boundaries for the protection and improvement of air quality in protected areas in the Northern New England in the U.S. and the Atlantic region of Canada. NERAQC will have membership from federal, state and provincial land management and regulatory agencies from both Canada and the United States. The paper details the mission, objectives and activities of the committee and considers the future the organization.

INTRODUCTION

The northeast region of Canada and the United States share biophysical characteristics, and a long history of economic interactions. Larger scale environmental concerns, in particular those related to air quality, bring home the fact that both countries share more than a common border. In the 1990's most agencies responsible for land and environmental protection in both countries have been trying to take a more holistic, ecosystem approach. However one defines it, trying to work with the ecosystem approach to management has resulted in a new willingness in government agencies to join partnerships to aid in the amelioration of ecosystem stresses originating outside legislative boundaries.

We set out in this paper to describe a work in progress. Canadian and United States agencies in the Northeast region of North America have been working to develop a regional approach to the resolution of air quality related stresses on protected area ecosystems. Our region, defined by mutual agreement, includes the States of Massachusetts, New Hampshire, Vermont and Maine and the Provinces of New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador.

In this paper we describe the establishment of a new organization called the Northeast Regional Air Quality Committee (NERAQC) that is focused on protecting and enhancing the air quality of protected areas in our region. We describe the rationale for the creation of NERAQC, make brief mention of the major air quality issues facing our region, detail the committee membership, its mission, its objectives and its operating procedures. We also describe actions already taken and briefly look at the future of NERAQC. Readers should note that written official endorsement for the establishment of NERAQC has not yet been sought from senior management of any of the member organizations. The organization as described herein is being developed as we speak and nothing stated here in any way commits any of the agencies mentioned to specific actions.

ORGANIZATIONAL CONTEXT

Although the member agencies from United States and Canada approach air quality management from different legislative bases, both share similar concerns and are facing similar issues in this international area. The area is generally "downwind" of major industrialized regions of the central and eastern United States and/or central Canada. Trans-boundary issues play a major role in the actual or anticipated impacts experienced in the region's protected areas.

From the perspective of the federal land managers on both sides of the border, the main objective is ensuring that air quality is maintained or improved in regional "protected" areas, which represent important ecosystems. Federal, provincial and state regulatory agencies share these concerns but are also interested in protecting all areas and receptors in the region, as well as responding to international commitments such as the Canada/United States Air Quality Agreement (Government of Canada and Government of the United States of America, 1991).

The United States

From a United States perspective, in August of 1977, the Clean Air Act was amended to “prevent significant deterioration” in areas of the United States known to have air cleaner than National Ambient Air Quality Standards set by the Environmental Protection Agency (Government of the United States of America, 1977). The United States Congress specified that certain areas of special national significance would be provided additional air quality protection and would be designated as class I areas. These include all national parks more than 6000 acres (2,430 ha), national wilderness areas more than 5,000 acres (2,024 ha) and international parks. Although special air quality protection was afforded to Class I areas, United States Federal land managers are concerned about the level of air pollution in parks and wilderness areas and observed physical and biological impacts to the resources they are entrusted to protect. The land managers are pursuing cooperative relationships with State and federal regulatory agencies and with land managing and regulatory agencies of the Canadian government to exchange information on known effects and work jointly on mitigation strategies.

Canada

In Canada, similar legislative authority does not exist to afford additional air quality protection for “protected areas” as in the United States. However, under Annex 1, Part 4 of the Canada/United States Air Quality Agreement, Canada made a commitment “to develop and implement means affording levels of prevention of significant air quality deterioration and protection of visibility” comparable to those under the United States Clean Air Act in relation to sources contributing to trans-boundary air pollution. Canada supports continued bilateral efforts for the protection of air quality and visibility in “protected areas.” As well, Canadian domestic federal/provincial agreements and programs, such as the Eastern Canada Acid Rain Control Program (Environment Canada, 1985) and the NO_x/VOC Management Plan (Canadian Council of Ministers of the Environment, 1990) are aimed at protecting all receptors. Federal land managers and federal and provincial regulatory agencies in Atlantic Canada see the opportunity to track commitments and progress under Annex I of the Canada/US Air Quality Agreement, as well as support cooperative international programs and policies to improve the protection of sensitive receptors in the Northeast Atlantic region.

AIR QUALITY ISSUES AND CONCERNS

As noted earlier, both countries share similar air quality issues and concerns regarding demonstrated impacts throughout the region. It is not the intention to provide an in depth review of the documented or suspected impacts in this paper, but rather to highlight the major issues of concern. The assessment study under the auspices of the Committee, which is described latter in the paper, will provide a more detailed look at air quality and its impacts in protected areas in the region. Air quality impacts are a result of local activities as well as regional or distant emissions sources. In some cases activities such as wood burning and increased vehicle traffic in protected areas result in local problems in park areas.

Acid Deposition

Throughout the region acid deposition is a concern because of ecosystem based on highly sensitive geology. Impacts have been documented for decreased fish stocks and other aquatic organisms, implicated in reduced forest and soil and wildlife productivity. Sulphur dioxide emissions control programs are underway in both the United States and Canada resulting in a decline in emissions in Eastern North America. Deposition monitoring data for Atlantic Canada suggests a decrease in sulphate deposition below the Canadian target load of 20 kilograms of sulphate per hectare per year, with levels in Nova Scotia and New Brunswick below 15 kilograms of sulphate per hectare per year. However, these improvements may not be enough since scientists are indicating that critical loads in Atlantic Canada should be at 8 kilograms per hectare per year or less to protect sensitive ecosystems (Environment Canada, 1990).

Ground-Level Ozone

Many areas in the United States, including the northern New England states are in non-attainment areas i.e. greater than 120 ppb for one hour for ground-level ozone, with resulting health and vegetation impacts. In Atlantic Canada, although not as severe a problem, levels above the Canadian ambient air objective of 82 ppb are measured, especially in southern New Brunswick and south westerns Nova Scotia, and have raised concerns regarding the long range transport of ozone or its precursors into those areas.

Air Toxics

Air toxics or hazardous air pollutants are a growing concern in the region both in terms of local sources and the regional transport of metals and organics. A recent example is the high levels of mercury measured in certain species of freshwater fish. This has resulted in the issuing of health directives and warnings regarding consumption in many states, including Maine, and more recently in the provinces of New Brunswick and Nova Scotia. The long range emission sources, such as coal-fired power plants, are thought to be the major source.

Visibility – Prevention of Significant Deterioration

Visibility is a priority from the United States perspective and is considered to be one of key air quality related values (AQRV) for national parks. Reduced visibility is mainly associated with sulphates in both the United States and Canada, but fine particles and photochemical smog also contribute to regional haze problems. Visibility impairment in Eastern Canada is approximately the same area that receives high sulphate deposition and is particularly prevalent during the summer months. It has not been a high priority for Canada. However, as result of commitments under the Canada/United States Air Quality Agreement, Canadian agencies are developing historical visibility information to act as a baseline for comparison to future changes. Interagency Monitoring of Protected Visual Environments (IMPROVE) monitors are now operating in several locations across Canada including one site in southern New Brunswick.

The prevention of significant air quality deterioration in pristine and protected areas in Canada and the United States is another shared concern of the Committee. The United States has specific legislation in place for the prevention of significant deterioration, whereas Canada is ensuring its consideration during the environmental impacts assessment review processes for new or modified industries at the provincial or federal levels.

Other related issues are acid aerosols and fine particle measurements in the region. These pollutants are emerging as significant health concerns in both countries. As an example, Saint John, New Brunswick was found to have the highest acid aerosol levels in several urban centres in Canada.

THE ESTABLISHMENT OF THE NORTHEAST REGIONAL AIR QUALITY COMMITTEE

The origins of the establishment of the Northeast Regional Air Quality Committee (NERAQC) can be traced to the chance meeting of United States Park Service, Air Quality Planner, Eric Hague and Neil Munro, Parks Canada, Atlantic Region, Director of Policy, Planning and Research at a conference in 1992. They discussed the different approaches to air quality issues in protected areas in the two countries and arranged for a meeting of Canadian and United States National Parks and air quality managers at Roosevelt Campobello International Park in June 1993. The purpose of this meeting was to meet the people and see if there were areas where cooperation and partnerships could be forged, perhaps on a regional basis. Later another meeting was organized by Eric Hague and other United States National Park Service officials from the Northeast Region of the United States National Park Service. This meeting included a wide range of groups from both government and nongovernment. It was called to explore the idea of preparing a regional air quality plan for the Northeast Region of the United States. Having become familiar with his Canadian colleagues at the earlier Campobello meeting, Eric Hague also invited some of these Canadians. This meeting was also held at Roosevelt Campobello International Park, in September 1994. At that meeting agreement was reached to establish an organization to work on regional air quality issues and protected areas in the northeast region of eastern North America.

As an outcome of the September 1994 meeting, a steering committee was formed and the members charged with developing a charter and operating procedures for the new organization. The steering committee included members from Canadian and United States federal protected area managers as well as State and Provincial officials and representatives from Canadian and United States environmental agencies. It met several times at convenient near border locations through the fall and winter of 1994/95. The members prepared a mission statement, objectives, operating procedures as well as developed some tangible projects for the new organization. The full organization met again in May 1995 to consider the work of the steering committee; Hence NERAQC is still a work in progress.

The Mission

The mission of NERAQC is; To preserve and enhance air quality and the air quality related values (AQRV) of protected and other sensitive areas of the northeast United States and Atlantic Canada.

In developing this mission we were forced to consider what we meant when we referred to protected areas. We toyed with using the wording directly from Annex 1 – Part 4 of the Canada-US Air Quality Agreement but found the wording ambiguous. After much discussion, we agreed to define a protected area for our purpose in a very open manner. In NERAQC protected areas will include all U.S. Class I and Class II floor areas (under terms of the U.S. Clean Air Act), international parks and in Canada all Federal and Provincially designated protected areas meeting World Conservation Union (IUCN) Protected Area Management Category I and II criteria (Commission on National Parks and Protected Areas, 1994). Protected areas for NERAQC will also include any additional areas that are identified as such by its members. Thus each jurisdiction maintains the flexibility to include areas that it feels warrant the attention of NERAQC.

Objectives

Six objectives have been proposed to guide the activities of NERAQC. Together they define the scope of activities for NERAQC.

Coordinate regional air quality reviews

We expect the committee to coordinate regional air quality reviews with emphasis on protected areas, at the request of member agencies. The types of reviews envisaged will include but are not being limited to;

- 1) major permitting actions;
- 2) major regulatory changes;
- 3) major emission trades;
- 4) regional air quality trends.

A channel for the transfer and exchange of information

The organization, through regular meetings and the establishment of one-on-one relationships among staff of member agencies will open a channel for the transfer and exchange of information of mutual interest between member agencies and the public on air quality issues in the region.

Annex 1 (4) of the Canada/United States Air Quality Agreement

Annex 1 (4) of the Canada/United States Air Quality Agreement specifically addresses the prevention of air quality deterioration and visibility protection in protected areas in the United States and Canada. Those of us working to establish NERAQC entered the process with the hope

that it could contribute to implementation of that agreement. In fact, the preliminary meetings leading to the formation of NERAQC have been cited in 1994 Canada-United States Air Quality Agreement Progress Report (Government of Canada and Government of the United States of America, 1994).

Resource Management Issues

NERAQC will provide a multi jurisdictional forum that will facilitate the identification and prioritization of regional air quality resource management issues affecting protected areas in the region. It will assist member agencies to formulate broader regional strategies to address such issues that can be used by member agencies as a basis for local action.

Regional Air Quality Monitoring

Another NERAQC objective is to promote coordinated regional air quality monitoring among its members. Considering problems that transcend each others boundaries will promote recognition of opportunities for cooperation and the coordination of air quality monitoring.

Regulatory Proceedings

Furthermore NERAQC intends to serve as a vehicle to support information dissemination on regulatory proceedings in the region between member agencies and the public as they affect protected areas.

Membership & Observers

As now conceived, membership in NERAQC will include fifteen (15) federal, state and provincial agencies for the United States and Canada and one International organization, the Roosevelt Campobello International Park Commission. Table 1 details the member agencies of NERAQC. In addition provisions are being made to accommodate United States and Canadian non-government organizations, industry associations and other interested federal, state and provincial agencies. Such groups will be welcome to attend all NERAQC meetings. The intent is to operate an open forum where information can flow freely and opportunities for coordination and cooperation on initiatives leading to the realization of the objectives of NERAQC can be developed.

Operation

NERAQC will operate under the direction of a Chair and a Co-chair. These individuals will provide administrative support for the Committee. Funding for regional air quality reviews and other activities will be shared among the member agencies. Funds will be provided through, in kind support, grants and/or direct funding, as resources are available to member agencies. The Chair and a Co-chair will preside over meeting of the Committee. A Canadian and a U.S. representative will serve as the Chair and Co-chair and will alternate responsibilities with staggered two-year terms.

Decisions in NERAQC will be reached by consensus after a full review and comment period by all members of the Committee. The Chair and Co-chair will be responsible for ensuring all comments received from members are addressed by the Committee. The Committee will meet in the spring and fall each year with the meeting dates decided at the preceding meeting, or as necessary.

Provisions have been made for the establishment of subcommittees to deal with specific matters. An annual report on Committee activities will be prepared by the Chair and Co-chair at the end of each calendar year and provided to member agencies and other interested parties.

Table 1. Membership in the Northeast Regional Air Quality Committee				
Canada		International	United States	
Federal	Provincial		Federal	State
Environment Canada, Atlantic Region	Newfoundland Department of Environmental Protection	Roosevelt Campobello International Park Commission	United States National Parks Service – Northeast Field Area	Maine Department of Environmental Protection
Heritage Canada, Atlantic Region	New Brunswick Department of the Environment		United States Fish & Wildlife Service – Region 5	Vermont Agency of Natural Resources
Canadian Forest Service	Nova Scotia Department of the Environment		United States Forestry Service – Region	New Hampshire Department of Environmental Services
	Prince Edward Island Department of Environmental Resources		United States Environmental Protection Agency – New England	Massachusetts Department of the Environment

ACTIONS ALREADY TAKEN

In coming together to work for the establishment of the NERAQC, representatives from several jurisdictions have recognized opportunities to pool scarce resources and work together in a meaningful and cost-effective manner.

Ozone Monitoring in Roosevelt Campobello International Park

The Roosevelt Campobello International Park is established under legislation in both Canada and the United States. Although located in Canada, the Park is designated as a Class 1 area under the U.S. Clean Air Act. High levels of ground level ozone have been recorded frequently in Acadia National Park to the south of Roosevelt Campobello International Park, but no ozone monitoring has occurred in the Roosevelt Campobello park area. While working on the steering committee to establish the NERAQC officials from the State of Maine, Roosevelt Campobello International Park, the Province of New Brunswick and Environment Canada recognized that ozone monitoring at this park was affordable if they worked together and pooled resources. With Environment Canada purchasing the equipment, Roosevelt Campobello taking care of day to day

operation, New Brunswick and Maine providing calibration and technical support it has been possible to install and make operational a new ozone monitoring station inside Roosevelt Campobello International Park.

Cooperative Funding for a Regional Air Quality and Protected Areas Situation Study

Although the NERAQC member agencies recognized the value of a regional study that put protected areas in the region into their air quality context, no single agency had the financial flexibility or perhaps more importantly – a mandate, to work on such a project. In working for the establishment of the NERAQC officials from agencies on both sides the international boundary recognized that by pooling small amounts of available funds and working through the NERAQC they could do what otherwise would not be possible. By pooling available resources NERAQC has been able to assemble a fund of some \$40,000. US. NERAQC has issued a call for expressions of interest in carrying out a study and the NERAQC steering committee is now in the process of hiring a contractor to conduct the work necessary to meet agreed objectives. The objectives of this study are presented in Table 2.

Table 2. Information Requirements for the North East Regional Air Quality Situation Analysis Study	
Item	Requirements
1	A map of the region with protected areas identified including aerial boundaries. A list of protected areas with brief narrative descriptions will be provided by the NERAQC member agencies.
2	A status report of regional air quality. This would include the existing status of criteria pollutants, toxics, and other information from special studies conducted by member agencies, the identified historical trends and gaps in air quality data. These data are generally available in some cases from the AIRS data base and from each State and Province, however, a compilation and assessment are needed. Recommendations for improved or expanded monitoring, if warranted, will be provided.
3	A compilation of detailed air quality information (criteria pollutants, acidic precipitation, toxicities, and special studies) for each protected area in the Northeast U.S. and Atlantic Canada, identified by the member agencies, including international parks, national parks, and designated wilderness areas, and state and provincial parks.
4	A review of the known effects of air pollution on the air quality related values including visibility of protected areas. This would include a compilation and assessment of known effects to resources in the protected areas.
5	A list of point sources, source categories, etc. by pollutant and source area which have the potential to affect protected areas. Source area categories consist of; a) sources within protected areas; b) the region represented by the committee; c) areas outside the region. Sources of information include the AIRS data base, the Residual Discharge Inventory System, the Industrial Standard Code, and the park areas themselves for fuel use and vehicle use and other source information.
6	List and summarize US – Canadian environmental statutes, regulations, policies, legal mandates and international agreements.
7	Assess the ability of member agencies to provide air quality protection and provide recommendations for actions to enhance protection efforts.

CONCLUSIONS AND NEXT STEPS

Although NERAQC is essentially an informal committee at this time and relatively new in “bureaucratic” terms, it has been proactive. Through the combined efforts of its member agencies, it has secured funding from both countries to support and initiate a regional air quality assessment study for the region. Informal discussions at the Steering committee lead to the establishment of a cooperative (Canada/United States federal, state and provincial levels) ground-level ozone monitoring site at Roosevelt Campobello International Park. This has taken place within eight months! The progress to date bodes well for future cooperation on air quality activities among all levels of government in this international region. However, the greater challenge will be to highlight the air quality concerns in the region and in influencing policy makers in both countries to make the appropriate changes to enhance protection for parks and wilderness areas.

In the short term, the next steps for NERAQC will be to formalize its Terms of Agreement and ensure the sign on by all the member agencies in the region. In addition NERAQC will monitor and guide the completion of the regional assessment study. In the medium to long term we hope to see NERAQC and its member agencies finds ways to see action on the recommendations from the assessment study including international monitoring activities to fill information gaps and the exchange of information on air quality issues in the region. As well, NERAQC will explore its role relative to other groups interested in air quality in the region, such as the Northeast States for Coordinated Air Use Management (NESCAUM), the Gulf of Maine Council and the International Joint Commission.

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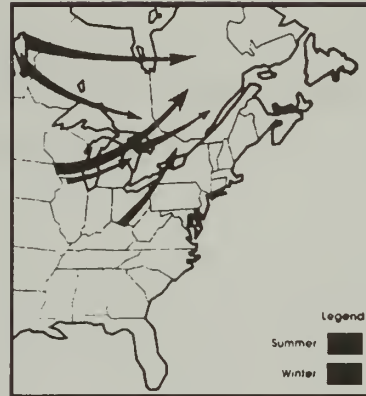
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**THE NORTHEAST REGIONAL
AIR QUALITY COMMITTEE (NERAQC) —
A FIRST ADVENTURE INTO CROSS-BORDER
COOPERATIVE ACTION ON
AIR ISSUES AND PROTECTED AREAS**

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Important Summer and Winter storm paths
Source: Ontario Ministry of the Environment

ISSUES AND CONCERNS

- **ACID DEPOSITION**
—highly sensitive ecosystems throughout the region
- **GROUND-LEVEL OZONE**
—standards/objectives exceeded in New England states and
New Brunswick and Nova Scotia
- **AIR TOXICS**
—local & long range sources of metals & organics eg. mercury
- **VISIBILITY**
—key AQRV in the United States
- **PREVENTION OF SIGNIFICANT DETERIORATION**
- **EMERGING ISSUES**
—acid aerosols

North East Regional Air Quality Committee

**A First Adventure into Cross-Border Action
on Air Issues and Protected Areas**

THE NERAQC MISSION

To preserve and enhance
air quality and the air quality related
values (AQRV) of protected areas
of the northeast United States
and Atlantic Canada.

North East Regional Air Quality Committee

**A First Adventure into Cross-Border Action
on Air Issues and Protected Areas**

OBJECTIVES

- Coordinate air quality reviews
- Transfer and exchange of information
- Annex 1 (4) of the Canada/United States
Air Quality Agreement
- Air quality resource management issues
- Regional air quality monitoring
- Regulatory proceedings

North East Regional Air Quality Committee

**A First Adventure into Cross-Border Action
on Air Issues and Protected Areas**

MEMBER AGENCIES — U.S.

- U.S. National Park Service — Northeast Field Area
- U.S. Environmental Protection Agency — New England
- U.S. Fish & Wildlife Service — Region 5
- U.S. Forestry Service — Region
- Maine Department of Environmental Protection
- Vermont Agency of Natural Resources
- New Hampshire Dept. of Environmental Services
- Massachusetts Department of the Environment

North East Regional Air Quality Committee

**A First Adventure into Cross-Border Action
on Air Issues and Protected Areas**

MEMBER AGENCIES — CANADA

- Environment Canada, Atlantic Region
- Canada Heritage, Parks Canada, Atlantic Region
- Canadian Forest Service
- New Brunswick Department of the Environment
- Nova Scotia Department of the Environment
- PEI Department of Environmental Resources
- Newfoundland Dept. of Environmental Protection

North East Regional Air Quality Committee

**A First Adventure into Cross-Border Action
on Air Issues and Protected Areas**

OPERATION

- Chair and Co-Chair
 - each country represented
 - staggered two year terms
 - administrative support
- Funding
- Decision making
- Meetings spring & fall
- Subcommittees
- Annual Report

North East Regional Air Quality Committee

**A First Adventure into Cross-Border Action
on Air Issues and Protected Areas**

OBSERVERS

United States and Canadian
non-government organizations,
industry associations and other
interested federal, state and provincial
agencies are welcome to attend
Committee meetings.

North East Regional Air Quality Committee

**A First Adventure into Cross-Border Action
on Air Issues and Protected Areas**

OBSERVERS

- Regional Air Quality Situation Review Funding
- Roosevelt Compobello Ozone Monitoring

North East Regional Air Quality Committee

**A First Adventure into Cross-Border Action
on Air Issues and Protected Areas**

**REGIONAL AIR QUALITY
SITUATION ANALYSIS**

- Mapping of protected areas in the region
- Status report of Regional Air Quality
- Detailed information on air quality for each protected area
- Effects on AQRV's of protected areas
- Review of sources for:
 - sources within protected areas
 - within the NE region
 - areas outside the region
- Summary of tools to effect air quality in the region
- Recommendations for actions

North East Regional Air Quality Committee

**A First Adventure into Cross-Border Action
on Air Issues and Protected Areas**

THE FUTURE FOR NERAQC

Short Term

- Sign the Terms of Agreement
- Complete Regional Air Quality Situation Analysis

Medium—Larger Term

- Respond to the Regional Air Quality Situation Analysis
- Explore links to other organizations (NESCAUM,
Gulf of Maine Council, IJC)



U.S. Fish & Wildlife Service Air Quality Roles and Responsibilities

*Joe Carriero
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This paper will describe the role played by the U.S. Fish and Wildlife Service Air Quality Branch (FWS AQB) in monitoring and protecting air quality in the United States. The Fish and Wildlife Service is part of the Department of the Interior along with a number of other agencies, including the National Park Service, the Bureau of Land Management, the U.S. Geological Survey, the National Biological Service, the Bureau of Indian Affairs, the Bureau of Reclamation, and others.

The Air Quality Branch of the Fish and Wildlife Service consists of five employees; the total budget of the office is approximately \$500,000 annually. The office gets its direction and mandate from the **Clean Air Act** and the **Wilderness Act**. The Clean Air Act gives Class 1 area federal land managers an affirmative responsibility to protect Air Quality-Related Values (AQRVs) in Class 1 areas. The Wilderness Act, which was instituted in 1964, provides specific guidelines for managing wilderness areas. In general, the Air Quality Branch has as its mission the protection, management, and conservation of air resources on Fish and Wildlife Service lands. A primary strategy on how to achieve this is through the sharing of information, cooperating with other agencies, and forming partnerships where possible.

After extensive deliberation, it was decided that the best way to present the Service's message was through the use of an innovative, complex procedure known as the "Top Ten". FWS employees have completed exhaustive research in creating the "Top Ten", and have struck the following items from their list:

the headquarters of the Air Quality Branch is located only six miles from the new home of Colorado's new National Hockey League team formerly known as the Quebec Nordiques

in a recent survey, 4 out of 5 FWS employees preferred breathing clean air

the Fish and Wildlife Service has its own improved program; IMPROVE stands for “I Managed Procrastinating Removing Owls Virtually Everywhere”

in the Fish and Wildlife Service, AQRV stands for “America’s Quality Recreational Vehicles”

most FWS employees believe the National Park Service’s IWAQM program refers to minor human rights violations

Proceeding quickly to the real “Top Ten”:

SUMMARY OF OVERHEADS

Overheads 1 & 2: *The Top Ten Things You Should Know*

- About The FWS Air Quality Program

Overhead 3: *Fish and Wildlife Service Air Quality Program*

- the function of the Regional Air Quality Coordinators is principally to conduct permit reviews, and to liaise with wilderness refuge managers

Overhead 4: *Fish and Wildlife Service Class 1 Areas*

- there are 21 Class 1 areas managed by the FWS, amounting to more than 500 wilderness refuges
- FWS controls almost as much land as the National Park Service; total land controlled is more than the total land covered by Switzerland, Liechtenstein, Luxembourg, San Marino, and the Vatican

Overhead 5: *Fish and Wildlife Service Class 1 Areas: Regional Offices*

Overhead 6: *Impacts Of Air Pollutants On Ecological Resources*

CASE STUDIES: CURRENT ISSUES

Moosehorn Wilderness Area, Maine

This wilderness area currently has a visibility problem. The source of the problem has been identified as a pulp mill near the area, which is emitting sulphur dioxide (SO₂) and nitrogen oxides (NO_x). The facility underwent a new source review analysis and a permit review, and ultimately was required to increase controls on new and existing emission sources, and also to do a 1-year visibility analysis. A plume is still visible; the FWS may now be approaching the State of Maine with a request to rectify the situation.

Breton Wilderness Area, Louisiana

Measurements taken in this area show exceedances of allowable SO₂ increments, which have been traced to emissions from offshore oil rigs. The FWS is working with the U.S. Minerals Management Service, in an attempt to require better controls for offshore rigs. Negotiations with the State of Louisiana may take place to ensure this.

Southeastern Wilderness Areas

Certain areas, (including Breton, Louisiana; Chassahowitzka, Florida; and Cape Romain, South Carolina) have seen their allowable increments for SO₂ nearly depleted. There is a need for modeling data to establish the emission sources that are causing these results. The goal in this instance is again to get the states in question to remedy the problems.

THE TOP 10 THINGS YOU SHOULD KNOW ABOUT THE FWS AIR QUALITY PROGRAM

10. It includes efforts at 3 levels:

Refuges — Regional Offices — Headquarters

9. FWS has 21 class I areas
8. FWS has 7 regional offices
7. The headquarters office is the air quality branch (AWB)
6. The AQB is colocated with the NPS AQD in Lakewood, Colorado

Overhead 1

5. AQB staff consists of 5 employees
4. Direction comes from the Clean Air Act and Wilderness Act
3. Mission of the AQB is protect FWS areas from impacts of air pollution
2. A major focus of the AQB is PSD permit review

AND THE NUMBER 1 THING TO KNOW ABOUT THE FWS AIR QUALITY PROGRAM IS . . .

1. **Partnering is vital to the FWS Air Quality Program**

Overhead 2

FISH AND WILDLIFE SERVICE AIR QUALITY PROGRAM

- HEADQUARTERS: Air Quality Branch (Denver)
- REGIONS: Air Quality Coordinators (7 regional offices)
- FIELD: Refuge Managers

Overhead 3

IMPACTS OF AIR POLLUTANTS ON ECOLOGICAL RESOURCES

- Acidification of lakes, streams, and soils
- Direct toxicity to sensitive species
- Changes in species composition
- Bioaccumulation of toxins in food chains

Overhead 6

FISH & WILDLIFE SERVICE CLASS I AREAS



Overhead 4

FISH & WILDLIFE SERVICE CLASS I AREAS



Overhead 5



International Air Issues Workshop

U.S. Forest Service Roles and Responsibilities

*Ann L. Acheson
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The Forest Service is honored to be a part of this International Air Issues Workshop and supports the concept of partnerships and agreements to best manage and protect air quality and natural resources.

This paper provides background information on who the Forest Service (FS) is (our mission and structure), what current or planned air quality or air quality effects monitoring we are doing, and major highlights or issues we're involved in.

WHO WE ARE

Mission

The heart of the Forest Service is characterized in its mission of “Caring for the Land and Serving People.” We are a multiple-use agency dedicated to producing goods and services for the American people while sustaining ecosystem health. We are guided by such legislation as the National Environmental Policy Act, National Forest Management Act, Wilderness Act and, of special interest in this conference, the Clean Air Act.

The Forest Service manages about 191 million acres across 42 states. Thirty-two million of those acres are managed as wilderness. Of those 32 million acres, 12 million are managed as Class I wilderness. (Class I areas are those afforded special air quality protection by the federal Clean Air Act). Ninety-one percent of the 12 million acres are in 10 western states. In the eastern U.S., the total class I acreage is smaller but the class I areas occur in more states.

The Forest Service has a national policy to integrate air resource management objectives into all Forest Service resource planning and management activities and to use cost effective methods

to achieve these objectives. Current air resource objectives are to protect air quality related values in Class I areas, to control and minimize air pollutant impacts from land management activities, and to cooperate with air regulatory authorities to limit significant adverse effects of air pollutants and atmospheric deposition on forest and rangeland resources. Although regional policies may differ, they are based on national policy.

Structure

The Forest Service is a very decentralized organization composed of nine regions (1-6, 8-10) spread across the United States. Each region is composed of forests composed of districts. To a certain degree, any of these entities may act independently of the others. Decentralization has advantages of allowing managers to respond quickly and creatively to local situations. Disadvantages may arise when trying to establish national or international policy.

Each region has a Regional Forester delegated responsibility to fulfill the requirements of the Clean Air Act by the Chief of the Forest Service. In some regions, this responsibility is delegated down to the Forest Supervisor. Each region has at least one full-time air quality specialist to respond to Prevention of Significant Deterioration permit applications, other air quality regulations, address smoke management issues, oversee baseline monitoring for air quality effects, etc.

I work for Region 1 which covers northern Idaho, Montana, North Dakota and western South Dakota. The Forest Service manages six Class I areas in Region 1: the Bob Marshall Wilderness and Scapegoat Wilderness which lie along the Continental Divide, Anaconda Pintler Wilderness, Mission Mountains Wilderness, Selway-Bitterroot Wilderness, and Gates of the Mountains Wilderness. The size of the areas ranges from almost 30,000 acres in the Gates of the Mountains to over a million acres in the Bob Marshall Wilderness.

MONITORING

The Forest Service has more than 100 monitoring projects across the country to gather information regarding the effects of air quality on natural resources.

Lakes

Lake monitoring occurs in many Forest Service Regions in order to document baseline conditions and determine trends due to air pollution. Extremely low buffering capacity has been measured in many wilderness lakes including lakes in the Clearwater and Alpine Lakes Wilderness areas in Washington, the Mt. Zirkel Wilderness in Colorado, and the Cabinet Mountains and Selway Bitterroot Wilderness areas in Montana.

Two lakes in the Cabinet Mountains Wilderness area have acid neutralizing capacity less than 20 ueq/l. These lakes would be considered extremely sensitive to future inputs of acidic deposition. Similarly, in the Selway Bitterroot Wilderness, Blodgett Lake and North Kootenai lakes

have acid neutralizing capacity less than 20 ueq/l. Long term monitoring is scheduled to continue in order to build upon the baseline data already gathered.

Lichens

The FS has inventoried lichens in many states including Utah, Wyoming, Montana, Idaho, Virginia, Arizona, Alaska, Colorado, and Washington. Lichens are used as bioindicators of air quality via elemental analysis of lichen tissue, mapping of species adjacent to pollution sources, and transplant studies. Preliminary data from Idaho and Montana indicate that lichen flora for these areas is diverse and well developed and that crustose, foliose, fruticose, and squamulose species are all present. Baseline concentrations of potential pollutant elements are relatively low indicating generally good air quality around the sites inventoried.

Visibility

To gain information to protect visibility and remedy existing impairment in Class I wilderness areas, the Forest Service has operated visibility monitoring equipment for over 10 years in various locations. We currently operate 10 nephelometers, three meteorological sites, and 34 automatic remote cameras in or around many of our wilderness areas. This is in addition to the monitoring conducted as part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) program.

This information has been used, often in conjunction with lake data, to certify adverse impact for four Prevention of Significant Deterioration permits to air quality regulators.

Smoke

As a major contributor to smoke, whether from wildfire or prescribed fire, the Forest Service is very involved in smoke management, research and training. We are major players in many of the smoke cooperatives or agreements that exist around the country. These agreements are developed to allow agencies or entities to use prescribed burning to meet resource objectives while still protecting air quality and human health. Examples of these agreements exist in Montana, Idaho, Arizona, Minnesota, Washington, Oregon. Examples of other players are the National Park Service, U.S. Fish & Wildlife Service, state air regulatory agencies, private burners, the Nature Conservancy, etc.

The Forest Service has also been a leader in research aimed at reducing smoke emissions from prescribed fires, understanding the chemistry of forest fire smoke and its effect on the atmosphere as well as human health, and reducing the hazard of impaired highway visibility from prescribed fires.

Smoke management training is mandatory and critical to those involved in wildfire and prescribed fire. Its intent is to give students the tools to reduce the emission or effects when possible due to prescribed fire or wildfire.

HIGHLIGHTS/ISSUES

Eastside Ecosystem Management Project

In July 1993, as part of a plan for ecosystem management in the Pacific Northwest, President Clinton directed federal resource management agencies to focus on the health of forest ecosystems east of the Cascades. The Eastside Ecosystem Management Project was formed and is directed by the Forest Service and Bureau of Land Management to address such issues as salmon runs, forest and rangeland health, and species at risk within the entire Columbia River Basin. The boundary delineated for this project is generally from the crest of the Cascades to the Continental Divide, north to the Canadian border and south taking in parts of Wyoming, Utah, Nevada, and California.

A team has been assembled to examine the effects of anthropogenic air pollution on natural resources within the Columbia River Basin. The team is composed of scientists from several federal land management agencies with expertise in aquatics, atmospheric deposition, visibility, vegetation, and climatology. The assessment of air quality effects is scheduled for completion by October 1, 1995.

Southern Appalachian Assessment

This assessment will be discussed by others at this conference but is meant to be interagency examination of current and projected conditions in the southern Appalachian Mountains. The air quality part of this assessment will focus on visibility, ozone exposure, atmospheric deposition, particulate matter concentrations, emissions and pollution exposure.

Grand Canyon Visibility Transport Commission

The Commission was established per the requirements of the 1990 Clean Air Act Amendments. Its purpose is to assess what, if any, action should be taken to preserve clear days and improve existing visibility impairment in 16 national parks and wilderness areas on the Colorado Plateau. The Forest Service serves on many of the committees including the emissions committee. Prescribed fire and wildfire have been identified as significant sources of visibility impairing emissions throughout the western U.S. The Forest Service is leading an effort to develop a GIS database system in order to demonstrate the future use of fire in meeting forest health and ecosystem objectives and the effects on visibility.

Mt. Zirkel Wilderness

The Mt. Zirkel Wilderness is a Class I wilderness designated under the federal Clean Air Act. It is a 140,000-acre wilderness which lies along the Continental Divide northeast of Steamboat Springs, Colorado, with high elevation aquatic ecosystems naturally very sensitive to atmospheric deposition. The higher elevations of the wilderness receive up to 70 inches of precipitation per year. Snow chemistry monitoring by the U.S. Geological Survey indicates that wilderness snowpack contains elevated sulfate and acid level sometimes 2-3 times greater than that measured in other parts of Colorado.

The wilderness is immediately downwind of two large coal-fired power plants, the Craig and Hayden Generating Stations which emit 99.6% of the sulfur dioxide, 92% of the nitrogen oxides, and 62% of the particulates emitted from stationary air pollution sources in northwest Colorado.

The State of Colorado has developed regulations to implement the national visibility goal of preventing and remedying any existing impairment of visibility in mandatory Class I areas caused by manmade air pollution. These regulations provide the State with the authority to require an air pollution source to install Best Available Retrofit Technology if the source is causing or contributing to visibility impairment within a mandatory Class I area.

In July 1993, the Forest Service officially certified to the Governor of Colorado that based on the best available information it was reasonable to believe that the Hayden and Craig power plants are causing or contributing to adverse impacts to visibility and aquatic ecosystems in the wilderness.

At the request of the two power plants, state legislation was introduced and passed which significantly increased the amount of information that the State must have before considering whether or not to require an existing source to reduce emissions due to monitored visibility impairment within a Class I area.

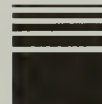
As a result, the State, Forest Service, EPA, and the owners of the two power plants developed a 16 month, \$3,000,000 study to determine the extent and sources of visibility impairment within the wilderness but the study will not address impacts to aquatic ecosystems.

A Visibility and Air Quality Related Values Policy Task Force was established by the Colorado Legislature to identify and discuss policy issues and recommend protection and enhancement strategies for Class I areas and the need for legislation and regulation. Representatives on the task force include those from the electric power industry, coal mining industry, coal miners union, natural gas industry, county commissioners, and environmental groups but no federal land managers.

This issue is ongoing and has yet to be resolved.

SUMMARY

The Forest Service is an agency dedicated to ensuring sustainable ecosystems while providing multiple uses to the American public. Protecting air quality is a key component of sustainable ecosystems. We conduct a myriad of monitoring for air quality purposes across our nine Forest Service regions and are partners with many other agencies and private entities in monitoring, environmental analysis and assessment, smoke management, and research. We are honored to be a participant in this international air issues workshop and look forward to being a partner in future international agreements.



Air Quality Monitoring in U.S. National Parks

Miguel Flores

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This paper will discuss air quality monitoring programs in U.S. national parks, current air quality monitoring strategies, and planned future strategies in light of current restructuring and downsizing activities.

BACKGROUND AND HISTORY OF THE AIR QUALITY DIVISION

The Air Quality Division of the National Park Service (NPS AQD) was established as a permanent office in 1978, as it became essential to collect information on air resources, in order to meet obligations under the Clean Air Act and the Organic Act. Information on ambient concentrations, wet deposition, and resource monitoring (for visibility among other items) is currently maintained. Originally funded by the Environmental Protection Agency, the National Park Service secured its own funding for air quality protection within years of the inception of the Air Quality Division. There was quickly a need for valid, up-to-date information in order to engage in permitting activities, and to measure the impacts of air pollution on biological resources. As this need increased, so did the parallel need for data on ozone and sulphur dioxide (SO₂). These requirements led to the establishment of continuous monitoring stations for these two pollutants in support of research on the biological effects of air pollution.

In 1985, the United States Congress held oversight hearings on air quality monitoring; it was determined at that time that insufficient data were being collected on air quality in Class 1 areas. 1986 and 1987 saw \$1 million increases in base funds appropriated for monitoring the 17 Class 1 areas which previously were subject to no monitoring activities at all.

The Interagency Monitoring of Protected Visual Environments (IMPROVE) agreement was completed in 1986. Its mandate was threefold: to ascertain present visibility levels in Class 1 areas, to identify sources of anthropogenic impairment or injury to visibility, and to document the long

term trends toward or away from the national goal of no man-made impairment to visibility in Class 1 areas. Improve is a cooperative effort among U.S. federal land managing agencies, the U.S. Environmental Protection Agency, and land and several state agency groups to operate and maintain a national visibility monitoring network.

In 1990 a strategy for ambient gaseous monitoring was developed at the behest of the NPS's Regional Air Quality Coordinators, to ensure a more directed approach. This strategy has been in the implementation process since 1991. Its focus is to maintain in perpetuity an eco-region-based status & trends network of ozone, SO₂, wet deposition, and meteorological parameters. It has as an additional objective the maintenance of an intermittent sub-network of baseline sites, in order to allow for monitoring in all Class 1 sites by the year 2000. Currently the National Park Service administers 48 Class 1 sites; as of 1991, 12 of these were host to no monitoring stations for sulphur dioxide or ozone.

Current pressures on the division include the divergent goals of maintaining current monitoring activities while at the same time reducing funding. Without increases in funding, it is in fact likely that the size of the networks operated by the AQD will shrink, and/or that some monitoring activities will be eliminated. A third possibility is potentially to switch to lower-cost methods of collecting data, through new techniques such as integrated sampling.

AIR QUALITY DIVISION MONITORING PROGRAMS: PHILOSOPHY

It is important to collect air pollution data for the simple reason that air pollution can adversely affect Air Quality-Related Values (AQRVs). The data must be collected in a scientific and defensible fashion; NPS officials have as their goal the consideration of NPS data in any regulatory decisions made by state, local, and federal agencies. Consequently, a great deal of effort is put into ensuring that the NPS's data is of high quality. Quality assurance/quality control data collected by the NPS are routinely shared with those regulatory agencies. The National Park Service is committed to the use of air data to further an understanding of the causes and processes that impair park AQRVs, to guide decisions related to air resources management, and to educate park visitors and the general public of park air quality conditions and how they are changing.

The model followed by the National Park Service Air Quality Division is one of primary self-sufficiency and centralization of operations. As part of its stewardship responsibilities, the AQD is primarily responsible for the collection, validation, analysis, and reporting of data. While it was felt that the Service needed to take the lead role in this regard, there is reliance on public **and** private partnerships to gather data and meet air quality monitoring objectives.

SUMMARY OF OVERHEADS

Overhead 1: *NPS Management Policies*

- these policies reaffirm the need for air resource information

Overhead 2: *Pollutants/Parameters to Monitor*

Overhead 3: *Monitoring Objectives*

- note: there have been documented exceedances of the National Ambient Air Quality Standard in 13 parks in recent years; this is not the type of condition that is expected or wanted in national parks

Overhead 4: *Summary of Air Quality Measurement Methods Used by NPS*

Overhead 5: *How NPS Operates The Monitoring Network*

- note: initially, monitoring was primarily done by state/county agencies; data did not generally reach the NPS in a timely fashion
- centralization of operations occurred in 1984-85 and continues today, with extensive use of contractors to supplement NPS activities

Overhead 6: *NPS Criteria Pollutant Monitoring Network Organization, January 1995*

Overhead 7: *NPS Monitoring Strategy Elements*

Overhead 8: *National Park Service Ozone Monitoring Network, 1995*

- this map, showing the approximately 38 locations where monitoring takes place, represents the AQD's trends monitoring network
- some sites (Yosemite, Shenandoah, Great Smoky Mountains) have more than one monitor

Overhead 9: *1991 National Park Service Ozone Monitoring Data*

- RED results (≥ 110 ppb) = exceedance of the National Ambient Air Quality Standard; likely to cause visible injury to sensitive species
- YELLOW results (76 ppb-109 ppb) = high probability of injury to sensitive species
- GREEN results (≤ 75 ppb) = little probability of injury

Overhead 10: *National Park Service Wet Deposition Network*

- the NPS contributes significantly to the USA's acid rain program

Overhead 11: *Annual Precipitation – Weighted Mean Sulfate Ion Concentrations, 1993*

Overhead 12: *NPS Visibility Program*

- note: this program is the showcase of the AQD's monitoring efforts what is not shown is the data analysis and research component which is conducted in partnership with Colorado State University's Cooperative Institute for Research in the Atmosphere

Overhead 13: *IMPROVE Visibility Monitoring Network (Optical)*Overhead 14: *IMPROVE Fine Particle Monitoring Network, 1995*Overhead 15: *Possible Strategies for Obtaining Data for Parks*

CONCLUSION

The Air Quality Division's monitoring program costs \$2.8 million annually (split evenly between gaseous and visibility monitoring). An additional \$600,000 is spent on visibility research, while the cost of a full annual cycle of monitoring at one site is approximately \$110,000. It may be necessary in the future to obtain air quality data for parks from other sources.

Since the Air Quality Division was established, it has made a significant contribution not merely to the National Park Service's air resource management activities, but also to the scientific community at large. Without NPS data, there would be a gap in the knowledge about air quality levels across the rural United States.

NPS MANAGEMENT POLICIES

- Inventory Air Quality Related Values Associated with Each Park
- Monitor & Document the Condition of Air Quality Related Values
- Evaluate Air Pollution Impacts and Identify Causes

Overhead 1

POLLUTANTS/PARAMETERS TO MONITOR

GASES

- Ozone • SO₂ • NO₂
- CO • HNO₃ • Toxics (VOCs & SVOCs)

PARTICLES

- Fine Particles (<=2.5 microns)
- Inhalable Particles (<=10 microns)

ACIDIC DEPOSITION

- Wet • Dry • Snow
- Cloud • Fog

METEOROLOGY

- WS, WD, T, RH, delta T, Solar Radiation, Precipitation Barometric Pressure

RESOURCE

- Visibility
 - Optical • Scene
- Biological
 - Flora • Fauna • Soils

Overhead 2

NPS AIR QUALITY MONITORING OBJECTIVES

- Judge Attainment of Air Quality Standards
- Assess Trends in Air Quality in National Parks
- Assess Air Quality Impacts from Industrial Sources
- Establish Baseline Air Quality Levels in Parks
- Develop Control Strategy Policies
- Evaluate Atmospheric Models
- Assess Effects on Biological Resources in Parks

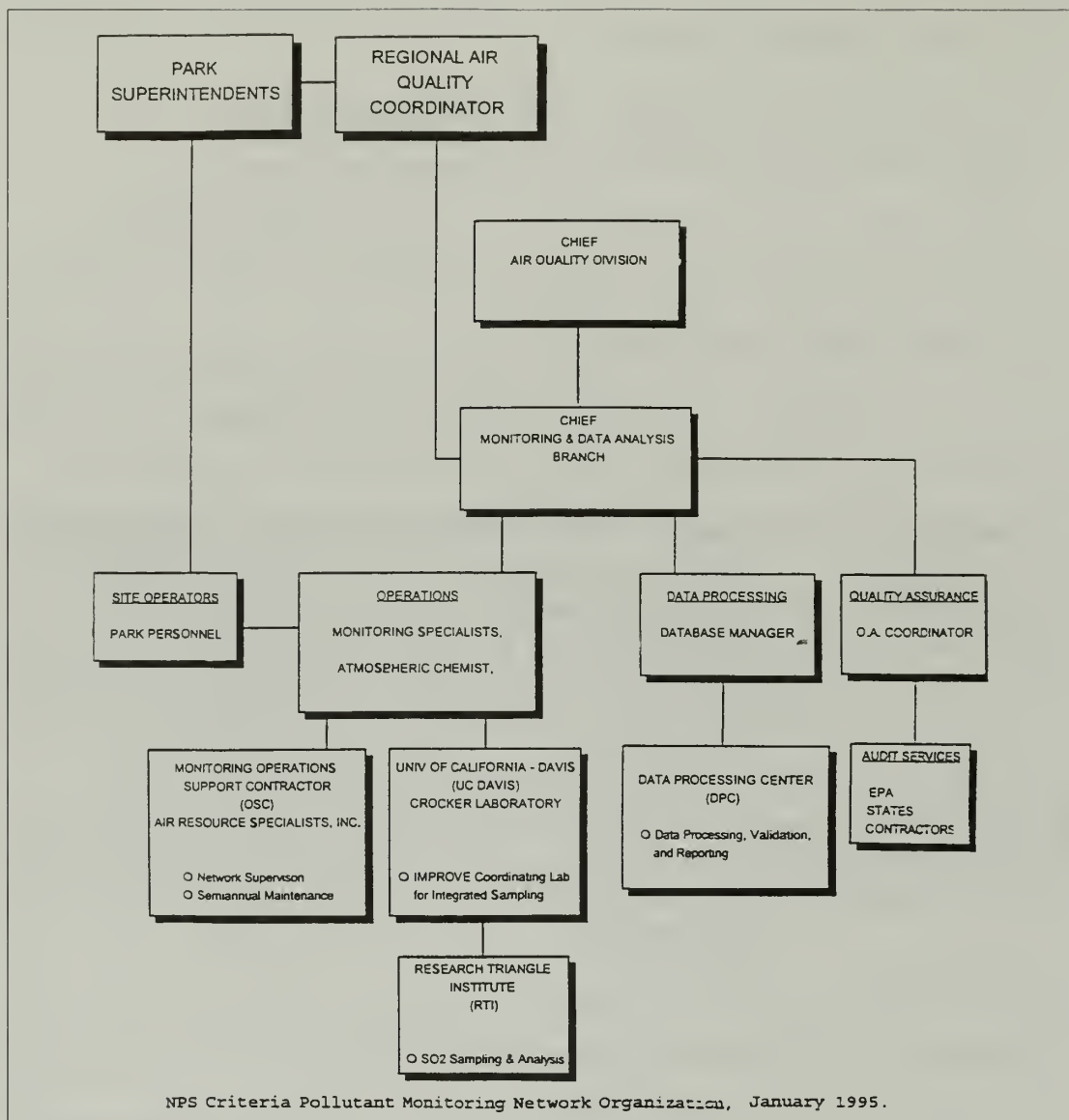
*Overhead 3***HOW NPS OPERATES THE MONITORING NETWORK**

- Trained NPS Personnel
- State/County Cooperative Agreements
- State/County Monitoring Network Sources
- Contractors

*Overhead 5***SUMMARY OF AIR QUALITY MEASUREMENT METHODS USED BY NPS**

MEASUREMENT	MEASUREMENT PRINCIPLE	SAMPLING DURATION
Ozone	UV Photometry, Chemiluminescence Passive	Continuous Continuous 7-day
Sulphur Dioxide	Fluorescence Impregnated Filter	Continuous 24h (2x/wk) or weekly
Nitrogen oxides	Chemiluminescence	Continuous
Volatile Organics	Summa Canisters	1h to 24h
Visibility (Optical)	Transmissometry (b_{ext}) Nephelometry (b_{scat})	Continuous Continuous
Visibility (Scene)	35mm Camera 8mm Time Lapse Camera	3x/day 1 frame/minute
Fine Particles	IMPROVE sampler (various filter media)	2x/wk
Wet Deposition	AeroChem sampler	weekly
Dry Deposition	Filter Pack	weekly

Overhead 4



Overhead 6

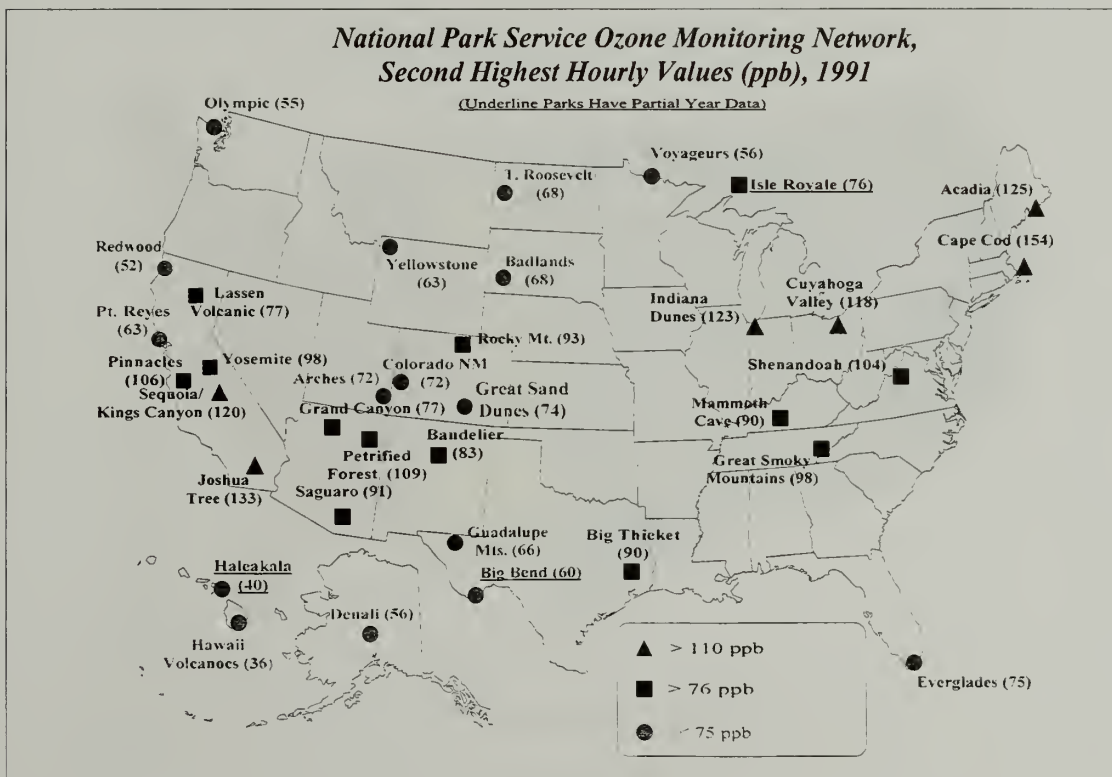
NPS MONITORING STRATEGY ELEMENTS

- Establish Site Classification System
- Expand Parameter Coverage
- Establish Closer Linkages with Other Programs
- Develop & Test New Methods
- Conduct Special Studies
- Establish Role & Functions HQS., Regions, Parks
- Develop Comprehensive Quality Assurance Program
- Secure Sufficient Funding for Program

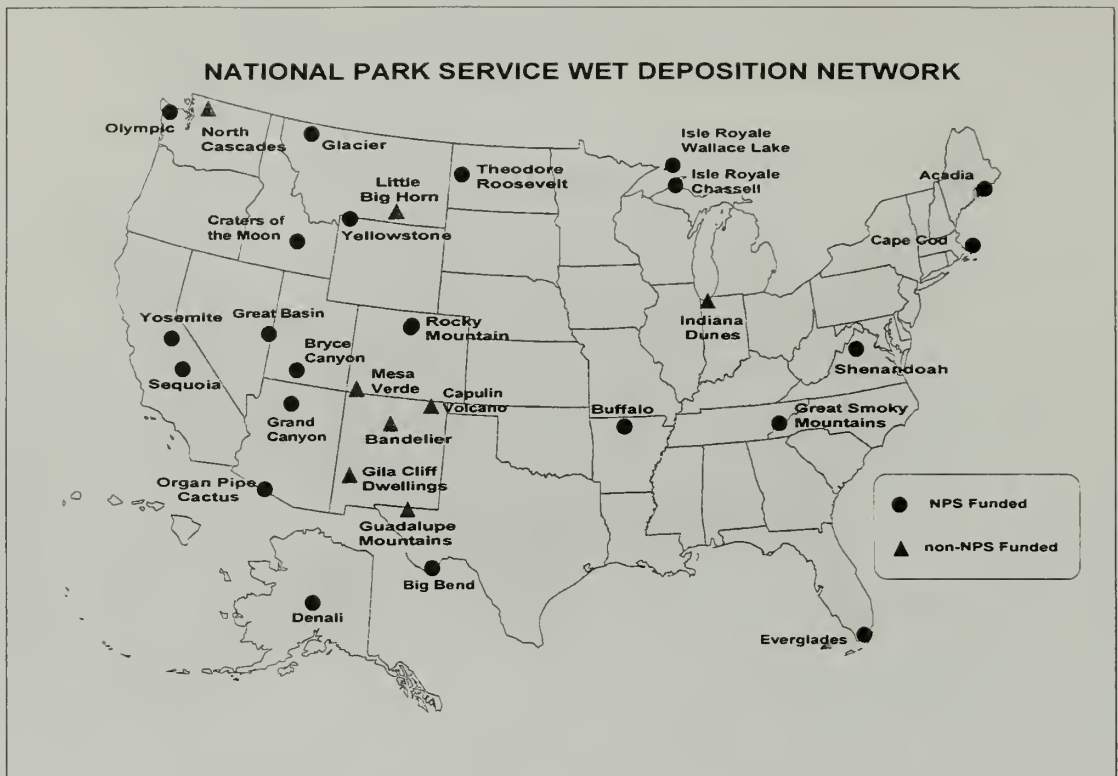
Overhead 7



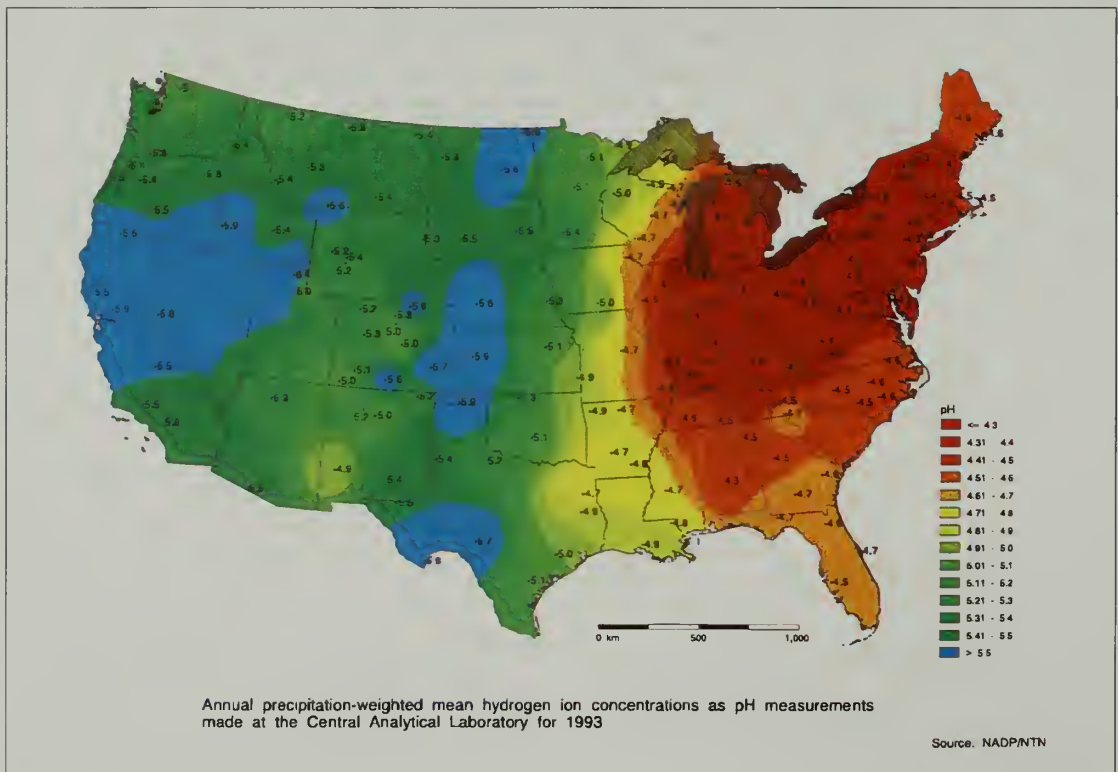
Overhead 8



Overhead 9

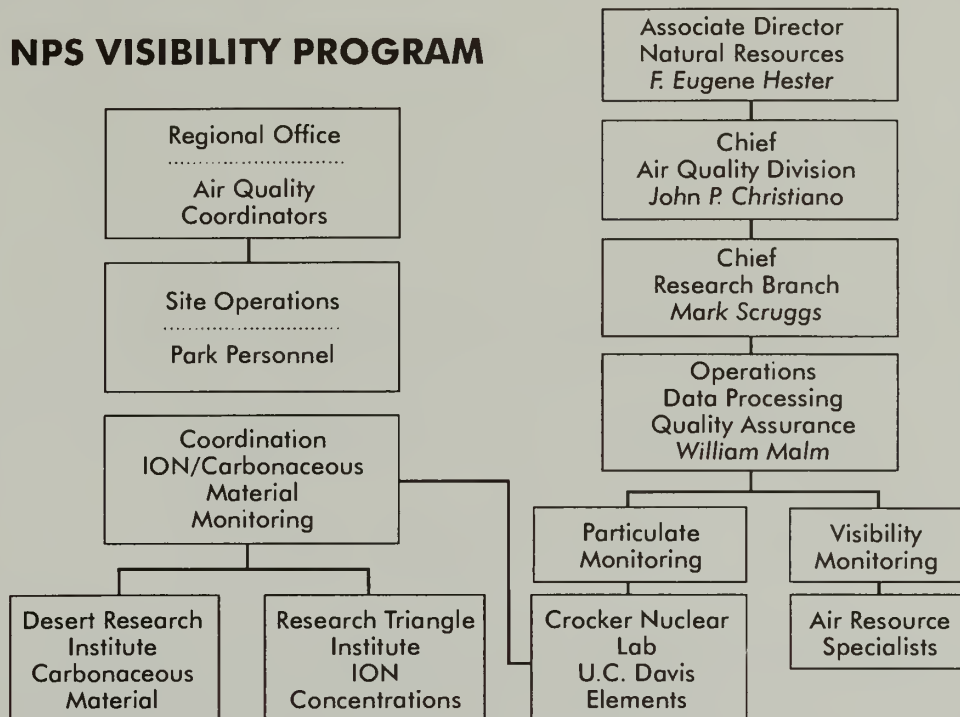


Overhead 10



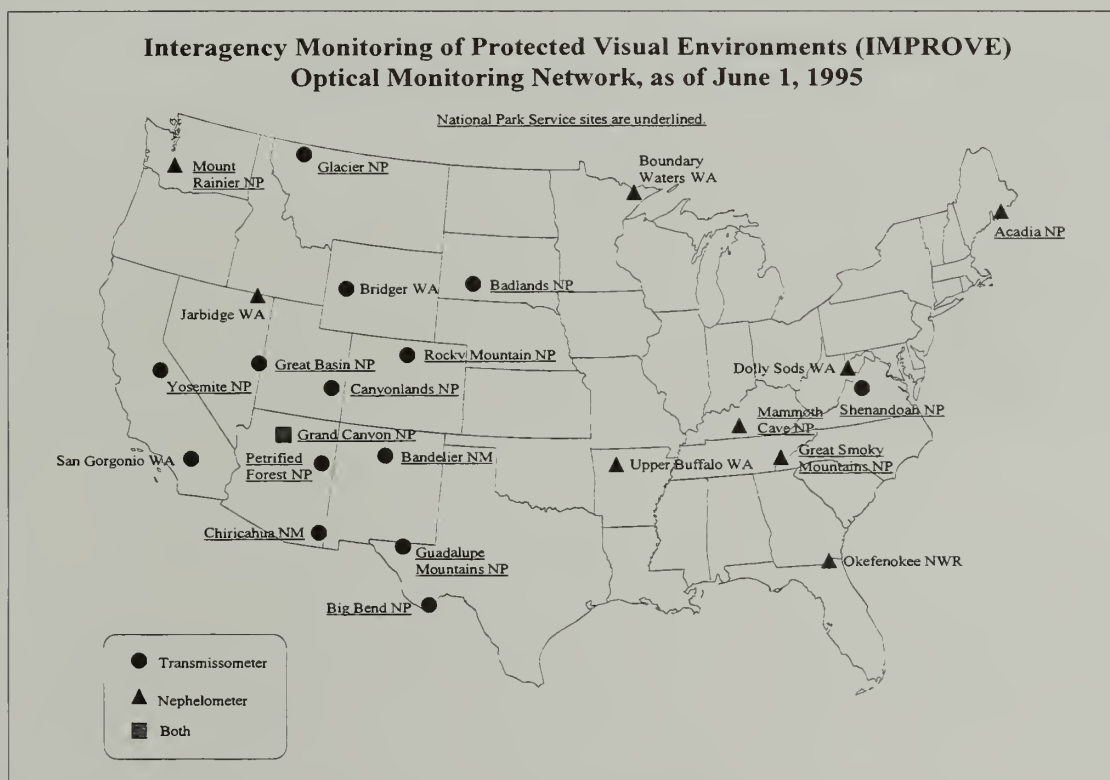
Overhead 11

NPS VISIBILITY PROGRAM

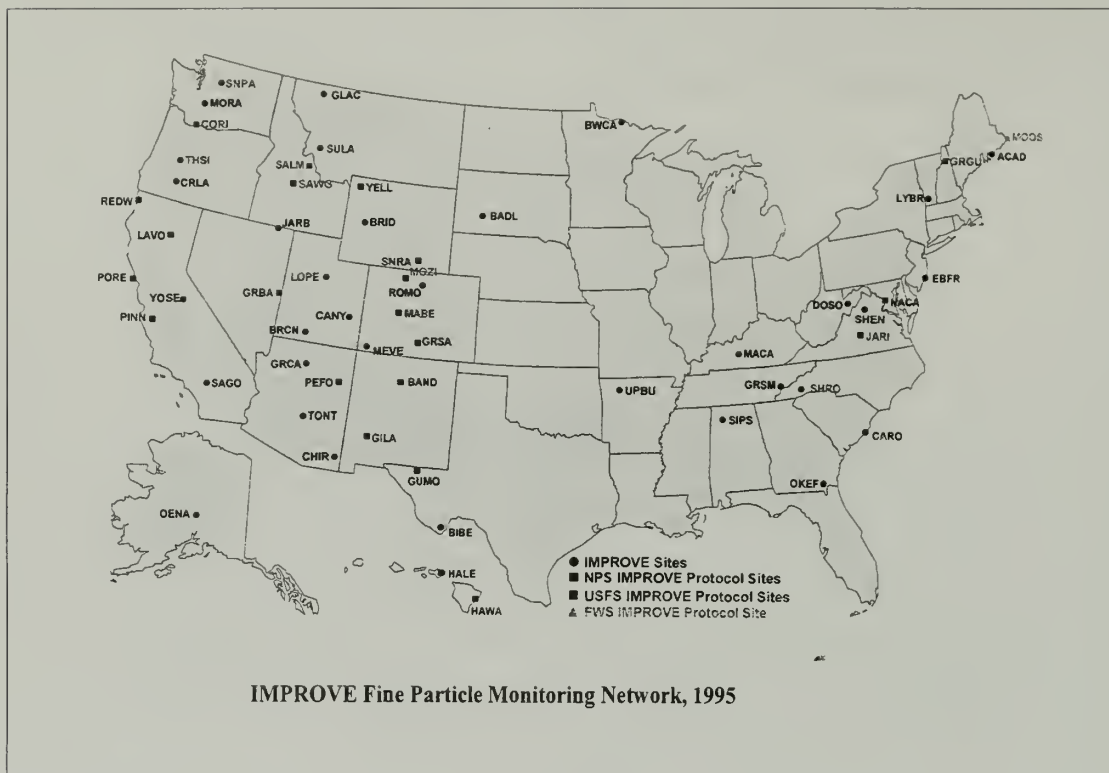


Overhead 12

Interagency Monitoring of Protected Visual Environments (IMPROVE) Optical Monitoring Network, as of June 1, 1995



Overhead 13



Overhead 14

**POSSIBLE STRATEGIES FOR OBTAINING
MONITORING DATA FOR PARKS**

- Utilize data from existing monitoring networks
- Get somebody else to collect data
 - Federal, State, Provincial, Local Governments
 - Industry
 - Universities
- Utilize cooperative efforts
 - Federal, State, Provincial, Local Governments
 - Regional or International Initiatives
- Park sponsored monitoring program

Overhead 15



Shenandoah National Park Case Study

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This paper will describe, using Shenandoah National Park as a case study, how a park air quality program was developed, and why such an initiative has proven to be necessary. Shenandoah, located in Virginia, is an ideal example given the amount of air quality activities (ie. monitoring and research) in and around the park. Shenandoah is located within 1/2 day's driving distance of approximately one-half of the U.S. population. It is frequently visited, with an estimated 2-million visitors per year. Major attractions at Shenandoah include the scenic vistas, the plant and animal life, and various water-related activities.

Shenandoah is located downwind of major industrial areas. Monitoring and research data show that air pollutants are entering the park and degrading park resources. In particular, visibility is often poor, particularly during the summer. Since 1948, overall visibility at Shenandoah has declined by 60%, with reductions of 80% during summer and 40% during winter. In addition, pollutant-associated vegetation injury has been evidenced, and aquatic areas such as streams are gradually losing their buffering capacity, becoming increasingly acidified. It is expected that acidification in the park will continue; models indicate that with no reductions in source emissions, acidification will increase dramatically. A 50% reduction in emissions will be required to maintain current levels of acidification over the next century, and a 100% emission reduction will be necessary to reduce levels of acidification.

During the 1980s the National Park Service began expressing concern to the State of Virginia about the condition of the resources in the park, and repeatedly made requests of the state to take action to minimize pollution. The state did not adequately address the requests, and was unpollution problems. The situation became much more serious in 1990, with a huge increase in the number of proposed or newly-permitted polluting sources near the park, in the form of coal-fired electric utilities.

At that time, based on extensive park research and monitoring data, the National Park Service concluded that visibility, terrestrial, and aquatic resources in the park were being adversely

affected by existing air pollution levels. Additional pollution, would exacerbate these adverse impacts and was unacceptable. The expected effects could be summarized as follows:

- 1). the national significance of the area would be diminished
- 2). the quality of the park visitor's experience would decline
- 3). the structure and functioning of the ecosystem would be impaired or damaged

On September 18, 1990, the U.S. Department of the Interior published a preliminary adverse impact finding for Shenandoah in the *Federal Register*, based on the existing and projected future air pollution impacts in the park. This was the first time an adverse impact determination was made by the National Park Service. This action was taken by the NPS in the context of overwhelming public support; of the 200 public comments received, 90% were in favor of the National Park Service's action.

Since 1990, findings of adverse impacts in the region have not stopped the permitting of proposed new sources, but they have had the following effects:

- 1). Awareness of the impact of air pollution and of the need for analysis has been raised
- 2). Applicants for permits are now performing more refined analyses, including analyses for regional haze and acid deposition
- 3). There is greater cooperation between federal land managers, the state, and permit applicants; the state acknowledges that there are adverse impacts from air pollution
- 4). Mitigating actions are being taken, resulting in reduced emissions; this is a result of changes to permits, capping emissions at lower levels

The National Park Service emphasizes a five step approach in dealing with new sources of emissions near Shenandoah and other park's exhibiting adverse effects. The five step process is as follows:

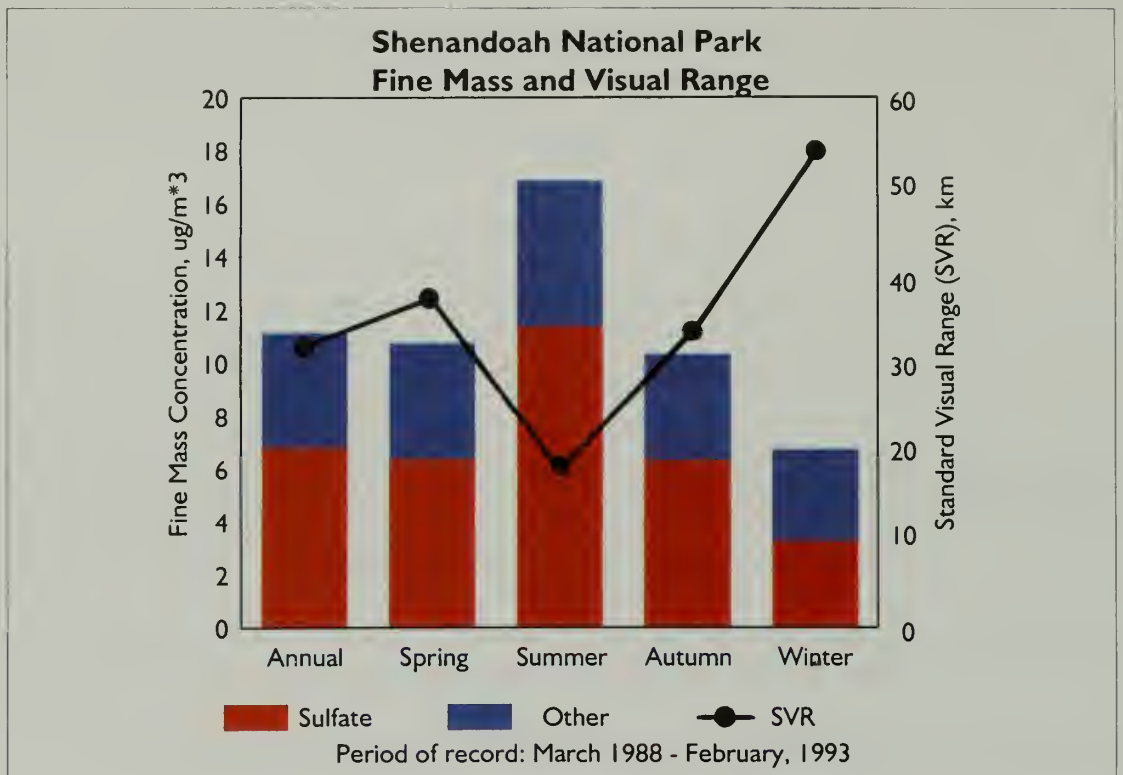
- 1). New sources should install "best" available control technology to minimize emissions.
- 2). New sources should obtain emission offsets so the adverse impacts do not worsen.
- 3). New sources should help fund monitoring/research activities to better assess air pollution effects aqt the park.
- 4). The state and federal land managers should pursue a regional approach to resolve air quality concerns.
- 5). The state should deny the permit if adverse impacts still would occur.

Consistent with item 4) above, the National Park Service actively participates in the Southern Appalachian Mountains Initiative (SAMI), a regional initiative involving the eight southeastern states which are home to two national parks. SAMI's mission is to recommend reasonable measures to remedy existing and to prevent future adverse effects from human-induced air pollution on air quality in the region.

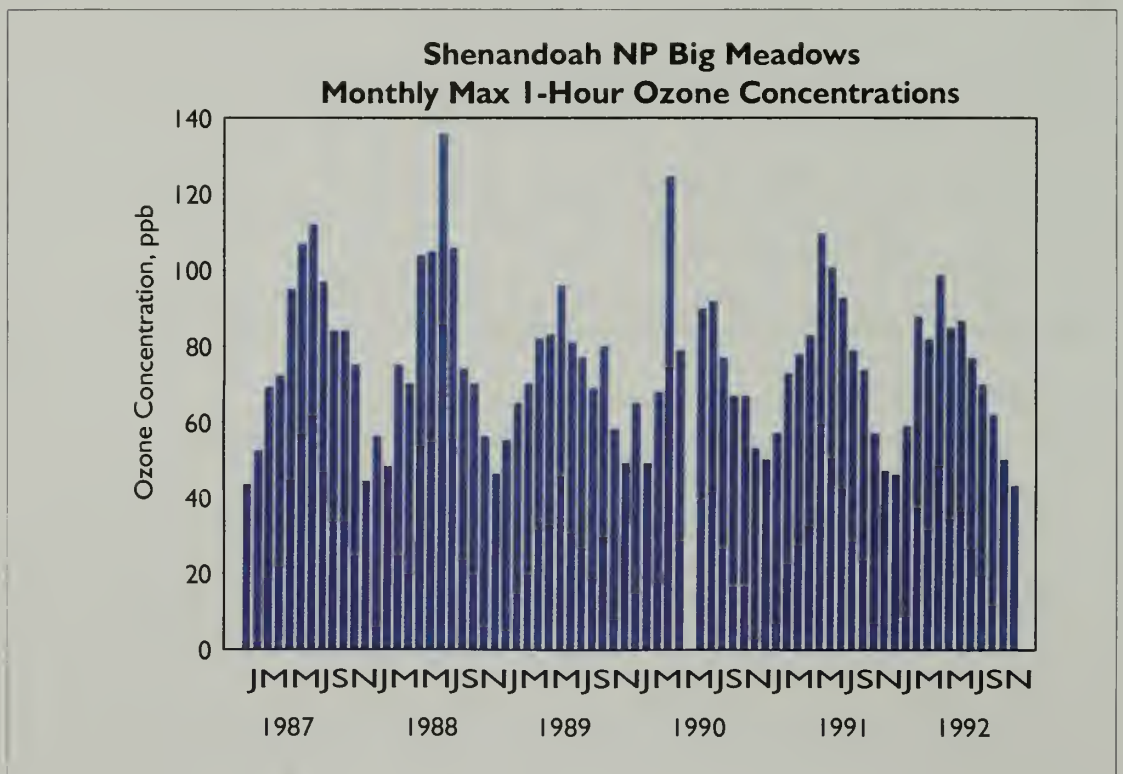
In summary, the Shenandoah adverse impact determination was based on the strength of its research and monitoring data, and emphasizes the importance of good science where air pollution effects are concerned. The management responsibilities of the Park Service dictated that the NPS err on the side of protecting park resources; that is what happened in this case.

SUMMARY OF OVERHEADS

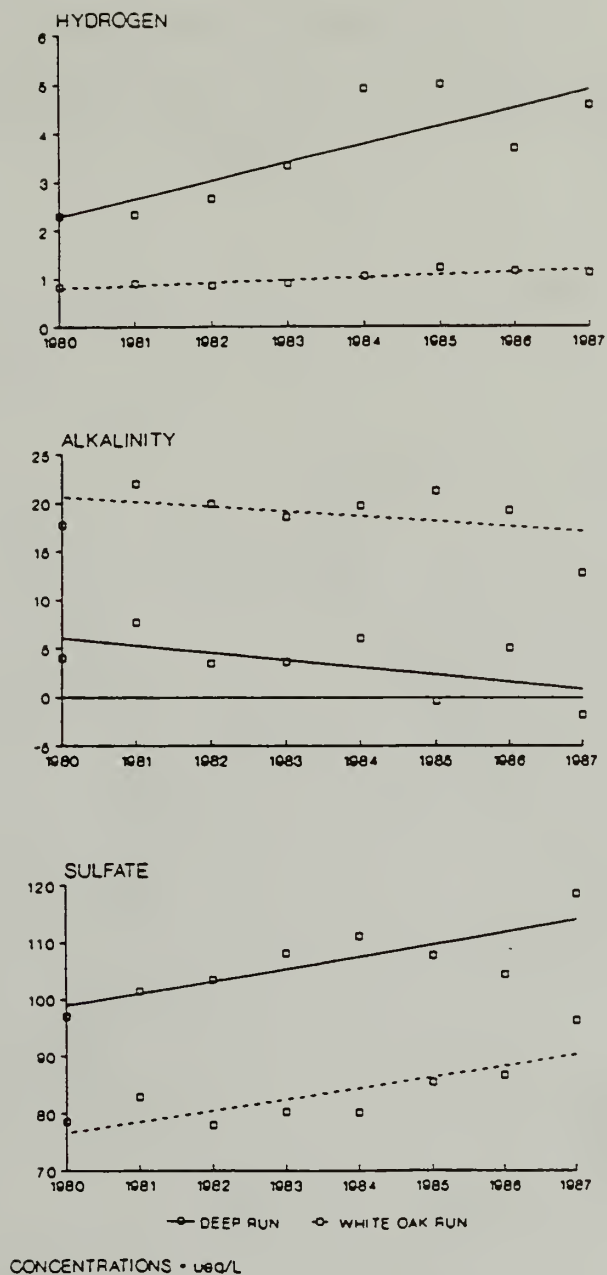
- Overhead 1: *Shenandoah National Park – Fine Mass and Visual Range*
- Overhead 2: *Shenandoah National Park – Big Meadows
Monthly Maximum 1-Hour Ozone Concentrations*
- Overhead 3: *Trends in Sulfate, Alkalinity and Hydrogen Ion Concentrations*
- Overhead 4: *Electric Power Generation in Virginia, 1990*
- Overhead 5: *Adverse Impacts*
- Overhead 6: *Electric Power Generation in Virginia, 1994*
- Overhead 7: *Proposed/Permitted Emissions*
- Overhead 8: *Permit Review Approach*
- Overhead 9: *Southern Appalachian Mountains Initiative – Map*
- Overhead 10: *Southern Appalachian Mountains Initiative – Mission*



Overhead 1



Overhead 2



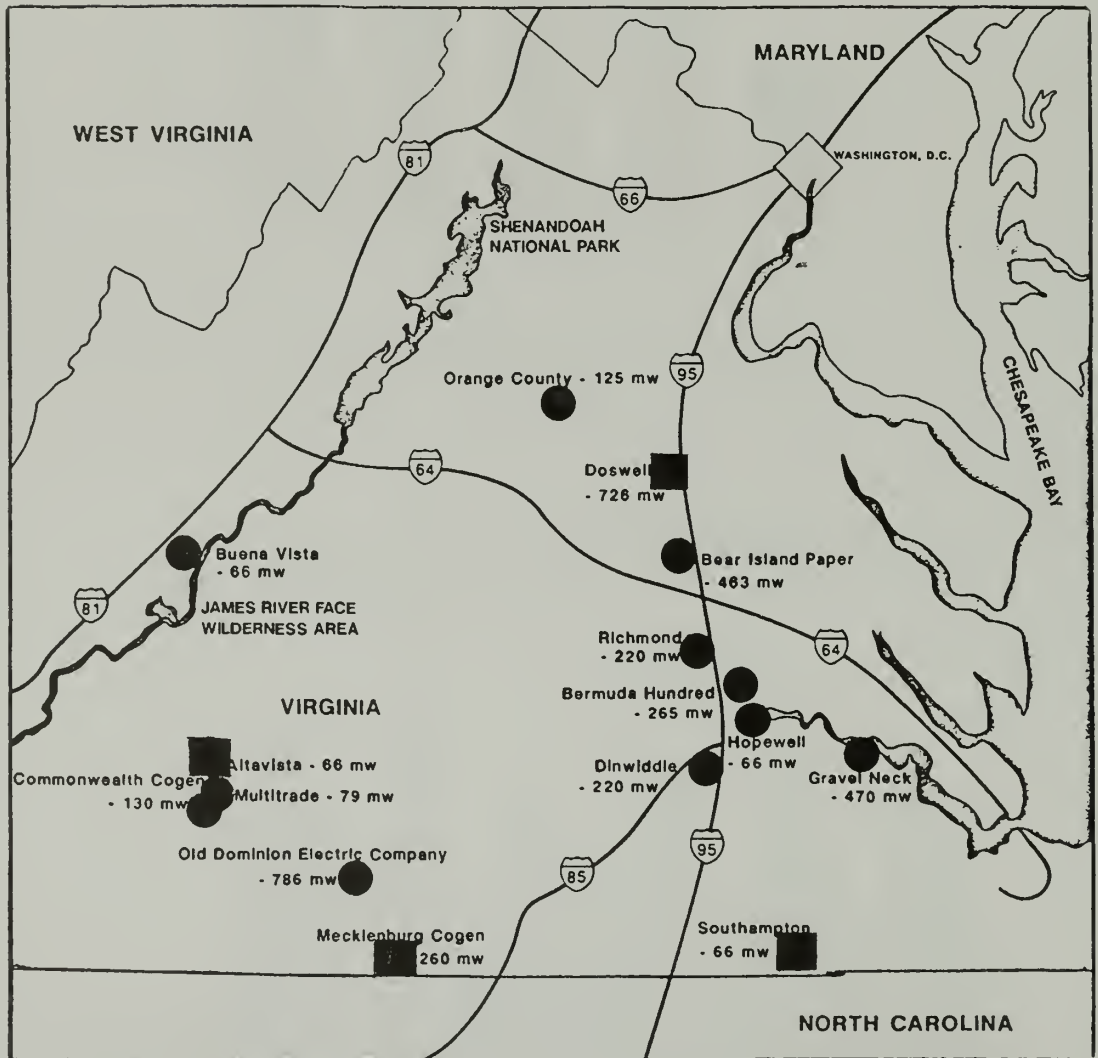
Trends in sulfate, alkalinity, and hydrogen ion concentrations (volume-weighted annual means) for Deep Run and White Oak Run.

Overhead 3

ELECTRIC POWER GENERATION IN VIRGINIA 1990

■ PERMITTED

● UNDER REVIEW



Overhead 4

ADVERSE IMPACT

- Diminish the national significance of the area
- Impair the quality of the visitor experience
- Impair the structure and functioning of ecosystems

*Overhead 5***EMISSION REDUCTIONS ACHIEVED NEAR
SHENANDOAH NATIONAL PARK**

Pollutant	Proposed Emissions (TPY)	Permitted Emissions (TPY)	Difference (TPY)
SO ₂	18,949	6,811	12,138
NO _x	35,313	29,975	5,338
VOC	2,042	1,963	79

*Overhead 7***PERMIT REVIEW APPROACH**

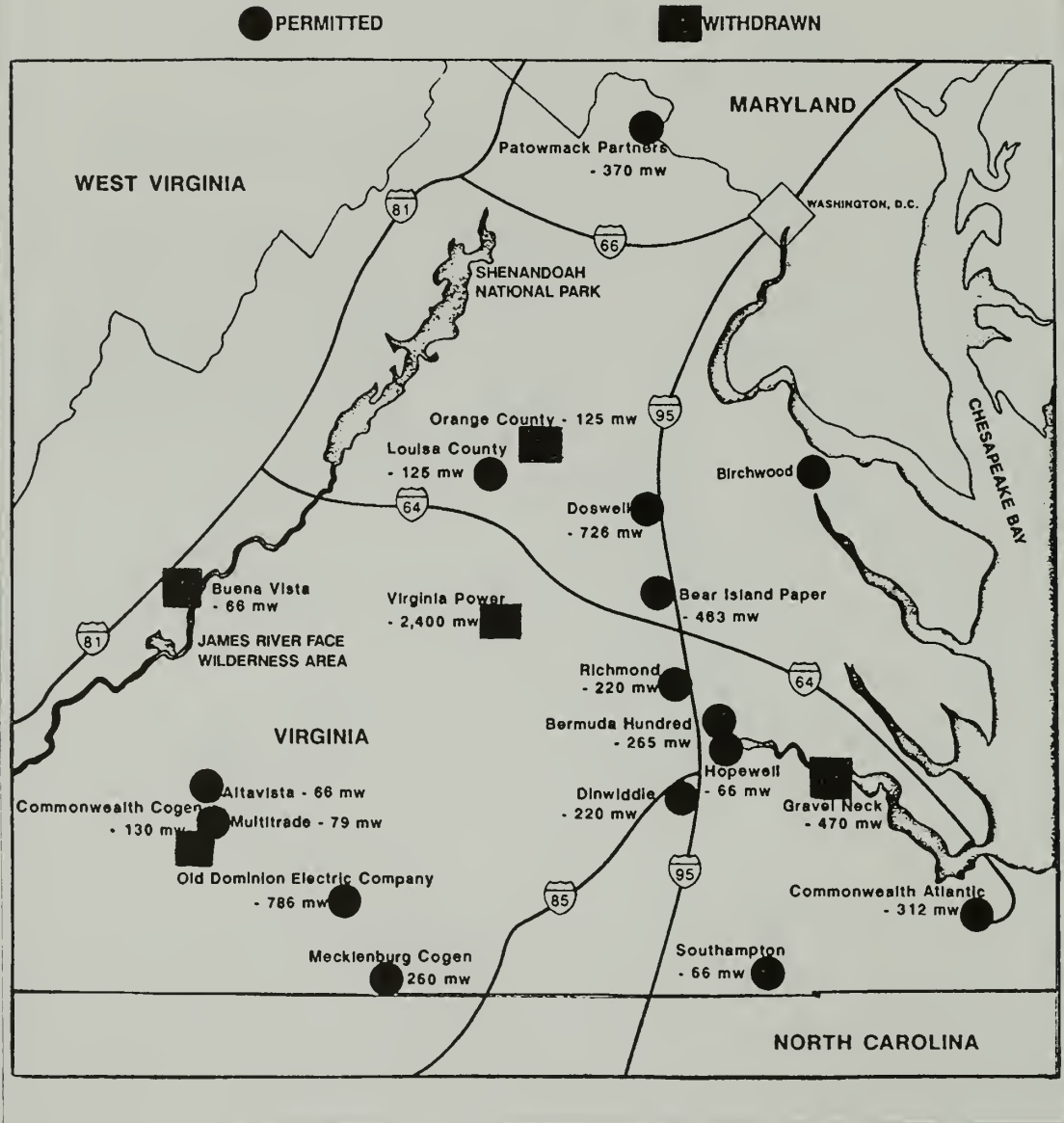
1. Install "best" available control technology
2. Obtain emissions offsets
3. Fund monitoring/research activities
4. Pursue regional approach

*Overhead 8***SOUTHERN APPALACHIAN MOUNTAINS
INITIATIVE**

Mission: Through a cooperative effort, identify and recommend reasonable measures to remedy existing and to prevent future adverse effects from human-induced air pollution on the air quality related values (AQRVs) of the Southern Appalachians, primarily those of Class I parks and wilderness areas, weighing the environmental and socioeconomic implications of any recommendations.

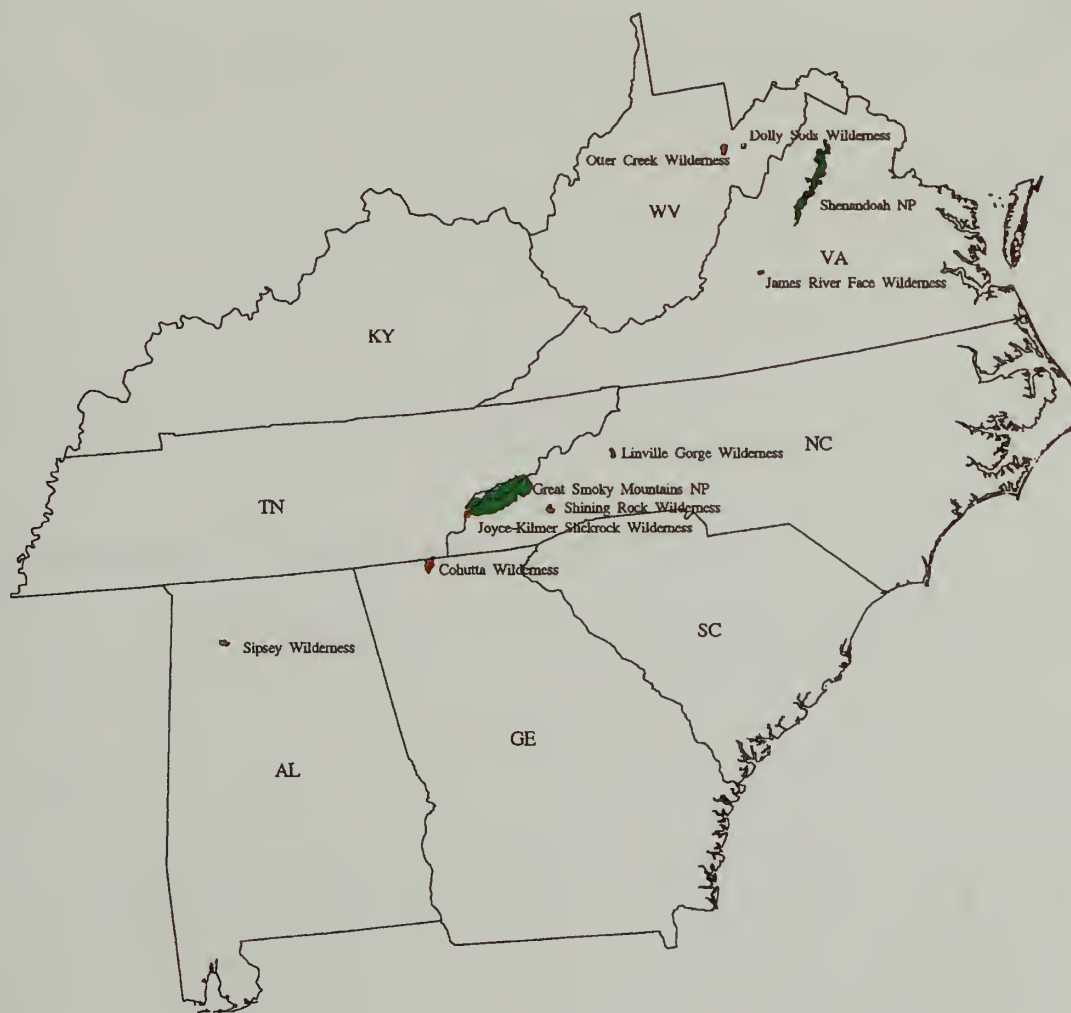
Overhead 9

ELECTRIC POWER GENERATION IN VIRGINIA 1994



Overhead 6

SAMI REGION



Map produced by the National Park Service Air Quality Division 2/7/1995

Overhead 10



Grand Canyon National Park Case Study

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This paper presents the Grand Canyon National Park Case Study and discusses air quality monitoring, and some data analysis methods and techniques for measuring air quality.

PROCESSES AFFECTING AIR QUALITY

It is useful to understand certain processes if one is to gain an understanding of how air quality can be affected:

Sulphur Dioxide (SO₂)

When sulphur dioxide (SO₂) is emitted from a source (typically a coal-fired electric utility), it can compromise air quality or act as a pollutant in the following ways: 1) the SO₂ enters the atmosphere, where it becomes a sulfate (SO₄), and is deposited back on the earth (dry acidic deposition). It can also enter a cloud after being emitted, in which case the sulfates are returned to earth through precipitation (wet acidic deposition, known as acid rain) and 2) SO₂ can also form regional and/or layered hazes after being emitted, which diminish visibility.

The National Park Service has as one of its missions to analyze these hazes and depositions, and collect data about them, when they occur in National Parks and other Class I areas. Once the data is collected, efforts are made to trace hazes and depositions to the sources of SO₂ that created them.

NO_x/VOCs/Organics

Nitrogen Oxides (NO_x) can also be emitted, becoming nitrates (NO₃) in the atmosphere. VOCs, or Volatile Organic Carbon emissions, change from a gaseous state into particulate organics in the atmosphere. Burning, for example, causes the emission of VOCs, the emission of NO_x, and also the direct emission of particulate organics. Industry activity also causes these emissions. Regardless of the source from which they were emitted, NO_x, VOCs, and particulate organics contribute to regional hazes and affect visibility. Nitrogen Oxides and Volatile Organic Carbons can also combine to produce excess ground-level ozone.

MONITORING ACTIVITIES

The National Park Service conducts essentially three types of monitoring, as follows:

- 1) Particulate Monitoring
- 2) Optical Monitoring
- 3) Photographic Monitoring

Particulate monitoring is undertaken to detect the causes of visibility reduction. The National Park Service monitors for the following substances in the atmosphere:

- 1) SO₄ (sulfates)
- 2) NO₃ (nitrates)
- 3) NH₄ (ammonia) – ammonia is produced at some sources and combines with NO₃ or SO₄ to form a particle
- 4) organics
- 5) carbon
- 6) soil elements
- 7) fine mass, which is typically of anthropogenic origin
- 8) coarse mass, which is typically produced naturally
- 9) trace elements, which help scientific observers to trace pollutants to their sources

Optical monitoring measures visibility reductions due to the existence of particles in the atmosphere. The net extinction of light from the sight path (which is how any visibility impairment occurs) is measured. This extinction of light can occur due to scattering or absorption of light by

particles. Measuring these activities requires the use of specialized equipment, such as *transmissometers* and *nephelometers*.

Photographic monitoring is used to visually depict what is happening in the atmosphere, to show the effects of light extinction on visibility. In this way, the effects of pollutants in the air can be shown in a format that is easily understood.

Once the data is collected, it is used principally in two ways. National Park Service scientists attempt to understand the relationships between the emissions data, and the sources of the emissions. That is to say, based on the data collected, scientists attempt to trace emissions to their sources. The results of this analysis are subject to strict standards to ensure their quality, including publication in journals and independent expert peer review. Peer review as a tool for verifying quality in research bolsters the credibility of that research.

The data is also put into a format where it is suitable for public dissemination. The public in this context includes the general and attentive publics, the parks themselves, and decision-making authorities. There are a number of mediums to accomplish this objective, including videos, written materials, CD-ROM technology, and most recently the Internet.

CASE STUDY: THE GRAND CANYON

The Grand Canyon case study began when it became apparent to the National Park Service that visibility in the canyon was increasingly being degraded. In many instances, viewers could see a residual haze in the canyon after the evaporation of any low-hanging cloud formations that would collect in the canyon. Analysis showed that visibility was being impaired by a haze that was almost 95% ammonium sulfate (NH_4SO_4). Ammonium sulfate is created, as discussed, from sulphur dioxide (SO_2), an emission most readily attributable to coal-fired electric utilities.

The National Park Service, based on the results of the data, hypothesized that the haze in the Grand Canyon was attributable to emissions from the Navajo Generating Station power plant, on the eastern edge of the canyon. A protracted and difficult conflict ensued, where the scientific accuracy and credibility of the National Park Service's studies were attacked, in concert with attacks of both a professional and a personal nature on the NPS's researchers.

Ultimately, the National Park Service's findings and methods were reviewed by the National Research Council of the United States, which concluded that the emissions creating the haze in the Grand Canyon could be reasonably attributed to the Navajo Generating Station. From that point on, the conflict became strictly a legal process as opposed to a scientific issue, and ultimately the National Park Service was successful.

VISIBILITY IN THE UNITED STATES: RESULTS OF DATA ANALYSIS

Monitoring data has provided results about visibility. Under natural conditions, visibility in the eastern United States is 60-80 miles; in the western United States it is 100-115 miles. By

contrast, under present-day conditions, summertime visibility in the east could be expected to extend only about 10-15 miles.

The following table shows contributions to visibility impairment under **natural** conditions:

	East	West
Clear Sky Scatter	44%	62%
Sulfates	10%	5%
Nitrates	5%	4%
Carbon	31%	13%
Dust	10%	16%

East – West Differences

A very substantial east-west dichotomy can be noticed: typical summertime visibility in the East is 10 miles, as opposed to 100 miles in the West. The best visibility in the country is essentially on the Colorado Plateau, with the worst being along the Ohio River basin and in the southeastern USA. The eastern USA is consistently hazier.

Annual SO₄ Extinction

As discussed, extinction is the sum of scattering and absorption of light. Extinction that can be attributed to sulfates (SO₄) is lowest in the western USA and highest in the eastern USA. As a percentage of total extinction, sulfates comprise 60% of total extinction in the east, compared with only 30% in the west generally, as shown in Figure 1.

Annual NO₃ Extinction

Extinction attributable to nitrates (NO₃) is not particularly noticeable anywhere in the country; visibility is adversely impacted primarily by sulfates. Figure 2 shows that as a fraction of total extinction, nitrates make up only about 5-10%, across the USA. The only exception to this is in southern California, where nitrates have a greater impact on visibility than do sulfates.

Annual Soot Extinction

Extinction in the west is due less to sulfates and nitrates, and more to soot and organics in the atmosphere. Soot extinction is relatively higher in the west, comprising 10% of total extinction, whereas in the east, soot extinction is relatively lower, much lower, making up only 5% of total extinction as seen in Figure 3.

The trends in Figures 4 and 5, using the southeastern USA as a case study, show that in the period from 1940 to 1980, sulphur dioxide emissions increased dramatically, from almost no emissions initially. By contrast, visibility saw an approximately equivalent decrease. Presently, the relationship is purely empirical. It has not been proven that the increases in emissions caused the decreases in visibility, but obviously, many in the National Park Service believe that the two events are related.

BACK-TRAJECTORIES: EMISSION SOURCES

Using statistical analysis, scientists are able to estimate sources of emissions through back-trajectories. This is an inferential process. Two “plots” are typically used. A ***conditional probability plot*** asks what the probability of having air arrive at a monitoring site with a certain characteristic (such as being polluted) is. A ***source contribution plot*** traces the origins of air that has a certain characteristic (again, such as being polluted). Using five years of data from Glacier National Park, the National Park Service has been able to infer the following conclusions:

For Carbon Emissions:

Source Contribution Plot: the area surrounding and immediately north of Glacier National Park contributes most of the carbon emissions that are detected at monitoring sites in the park itself.

Conditional Probability Plot: it is very likely that air arriving from south of Glacier will arrive with a high concentration of carbon.

For Sulphur Emissions:

Source Contribution Plot (Figure 6a): most of the sulphur found in the air at Glacier National Park is from further west, from Washington State and the Pacific Northwest.

Conditional Probability Plot (Figure 6b): air arriving from the front range of the Rocky Mountains is almost guaranteed to arrive at the park with a high concentration of sulphur.



Canadian Air Quality Monitoring Program

Keith Puckett
Atmospheric Environment Service
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This paper will discuss the federal air quality monitoring networks that are in place in Canada, what they measure, and will show some of the data obtained from those networks, as well as some results from the monitoring of other components of the atmosphere. Specifically, the following monitoring efforts will be described:

- 1). Monitoring of air concentrations of various species
- 2). Monitoring of acidic deposition
- 3). Ozone Monitoring
- 4). Monitoring of Suspended Particulates
- 5). Monitoring of air quality as it relates to visibility.

In addition, monitoring of other atmospheric changes, including global warming, and changes to the total ozone column, will be presented.

SUMMARY OF OVERHEADS

Overhead 1: *Canadian Air Quality Monitoring Programmes – Introduction*

Overhead 2: *Schematic of Atmospheric Processes Important in Considerations of Air Quality*

- the boxed area includes the parameters which are normally monitored

Overhead 3: *Canadian Air Quality Monitoring Programmes*

- two major networks:
NAPS: which primarily has monitoring stations in urban areas, only monitors ambient concentrations, and is managed by the Environmental Protection Service, Environment Canada in cooperation with provincial air quality agencies;
- **CAPMoN:** which primarily has monitoring stations in rural areas, monitors both levels in ambient air and precipitation, and is managed by the Atmospheric Environment Service, Environment Canada

AIR CONCENTRATION and DEPOSITION MONITORING

NAPS monitoring sites measure air concentrations of a wide ranges of species, described by the following overheads:

Overhead 4: *National Air Pollution Surveillance Network (NAPS) – Location of Monitoring Stations*Overhead 5: *Elements Measured by NAPS Monitoring Stations*Overhead 6; *Anions & Cations Measured by NAPS Monitoring Stations*Overhead 7: *PAHs & PCCDs/PCDFs Measured by NAPS Monitoring Stations*Overheads 8, 9, 10: *Volatile Organic Compounds Measured by NAPS Monitoring Stations*

- NAPS is in the first instance a surveillance network; one way to conduct surveillance is to compare ambient levels of various compounds against air quality objectives:

Overhead 11: *Sulphur Dioxide Annual Average Levels (ppb) in Selected Cities*

- the National Ambient Air Quality Objective (NAAQO) is 23 ppb; Canadian urban areas are within acceptable and almost within desirable levels
- however, the air quality objective is set on the basis of the direct impacts of SO₂ on human health and vegetation; it does not consider the impact of the transformation products of SO₂ such as acidic deposition

Overhead 12: *Nitrogen Dioxide Annual Average Levels (ppb) in Selected Cities*

- the NAAQO is 53 ppb; Canadian urban areas are again within acceptable levels
- the objective does not consider the impact of the transformation products of NO_x, such as acidic deposition and ground-level ozone

Overhead 13: *Canadian Air and Precipitation Monitoring Network (CAPMoN) – Location of Monitoring Stations*

Overhead 14: *Canadian Air And Precipitation Monitoring Network (CAPMoN) – Summary of Measurements*

Overhead 15: *SO₄ Annual Wet Deposition (1988 – 1993)*

- high in the east; low in the west

Overhead 16: *Location of Federal and Provincial*

- Operational Precipitation Chemistry Monitoring Sites (May 95)

Overhead 17: *5-Year Mean Sulphate Deposition (1986-90)*

- note: there is a very noticeable east-west dichotomy in terms of which region of eastern North America receives the most acidic deposition

Overhead 18: *5-Year Mean Nitrate Deposition (1986-90)*

- the same dichotomy is visible for nitrates, although there is increasing concern about the amount of deposition in the Pacific Northwest

Overhead 19: *ESTHER – Precipitation and Air (OCT/91 – DEC/93)*

- finer data resolution showing seasonal differences with higher SO₂ and p-NO₃ concentrations in winter

OZONE MONITORING

Overhead 20: *Average Number of Days when 1 h Ozone AQO (82 ppb) was Exceeded at Selected Cities (1987 – 1992)*

Overhead 21: *# hours > 82 ppb ozone (1980 -1994)*

Overhead 22: *Ozone Data for Calgary (January 1980 – November 1991)*

MONITORING OF SUSPENDED PARTICULATES

Canada's Air Quality Objective for particulates is currently expressed in terms of total suspended particulates. This objective is under review, and will likely be replaced by a PM₁₀ or PM_{2.5} Objective.

Overhead 23: *PM₁₀ Concentrations by Region and Year*

- showing a decline with time for most regions of the country

Overhead 24: *Trend in Total Lead Concentrations for Selected Cities*

- showing a decline in concentration over time for all cities studied

Overhead 25: *Ratio of $PM_{2.5}$ Mass to PM_{10} Mass*

- showing that on average $PM_{2.5}$ is about 40-60% of PM_{10} mass, and that prairie cities tend to be at the lower end of the range

VISIBILITY MONITORING

Suspended particles, if they are small enough, can have an impact on human health, and on a regional basis can mask the impact of global warming and/or impair visibility. In the past, visibility as a function of air quality has not been monitored in Canada; it has only become an issue with the signing of the Air Quality Agreement in 1991. Canadian air quality networks to this day do not monitor the parameters needed in order to assess the impact of air quality changes on visibility. The only data that have been collected is a 40 year data set based on observations made at Canadian airports as required by aviation safety requirements. On the basis of this data, Environment Canada has been able to draw some initial conclusions about how visibility ranges vary across Canada:

Overhead 26: *Summer Visibility (RH 80%), 1951 – 1990*

- the distribution shown is based on a data set which includes only observations when the RH was 80%
- the tracings near the vertical axis of the map represent the west coast of North America; those near the top of the map represent the north coast and the Arctic; the dark area along the horizontal axis represents eastern Canada and the eastern USA

Based on the data collected, there are three areas of concern. In eastern Canada, visibility in the lower Great Lakes Region is on the order of only 30 kilometres. The lower Fraser Valley is the second area of concern, and the prairies are the third. The role of changing air quality on the regional visibility degradation is still under investigation.

OTHER ATMOSPHERIC MONITORING

In considering impacts on regional air quality, additional global changes in the atmosphere need to be considered as well, as they also have an impact on ecosystems, in concert with changing air quality. These include global warming, and stratospheric ozone depletion.

Overhead 27: *Regional Trends in Seasonal Average Temperature for 1895 – 1992*

- this region has seen a statistically significant change of 0.7 degrees Celsius warming during summer, and 1.3 degrees Celsius warming during spring

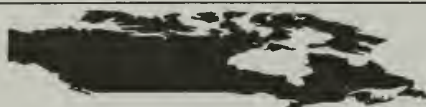
Overhead 28: *Implication of Changes to the Ozone Column*

- total ozone levels, as measured at Edmonton, Alberta have declined by more than 5% since pre-1980 with accompanying increases in UV_B levels

Overhead 29: *Canadian Air Quality Monitoring Programmes – Summary*

- Environment Canada's Atmospheric Environment Service is facing a 33% reduction in its resources; it is important to maintain monitoring networks, and thus the service will be looking at such economies as can be found, and for new ways of collecting information on changing air quality. However, monitoring needs to be continued in order to assess the effectiveness of existing emission limitation measures and to identify new air quality issues as they arise

Canadian Air Quality Monitoring Programmes



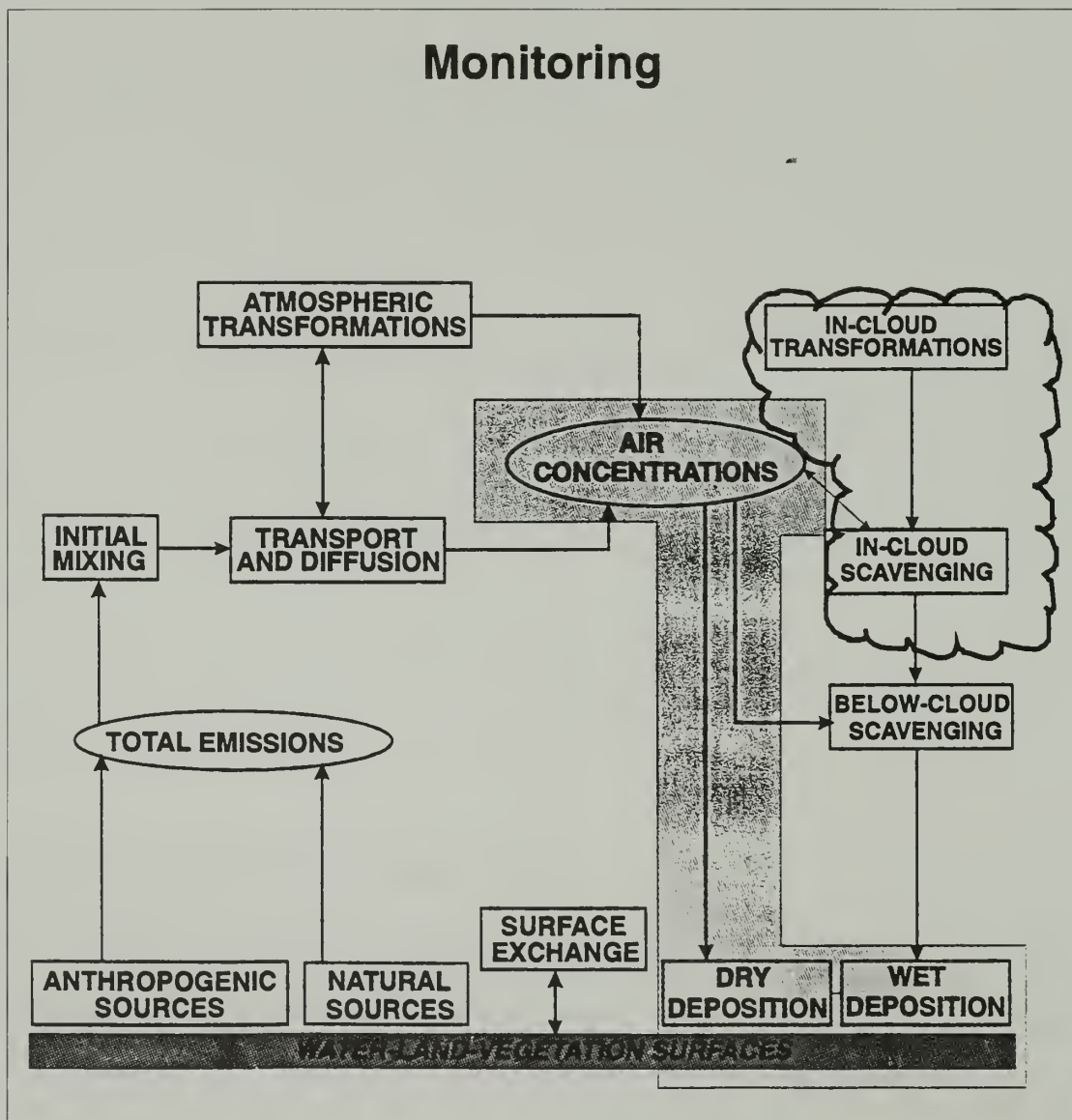
Overhead 1

CANADIAN AIR QUALITY MONITORING PROGRAMMES

- Air Quality
- National Air Pollution Surveillance [NAPS]
- Canadian Air and Precipitation Network [CAPMoN]

Overhead 3

Monitoring



Overhead 2



Overhead 4

PAHs:

Acenaphthylene
 Acenaphthene
 Fluorene
 2-Methyl Fluorene
 Phenanthrene
 Anthracene
 Fluoranthene
 Pyrene
 Benzo(a)Fluorene
 Benzo(b)Fluorene
 1-Methyl Pyrene
 Benzo(g,h,i)Fluoranthene
 Benz(a)Anthracene
 Chrysene & Triphenylene
 7-Methyl Benzo(a)Anthracene
 Benzo(b,k)Fluoranthene
 Benzo(e)Pyrene
 Benzo(a)Pyrene
 Perylene
 2-Methyl Chalanthrene
 Indeno(1,2,3-cd)Pyrene
 Dibenzo(a,c)&(a,h)Anthracene
 Benzo(b)Chrysene
 Benzo(g,h,i)Perylene
 Anthanthrene

SUSPENDED PARTICULATES:

PM10 & PM2.5

PCDD/PCDF:

2,3,7,8-TCDD
 TCDD
 1,2,3,7,8-P5CDD
 P5CDD
 1,2,3,4,7,8-H6CDD
 1,2,3,6,7,8-H6CDD
 1,2,3,7,8,9-H6CDD
 H6CDD
 1,2,3,4,6,7,8-H7CDD
 H7CDD
 OCDD
 Total PCDD
 2,3,7,8-TCDF
 TCDF
 1,2,3,7,8-P5CDF
 2,3,4,7,8-P5CDF
 P5CDF
 1,2,3,4,7,8-H6CDF
 1,2,3,6,7,8-H6CDF
 2,3,4,6,7,8-H6CDF
 1,2,3,7,8,9-H6CDF
 H6CDF
 1,2,3,4,6,7,8-H7CDF
 1,2,3,4,7,8,9-H7CDF
 H7CDF
 OCDF
 Total PCDF

Overhead 5

ELEMENTS

Aluminum	Copper	Cadmium
Silicon	Zinc	Indium
Phosphorus	Gallium	Tin
Suphur	Germanium	Antimony
Chlorine	Arsenic	Tellurium
Potassium	Selenium	Iodine
Calcium	Bromine	Cesium
Scandium	Rubidium	Barium
Titanium	Strontium	Lanthanum
Vanadium	Yttrium	Lead
Chromium	Zirconium	Sodium*
Manganese	Niobium	Magnesium*
Iron	Molybdenum	Ceriu*
Cobalt	Palladium	Praseodymium*
Nickel	Silver	Neodymium*

Overhead 6

ANIONS & CATIONS:

Sulphate	Oxalate	Rubidium
Nitrate	Methane Sulfonate	Magnesium
Bromide	Propionate	Manganese
Nitrite	n-Butyrate	Cesium
Phosphate	Chloroacetate	Calcium
Fluoride	Lithium	Strontium
Chloride	Sodium	Barium
Acetate	Ammonium	
Formate	Potassium	

Overhead 7

SPECIES MEASURED — CURRENT LIST

VOLATILE ORGANIC COMPOUNDS

1,2,3-Trimethylbenzene	2,4-Dimethylhexone
1,2,4-Trimethylbenzene	2,4-Dimethylpentone
1,2-Diethylbenzene	2,5-Dimethylheptone
1,3,5-Trimethylbenzene	2,5-Dimethylhexone
1,3-Butadiene	2-Ethyltoluene
1,3-Diethylbenzene	2-Methyl-1-butene
1,4-Diethylbenzene	2-Methyl-1-pentene
1,4-Diethylbenzene/n-Butylbenzene	2-Methyl-2-butene
1-Butene	2-Methyl-2-pentene
1-Butene/Isobutene	2-Methylheptone
1-Butyne	2-Methylhexone
1-Hexene	2-Methylpentane
1-Pentene	3-Ethyltoluene
1-Propyne	3-Methylheptane
2,2,4-Trimethylpentone	3-Methylhexone
2,2,5-Trimethylhexane	3-Methyloctone
2,2-Dimethylbutane	3-Methylpentone
2,2-Dimethylpropane	4-Ethyltoluene
2,3,4-Trimethylpentane	4-Methylheptone
2,3-Dimethylbutane	4-Methyloctone
2,3-Dimethylpentane	

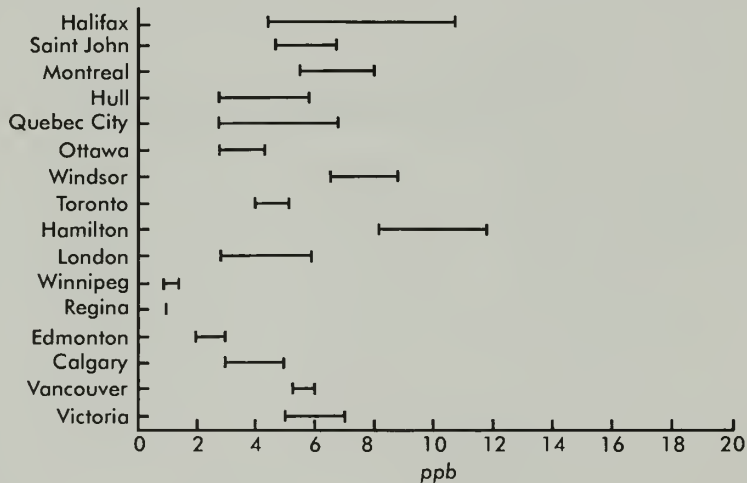
Overhead 8

Acetylene	Isoprene
Benzene	m and p-Xylene
Butone	Methylcyclohexone
cis-1,3-Dimethylcyclohexone	Methylcyclopentane
cis-2-Butene	n-Butylbenzene
cis-2-Heptene	n-Propylbenzene
cis-2-Hexene	Nanone
cis-2-Pentene	O-Xylene
cis-3-Methyl-2-pentene	Octane
Cyclohexone	p-Cymene
Cyclopentone	Pentane
Decone	Propone
Dodecone	Propylene
Ethone	sec-Butylbenzene
Ethylbenzene	Styrene
Ethylene	Toluene
Heptane	trans-1,3-Dimethylcyclohexane
Hexone	trans-2-Butene
Indone	trans-2-Heptene
iso-Butylbenzene	trans-2-Hexene
iso-Propylbenzene	trans-2-Pentene
Isobutone	trans-3-Methyl-2-pentene
Isapentone	Undecone

Overhead 9

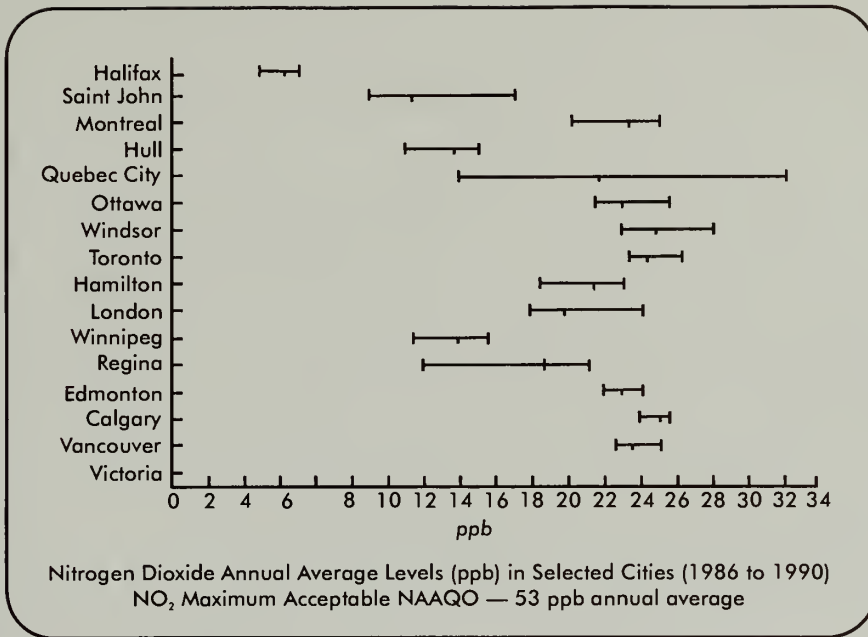
Freon22	EDB
Freon12	Tetrochloroethylene
Freon114	Chlorobenzene
Vinylchloride	Bromoform
Freon11	1,1,2,2-Tetrochloroethone
1,1-Dichloroethone	1,3-Dichlorobenzene
Dichloromethone	1,4-Dichlorobenzene
trans-1,2-Dichloroethylene	1,2-Dichlorobenzene
1,1-Dichloroethylene	1,2,4-trichlorobenzene
Bromochloromethone	hexochlorobutadiene
Chloroform	Formoldehyde*
1,2-Dichloroethane	Acetoldehyde*
1,1,1-Trichloroethone	Acrolein*
Corbontetrochloride	Acetone*
Dibromomethone	Propionoldehyde*
1,2-Dichloropropone	Crotonoldehyde*
Bromodichloromethone	MEK*
Trichloroethylene	Benzoldehyde*
cis-1,3-Dichloropropene	2-Pentanol*
1,1,2-Trichloroethone	MIBK*
Dibromochloromethone	Hexonol*

Overhead 10

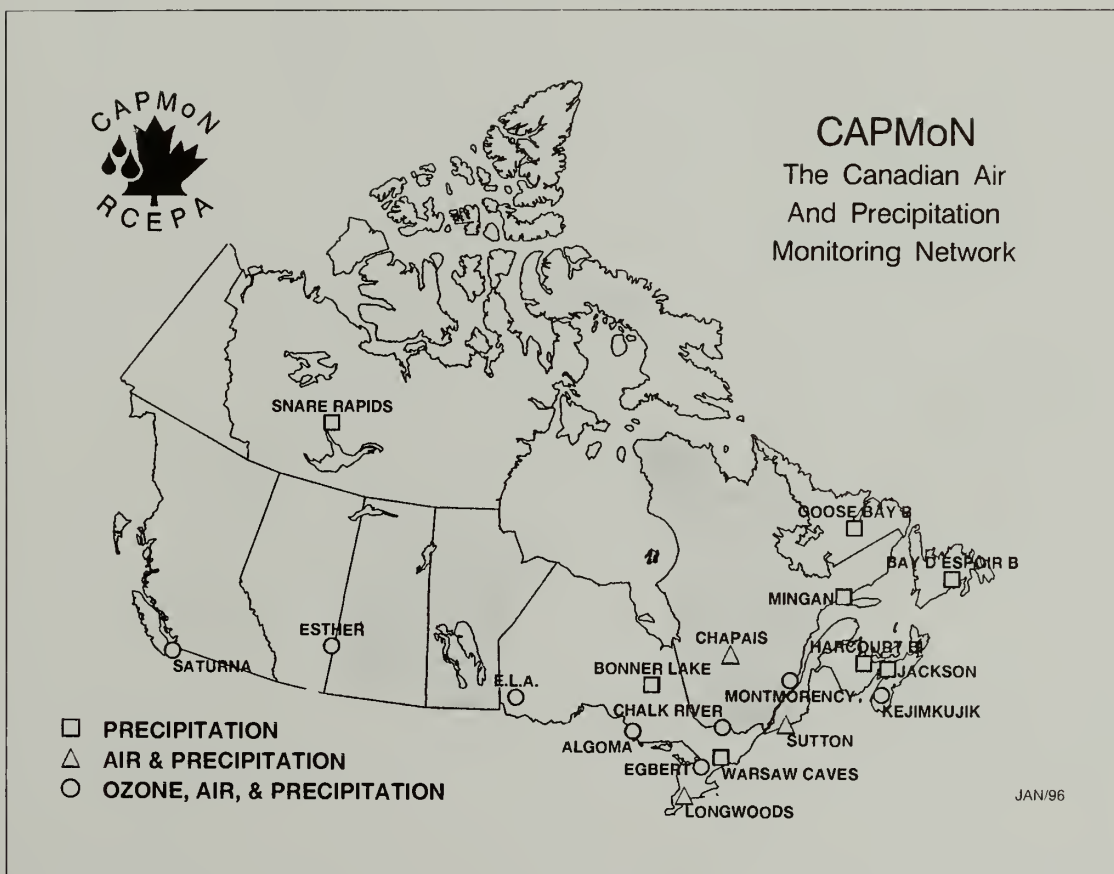


Sulphur Dioxide Annual Average Levels (ppb) in Selected Cities (1986 to 1990)
SO₂ Maximum Acceptable NAAQO — 23 ppb annual average

Overhead 11



Overhead 12



Overhead 13

CAPMON

**Canadian Air and Precipitation
Monitoring Network**

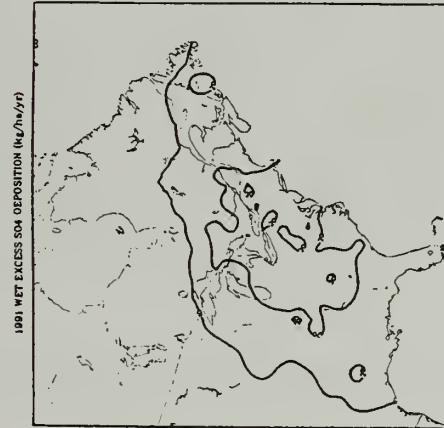
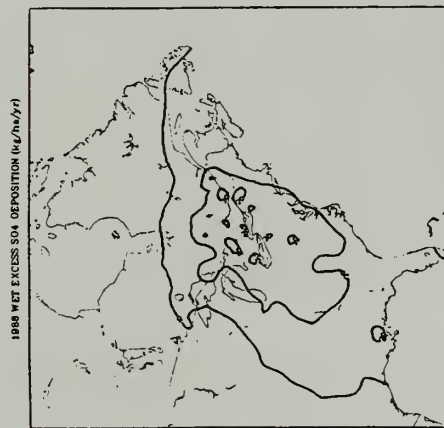
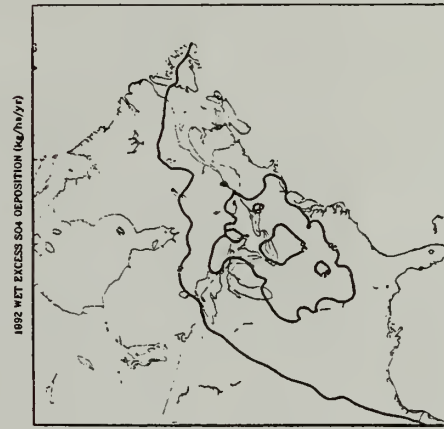
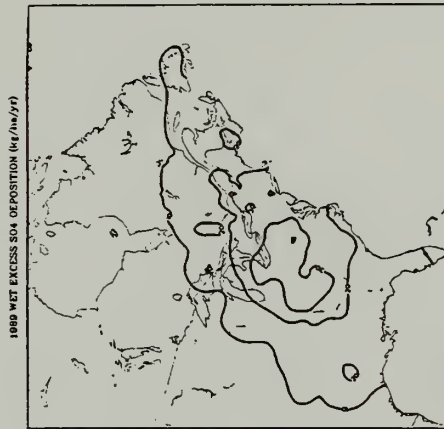
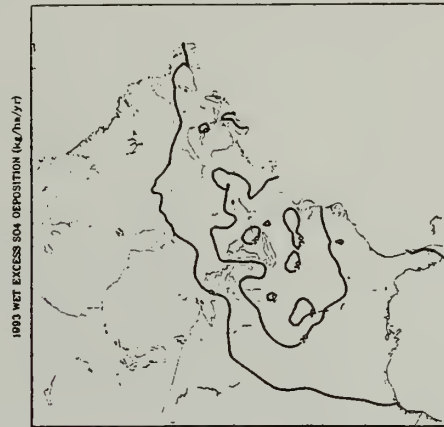
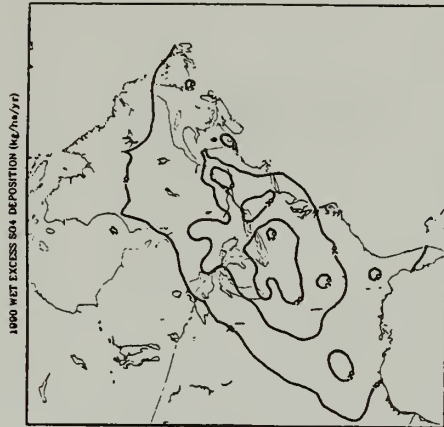
- Precipitation Chemistry
18 Sites in Canada
1 Site in U.S.
Data: 1978-1994
- Air Chemistry (Regional)
11 Sites in Canada
Data: 1978-1994
- Ozone (Regional)
8 Sites in Canada
Data: 1988-1994

Overhead 14

**Canadian Air Quality Monitoring
Programmes**

- Summary
- need for continued monitoring
 - compliance
 - identification of new issues
- harmonisation – roles and responsibilities

Overhead 29

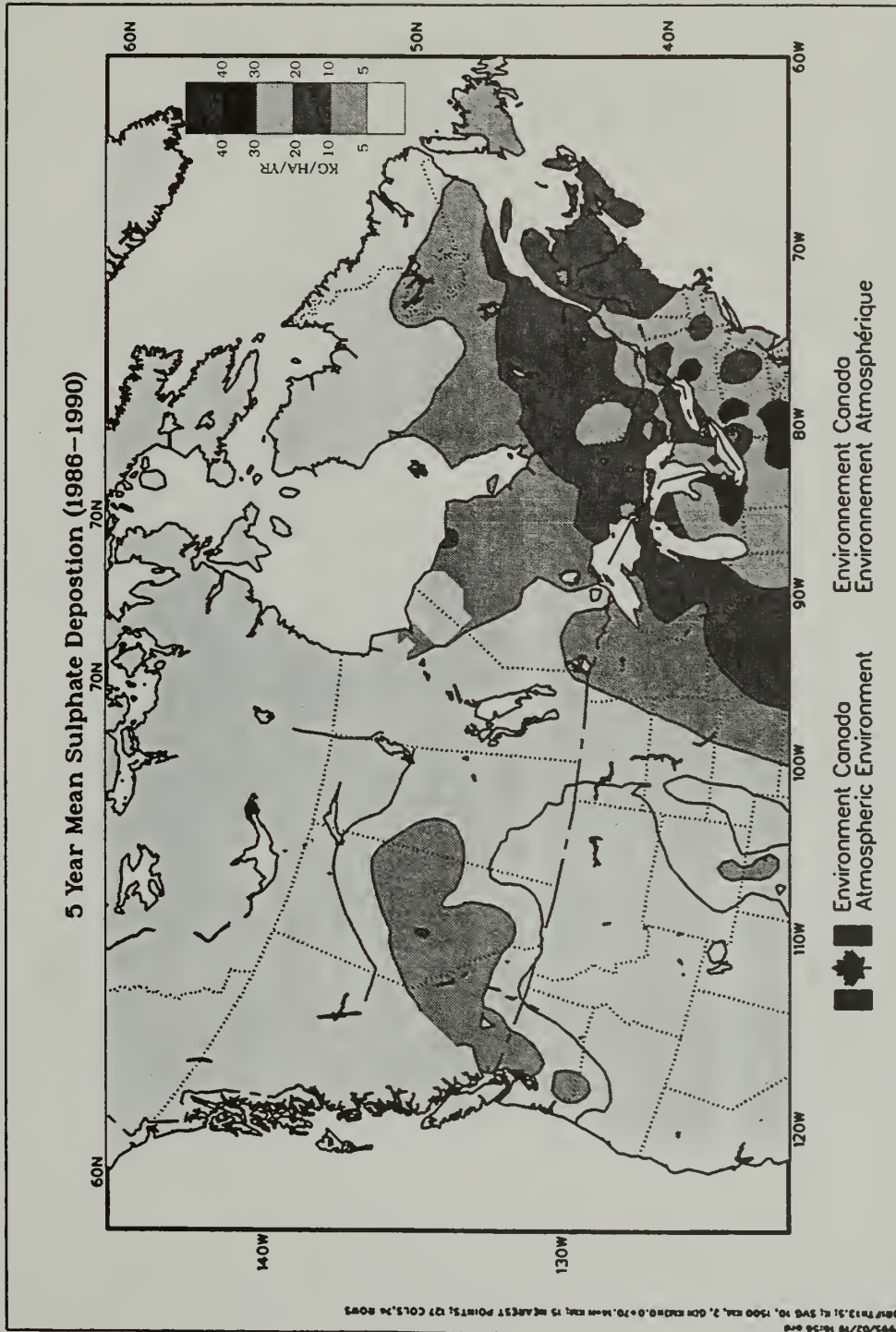


Overhead 15

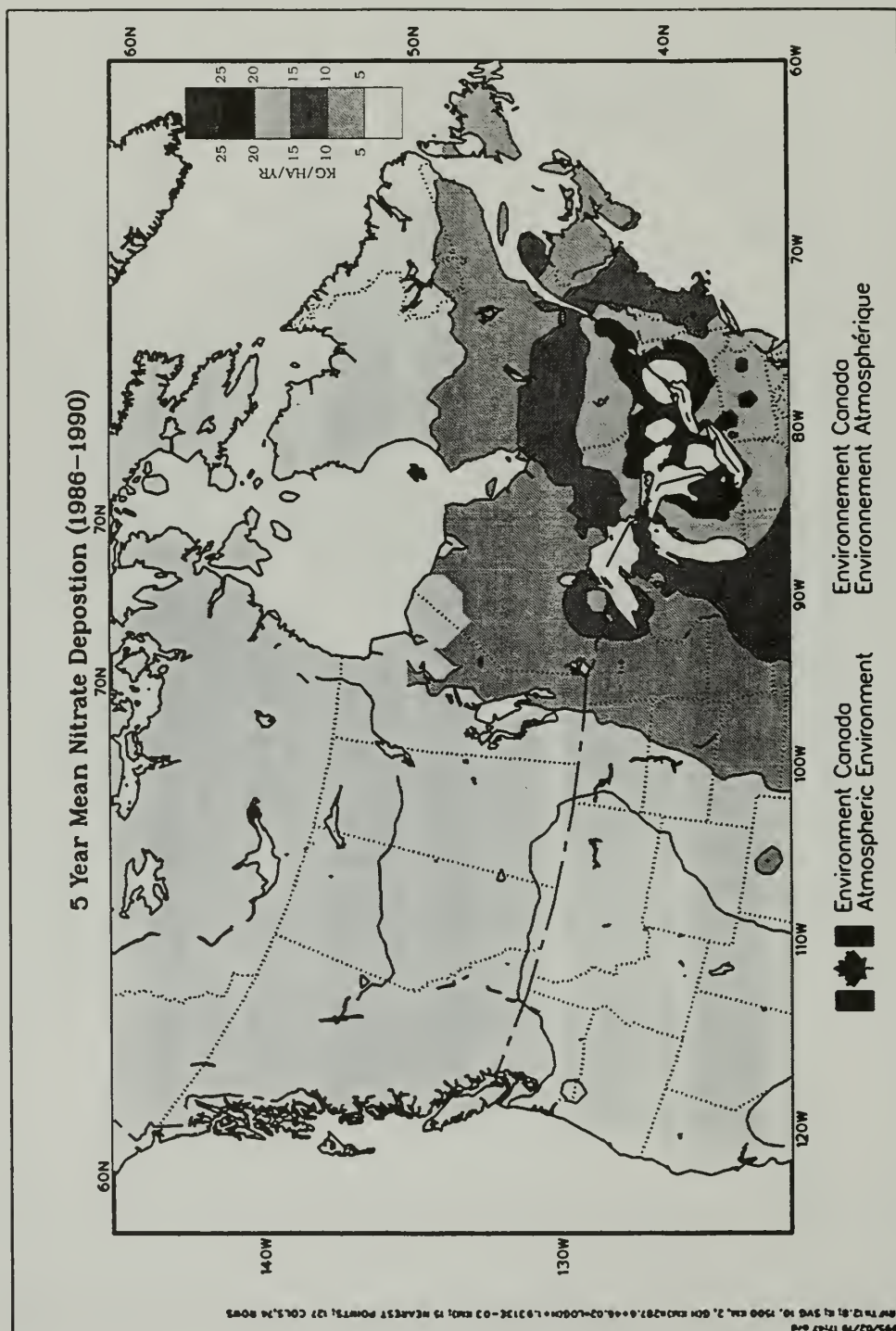


Figure 1.1: 1993 Precipitation Chemistry Monitoring Sites in Canada and the United States

Overhead 16



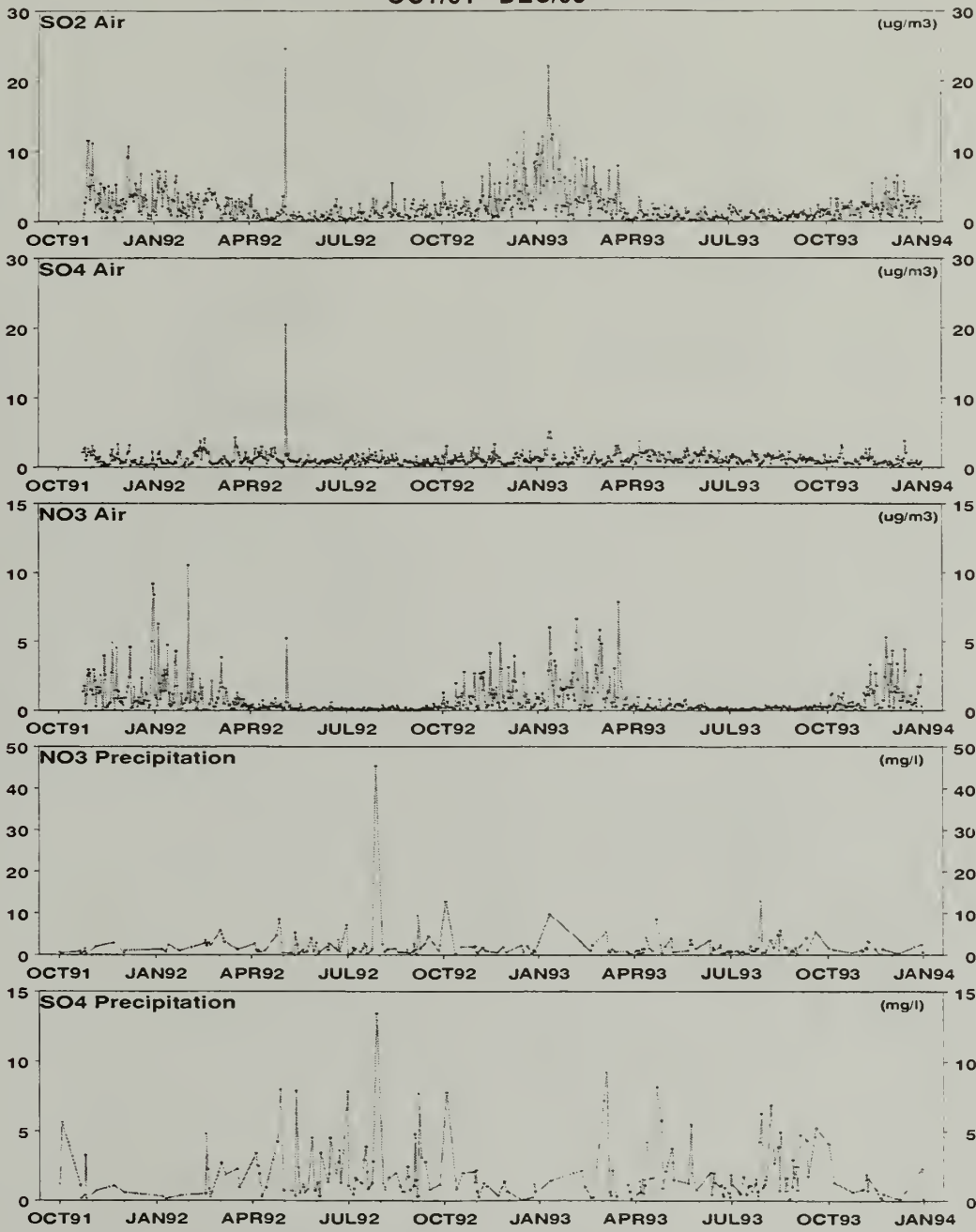
Overhead 17



Overhead 18

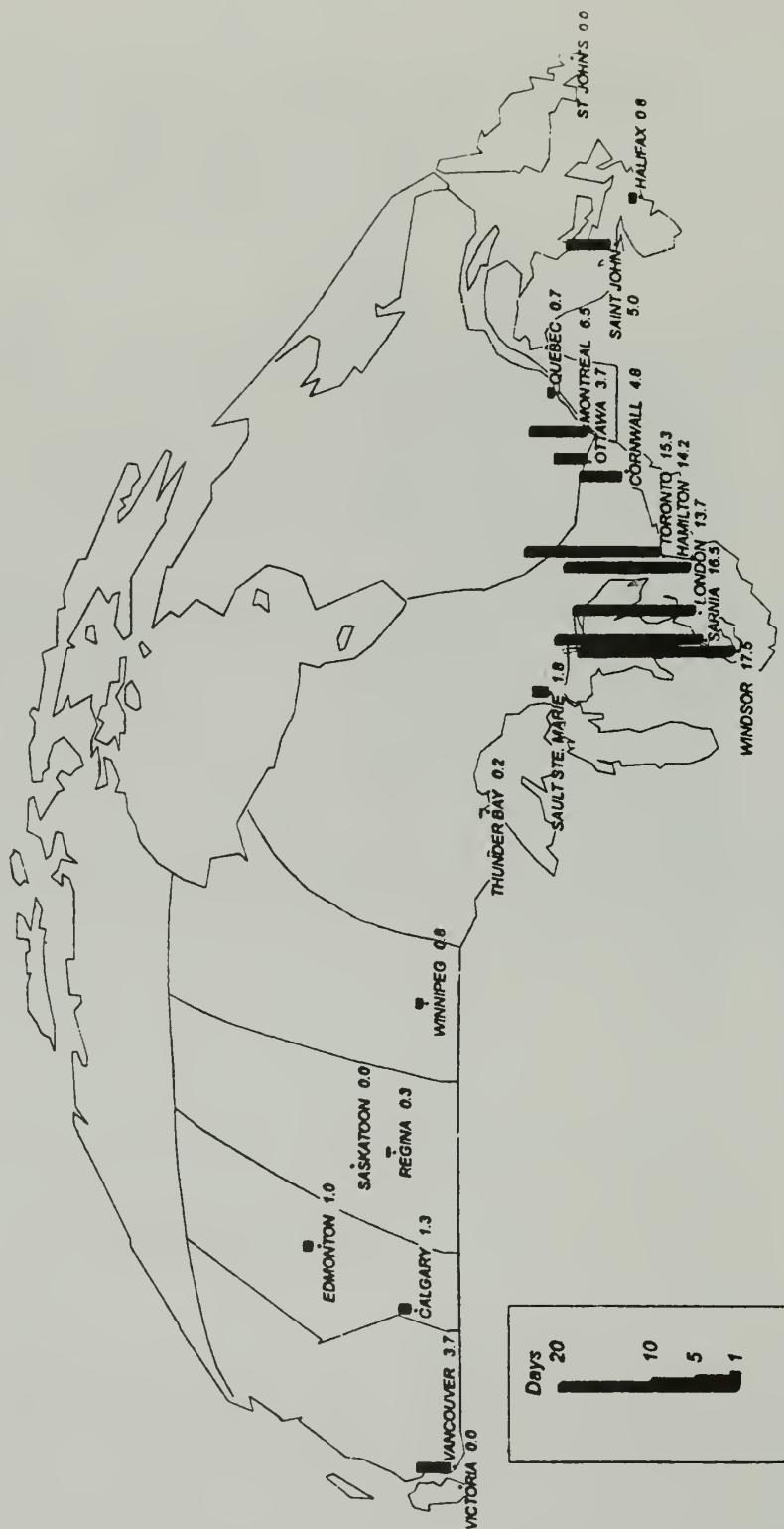
ESTHER - Precipitation and Air

OCT/91 - DEC/93



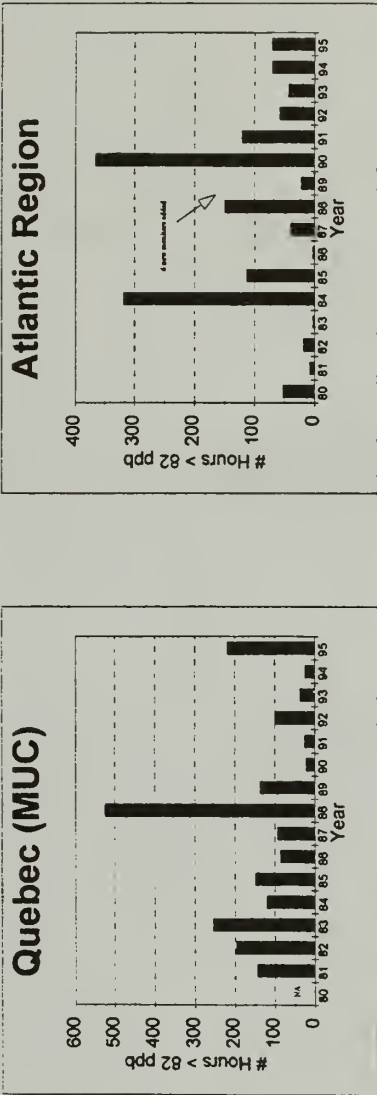
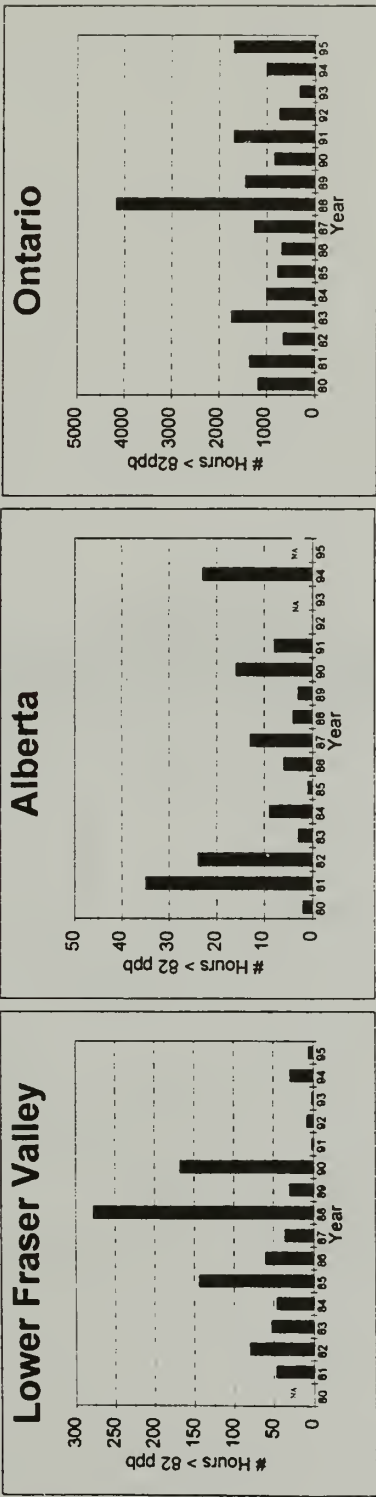
Overhead 19

Average Number of Days when 1h Ozone AQO (82 ppb) was Exceeded (1987 - 1992) at Selected Cities



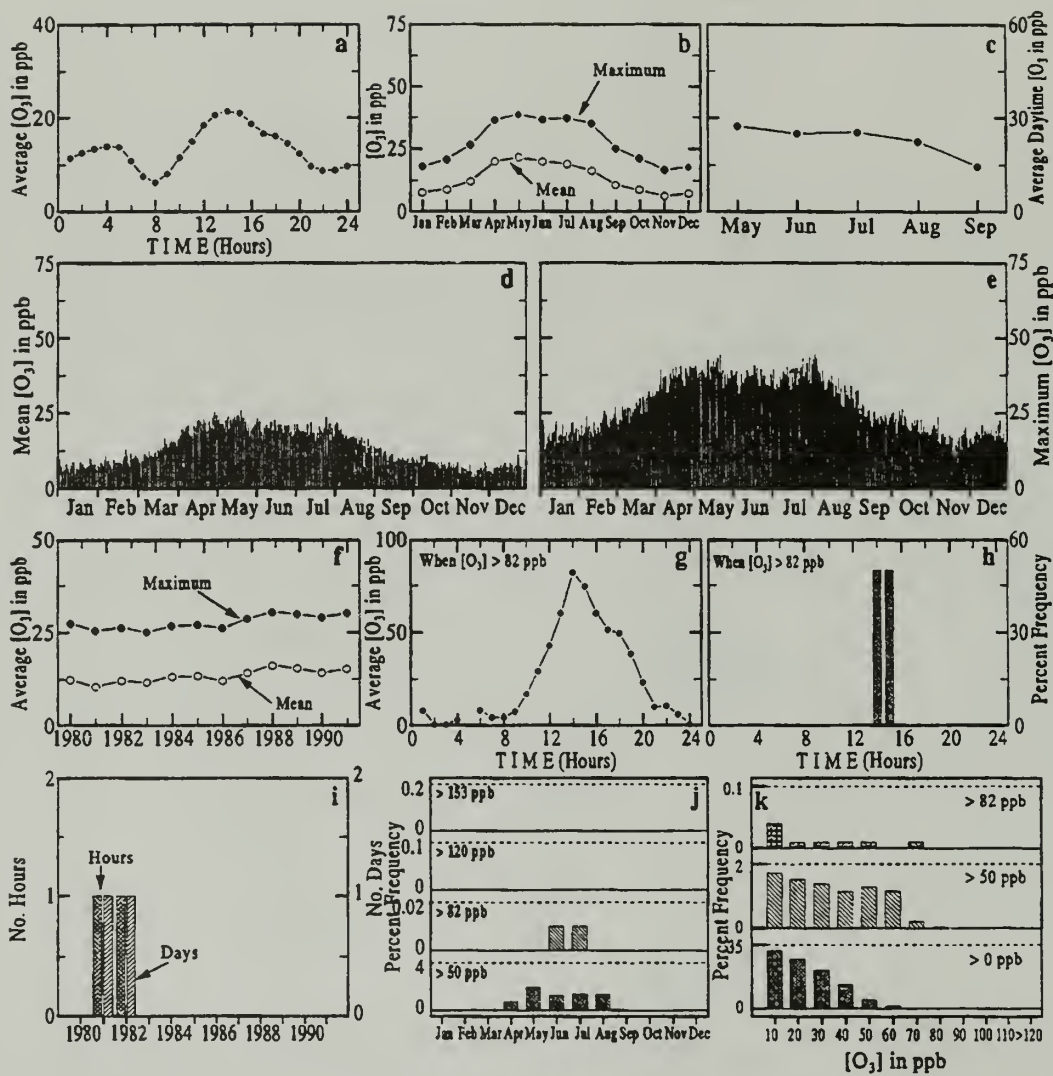
Overhead 20

hours > 82 ppb ozone*
1980-1995



*Hours not adjusted for number of stations in each region.

*1995 data preliminary



Ozone data for Calgary (4th St SW) during 1 January 1980 - 23 November 1991

*PM₁₀ Concentrations ($\mu\text{g}/\text{m}^3$) by Region and Year
(All Dichot & SSI Trend Sites 1984-1993)*

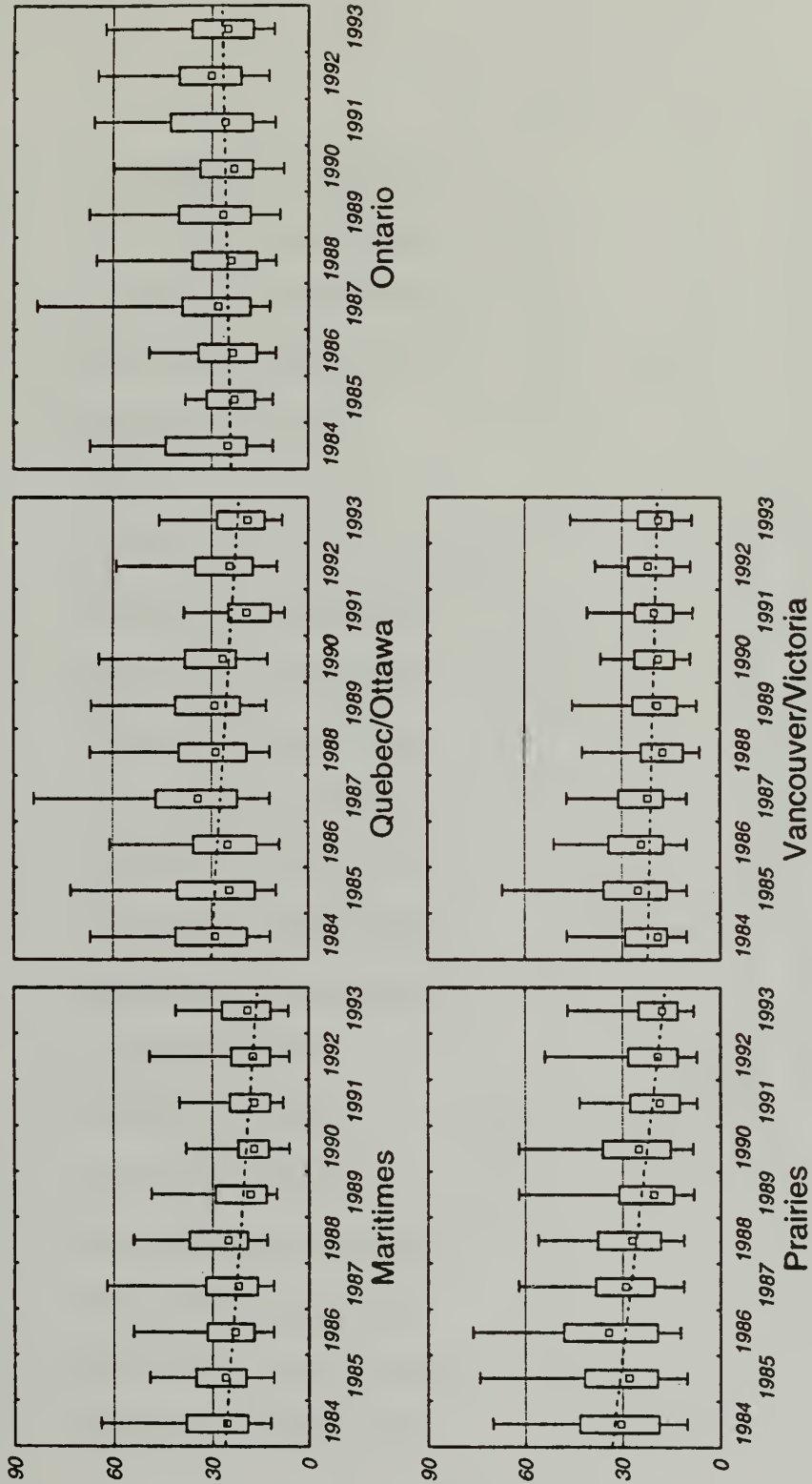
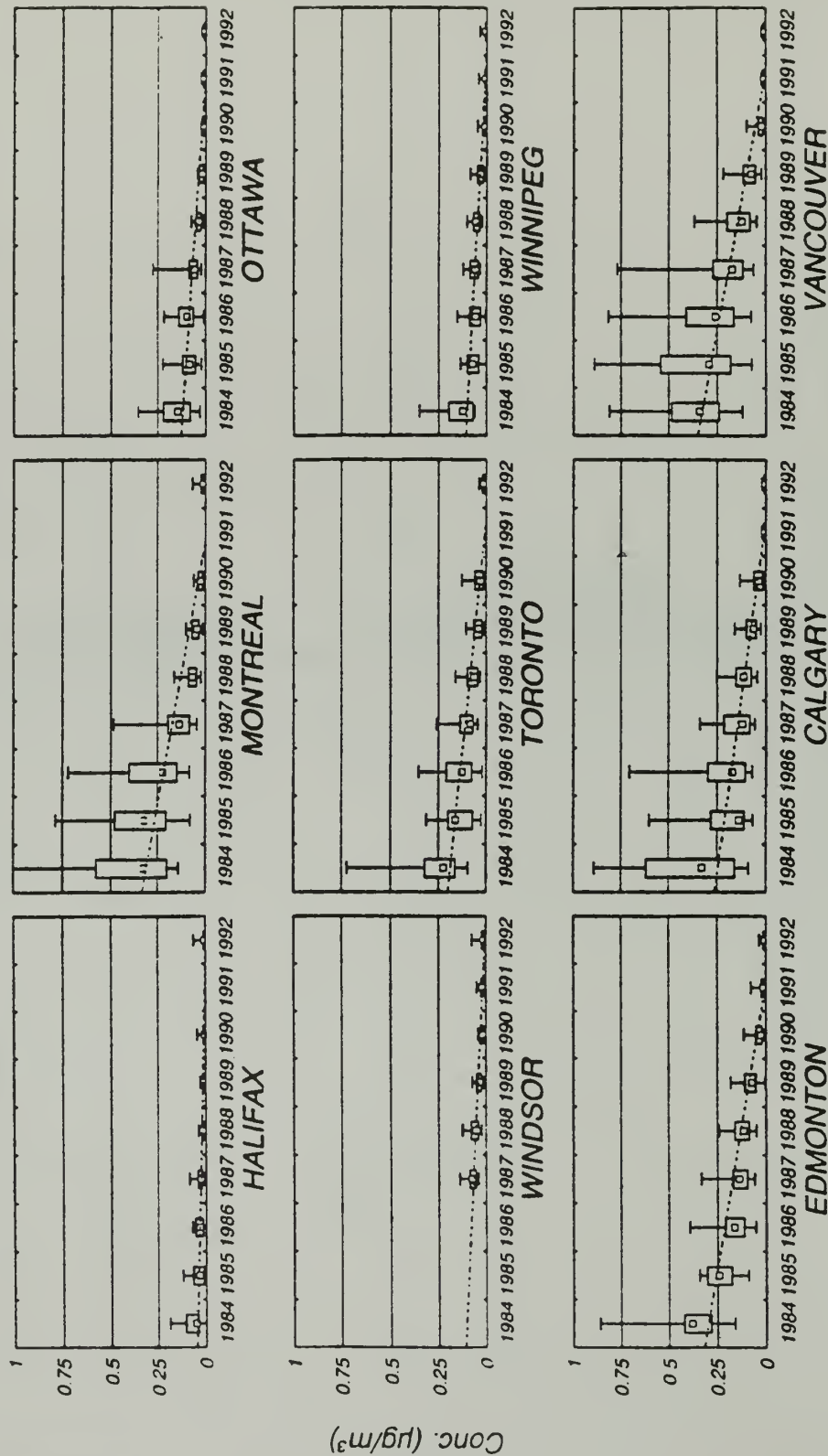
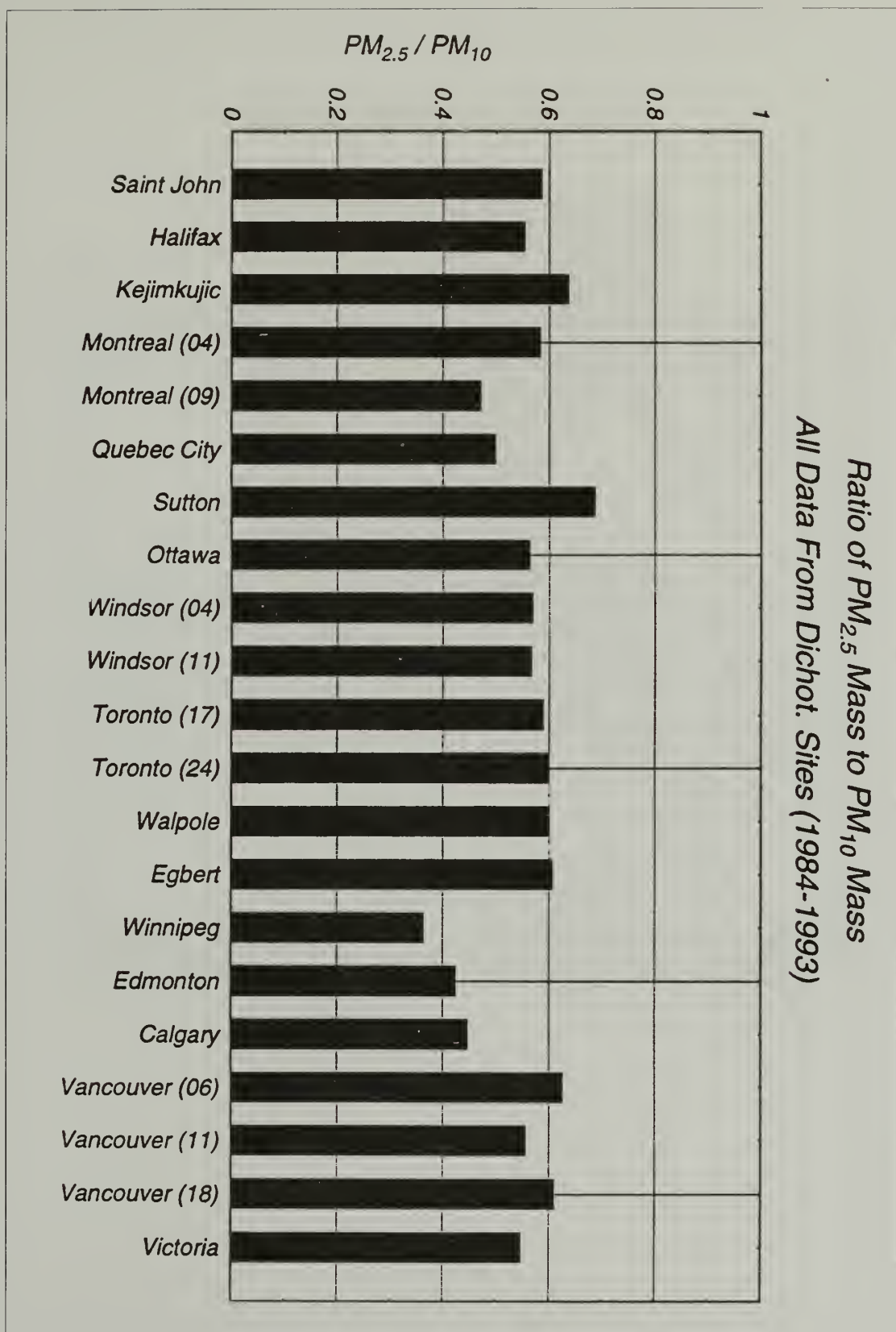
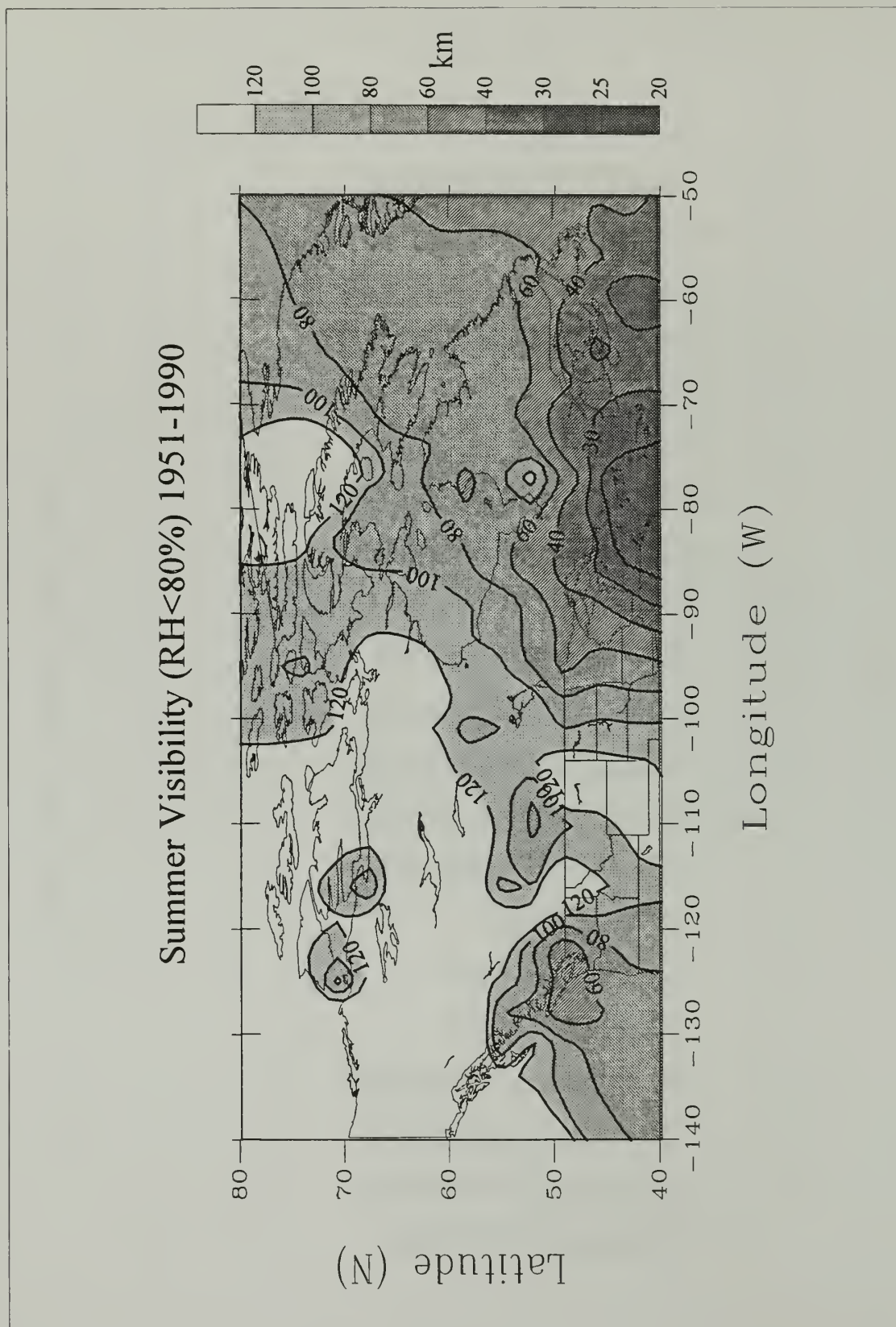


Figure 34: Trend in Total Lead Conc. ($\mu\text{g}/\text{m}^3$) for Selected Cities (1984-1992)



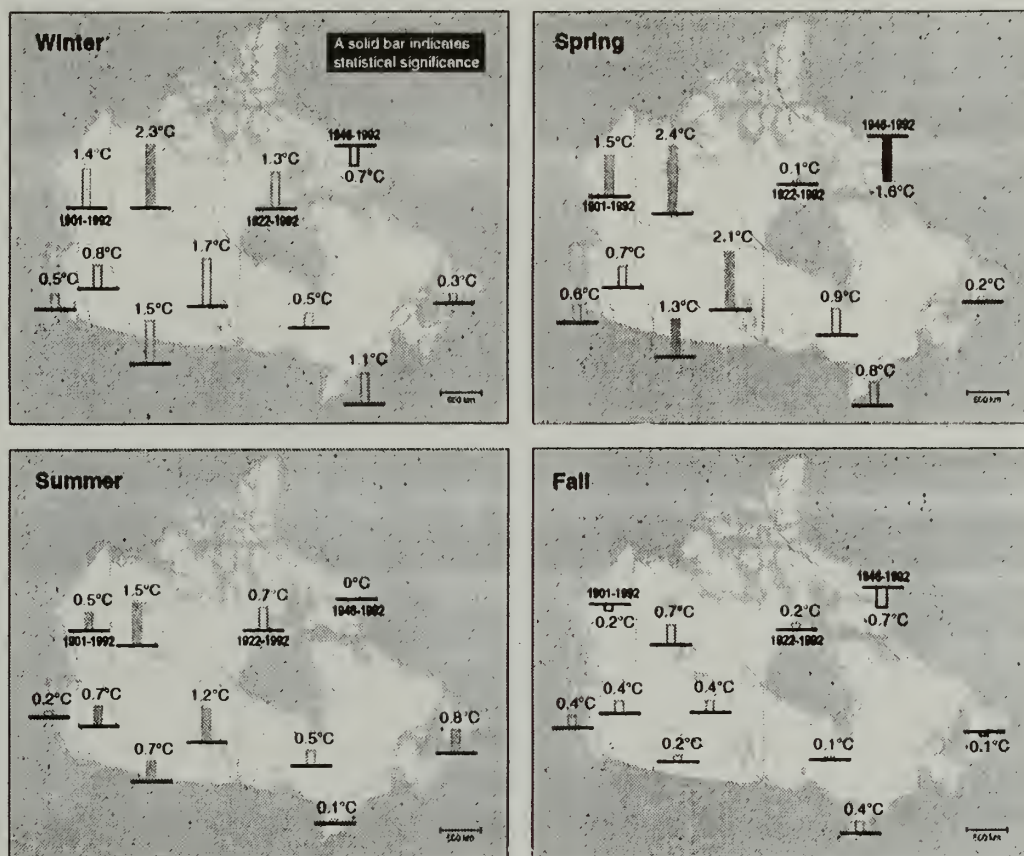


Overhead 25

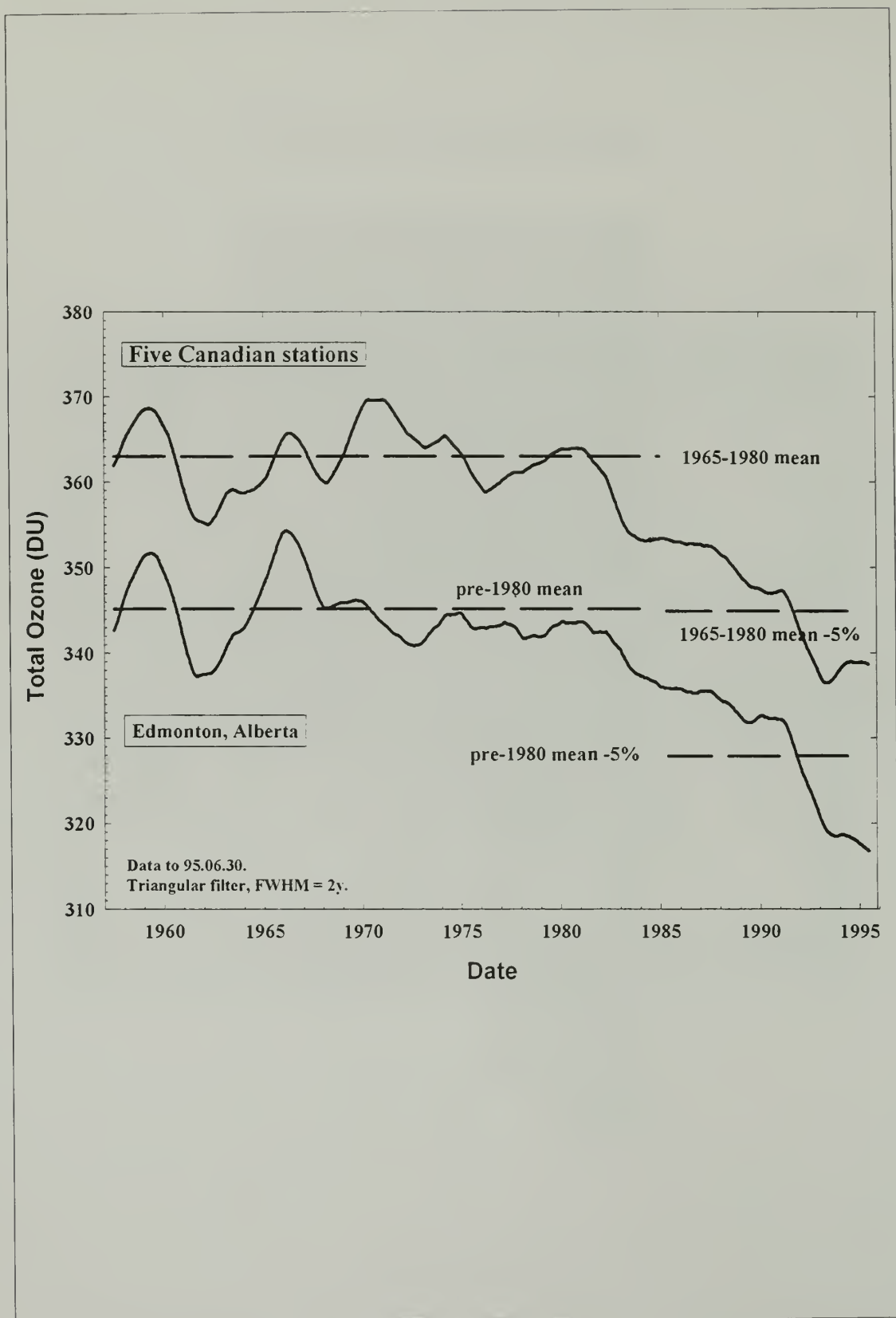


Overhead 26

Figure 8
Regional trends in seasonal average temperature for 1895–1992



Source: Environment Canada.



Overhead 28



Integrated Ecological Monitoring and Atmospheric Issues in Kejimikujik National Park

*Clifford D. Drysdale
Kejimikujik National Park
Parks Canada*

*Billie Beattie
Environment Canada*

INTRODUCTION

Stressors such as air pollution, acid deposition, ultra-violet B radiation, climate change, toxic chemicals, habitat fragmentation and non-sustainable land and aquatic systems use, threaten to destroy the ecological and economic basis for continued global stability. To permit society to develop better strategies for sustainable resource use and regulation, while protecting critical natural assets and biodiversity, it is necessary that we understand ecozone specific complexities of ecology and associated stressors in a more comprehensive manner. This effort must incorporate governments, industry, educators and the general public, thereby ensuring that land use practices and regulations are realistic, and research is cost effective (Drysdale and Howell, 1995 in prep).

Research and monitoring of ecological function must be carried out worldwide to permit measurement of environmental changes which span international boundaries, and affect global dynamics on a massive scale. To facilitate interpretation of information from ecological process research, data collection methods should be standardized whenever feasible.

This paper describes development of the Kejimikujik Ecological Research and Monitoring (ERM) Site in Southwestern Nova Scotia in context with Canada's Ecological Monitoring and Assessment Network (EMAN). It also discusses the atmospheric monitoring in Kejimikujik.

EVOLUTION OF KEJIMKUJIK ECOLOGICAL RESEARCH AND MONITORING

The origins of Kejimikujik's role as a centre for ecological research and monitoring are based on its status as one of Canada's first fully inventoried national parks, and as a consequence of the Canadian federal research program on occurrence and effects of long-range transport of airborne pollutants (LRTAP), developed during the period 1976 through 1978 (Elder and Martin, 1989; Kerekes et al, 1995). Canada's Acid Rain National Early Warning System (ARNEWS) forest study plot method also developed as a consequence of the LRTAP study initiative (D'Eon et al 1994).

Perhaps as a result of the initial success of these study programmes in identifying and quantifying critical ecological processes and stressors, the Canadian Green Plan (1990) recognized the importance of a comprehensive ecological approach to environmental management. It called for establishment of "a long-term monitoring and assessment capability to study resources at risk, ecosystem response, and the impact of major disruptions to ecosystems". This capacity is now being established through the Ecological Monitoring and Assessment Network of Environment Canada.

Within the EMAN initiative, ecological monitoring sites such as the pilot at Kejimikujik (Fig. 1) have a number of common characteristics; they are representative of their ecozones; have site security and a long-term commitment to ecological research and monitoring; encourage

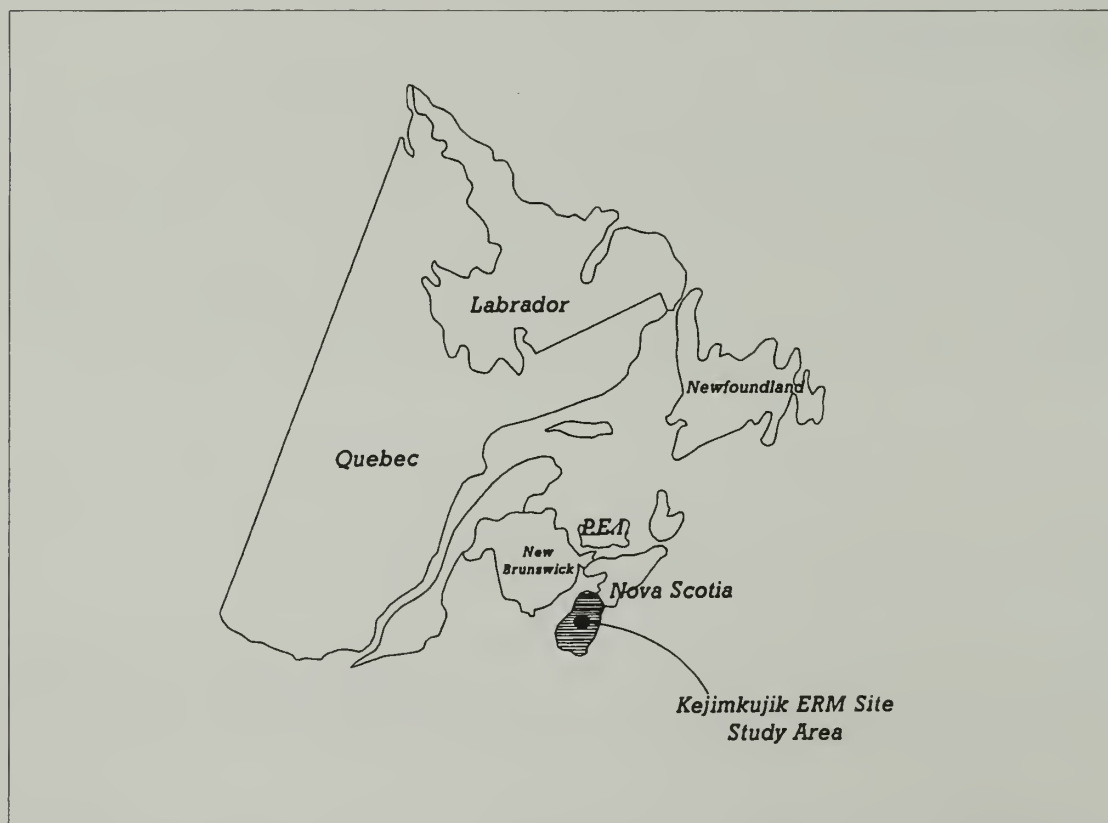


Figure 1. Map of Eastern Canada showing Kejimikujik ERM zone of coverage

interdisciplinary research; rely on partnerships; build on existing strengths; and involve the local community in their activities.

Elements of the acid rain research program still serve as an important component of ecological monitoring at Kejimikujik (Fig. 2), with results continuing to show low pH values in precipitation (Beattie et al, 1994; Beattie and Keddy, 1995).

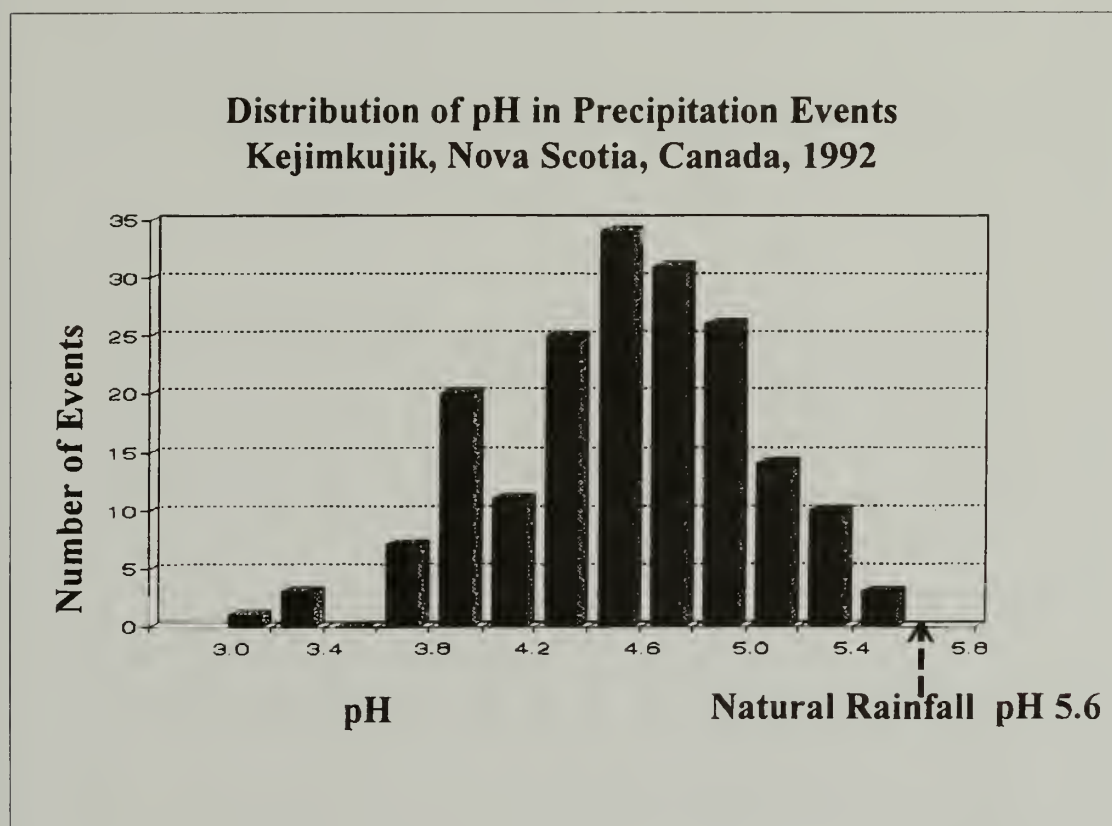


Figure 2. Histogram of precipitation pH values. (Courtesy B. Beattie)

THE DECISION MAKING INFRASTRUCTURE FOR ECOLOGICAL RESEARCH AND MONITORING IN KEJIMKUJIK

In 1993 Kejimikujik was the first location in Canada to be designated as an ecological research and monitoring site in Environment Canada's Ecological Monitoring and Assessment Network initiative. Figure 3 shows the decision making infrastructure, and operational interrelationships to support integrated ecological research and monitoring objectives for the southwestern Nova Scotia portion of the Atlantic Maritime Ecozone (Drysedale, 1995).

The primary scientific strategy development role in Kejimikujik is carried out by the Ecological Research and Monitoring Steering Committee. This multi-disciplinary group of scientists

is familiar with the Kejimikujik area. They develop research and monitoring objectives relevant to Environment Canada needs, and those of other partners, and direct recommendations for projects to relevant agencies and institutions for action as appropriate. Table 1 shows the various research and monitoring projects now being carried out in conjunction with the Kejimikujik Ecological Research and Monitoring Site.

In order to optimize relevance and utility of scientific study at the local level, a Resource User Research and Monitoring Advisory Committee has been created. It is comprised of representatives from local forest-based and tourism businesses, educational institutions, utility companies, government resource management agencies, citizen groups and health services. Recommendations from this group are channelled through the Ecological Research and Monitoring Steering Committee as required. This committee facilitates opportunities for services-oriented studies, public education and information exchange associated with the concept of sustainable use.

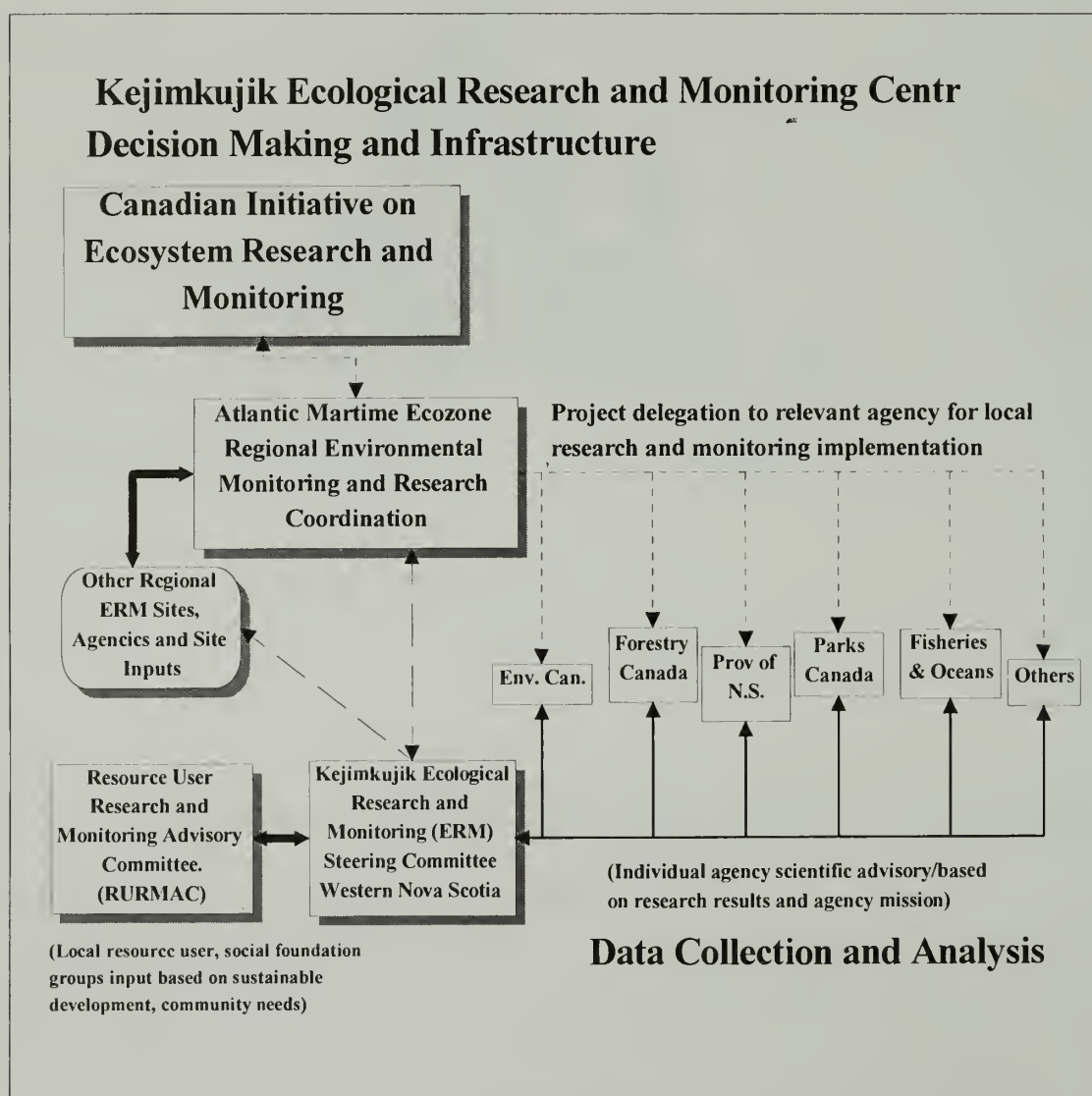


Figure 3. *Kejimikujik ERM decision making infrastructure (Drysdale and Howell, 1995 in prep)*

Table 1. Summary of Ongoing Research and Monitoring in Kejimikujik National Park and Vicinity 1994-95
(courtesy Kerekes 1994)

Agency	Title	Investigator/ Coordinator	Cooperating Agencies
Atmospheric Environment Downsview, Ontario	Canadian Air and Precipitation Monitoring Network (CAPMoN) Station	D. MacTavish, Atmospheric Environment Service (AES), Downsview	Atmospheric Environment Branch (AEB), B. Beattie
	Canadian Acid Aerosol Measurement Program (CAAMP)	J. Brook, AES, Downsview	Centre for Atmospheric Research (CARE), EPS River Rd. Lab.-NCR, Health & Welfare-NCR
	NO _x /NO _y Characterization	A. Gallant, AES, Downsview	AEB S. Beauchamp
	Carbon Monoxide (CO) Measurements	F.Hopper, AES, Downsview	AEB S. Beauchamp
Atmospheric Environment Branch, Bedford, NS	Climate Station	AEB	Parks Canada (PC)
	Stream Flow (Mersey River) and Water Level (Kejimikujik Lake) Monitoring	C. Power, AEB	
Environmental Technology Centre, Environmental Protection Service, Ottawa, Ontario	VOC Monitoring Program	T. Dann, NPS, Ottawa	AES – Downsview, AEB
Natural Resources Canada, Canadian Forest Service, (CFS), Fredericton, NB	Acid Rain National Early Warning System (ARNEWS) Station	L.P. Magasi, CFS, Fredericton	AEB
	Forests Insect and Disease Survey (FIDS)	L.P. Magasi, E. Hurley, CFS, Fredericton	PC PC
Environmental Conservation Branch, Ecosystem Science Division, Moncton, NB Sackville, NB	Water quality monitoring of streams and rivers, calculation of sulphate input-output budgets	J. Pomeroy, Environment Canada Branch (ECB-AR)	University of New Brunswick
	Water quality monitoring of lakes, description of trends	J. Pomeroy, ECB-AR	
	Wetland Studies, "Pine martin" Bog	T. Clair, ECB-AR	
	Nitrogen cycling, soils and vegetation	T. Clair, ECB-AR Paul Arp UNB	

Table 1. (continued)

Agency	Title	Investigator/ Coordinator	Cooperating Agencies
Environmental Quality Laboratories, Moncton, NB	Organics in precipitation	G. Brun ECB – AR	PC, AEB
National Water Research Institute, Burlington, Ontario	Dissolved trace contaminants in wet precipitation – low level detection	H. Wong, National Water Research Institute (NWRI)	Ont. Ministry of Environment AEB and AES Downview
Canadian Wildlife Service, Dartmouth, NS	Baseline characterization of piscivorous waterfowl populations and their food (biomonitoring) Assessment of calcium levels in aquatic invertebrates (water fowl food) Kejimikujik Basins Study modelling, long term monitoring	J. Kerekes, Canadian Wildlife Service (CWS) – AR J. Kerekes, CWS – AR CWS – AR, MEB – AR, AES, CFS	Parks Canada, ECB – AR CWS – Ont. R; CWS NWRC – NCR PC, CWS, AEB, NWRC – NCR
CWS, Sackville, NB	Black Duck breeding pair survey study block	M. Bateman, CWS – AR	B. Pollard, Wetland & Waterfowl, Inst. D.U. Winnipeg, Man.
Fisheries and Oceans, Scotia Fundy Region, Halifax, N.S.	Assessment of fish populations in three lakes (Cobrielle, Big Dam East and West Lakes) Biomonitoring of invertebrates in three lakes and in the Medway River at Caledonia	W.J. White Fisheries and Oceans Canada (DFO) N. Watson, DFO	Parks Canada Parks Canada
DFO, St. Andrews, NB	Atlantic salmon recovery in the Medway River System	G. Lacroix, DFO	N.S. Fisheries Dept., U. of N.B., U. of Manitoba, Freshwater Inst., Winnipeg

Table 1. (continued)

Agency	Title	Investigator/ Coordinator	Cooperating Agencies
Parks Canada, Kejimikujik	Monitoring of brook trout populations	R. Nicholas, C. Drysdale, PC	Dept of Fisheries & Oceans (DFO)
	Climate Station	J. Wentzell, PC	AES-AR
	Loon population monitoring in selected lakes	KNP Res. Con.	CWS
	Grafton Watershed Assessment	C. Drysdale, PC M. Brylinsky, Acadia U.	F&O Can., CWS, ECB-AR
	Forest Biodiversity Monitoring (see page 10-11)	C. Drysdale, PC I. Morrison, E. Muntz	MEB-AR; CWS-AR; PC-AR
	Interpretation of the acid rain problem to park visitors	P. Hope, PC	Smithsonian Institution/UNESCO, CFS, Environment Canada, Acadia U., N.S. College of Geographic Sciences
	Coyote Biology	B. Patterson	N.S. Dept. of Nat. Res.
	Blandings Turtle population research	I. Morrison, PC Tom Herman	Acadia University
	Piping Plover Monitoring and Management; Seaside Adjunct	N. Wentzell, PC G. Kenney, PC	CWS; N.S. Dept. of Nat. Res.
	American Marten Re-introduction Assessment	E. Muntz, PC J. Wentzell, PC	U. of Alberta
	Bryophyte Inventory	R. Belland	Mt. St. Vincent U.
	Rare Vegetation Inventory; Seaside Adjunct	N. Hill	
	Deer-Coyote Ecology in Working Landscapes	B. Patterson Tony Duke	Parks Canada Canadian Forestry Service
N.S. Department of Natural Resources			

At Kejimikujik, the Park Ecologist serves as on-site research and monitoring coordinator by participating in community and scientific committees, while maintaining liaison with other researchers, agencies, park staff, schools, land owners, non-government organizations and businesses. The coordinator oversees initiatives to increase ecological understanding, and directs the operation and regular updating of the Park based ecological information management system for the western Nova Scotia area. In addition to providing guidance for researchers and managers, the project coordinator/ecologist develops cross sectoral partnerships, helps direct graduate study programmes, and student based co-operative assignments.

Information Management

With development of the microcomputer, it has become possible to establish integrated databases at the field level, and carry out relational analysis or modelling functions in rapid fashion. Kejimikujik is consequently developing a coordinated information management system operated by a data management specialist (Fig. 4). Activities include establishment and application of file management protocols following consultation with researchers to ensure optimal data security,

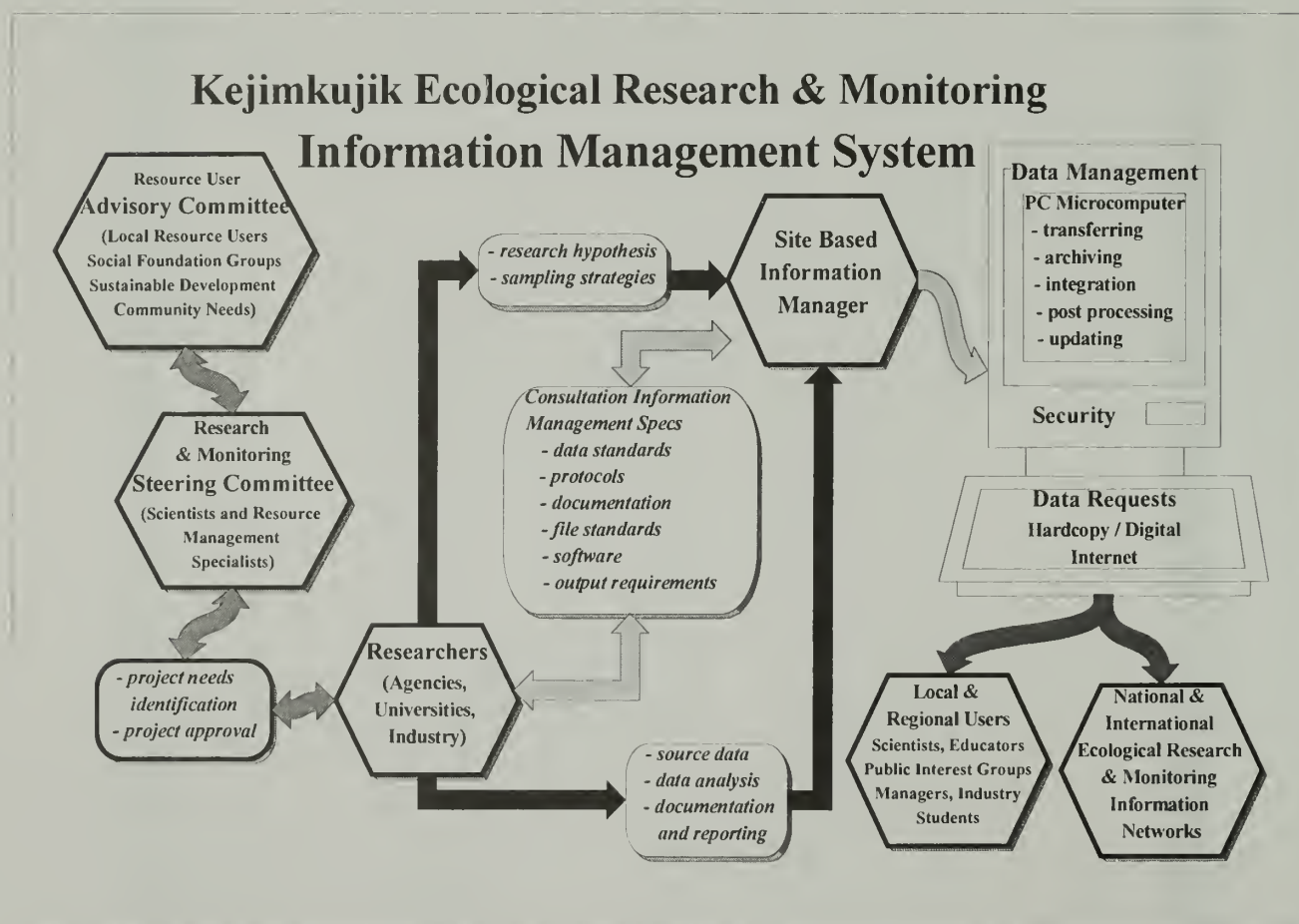


Figure 4. Kejimikujik ERM Information Management System (Drysdale 1995 in prep)

quality, and compatibility. The data management specialist also provides access to data sets and information products to a variety of clients, including managers, scientists, educators, and students.

Central to the Kejimikujik information management system is development and maintenance of a comprehensive microcomputer based integrated ecological information software module (I.E.I.S.M.). Developed by Geoff Howell of Environment Canada, with Parks Canada staff, this system includes an ecological information search capability for southwestern Nova Scotia by study author, subject, or location. Supporting software includes G.I.S., database and text programmes, with provision made for easy access to information, and standardization of data set format. Arrangements are being made to make information available over the Internet so data can be exchanged with other researchers. University and public educators have expressed interest in this system for instructional purposes.

Smithsonian Man and Biosphere (SI/MAB) Plots for Biodiversity and Ecological Process Research and Monitoring in Kejimikujik

It became apparent that it would be desirable to develop an integrated monitoring strategy which permitted correlation of data associated with site specific terrestrial ecology studies and air pollution (Dallmeier F. 1992). Subsequently, installation of two 1 hectare SI/MAB plots in Kejimikujik National Park occurred in April, 1994, in conjunction with a course presented by Dr. Francisco Dallmeier and Jim Comiskey of the SI/MAB programme and Parks Canada to a variety of provincial and federal staff, academics and volunteers. Plot 1 was installed on a drumlin formation separating Kejimikujik Lake and Grafton Lake. It is comprised primarily of mixed hardwood forest on well drained till. Plot 2 was installed in a mixed softwood stand on moderately drained till near the northern shore of Grafton Lake. Table 2 provides a listing of studies that have been initiated since plot establishment to date.

Atmospheric and Climatic Monitoring; Keystones for Ecological Understanding

Long term monitoring of atmospheric processes and climate dynamics is essential for understanding of terrestrial and aquatic ecology. This knowledge is in turn important for development of sustainable use strategies for working landscapes. There are still some important gaps in knowledge to be addressed in Kejimikujik.

Studies of acidification impacts in the Kejimikujik area have proven invaluable in understanding the response of ecosystems and in establishing critical loads for sulphate. Continuing research and monitoring are required to determine whether the control actions being taken are actually producing the desired decrease in both sulphate deposition to the environment and in sulphate concentrations in lakes and streams, and recovery in biota (and if not, why not), and to establish critical loads for nitrogen (Fig. 5). The roles of airborne toxic chemicals and tropospheric ozone (Fig. 6) and its precursors in affecting terrestrial environments also need further investigation.

Table 2. 1995 SI/MAB Plot Based Studies in Kejimikujik

Title	Objective	Investigator
Multi User Plot Sampling Techniques	Develop plot based sampling techniques and protocols which permit analysis of ecological components and processes, without impacting on study plot integrity.	Dr. Soren Bondrup-Neilsen & Students (Acadia U.), C. Drysdale, (PC), Les Magasi (CFS), Geoff Howell (EC)
Air Quality Monitoring with Lichens	Evaluate the use of lichens to monitor air pollutants, in a fashion which preserves the ecological integrity of forest study plots. Cheryl M. Frail & Dr. David H.S. Richardson (St. Mary's U.) Software Development Develop programming improvements to the current "BIOMON" software to increase ease of use, automate statistical manipulation and display of data for a variety of users. To develop software capability to achieve broader application utility, including variable plot system size, georeferencing, quadrat resolution and three dimensional configuration for aerial, terrestrial and aquatic use.	Jim Comiskey (Smithsonian/MAB), Roger Mosher (NSCGS), Sally O'Grady (Kejimikujik)
Forest Succession & Gap Modelling	Explore use of forest succession and gap modelling software.	James Bridgeland (PC), Blair Pardy, Lary Brown, Colin Daniel
Use of Basidiomycete Fungi In Kejimikujik Study Plots as Indicators of Pollution	Resample existing monitoring plots, and sample SI-MAB biodiversity Plots to determine presence, and significance of basidiomycete fungi as pollution indicators, while preserving plot integrity.	Ivo Polach, U. of Toronto, Ken Harrison (CFS)
Forest Insect and Disease Survey	Carry out regular forest insect and disease surveys (FIDS) according to established Canadian Forestry Service methods, in SI/MAB Biodiversity Plots, while preserving plot integrity.	Ed Hurley, (CFS)
Terrestrial Beetles	Identify, document and compare beetle species and associations in protected and working landscapes in Nova Scotia.	Daniel Kehler, Dr. Soren Bondrup-Neilsen, Acadia U.
Microclimate Monitoring and modelling	Establish microclimate monitoring system in association with SI/MAB biodiversity plots to permit relational analysis of ecosystem elements and variables above ground, at surface level and in the soils.	Don MacIver, Adam Fenech (EC) P.Arps, C.Bourque, (UNB)
Working Forest Biodiversity and Ecological Productivity Monitoring and modelling	Evaluate biodiversity in working forest environments, and develop recommendations to optimize forest product and ecological sustainability.	Ted Bulley, Peter Jones (Bowaters Mersey), Blair Douglas (N.F. Douglas), Francisco Dallmeier (Smithsonian/MAB), Cliff Drysdale (Kej. ERM), P.Arps UNB

Table 2. 1995 SI/MAB Plot Based Studies in Kejimikujik

Title	Objective	Investigator
Terrestrial Myriapoda & Collembola Survey & Monitoring	Conduct an inventory of terrestrial myriapoda and collembola in 1 hectare SI/MAB Biodiversity plots, and to develop methods to monitor population changes in a fashion which preserves the ecological integrity of the plots.	Barry Wright
Forest Canopy Lepidoptera Survey & Monitoring	Conduct an inventory of forest canopy of 1 hectare SI/MAB Biodiversity plots, and develop methods to monitor population changes in a fashion which preserves the ecological integrity of the plots, while permitting relational analysis of ecological variables.	Georgette Smith, (CFS), Joseph Conway (PC)
Ground Vegetation Survey & Monitoring	Develop methodology to measure, map and monitor ground vegetation in 1 hectare SI/MAB Forest Biodiversity plots in a fashion which preserves the ecological integrity of the plots while permitting relational analysis of ecological variables.	Dr. Nick Hill, Mount St. Vincent U., Shelly Porter
Plot Access Control and Working Platform Development	Develop strategy, and design access control and working platform which preserves ecological integrity of the plots.	N. Melling (PC), C. Drysdale
Terrestrial Mollusca & Mites Survey & Monitoring	Conduct an inventory of terrestrial mollusca and soil mites in 1 hectare SI/MAB Biodiversity plots, and to develop methods to monitor population changes in a fashion which preserves the ecological integrity of the plots, while permitting relational analysis of ecological variables.	Derek Davis

An emerging issue of importance to some National Parks and heritage vistas in Canada is the decrease in visibility (clarity) due to airborne pollution. Only the trans-boundary aspects of visibility reduction are presently of concern to Environment Canada, and have prompted the application of modern techniques to monitor visibility – reducing pollution at a few sites, one being St. Andrews, New Brunswick (about 160 km northwest of Kejimikujik). Parks Canada does not presently monitor visibility in the vicinity of National Parks or other heritage vistas.

The depletion of stratospheric ozone caused by man-made ozone-depleting substances (such as CFCs) has been the cause of increased levels of ultra-violet radiation (Fig. 7). UV-B levels on some days can be as much as 50% higher than normal. This is a topic of growing concern that requires study because damage to commercially valuable plant species, aquatic productivity and human health could have major socio-economic impacts before control measures are effective in allowing the ozone layer to heal (which is expected by about the middle of the next century, if control schedules are adhered to).

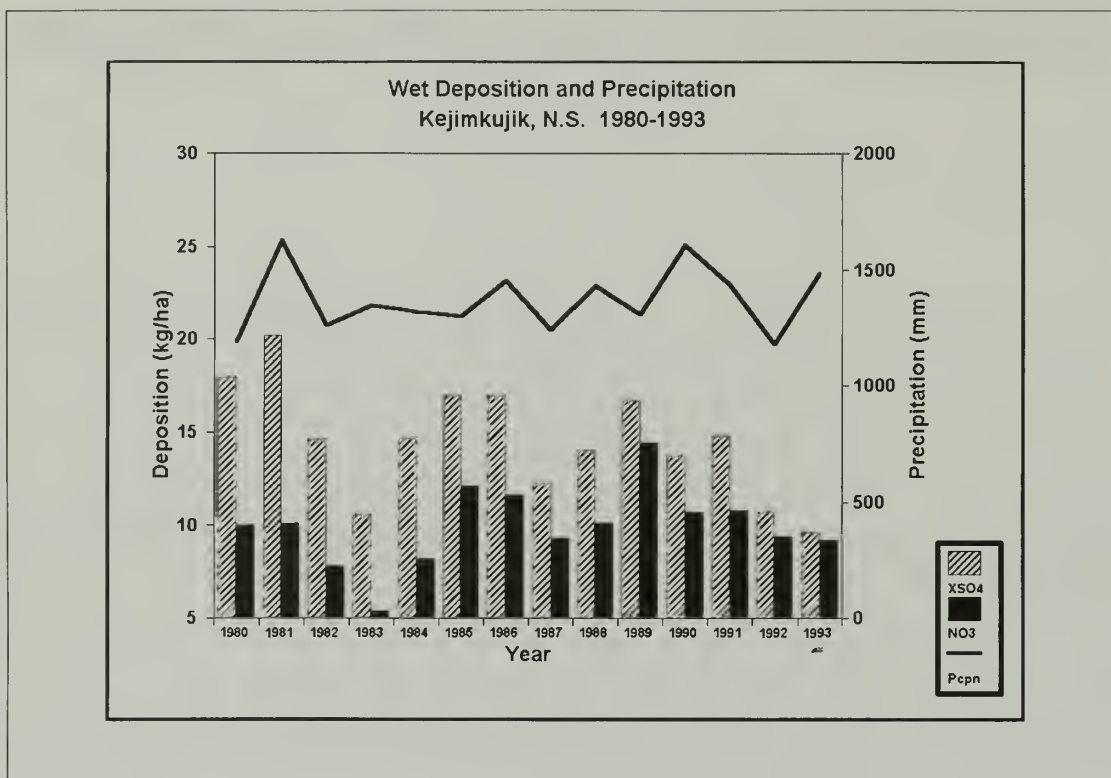


Figure 5: Wet Deposition and Precipitation

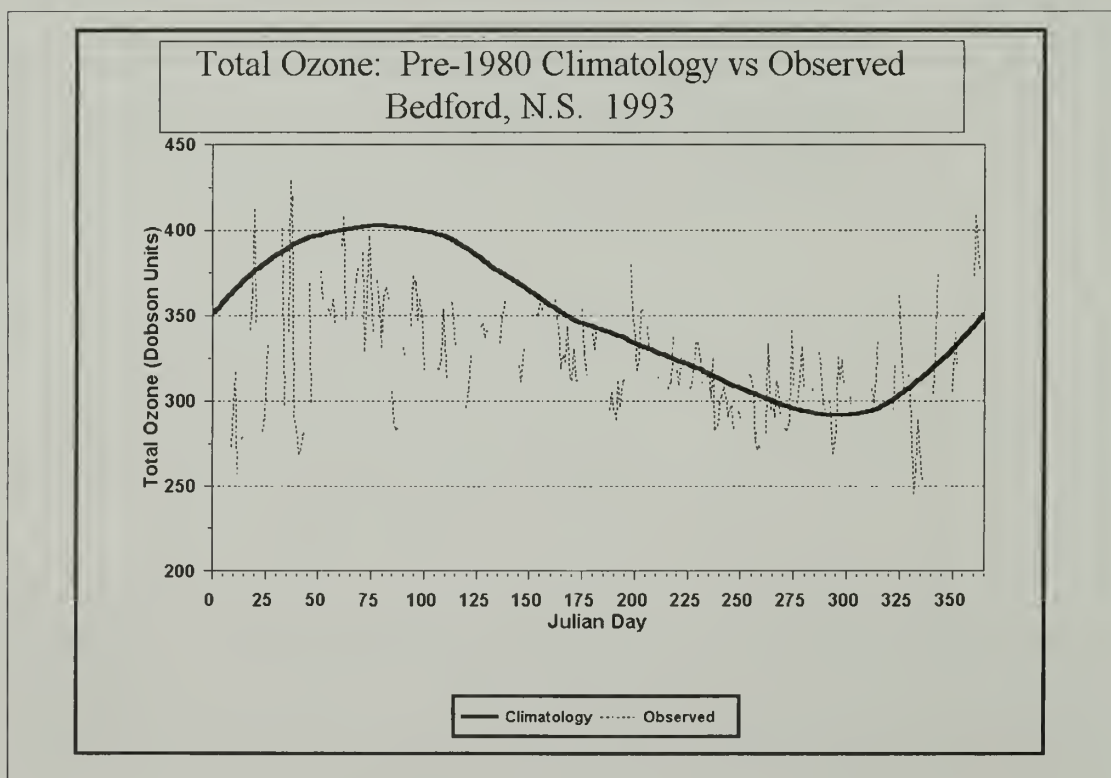


Figure 6: Total Ozone: Pre-1980 Climatology vs. Observed

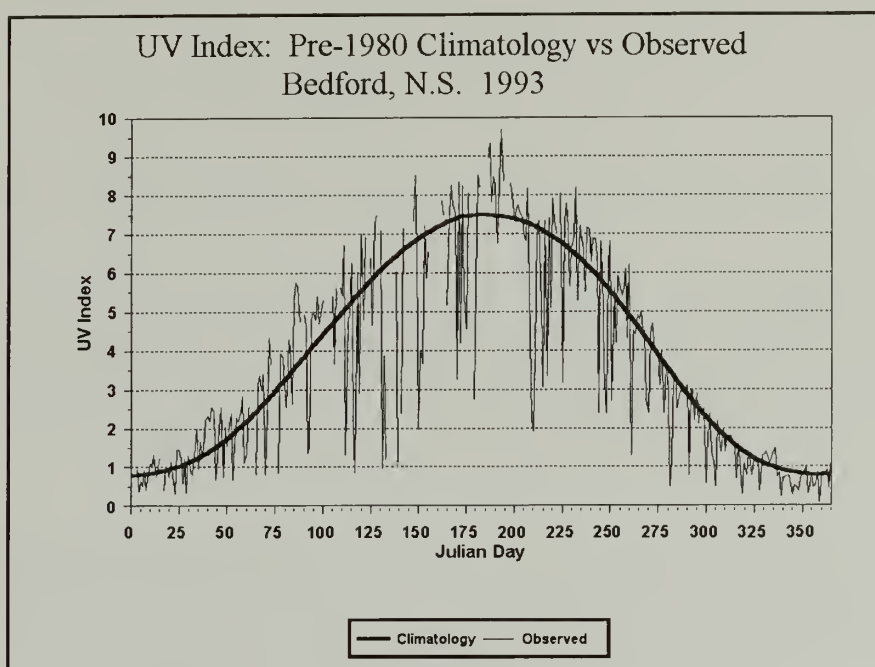


Figure 7. UV Index: Pre-1980 Climatology vs Observed

Another global atmospheric issue that the world community is grappling with is the threat of large-scale climate change caused by anthropogenic emission of greenhouse gases, such as carbon dioxide and methane. More research is required to quantify the natural and anthropogenic sources and sinks of carbon and to reduce the uncertainties about the rate, regional characteristics and implications for Canada of global warming. A contribution to this effort could be made by continued research and monitoring of ecosystems and climate elements (e.g., temperature, precipitation, hydrology) at Kejimikujik to allow the early detection and explanation of future changes.

The role of microclimate conditions in forested and non-forested areas is still insufficiently documented. Localized phenomena associated with changing forest canopies, various silvicultural techniques, insect and disease activity, and solar radiation quantities could have significant impact on species diversity, ecological, and economic sustainability. For example, climatic conditions under the forest canopy can be quite different from those associated with open areas, where most climate monitoring traditionally occurs. These issues stand as challenges for scientists conducting long term research and monitoring associated with the EMAN programme.

CONCLUSIONS

Establishment of the pilot Kejimikujik Ecological Research and Monitoring Site, with maintenance of long term atmospheric and climatic studies, and initiation of a variety of SI/MAB plot based studies, reflects the need in Canada to rapidly develop economically efficient, cohesive, scientific strategy and infrastructure for ecological process and sustainable use research.

The following are some specific conclusions associated with progress made at Kejimikujik in context with the preceding discussions:

- 1) The need for information on ecoregion based ecological function, stressors, and sustainable use is significant. There is a requirement to direct integrated research and monitoring activities to address these needs, while optimizing data utility to serve national and global information requirements in an effective and cost efficient manner.
- 2) The concept of Environment Canada's Ecological Monitoring and Assessment Network appears to be a sound and timely one. It has the potential to advance the concept of integrated ecological research and monitoring, while optimizing cooperative activities with various government levels, educational institutions, industry and the general public. It also complements the concept of Biosphere Reserves, and could be used as a framework for research infrastructure in that context.
- 3) Atmospheric monitoring studies carried out at Kejimikujik continue to serve as an essential foundation for stressor and ecological systems research in the areas of acidification, toxics, tropospheric ozone, and climate change. There is additional need to examine forest microclimate, the effects of UV radiation, and to establish air clarity parameters to augment existing knowledge.
- 4) In Nova Scotia, Canada, and undoubtedly worldwide, there is a necessity to establish more integrated research and monitoring sites to facilitate study of ecological function stressors and biodiversity. The SI/MAB forest biodiversity monitoring plot appears to be an excellent tool which can serve as a focal point and stimulus for standardized long-term study programs. To support the establishment of integrated research and monitoring sites, there is a need to instruct more scientists and managers about the rationale, techniques and infrastructure required for implementation. There is also a need to develop more plot installation teams, in support of the SI/MAB group, to sample a wider variety of ecozones.
- 5) There is a need to further develop and refine standardized plot based study methodologies for various ecological elements, to ensure zero impact on plot integrity, while obtaining information which can permit relational analysis of ecological variables. It would be useful to publish a compendium of standard methodologies for use by researchers worldwide.
- 6) There is a need to further develop, refine and permanently institutionalize a common information management system associated with ecological research and monitoring sites. Critical elements include: Use of universal data set formats based on standardized sampling methods where feasible; integrated ecological databases which permit rapid searches based on topic author and location; and linked global digital information transfer systems with common file formats, based on the Internet concept.
- 7) There is a need to further develop an integrated prioritization structure to efficiently and economically address ecological research and monitoring needs from a global,

national, regional and local perspective. This should incorporate a systematic, tiered and interconnected assignment of study tasks which avoids unnecessary duplication, while ensuring that site based research fulfils common information needs for a variety of hierarchical levels when possible. UNESCO would seem to be a logical agency to develop and apply such a system.

- 8) It is necessary to further develop ecological research and monitoring strategy to reflect broader client based needs, and support the principle of sustainable use of natural resources. Through establishment of multi-sectoral steering committees, the information requirements of local resource users (i.e. industry, private land owners) can be considered and integrated with research design and prioritization activities associated with coordinated study systems. Every effort must be made to carry out public education about study activities and to incorporate the use of students and interested public when feasible.

ACKNOWLEDGEMENTS

The authors are grateful to Sally O'Grady, Parks Canada and Adam Fenech, Environment Canada, for their assistance on this project.

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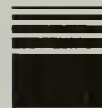
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Jasper National Park – Particulate and PAH Studies

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Jasper National Park is located in the Rocky Mountains of western Canada (see figure 1 in the paper by Welch and Kovacs, p. 77). Concerns expressed by Jasper residents and visitors about the apparent effects of campfire wood smoke on their health, and the reduced visibility on the roadway around the Whistlers Campground during peak summer camping season, prompted Parks Canada and Atmospheric Environment Branch of Prairie and Northern Region to conduct a preliminary study on air quality in the Whistlers Campground of Jasper National Park from September 09 to October 18, 1992. The study was designed to measure levels of total suspended particulate (TSP) in the Whistlers Campground, and to determine whether levels of TSP were above the current national acceptable level for a 24-hour average sample of $120 \mu\text{g}/\text{m}^3$.

In the 1992 Whistlers Camping season, wood was supplied in the campground in large wood piles and there was no restrictions on the amount of wood burned. The preliminary study showed that 47.4% of the days during September 09 to October 18, 1992 were above $120 \mu\text{g}/\text{m}^3$, even though Whistlers Campground occupancy only reached 413 out of a maximum of 781 sites [Bailey 1992; Bailey and Stendie 1993]. Given the high levels of TSP measured despite low occupancy rates, it was expected that TSP levels would reach the maximum tolerable levels ($400 \mu\text{g}/\text{m}^3$) if no changes in wood supply or use were made. In order to reduce the amount of wood burning in the campgrounds of Jasper National Park, Parks Canada of Jasper National Park initiated the selling of campfire wood in the Whistlers and Wapiti Campgrounds of Jasper National Park. Campfires at the Wapiti Campground, which is just across Highway 93 from Whistlers Campground and which has 366 sites, may also influence levels of particulate measured (Figure 1).

To ensure levels of particulate were reduced by the selling of wood, the sampling of total suspended particulate was continued for the period May 7, 1993 to October 10, 1993 in Whistlers Campground. Several days were also sampled for particulate matter less than $10 \mu\text{m}$ in diameter (PM₁₀) to determine whether the major fraction of particulate measured with the high-volume samplers was inhalable particulate, which is of greater health concern than health impacts from

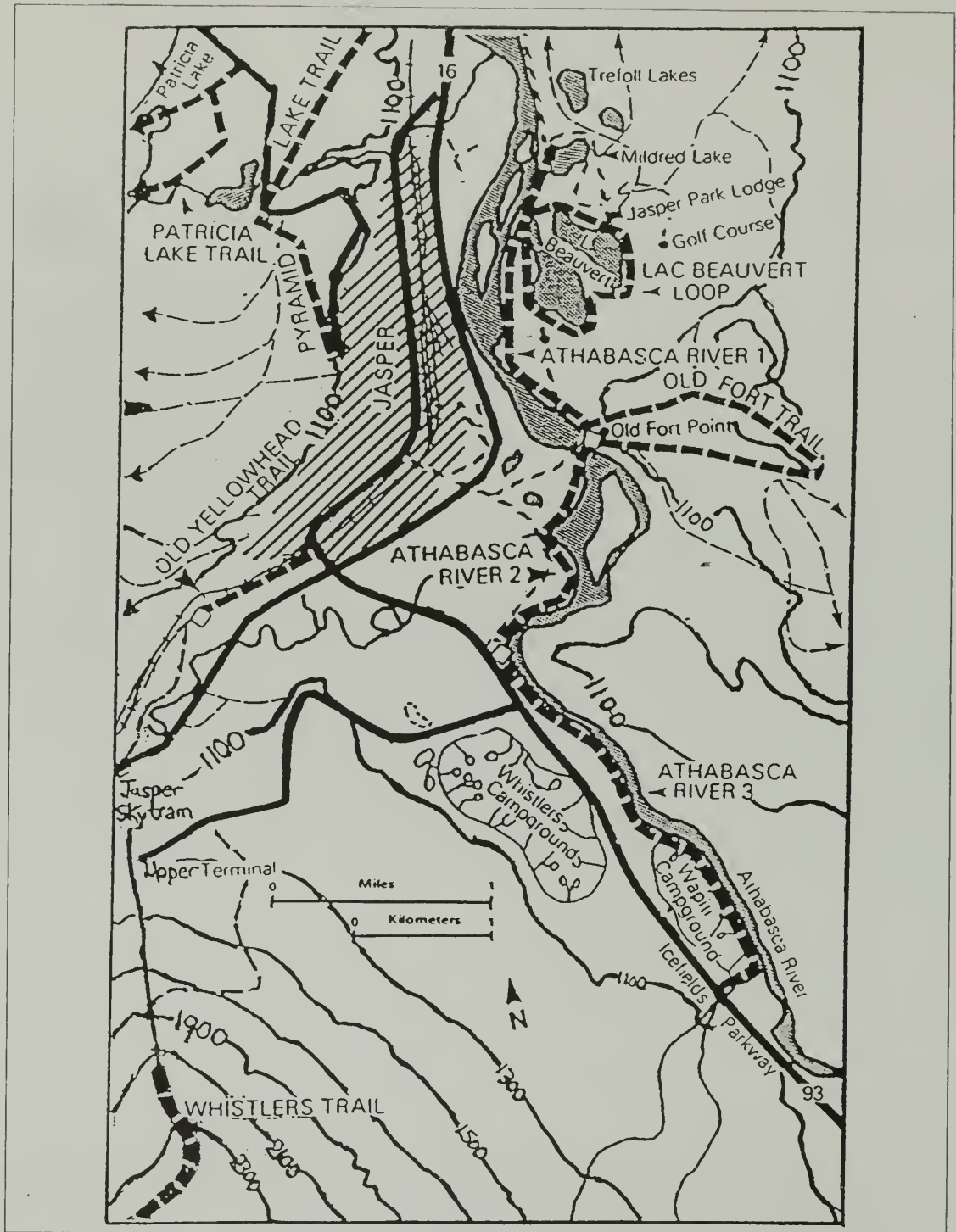


Figure 1: Jasper National Park (south)

coarse particulate. Total suspended particulate samples were also taken during 3 days in 1993 from the Wabasso and Whistlers Campgrounds of Jasper National Park for analysis of polycyclic aromatic hydrocarbons (PAHs) by Atmospheric Environment Service. Wood was supplied in large wood piles in the Wabasso Campground, while in the Whistlers and Wapiti Campgrounds in 1993 wood was sold in bundles or as dellogs by SBC Firemaster Enterprises Ltd. In conjunction with the air measurements, a survey in Whistlers and Wabasso Campgrounds on campground satisfaction and wood smoke was completed by Canadian Heritage, Strategic Information, Corporate Services [Canadian Heritage 1993]. Several talks were also given by Heritage Communications in the Whistlers Campground in order to educate visitors about the effects of wood smoke and the benefits to reducing the amount of wood burning. During 1992 and 1993 camping season Jasper Weather Office staff did the collection and weighing of filters and in the 1994 camping season collected the PM₁₀ filters. Whistlers campground staff were also involved in the collection of filters in 1993 and answered questions about the selling of wood. SBC Firemaster Ltd. provided daily wood sales in Wapiti and Whistlers Campground for comparison with particulate levels. A technical and executive report on 1992 and 1993 results is available [Bailey 1994].

Table 1 shows a comparison of particulate levels in 1992 and 1993 camping seasons. Particulate levels were substantially lower in 1993 than during the 1992 Whistlers camping season despite occupancy in the campground reaching the maximum during the months of July and August. During September 9 to October 18, 1992 when wood was available in large wood piles, average particulate levels were 104.6 $\mu\text{g}/\text{m}^3$ and 80% of the days sampled were above 50 $\mu\text{g}/\text{m}^3$. In 1993 when the selling of wood was initiated, the monitoring showed that average particulate levels dropped to 19.4 $\mu\text{g}/\text{m}^3$ with no days above 120 $\mu\text{g}/\text{m}^3$ and only 8.2% of the days above 50 $\mu\text{g}/\text{m}^3$. Figure 2 shows that during September 9 to October 10, 1992 particulate levels often increased with increasing occupancy in the campgrounds, while for 1993 during the same period particulate levels were much lower even though occupancy is higher than in 1992. Figure 2 also shows that even though maximum occupancy is often reached during July and August, a large number of days in September 1992 had particulate levels 25 $\mu\text{g}/\text{m}^3$. Figure 3 shows the emissions calculated from wood sales in Whistlers and Wapiti Campgrounds during 1993 camping season. In general, wood sales follow a similar pattern to occupancy in the campground. Although particulate levels are low in 1993, there are periods when particulate levels increase sharply and then decrease several days later. Increases in particulate levels correspond to increases in occupancy and wood sales in the campground.

Table 1. Particulate Levels in Whistlers Campground

Sampling Period	Average Particulate ($\mu\text{g}/\text{m}^3$)	Maximum Particulate Level ($\mu\text{g}/\text{m}^3$)	Percentage Days > 120 $\mu\text{g}/\text{m}^3$	Percentage Days > 80 $\mu\text{g}/\text{m}^3$	Percentage Days > 50 $\mu\text{g}/\text{m}^3$
Sep 9 - Oct 18, 1992	104.6	252.6	54.5	69.7	84.8
May 7-Oct 11, 1993	19.4	89.5	0	0.7	8.2
Aug 24-Oct 12, 1994	9.9	26.0	0	0	0
Note: 1992 and 1993 measurements were total suspended particulate; 1994 measurements were PM ₁₀					

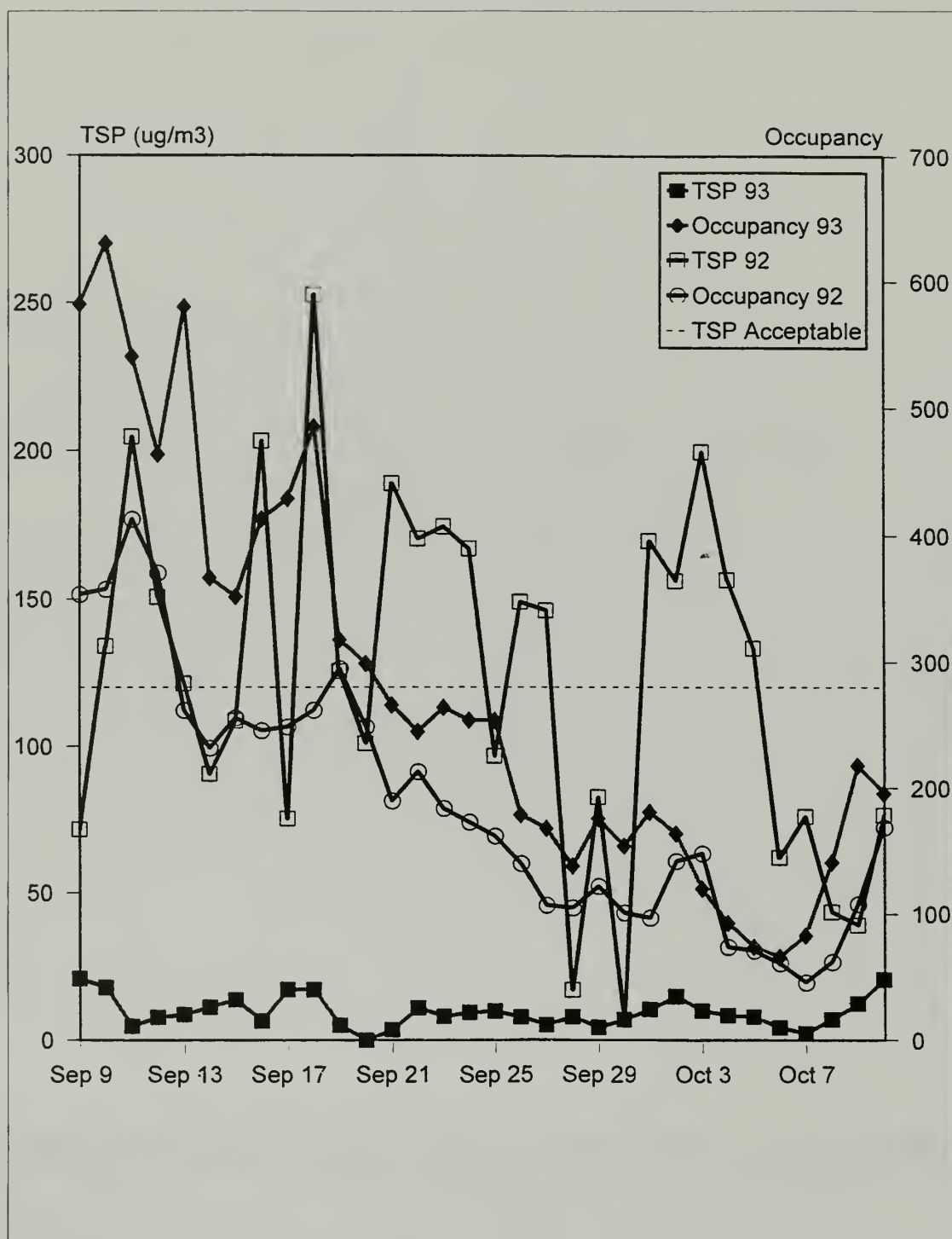


Figure 2: Daily total suspended particulate and occupancy in the Whistlers Campground during September 9 to October 10 of 1992 and 1993.

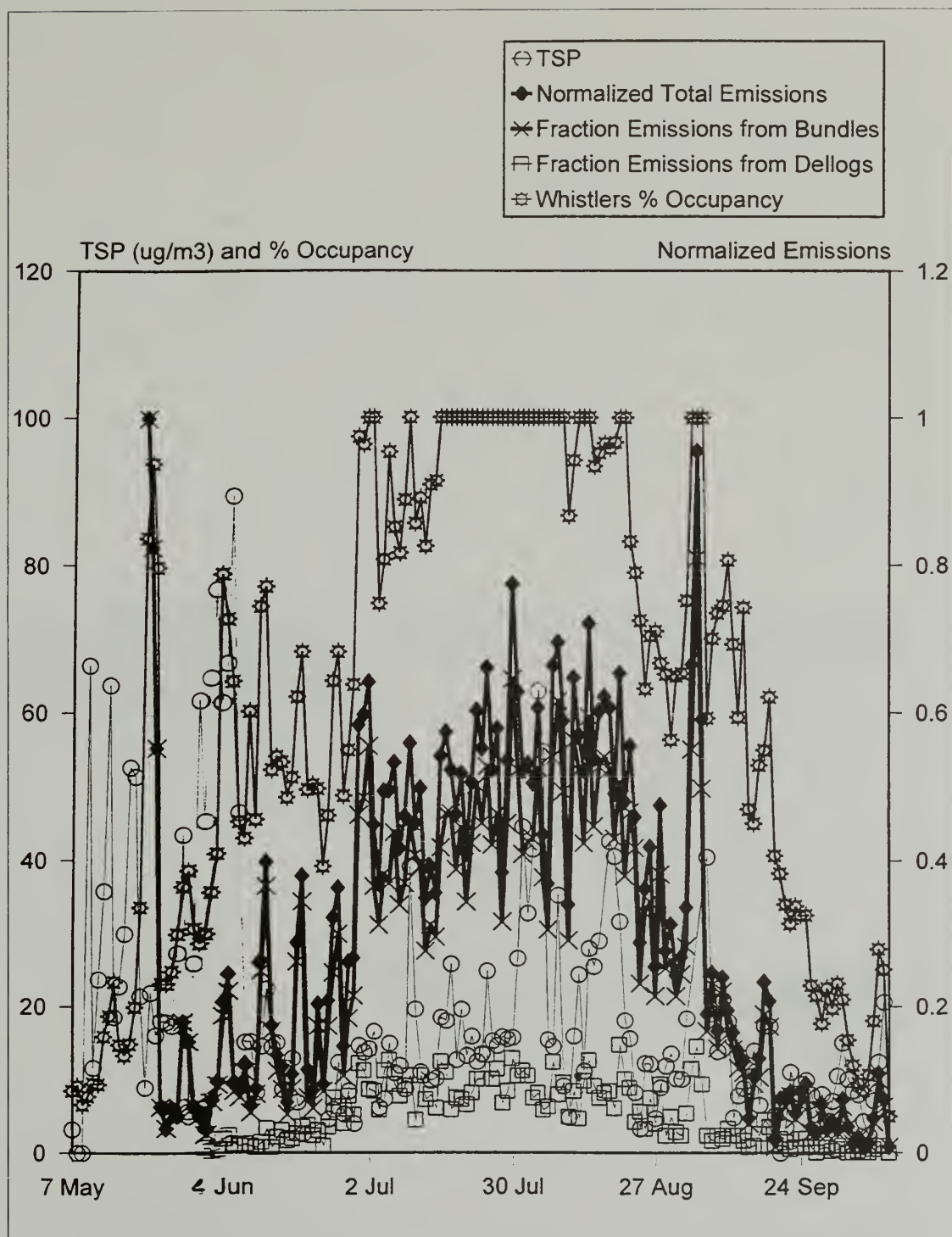


Figure 3: Daily total suspended particulate, and percentage occupancy in Whistlers Campground, and total emissions, emissions from bundles of wood, and emissions from dellogs for Whistlers and Wapiti Campgrounds, 1993

Although particulate levels have been reduced substantially, the presence of polycyclic aromatic hydrocarbons were observed in several samples taken during the 1993 camping season in the Wabasso and Whistlers Campgrounds. Analysis of the filter samples showed higher levels of PAHs than expected, particularly indeno (1,2,3-cd) pyrene, benzo (b) fluoranthene and benzo (a) pyrene, even though particulate levels were 20-40 $\mu\text{g}/\text{m}^3$. Natural level of particulate were expected to be $\sim 10 \mu\text{g}/\text{m}^3$ in this area. Figure 4 shows that benzo(a)pyrene concentrations are up to 0.20 and 0.96 ng/m^3 , and indeno (1,2,3-cd) pyrene concentrations up to 0.26 and 0.75 ng/m^3 (total PAH concentrations up to 1.48 ng/m^3 and 6.21 ng/m^3). The relative distribution of individual PAHs in Jasper National Park was also found to be different from other areas with high levels of wood smoke [Senes Consultants Limited 1993, P. D. Reid 1988, J. M. Dasch 1982] suggesting that other sources may be contributing to the PAH loading in the atmosphere in Jasper National Park.

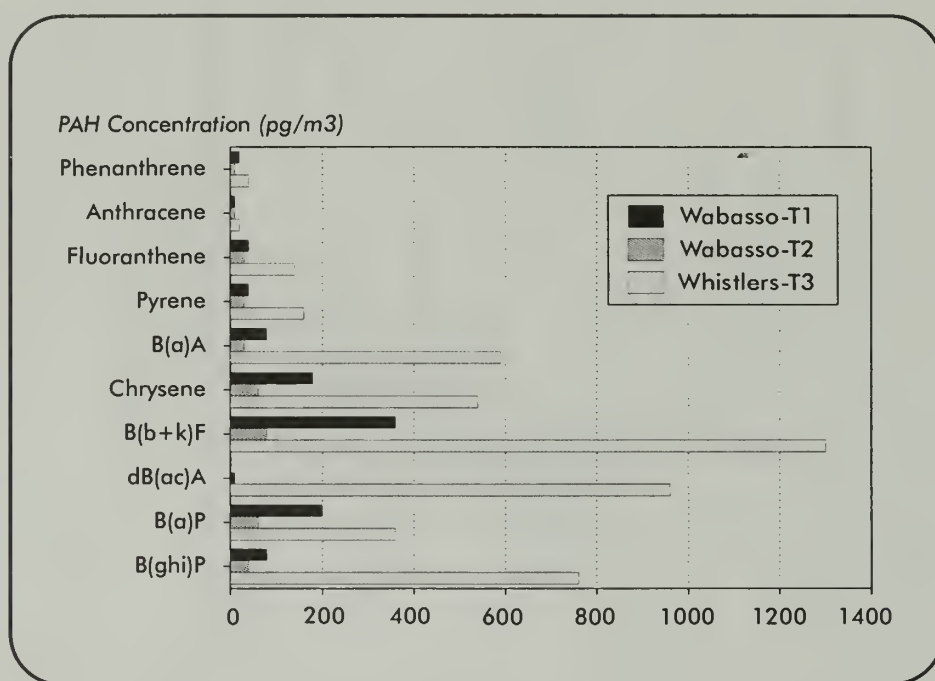


Figure 4: Particulate PAH Concentration for Whistlers and Wabasso Campgrounds (1993)

In order to obtain more information about levels of PAHs throughout Jasper National Park and the potential of transport of PAHs from Hinton, west of the park, where a pulp and paper mill is located, sampling of PM₁₀ and PAHs took place during February-March, 1995. This project is funded jointly by Atmospheric Environment Service, Atmospheric Environment Branch in Prairie and Northern Region, and Parks Canada in Jasper National Park with Environmental Protection, Pollution Measurement Division (Ottawa) and Chemistry Division, Environmental Technology Centre (Ottawa) involved in PAH analysis. Table 2 shows a list of the PAHs to be analyzed. The sampling will help identify sources of PAHs and background levels of PAHs and PM₁₀ in Jasper National Park. Table 3 lists the sites where PM₁₀ and PAH sampling took place and sites where wind data was obtained. Daily and weekly PM₁₀ and PAH samples were taken during

February-March, 1995. Snaring Warden Station and Miette Hotsprings are within Jasper National Park, while Jasper-Hinton Airport and Hinton Entrance airstrip are located between Jasper National Park and Hinton. Hinton Weldwood is the site where Weldwood collects continuous ambient air monitoring and wind data. Table 4 shows that these sites vary in elevation with Miette Hotsprings and Jasper-Hinton Airport having higher elevation. Wind speed and direction data was also obtained for Jasper townsite, Jasper-Warden Station, Jasper-Hinton Airport, and Hinton Weldwood.

PM10 samples were collected in the Whistlers Campground during the camping season of 1994 (August 24 – October 12). The sampling period was from 4 pm to 12 pm as the Campground survey showed that this was the period of maximum wood burning in the Whistlers and Wabasso Campgrounds (Figure 5). From the TSP/PM10 comparison made in 1993, it was determined that most of particulate in the Campgrounds was $<10\ \mu\text{m}$ in diameter and consequently particulate monitoring was changed from TSP to PM10. These samples were also taken to ensure that selling of wood in the Whistlers and Wapiti Campgrounds was maintaining the PM10 levels below $50\ \mu\text{g}/\text{m}^3$. PM10 samples taken during the 1994 camping season showed no days $>50\ \mu\text{g}/\text{m}^3$, a maximum level of $26\ \mu\text{g}/\text{m}^3$, and average level of $10\ \mu\text{g}/\text{m}^3$. Two of these particulate PM10 filter samples will also be analyzed for PAHs.

Table 2. Polycyclic Aromatic Hydrocarbons (PAHs) Measured Feb/Mar 1995

PAHs
Acenaphthylene
Acenaphthene
Fluorene
2-Methyl-Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo(a)Fluorene
Benzo(b)Fluorene
1-Methyl Pyrene
Benzo(g,h,i)Fluoranthene
Benz(a)Anthracene
Chrysene & Triphenylene
7-Methyl Benzo(a)Anthracene
Benzo (b&k) Fluoranthene
Benzo(c)Pyrene
Benzo(a)Pyrene
Perylene
2-Methyl Chloranthrene
Indeno(1,2,3-cd)Pyrene
Dibenz(ac)&(ah) Anthracene
Benzo(b)Chrysene
Benzo(g,h,i)Perylene
Anthanthrene

Table 3. Sampling Sites for PM10 and PAHs, Sampling Periods and Type of Analysis

Site Location	Sampling / Data Obtained
Snaring Warden Station	PM10 and PAHs
Miette Hotsprings	PM10 and PAHs
Jasper-Hinton Airport	PM10, PAHs, wind data
Hinton Entrance	PM10, and PAHs
Hinton Weldwood	PM10, PAHs, wind data
Jasper townsite	wind data
Jasper Warden Station	wind data

Table 4. Elevation of Monitoring Sites in Jasper-Hinton Area.

Site Location	Elevation (m)
Snaring Warden Station	~1100
Miette Hotsprings	1463
Jasper-Hinton Airport	1223
Hinton Entrance	1006
Hinton (Weldwood)	1014
Jasper Warden	1020
Jasper Townsite	1053

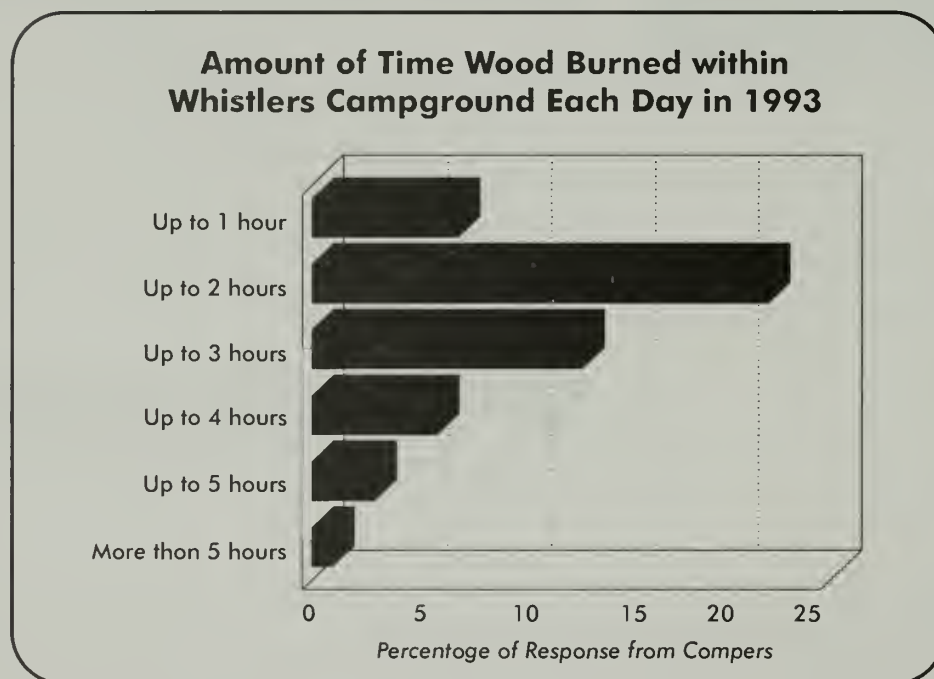
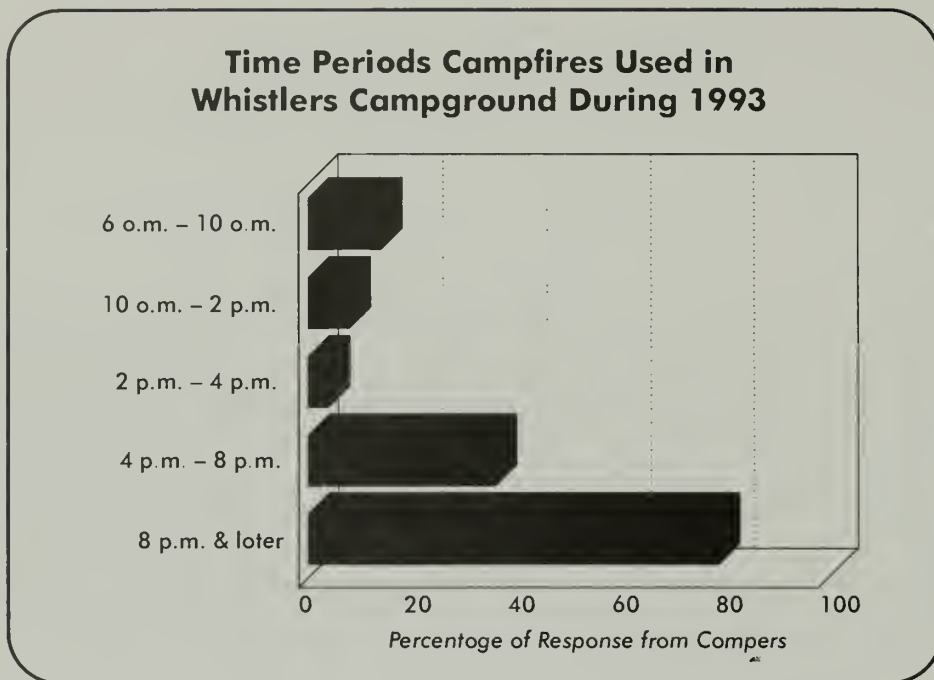


Figure 5: Wood Burning Patterns at Whistlers Campground, 1993

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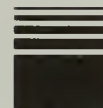
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Discussions: Questions and Results

INTRODUCTION

During Wednesday and Thursday, participants were divided into two groups and asked to deliberate on seven questions, each with several sub-questions. Each discussion group was led by a chairperson, and a rapporteur prepared a summary and presented it to the closing plenary session. Recording secretaries kept minutes. This summary is based primarily upon the rapporteurs' presentations. The minutes were used to add detail and context where necessary.

DISCUSSION THEMES

1. Air issues

Taking note of physical, chemical, biological and social effects, and global to regional issues,

- Identify and rank the air issues that affect national parks and protected areas, and
- What are the needs for air quality research and monitoring in national parks?

2. Education programmes

National parks present valuable opportunities to transmit messages to the visiting public and to public and private interests.

- Who are the audiences?
- What messages should be included?
- Who does what? What would be in an education or training action plan?

3. Exemplary practices

Leading by example is an important adjunct to education and lobbying.

- What sources of pollution do we recognize or contribute?
- What can each park and its stakeholders accomplish?
- What can be the roles of staff and visitors?

4. The Canada/U.S. Air Quality Agreement

An annex to the Agreement refers to preventing air quality deterioration in parks, and the need to consider the each other's protected areas in regulating air emissions.

- What is "significant" and what is the extent of "transboundary" for purposes of interpreting the Agreement for national parks?
- What obligations does the Agreement put on the two federal governments in general, specific departments, the two parks services, and provincial or state governments?
- What analyses and strategic plans should we formulate in this context?

5. Cooperative actions

- What opportunities lend themselves to cooperative actions?
- Who and what should be involved, e.g. academia and interest groups?
- What should be the balance between cooperation between the two parks services, between individual parks and their stakeholders, and between the parks services and other specialists and agencies?

6. Action plans for bilateral air quality management planning

We asked workshop members to share their views on how such cross-border collaboration will work best, particularly with regard to these points.

- Regional Air Quality Partnerships (RAQPs).
- Progress and lessons from the New England/Atlantic Canada RAQP.
- Defining "regional" in a geographic sense.
- Roles of non-government stakeholders.
- Proposals for future transboundary RAQPs.
- Strategies for Waterton-Glacier International Park and the Crown-of-the-Continent ecosystem.

7. Bi-lateral parks services air quality committee

If the group felt that there should be a bilateral committee, how would it function in relation to these points?

- Composition; what agencies should be involved; what type of membership?
- Five year action plans (conferences, consultations).
- Terms of reference.
- Should it be a working group, coordinating committee, or other advisory body?

RESULTS AND RECOMMENDATIONS

These themes and questions inevitably lead to a great deal of overlap and connectivity in the discussion. It is no surprise, therefore, that the groups produced comments and recommendations which transcend individual topics. Consequently, the results of the discussions appear here under action or output-oriented headings, chosen to reflect the manner in which they may be implemented. Some questions did not get resolved, such as defining “region” for the purpose of air quality partnerships.

Air issues

The workshop ranked air quality stressors in descending order of importance to park management. The order is based first on impacts on ecosystem health, then visitor expectations of clean air and long views, extent of the stress (global to local). Note that certain stressors cross-link to several effects.

High importance

- 1 Acid deposition and acidifying agents, includes SO₂, SO₄, NO_x, O₃ and volatile organic carbon (VOC)
- 2 Air toxics, e.g. Hg, organochlorines, Se, Cd, Pb, As
- 3 Visibility impairing substances, e.g. fine particulate, CO₂, SO₄
- 4 UVB effects on flora and fauna, especially sensitive fauna and high altitude lakes
- 5 Wildfire/smoke management
- 6 Oil and Gas Development
- 7 Fugitive dust

- 8 Global change, especially tropospheric warming, and related agents, e.g. CO₂
- 9 Overflights
- 10 Night sky (light pollution, haze)
- 11 Noise
- 12 Odour

Lesser Importance

This ranking should be used to guide the selection of topics for joint park service research and/or monitoring. Visibility (number 3) and pollutant deposition (numbers 1 and 2) were singled out, with special attention being given to high altitude lakes.

Education

Five audiences were targeted in terms of the probable effectiveness of national parks education programmes on improving in-situ air quality. They are decision makers, appropriate stakeholders, the media, environmental non-government organizations and parks staff at all levels. Lesser groups are the tourism industry, polluters, visitors, students, regulators and the general public, especially youth. However, it is important to match these audiences with the issues that are relevant to them. These could be their activities that cause air quality degradation, or air quality stresses that have direct impacts upon them. Education programmes should include ways in which the audience can reduce emissions or mitigate impacts.

Air quality education can be delivered through the customary range of media, including in-situ, interactive displays and interpretation programmes, press releases and newsletters. However, significant returns can also be achieved through staff training, especially at the management level, through partnerships that include opportunities for ecosystem stress identification and mitigation (e.g. greater park ecosystem cooperatives or co-management boards), and lobbying of curriculum developers in schools and universities.

Exemplary practices

- “Leading by example” contributes directly to improving in situ air quality for ecosystems and people, contribute marginally to improving regional air quality, and support education and lobbying goals by granting credibility to park organizations. The most effective practices are:
- Energy conservation, e.g. by heat storage and space heating.
- Smoke management, e.g. by curtailing or banning campfires, and using planned ignition prescribed fires which can be timed to conditions which minimize smoke.

- Transportation management, e.g. exhaust retrofits, fuel blending and switching to alternative fuels, such as propane and electricity, for park vehicles, curtailing the idling of bus and locomotive engines, controlling park access hours, and promoting park access by shuttle buses, bicycles and carpooling.
- Move infrastructure outside parks, with shuttles, bikes and vehicle restrictions inside.

National Lead

Given the continental scale of air issues and the common interests of park managers, there should be a standing liaison mechanism between the two park services. However, Parks Canada must first formally designate a national lead person, section or division before there can be a standing bilateral parks services air quality committee. Meanwhile, Natural Resources Branch can continue this role in an informal capacity.

Newsletter

At present there is no newsletter or bulletin for air issues in national parks. The discussants felt that it is important to keep resource specialists and managers in touch on this sort of issue, particularly during the early phases of a programme. The workshop recommended that Parks Canada should initiate or participate in an air issues newsletter. The workshop did not specify what form it should take. For example, though, it could be like the present one-page, near-weekly ecological monitoring electronic newsletter produced by Natural Resources Branch, or an Internet home page, or a joint effort with the U.S. NPS which could also include contributions by outside experts and other agencies.

Air Monitoring in Canadian National Parks

Many parks already have one or other air monitoring programme apart from standard meteorology, but there is no regional or national basis to this effort. Parks Canada should evaluate these programmes to report their results to a national audience, assess the need for common approaches and core measures, identify gaps in air issue or substance monitoring, and suggest links to reporting mechanisms and policy development.

Risk Assessment

The parks services should analyze the implications of air stressors for park ecosystems and species. Climate change, increasing UVB, acidification and other factors may change the nature of natural regions and the way that a park represents it. These air stresses may change the assumptions for vegetation management, may change the viability of many species, may change the scope for visitor experiences.

Bilateral Parks Services Air Quality Committee

Once a Parks Canada national lead and region and park counterparts are specified, a bilateral committee could initiate transboundary regional air quality partnerships and bilateral air monitoring programmes. It could prepare a North American national park situation analysis, develop joint park service air quality strategic and action plans, prepare joint submissions by the Assistant Deputy Minister of Parks Canada and U.S. National Park Service Director to the U.S.–Canada Air Quality Committee and the North American Commission on Environmental Cooperation. Submissions could include requests for assessment of transboundary air pollution, five year air quality reviews, and arguments in support of harmonizing air quality standards.

In the spirit of regional air quality partnerships, a bilateral committee should include representatives from outside the park services. In Canada, these include the Department of the Environment as having the relevant air quality research monitoring programmes, and selected provinces as having the main jurisdiction over emissions. In the United States, these agencies include the Forest Service, the Fish and Wildlife Service, the Bureau of Land Management, states and tribes.

Offer of Visibility Cameras

The U.S. NPS has offered to lend its visibility monitoring camera systems to Parks Canada. These cameras record perceived visibility and have proven useful to interpreting air quality problems to visitors and other agencies. Parks Canada should respond positively to this offer, but will need to fund their installation and operation. As well, photographic records of visibility only have a scientific base if they are accompanied by particulate samplers. Two or three visibility stations should therefore be accompanied by such samplers. A national study is needed to assess the costs and logistics to do this.

Join IMPROVE

Eventually, the workshop recommended, Parks Canada should join the Interagency Monitoring of Protected Visual Environments network led by the U.S. NPS. An IMPROVE site includes an instrument to measure light scattering and particulate samplers to provide a chemical analysis of aerosols in several size ranges.

Regional Lead for Air Quality Partnerships

The word regional has two meanings here. It refers to administrative regions in the context of persons and groups that would lead initiatives. It also refers to natural units, such as airsheds or greater ecosystems, which form the geographic extent of specific air quality partnerships. The North Atlantic Air Quality Partnership is an example, linking protected area and air monitoring agencies in Canada's Atlantic provinces and the US New England states.

The workshop endorsed this concept, adding that it does not need ongoing direction from a national committee. Rather, by not having a national air quality partnership committee it will be easier to keep a community perspective and involve provinces, first nations, cooperating associations and industry representation. U.S. NPS experience shows that a national lead is needed to bring the parties together, but then the partnerships quickly become self-propelled and need no further close support.

A Partnership should be led by a Board of Representatives or Working Group consisting of air quality specialists and managers at each agency's regional level, plus field unit managers and natural resource specialists. The Board would produce a strategic plan describing mutual benefits of the partnership, define roles and responsibilities, and contain commitments by senior managers.

The Board would create Issue Teams consisting of some of its own members plus other stakeholders on a case-by-case basis. These stakeholders include industries, political bodies, non-governmental organizations, universities and the local and regional public. The Issue Teams would produce specific products such as air issue assessments, provision of links to other sustainable development actions, and define quantifiable goals for air quality initiatives.

Park Level Working Groups

Individual national parks may need to form ecosystem-based, multi-disciplinary working groups to support their contributions to regional air quality partnerships. This may be by directing an air quality management plan for a park and its greater ecosystem. Air quality management plans include strategies for educating the public, influencing regional polluters, ensuring that park staff and visitors are not subject to air quality levels which contravene national standards (e.g. some campfire situations), and selecting and implementing exemplary practices.

Waterton-Glacier International Peace Park

A regional air quality partnership should include the Crown-of-the-Continent ecosystem. The area receives pollutants from prescribed natural fire, prescribed planned ignition fire, coal mining and thermal power plants, oil fields, urban areas, aluminum plants and fugitive dust.

Air issue research needs for the Crown-of-the-Continent were ranked as 1) ecosystem health, 2) human health, 3) ecosystem health in the parks themselves, 4) distribution of air pollution sources, and 5) relative contributions from natural sources.



Commentary and Recommendations: U.S. National Park Service Perspective

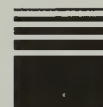
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The Air Issues Workshop was very successful. Representatives from Canadian and U.S. regulatory and land managing agencies gave presentations on their perspectives of a common problem, transboundary air pollution and its effects on protected lands. Through effective discussion, they made several recommendations to continue and enhance cooperative efforts to deal with that problem.

Several of the recommendations involve the National Park Service (NPS) and its Air Resources Division. One major recommendation was to expand participation in regional air quality partnerships. These primarily ecosystem oriented associations of land management and regulatory agencies and Indian nations collectively deal with regional air pollution impacts on protected lands. Several of these partnerships are presently being developed, while others have been proposed. At least three are international, with both Canadian and U.S. participation.

Other recommendations involving the NPS included: (1) participation in a bilateral committee (Canada-U.S.) to provide direction to partnerships, act as liaison with other agencies and stakeholders, and prepare joint submittals to transboundary agencies; (2) lending visibility monitoring cameras to Parks Canada; (3) suggested Parks Canada participation in IMPROVE, the NPS-led interagency visibility monitoring network; (4) establish a joint NPS-Parks Canada air quality newsletter (e.g., a home page internet link-up); (5) establish exemplary practices in U.S. and Canadian parks to improve air quality, such as adopting energy conservation measures, transportation management, smoke management, and moving infrastructures out of parks; (6) educating decision makers, stakeholders, media, environmental organizations, and park staff on air quality issues; and (7) conducting joint air quality monitoring and effects research.

A follow-up air issues workshop was not suggested. Instead, it was suggested that the Third International Conference on Science and Management of Protected Areas, to be held in Alberta in May 1997, contain an Air Quality Session at which reports could be made on progress in implementing the various recommendations of the Second Air Issues Workshop.



Recommendations for Parks Canada

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Some of these recommendations were made explicitly by presenters and discussion groups. Others flow from ideas and opportunities presented during the workshop. Despite some repetition of other sections of these proceedings, I have amalgamated them here to help provide direction to Parks Canada in pursuing air quality initiatives. Their inclusion on this list does not commit Parks Canada to any specific item, although Natural Resources Branch may follow some of them starting in 1996.

National lead. Given the continental scale of air issues and the common interests of park managers, there should be a standing liaison mechanism between the two park services. Parks Canada should formally designate a national lead person, section or division before there can be a standing bilateral parks air quality committee. Meanwhile, Natural Resources Branch can continue this role in an informal capacity.

Newsletter. Parks Canada should institute an information bulletin on air issues. The workshop did not specify what form it should take. For example, it could be like the present one-page, near-weekly ecological monitoring electronic newsletter produced by Natural Resources Branch, or an Internet home page.

Evaluate present air monitoring. Many parks already have one or more air monitoring programmes apart from a standard meteorology station, but there is no regional or national basis to this effort. Subject to 1996-97 work plan approval, Natural Resources Branch will evaluate the results of this monitoring and recommend future directions.

Risk assessment. Climate change, increasing UV-B, acidification and other factors may change the nature of natural regions, may change the assumptions for vegetation management, may change the viability of many species, and may change the scope for visitor experiences. Parks Canada should analyze the implications of air stressors and global change for park ecosystems and species.

Bilateral parks air quality committee. Once a national lead and region and park counterparts are specified, a bilateral committee could provide direction to regional air quality partnerships, to national air monitoring programmes, and prepare joint submissions by the ADM and U.S. NPS Director to the U.S.–Canada Air Quality Committee or the North American Commission on Environmental Cooperation. Submissions could include requests for assessment of transboundary air pollution or 5-year air quality reviews.

Offer of visibility cameras. The U.S. NPS has offered to lend visibility monitoring cameras to Parks Canada. They record perceived visibility and help to interpret air quality problems to visitors and other agencies. Parks Canada should respond positively to this offer, but will need to fund their installation and operation. Photographic records of visibility only have a scientific base if they are accompanied by particulate samplers. Two or three visibility stations should therefore be accompanied by such samplers. A national study is needed to assess the costs and logistics to do this.

Join IMPROVE. Eventually Parks Canada should join the Interagency Monitoring of Protected Visual Environments network led by the U.S. NPS. An IMPROVE site includes an instrument to measure light scattering and particulate samplers to provide a chemical analysis of aerosols in several size ranges. Even though the IMPROVE network is currently being scaled back, a limited number of Parks Canada sites would enhance the network and bring Parks Canada into full participation in North American air quality improvement.

Regional lead for air quality partnerships. The workshop endorsed this concept, adding that this does not need a national committee to direct. Rather, by not having a national air quality partnership committee it is easier to keep a community perspective and involve provinces, first nations, cooperating associations and industry representation. U.S. NPS experience shows that a national lead may be needed to bring the parties together at first, but then the partnerships quickly become self-propelled and need no further national guidance. Note that the word regional has two meanings here. It refers to administrative regions of persons and groups to lead initiatives. It also refers to natural units, such as airsheds or ecosystems, which form the geographic extent of specific air quality partnerships. The North Atlantic Air Quality Partnership is an example, linking protected area and air monitoring agencies in the Atlantic provinces and the New England states.

Park level working groups. Canadian national parks may need to form ecosystem-based working groups to support their contributions to regional air quality partnerships. This may be by directing an air quality management plan for a park and its greater ecosystem. Air quality management plans include strategies for educating the public, influencing regional polluters, ensuring that parks staff and visitors are not subject to air quality levels which contravene national standards, e.g. some campfire situations, and selecting and implementing exemplary practices.



Workshop Commentary from Environment Canada

Environment Canada is a science-based organization whose mission is to provide leadership in the achievement of sustainable development. In her recent Action Plan 1995/96 – 1997/98, Environment Minister Sheila Copps has committed to three primary goals. The first is to reduce risks to human health and the environment through national strategies and leadership in the international community. Secondly, by providing timely warnings of severe weather and environmental emergencies, risks to life and property will be minimized. Lastly, there is the commitment to give Canadians the tools they need to make environmentally-responsible decisions and thus build a greener society.

Three main priorities came out of the discussions at the Parks Canada/U.S. Parks Service workshop this spring: research, partnership, and education. Environment Canada's Action Plan addresses all three of these priorities.

Environment Canada will give priority to research on long-term and serious risks including loss of species and the capacity of ecosystems to regenerate or adapt to changing conditions. The focus will be on major ecozones, each with research and management plans which will go to stakeholders for review. It is very important to have regional and national Parks Canada involvement in the consultation. This process can address some of the specific concerns raised in the discussion groups such as the risk assessment for global air issues, the effectiveness of the existing monitoring networks and the integrated analysis of ecological data. Also, scientific support of international agreements is important to critically assess the information that goes into an agreement, identify the impacts of it, and investigate the success of its implementation.

Partnership is the cornerstone supporting work on the environment. The combination of Environment Canada's science and Parks Canada's public outreach programs offers a unique opportunity to address the complexity of air issues in the physical context of Canada's National Parks. With all sectors experiencing resource restrictions, partnership can help to make the most effective use of those resources. A key point from the discussions was that mutual understanding of the issues can only be attained through effective communications at the regional, national and

international levels. Environment Canada has a strong commitment to cooperation that will be paramount for the future. As an example, Environment Canada has sponsored with Natural Resources Canada a challenge to all government departments to take action on energy efficiency with the goal of decreasing greenhouse gas emissions from federal operations. Parks Canada has an opportunity to be an exemplary partner by meeting this challenge.

To ensure the long-term sustainability of the environment and our society, Canadians need the tools to make decisions that are environmentally responsible. Education is the key to achieving this goal whether the audience is government policy makers, industrial managers, youth, or the media. The discussion groups stated that when people visit the national parks, they expect clean, clear air. Their heightened interest in the environment provides an opportunity for the parks interpretive centres to educate visitors about air issues everywhere. An Environment Canada/Parks Canada partnership may help to ensure that people are receiving timely and accurate information in a format that encourages learning.

From the results of the discussion at the Waterton workshop, it is clear that the goals of Environment Canada and Parks Canada are similar with respect to air issues. This is a period of great change for Environment Canada and the entire federal government. We are changing the way we do business to be more efficient and effective. There is great opportunity for our departments to strengthen our partnerships at the regional, national, and international levels, and to bring the expertise from both departments together to tackle the complexity of air issues. Renewed cooperation between Environment Canada and Parks Canada will provide the confidence and commitment needed to reach beyond our borders to international relationships.

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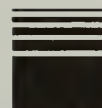
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Narratives

The following are narratives that were constructed using the verbatim minutes from the two discussion group sessions. These sessions led to the rapporteur summaries and recommendations that are included in these proceedings. The narratives describe in more detail how those summaries and recommendations were established. It should be noted that these narratives should not be taken as verbatim transcripts of the discussions.

International Air Issues Workshop — Group 1 **Chair: Neil Munro**

1). Action Plans for Bilateral Air Quality Management Planning

The group felt that any action plans must be designed by individuals with the same goals. Goals and objectives should be jointly developed. Consultation with as many stakeholders as possible should take place. There must also be a commitment from the political and/or senior management level to any joint action plans that may be developed. Moreover, from the U.S. perspective, issues must be found in which the U.S. Environmental Protection Agency and the U.S. National Park Service could get involved.

It was mentioned that both countries should rely on the information provided by outside air quality experts, and further that cooperation on information exchanges should be maintained; it would make no sense to duplicate programs on both sides of the border when the information could instead be shared.

It was also mentioned that Canada does not have any policy or basic information in the area of air quality as it relates to protected areas, although it is considered an important aspect of ecological monitoring. Benchmarks should be developed.

One method of approach discussed was to focus monitoring efforts on particular areas to identify stressors; using source receptor modelling, the sources of these stressors can be discovered. This information could hopefully be used to influence policy-makers on both

sides of the border. It was noted that there is not a lot of information available; monitoring programs are being developed to a level at which useful data can be generated over a larger-scale geographical area in order to generate more interest.

One opinion expressed was to the effect that a lot of differences in policies and programs currently exist, and in the interpretation of laws. Adding new programs would not be as good as making better use of existing programs.

Another suggested possibility was to focus on visible air quality issues, such as ultraviolet B radiation (UVB). The priority should be on research and monitoring.

It was suggested that perhaps one appropriate bilateral institution would be a committee or group with membership from both countries. However, it was equally stressed that leadership must come from people with a strong interest in the issue, to guide the program, and develop a project plan. This was seen as doubly important because one problem is that many people do not see air quality as a big issue; leaders need to connect the issues with the people. The project plan that is developed should be visionary, linking ambitious goals to realisable objectives. Expectations should be realistic, and specific goals and responsibilities should be known.

It was stressed that partners in the plan would have to be identified.

The issue of how to fund joint or bilateral actions or plans was raised.

The group discussed how to define the local region with respect to bilateral actions; one definition described the Crown-of-the-Continent as stretching from the Crowsnest Pass in Canada to Highway 200 in the USA. Another suggestion was to start in the impact area and radiate outwards. Another was to look at it from a park and a community point of view.

Mention was made of developing liaisons with eastern groups that have relevant experience.

The group also stressed that education is very key in developing responsibilities and building public awareness.

2). *Bilateral Working Group or Coordinating Committee*

The first question asked was why it was necessary to have a committee. The idea, according to one group member, was driven by Federal Land Managers in the USA, who have a responsibility to deal with visibility, Prevention of Significant Deterioration (as specified in the Air Quality Agreement), and generally need to deliver on promises made in the Air Quality Agreement.

One suggestion was to establish a regional approach to deal with existing sources. Its composition was questioned, and it was suggested that federal land managers in both countries would be included. However, the group should be kept consistent with government. While it would be very difficult to include non-governmental organizations,

in one committee member's opinion, it would be important on the Canadian side to include Environment Canada. Environment Canada has an air quality branch, which does not exist for Parks Canada.

Adding industry to the group/committee was discussed. One suggestion was to include industry in a discussion of the issues rather than in the working group. Provinces should also be included in a regulatory sense.

The role this group should play was considered. One suggestion was to use it to provide the best possible information and advice to regulators (such as the states and their governors). Another was that a lobbyist was needed to ensure that those in power will support the group's endeavours. Some members of the committee might have appropriate contacts with government.

Who the decision-makers are was discussed. One point was that all concerned parties should be informed and influenced. Federal as well as state and provincial governments all have a role. When looking at existing sources (of pollution), the higher levels of government should be included.

The goal of this working group, it was proposed, was to produce an action plan, in one group member's opinion. Another member suggested having a partnership, because organizations are a larger threat than a single individual and there is strength in numbers. Such a partnership should be defined in an official capacity by senior officials from both countries. Existing partnership models did not develop plans until after the partnership had been formed for three or four years.

By contrast, it was pointed out that it is hard to measure success or progress without a plan. Other suggestions included having a rough plan to monitor progress or a plan based on a memorandum of understanding.

It was stated as being important to have some guiding principles, which could be generic at first, and become more specific on an issue-to-issue basis. The working group's role would be to 1). conduct a situation analysis, 2). develop a strategic plan, 3). develop an action plan. The definition of a problem, it was stated, should include a general broad background.

Under this model, it was mentioned, the same partners would work on the same problems. At the beginning, the group should look at a reasonable allocation of resources, which would be included in the situation analysis. Plans that become too large and expensive have no chance for approval. One sentiment was that there has to be some sort of institutional commitment from the beginning.

The working group or partnership should seek out partners and consult with other stakeholders, but leadership should be assumed by the government agencies. In Canada, it was pointed out, regulatory authority lies within the provinces, with federal guidance (ie. the provinces may be more strict than the federal standards, but not more lenient).

Stakeholders should be included and given the opportunity to participate in whatever ways they could help. It was stressed again that federal and state/provincial authorities would always have management responsibilities.

3). *The Canada-U.S. Air Quality Agreement*

With respect to sub-points 1 and 2 in this section, the group referred to Annex 1 , Part 4 of the AQA, and points 1 and 2 above, respectively.

It was felt that the group should focus on significant issues in the Waterton-Glacier area that could be addressed in a discussion of the AQA. Broadening this definition to include the Crown-of-the-Continent was suggested.

The area was described as a receiver of pollutants from: prescribed natural fire, management-ignited prescribed fire, coal mining in British Columbia's Elk Valley, oil fields in Alberta, and urban pollution in Vancouver. Other emission sources include aluminum plants, fugitive dust, and thermal power plants in the Elk Valley. Acid deposition is also a factor in the region, as it has low buffering capacities.

The group considered whether visibility and ground-level ozone are factors in the region, as well as ultraviolet B radiation (UVB) and its effects on human health and on animals. It was suggested that the best approach on these issues would be to monitor and educate.

Another topic of discussion was areas that are subject to transboundary political and legal conflicts. One group member stated that some things can be done in one country which would not be acceptable to the other. The Prevention of Significant Deterioration clause of the Air Quality Agreement was suggested as one of these. One example cited was that British Columbia has higher allowable levels (of pollutants) than does the U.S. Environmental Protection Agency, creating a problem when emissions cross borders. A possible solution suggested was to harmonize laws in Canada and the United States. Another was inter-park cooperation; similar agencies in both countries could support each other, given early enough notice.

4). *Cooperative Actions*

The group felt that the topics listed under this section were adequately covered in the other sections.

5). *Exemplary Practices*

6). *Education Programs*

One argument was that the agencies involved have a very important communications function. There should be an internal journal to contact all those involved in air quality at all levels, and an information system. It was suggested that a group of four or five people should be established to communicate with federal and provincial/state governments,

universities, consultants, and the public. Holding public hearings by zone in terms of pollution, in order to determine priorities, was one method of public involvement suggested.

A precedent exists in the United States for a concerted communications campaign. A video was developed to provide education on pollution in Sierra Nevada. The proposal was accepted, and was given a grant of \$34,000. The video was made humorous and upbeat in order to appeal to high school teachers and students. Its message was “Only you can protect air quality”. Teachers were also supplied with educational background material as well as an evaluation form. One remark about this project was that consensus was difficult to achieve. Another was that once the video was created, the National Park Service was required to track its use.

One delegate stated that Environment Canada has much by way of funding that is not used.

The group agreed that using multimedia was probably the best way to get a message across; people want to see things as well as read them. There was some discussion about which media would be the most appropriate. Television was mentioned, as was the “most read magazine in North America, Reader’s Digest”. Mention was made of the successful acid rain message which was conveyed at times through interpreters’ videos. Interactive display was also suggested.

The group also discussed environmental education — using the park as a classroom. The State of Montana already requires a certain number of hours of environmental courses in its curriculum. Reference was made back to the Sierra Nevada video, where members of the partnership that put it together went to schools when it was shown. This set a good example for parks.

Another suggested angle was to educate industry and permitting authorities, which were described as equally important. A suggestion was to meet with industry to educate them of the standards that need to be reached, without preaching.

It was further suggested that internal staff should also be educated; convincing managers to follow emission-reduction plans is a hard task.

The group considered the fact that the public is often unaware of science and research carried out in national parks. The public is more interested today in the issues, but agencies are losing their ability to do interpretive work, due to funding cutbacks. Canada’s National Office of Interpretation had its offices reduced or eliminated. One delegate suggested that programs are suffering due to lack of direct access to senior management. Another felt it important to gain a rapport with upper management.

One idea was to make a list of creative funding sources; it was felt that there are many potential sources of funding available, and they should be explored.

7). *Air Issues and Research Needs*

The following suggestions were made with respect to what research needs exist:

- studies and impact assessments of pollution effects
- more emphasis on biological and physical effects — hard sciences as opposed to visual effects (such as Jeffrey and Ponderosa pines which are highly affected by ozone)
- ecological information analysis: biophysical data on an area
- GIS technology
- effects on human health
- biophysical inventories and status
- ecological processes (such as the effects of UVB on surface waters, which is known to produce hydrogen peroxide, an artificial stressor)
- system-wide stressors as well as point sources
- emission factors research for better smoke management
- land use change on an ongoing basis
- regional aspects to land use ecology; land use planning and monitoring
- ground level ozone
- global warming
- identification of air pollution-sensitive species
- sources of pollution

One suggestion was to decide on what equipment would be required to collect the necessary data, and decide who may utilize it. This could be part of a situation analysis or problem identification.

Another remark was that priorities will vary based on geographic location.

One concern that was raised was smoke management techniques; they need better implementation. Another was the need to be involved with land use management agencies.

The group was able to rank research issues for the Crown-of-the-Continent, and came up with the following list:

- 1). Ecosystem health
- 2). Human health
- 3). Ecological health in parks which depends on air quality
- 4). Air Quality-Related Values potentially impacted by air pollution

- 5). Geographic: whether sources are global, regional, or local
- 6). Contributions from natural sources which need to be understood

The last points made by the group was that Parks Canada needs air quality monitoring infrastructure, and that the group members were mandated to manage their respective lands. It was felt that they must show their bias to protect those lands and their contents.

International Air Issues Workshop — Group 2

Chairs: Janet Wise & Ian Church

- 1). *Action Plans For Bilateral Air Quality Management Planning*
- 2). *Bilateral Working Group or Coordinating Committee*

Initially, some delegates questioned whether a committee should be formed until a focus is established between agencies. If a standing committee is formed it will have no focus and accomplish nothing. An institutional commitment is what is required.

One query was whether a coordinating committee would be more effective at the regional level rather than at the national level; possibly it would be able to take quicker action and get things done. This idea received support, particularly from those working in the field. It was further mentioned that regionally strong, dedicated bilateral committees would require people to act as leaders who were dedicated to the issues at hand. However, another delegate cautioned that it would not be economically feasible to have one person working full-time on the issue; having a person devoting half of their time might be more practical.

Prior to establishing an international working group, it was argued, an institutional structure needs to be developed in Canada, to deal at the international level. Continuing to pursue existing regional relationships was also seen as important. One example offered was the Northeast Air Quality Committee. A cautionary note was expressed here: people need to view the Northeast Air Quality Committee as a work-in-progress, according to one group member. People should learn from it, but modelling it was not recommended. This point was used as evidence that the issue of air quality needs a focused person to deal with it on a regular basis.

- 3). *The Canada-U.S. Air Quality Agreement*
- 4). *Cooperative Actions*

One initial question from a group member was with respect to the objective of this section. Suggestions included having a discussion about the potential for information and equipment exchange or exchanging opinions about what existing or previous park exercises have yielded by way of results. Another response suggested discussing the use of national parks as sample sites. One delegate stated that if Canada could provide the U.S. with the appropriate information on air quality, U.S. park officials would be more than happy to

incorporate it into a monitoring data report. The reports would mean a lot more with different sites included rather than with just one. Any interested people could be provided with completed reports.

The sole concept of cooperating across the border was cited as a valid point, with the added point that the East has experience with this issue. However, it was suggested that before the U.S. and Canada can exchange information and cooperate, Canada should establish a point person to deal with the issue. Environment Canada has such a person, it was stated, but Parks Canada delegates felt that someone specific to their agency was needed in order to deal with the U.S. on the issue, to facilitate cooperation, and to become a member of the Canada–U.S. sub-committee. Another delegate remarked that each province has different ways of collecting data, and that Canada needs a common system for collecting and storing information in order to be effective. Any organized approach would work, but no work has been completed towards this. Environment Canada and Parks Canada do share the same database, and have an information exchange of the Emissions Inventory.

One suggestion for a recommendation was that agencies from both countries should form a joint proposal for cooperative relationships. Another was that the Canadian Federal-Provincial Parks Committee should annually submit a report on how the provinces are dealing with air quality issues.

One delegate professed a lack of awareness of an agreement to protect air quality in protected spaces under the Air Quality Agreement. It was remarked that the commitment is not all that strong, but that in 1995 is being conducted. A recommendation was for park staff in both countries to push for strengthening the transboundary assessment of the Air Quality Agreement and the North American Commission on Environmental Cooperation. Both the AQA and NACEC were cited as good ways to establish such an assessment.

The question of how to maximize utilizing people closely related to the issues was asked. One suggestion was to forward information about the issues to the Federal–Provincial Parks Committee because it has a high profile and gets lots of attention. Further to this idea, the group was informed that a meeting between the Assistant Secretary (U.S.) and the Assistant Deputy Minister (Canada) should result in some cooperative agreement and get a proposal on the agenda for the five year review of the Air Quality Agreement and the Trilateral Transboundary Agreement under NACEC. It was also suggested that any proposal should involve both science and policy.

Where air quality is concerned in the parks, it was felt that one problem is the lack of information that is getting to park managers. To solve this, they need to get regular, concise reports. This was for the U.S. parks; Canadian delegates brought up the point that Parks Canada does not have a program to focus on air quality issues which could provide that information to park managers.

One potential solution was to identify the appropriate roles and responsibilities at various levels, and determine where the communication needs between those levels exist. The use of newsletters and email links, was discussed; one suggested recommendation was to create

a U.S.–Canada air quality newsletter for protected spaces, while another was to look at electronic communications. One delegate commented that based on experience using the Parks Canada publication *Research Links*, having more of that kind of information would be a bonus to field workers, as would the existence of a point person.

5). *Exemplary Practices*

Roles of Staff and Visitors

According to one delegate, some parks in the United States have their own air quality programs. These determine contributors to air quality problems, and then the parks can arrange for the sources to clean up air quality within the park. Problems arise when other departments become angry when the Park Service takes this action. To solve this problem, one group member offered the idea of having regional instead of park-specific programs to solve this problem.

Other suggestions were to form multi-functional ecosystem working groups at the park level.

A discussion on various exemplary practices brought forth some examples. These examples involve energy conservation, and tie into education programs as well, it was remarked. Some communities have cut down on fuel to clean up the environment. British Columbia has the National Energy Association in the Golden District. Some parks in the U.S. have banned camp fires at certain times of the day, which helps with visibility.

Another problem that was identified was the tour bus industry. The Grand Canyon has reduced the amount of buses allowed, and greater use of propane and electric buses is being seen. In general, cleaner-burning fuels are being investigated, it seems according to some delegates.

The U.S. master plan for large parks, further, has the long-term goal of keeping all cars out of the park and limiting access to shuttle buses. Some parks were identified as already having this system, but the existing efforts do not cover entire areas and do not particularly cut down on emissions.

A recommendation for this section was identified as transportation management.

6). *Education Programs*

The following audiences were identified:

- Park managers
- Decision-makers
- Students

- Appropriate stakeholders
- Media
- Environmental community
- Tourism industry
- Polluters
- Park visitors
- Internal park staff and management

The question of who should be targeted was immediately asked.

The reason for an education program, it was argued, is to protect park resources. Another was simply to use it to achieve the desired results. One suggested recommendation was to recognize issues and make informed decisions. A discussion on what the desired results are ensued. Desired results depend, it was mentioned, on the issue and the scale of the issue, and on the publics involved.

One opinion was that concerns should not be limited to people who spend time in parks, but rather everyone is a stakeholder. Two of the identified major stakeholders include the general public and decision-makers. An immediate suggestion was to develop education programs from kindergarten to grade twelve to facilitate these major stakeholders throughout their lives.

With the issue of visibility there are specific stakeholders, in one group member's opinion. One idea was to take the issue of visibility and find a target audience.

The group discussed the tourism industry. The industry's clients need to know that they can be guaranteed a quality experience. Some delegates pointed out that the industry has been involved in the past and has no stake in the bad experiences. However, a quality experience was seen as important to the tour operator. Getting the industry involved would be beneficial to both the industry and to the parks.

Where decision-makers are concerned, one delegate pointed out that their motivation comes from the confidence of knowing that whatever decision they make will reflect favourably on them. The delegates' job is then to inform the electorates of the issues, and the electorates can in turn inform the government. One group member reported that it has been found that park employees are believed over any other information source; park staff were unaware that they had that kind of credibility.

The audience for an education program, it was re-stated, depends on the message. Another statement was that the situation is different in Canada as compared to the United States. Canada is not as focused on the issues. The question was then if the group should design an education program that people from both agencies could focus on together. A suggestion was to pick one audience, such as the tourism industry, and decide what could be done

jointly to present to the industry an information package. Some additional points on this theme were noted: cooperative efforts between the two parks agencies should be set up, and motivators and needs for each agency should be identified.

7). *Air Issues and Research Needs*

The following issues were identified:

Regional air pollutants and their effects on resources (such as acid deposition effects on high elevation lakes, visibility). The effects of ozone on human health, as well as the effects of NO_x, SO₂, and mercury. It was noted that mercury concentrations in fish are high, and are also high in some people. Health warnings have been issued before for organochlorides and selenium. One delegate reported that a meeting is upcoming involving environmental cooperation on persistent toxic substances.

Another expressed concern was ultraviolet B radiation, and global change. Global change is also affected by other global pollutants such as carbon dioxide and other greenhouse gases.

Three target pollutants were listed as cadmium, mercury, and lead, because lead has not yet been removed from gasoline on the U.S. side of this geographic area. It was noted that in Mexico concentrations of lead are very high. On the southern border of the United States arsenic is carried by the wind four months out of the year, and exceeds acceptable levels in Vermont.

Smoke was identified as a significant issue; a suggestion was to give it its own category. Another idea was to have a category on emissions and make smoke a sub-category.

Carbon monoxide was also cited as a major issue for U.S. national parks.

One question was what effects these pollutants are having on Waterton Lakes National Park and whether research has been done. Data is apparently available.

A suggested course of action was to go through the issues and list the research and monitoring needs of each, as well as identifying which more specific sites are of a concern to group members.

Rocky Mountain National Park was cited as an area where organochlorines are a problem, primarily due to urban emissions. Primary and secondary particles, volatile organic compounds, and direct emissions of carbon were also mentioned.

Urban car emission are becoming more of a concern and may contribute to urban emissions.

Another question of methodology posed was whether the issues should be prioritized according to importance or if the focus should be on issues of a transboundary nature.

High elevation lakes are an issue for Waterton, but it is unknown if UVB has an effect on plant and animal life. It is a large issue needing more work. Existing studies have been done under artificial conditions; it was felt that UVB was worth monitoring. UVB can also affect human health.

Organochlorines were also mentioned as an issue affecting lakes and that needs to be considered more closely.

It was reported that acid deposition is considered an important issue in the United States. Measuring the effects of acid deposition on lakes must be done over a long period of time. This demonstrates that pollutants are having a direct effect on the environment, and this is the easiest way to demonstrate it.

Which issues Canada is focused on and whether there are some issues that both countries can work on together was one question. The response was that visibility is an issue in Canada but it isn't as important as it is in the U.S. because the United States has legislation to deal with visibility, while Canada does not.

High Priority Common Issues

- 1). UVB
- 2). Acid deposition
- 3). Visibility
- 4). Toxics/ecosystem effects

For visibility, U.S. parks use cameras to extract information that can be seen, which are also used for extracting data. Slides were felt to be a very good method of defining the problem of visibility.

Finding common concerns for visibility was a stated goal.

Visibility in the mountain parks is linked to smoke according to Canadian delegates.

The group heard that organochlorides have been found in high elevation lakes in Banff and Jasper; it was deemed necessary to find out from where they came.

A suggested method was to narrow topics down to specific areas. One example offered was the issue of dealing climate change and species in an effort to protect biodiversity. Specific examples could be cited on this topic area. The proposed course of action was to let the species take care of themselves and monitor for change. This would need to be on a continental scale, and have the agencies responsible for protected species looking at their role in the process. Using the International Peace Park was another suggested dimension to this issue. A great deal of vertical species monitoring takes place in the park; monitoring what happens to these species could be used as useful indicators of pollution problems.

After discussing the need to work internationally and on a continental scale to protect biodiversity, the group agreed that global climate change was a concern.

Other general topics included ozone and oxygen levels, which, it was proposed, could be linked to acid deposition as one topic.

The remark was made that it is easy in a national park to define issues that we are concerned about, but taking them back to their root causes is the real issue.

A suggested proposal was to pick one or two issues that the group could deal with together that are common to both sides of the border. These issues would be ones that are known, where stresses can be measured, and that can be dealt with. Along the U.S.–Canada border there are very few stations that conduct measurements, with the exception of acid deposition. Visibility and deposition were both areas where it was felt that the U.S. could bring monitoring information and technology to Canada's attention. Canada would be interested in learning more, according to group members.

Monitoring of high altitude lakes was described as an area where Canadian agencies have done some work mapping airborne patterns, as well as with tissue, water, and soil samples. There is a desire to go further.

Toxic pollutants were considered to be another important issue. Annex 15 of the Air Quality Agreement is about airborne toxic pollutants. It commits both countries to decrease the pollutants that are affecting the Great Lakes. It is a very strong commitment, one that involves the territories of both countries. The known airborne toxics might be the ones about which suggestions could be made. A good list from which to start was thought to be Annex 15 of the Air Quality Agreement. The question was then posed: is it the group's role to suggest that Annex 15 be tied to the parks? Some delegates felt that this annex could be built upon from a protected spaces aspect. A network could be provided where monitoring facilities could be installed; park staff would be trained to maintain them. A partnership between environment Canada and the U.S. Environmental Protection Agency was suggested, and the policy could be to say that there is a network of lands in which the two countries work together.

A cautionary note was mentioned where the involvement of Mexico is concerned, as Mexico has very limited budgets. At the same time, it was stated that people are starting to recognize that there is a role for smaller countries.

Mention was made of the fact that Environment Canada was seen as a predator on Parks Canada in the early 1980s, but the relationship is now seen as much more of a partnership.

One delegate mentioned that a strong message needs to be sent concerning budget reductions; existing programs need to be kept.

One question was whether the group was talking about looking at joint efforts in the West, such as those that exist in the East, and if so the group should focus on issues that will have

an effect on such efforts. The response was that the group was not talking about harmonization. The issues being discussed were issues that threaten park agencies from meeting their agendas. The group was looking at partnerships to help parks meet their agendas, and at ways to facilitate information gathering that will satisfy current needs.

Taking a more basic view was offered as an option. One delegate suggested that two basic facts had been accepted: 1). there needs to be monitoring, something to focus on; 2). there needs to be baseline research to better define some of the issues. Another delegate offered a third vital issue: biodiversity and the need to come up with simple tools to measure an array of stressors. Existing monitoring, it was concluded, needed to be evaluated to see if it could solve a whole range of concerns, followed by an expansion, maintenance, or contraction of monitoring networks. Each region could identify where the gaps exist in its monitoring. A framework could be built between both parks services, and based on this a program could be developed.

One group member summarized that there were two objectives: regional and continental.



Selected Air Quality Publications and Videos

Clean Air Act, as amended (42 U.S.C. 7401 *et seq*)

Management Policies, U.S. Department of the Interior, National Park Service, 1988. Chapter 4:17-18,
AIR RESOURCE MANAGEMENT

Natural Resources Management Guideline, NPS-77, U.S. Department of the Interior, National Park
Service, 1991. Chapter 2, *Air Resources Management* (pp. 177-202)

Air Quality In The National Parks, Natural Resources Report 88-1, National Park Service, July 1988

Air Resource Management Manual, National Park Service, WASO Air Quality Division, October 1984

Colonial National Historical Park Air Resource Management Plan: A Prototype, National Park Service,
Natural Resources Report NPS/NRAQD/NRR-91/01, July 1991

“The National Park Service Air Quality Program: The Cutting Edge of Science in Resource
Protection”, Hauge, E.R., in *Proceedings of the First International Conference on Science and the
Management of Protected Areas*, Acadia University, Wolfville, Nova Scotia, Canada, May 1991, pp.
527-531

Impacts of Air Pollution on National Park Units, Hearings before the Subcommittee on National Parks
and Recreation, Committee on Interior and Insular Affairs, Ninety-Ninth Congress,
Washington, D.C., May 1985

*Transactions, Air Pollution Control Association's Specialty Conference “ Visibility Protection: Research and Policy
Aspects”*, Jackson Hole, WY, P.S. Bhardwada, ed., APCA, Pittsburgh, PA, 1986

Transactions of the AWMA/EPA International Specialty Conference on Visibility and Fine Particles, Estes Park,
CO, AWMA, Pittsburgh, PA, 1989

“The Effects of Air Pollutants on Wildlife and Implications in Class I Areas,” Maniero, T.G., Volume 7, Paper #92-150.05, in *Proceedings of the 85th Annual Meeting, Air and Waste Management Association*, Pittsburgh, PA, 1993

Transactions of the AWMA Specialty Conference on Tropospheric Ozone and the Environment II: Effects, Modeling, and Control, Air and Waste Management Association, Pittsburgh, PA, 1992

“IMPROVE – A New Remote Area Particulate Monitoring System for Visibility Studies,” Eldred, R.A., Cahill, T.A., Pitchford, M., and Malm, W.C., Paper #88-54.3 in *Proceedings of the 81st Annual Meeting of the Air Pollution Control Association*, Pittsburgh, PA, January 1989

“Air Quality Biomonitoring, California and Florida,” Jackson, L.L., Gough, L.P. Stolte, K.W., *George Wright Society Sixth Conference on Research and Resource Management in the National Parks and Equivalent Reserves*, El Paso, TX, 1990

Proceedings of Air Pollution Effects on Parks and Wilderness Areas, Mesa Verde National Park, May 1984

Proceedings of the 1992 Joint International Symposium on Air Pollution, Soil Microbiology, and Biotechnology of Forestry, Taipei, Taiwan, June 1992

Using Vegetation Biomonitoring to Assess Air Pollution Injury in National Parks – Milkweed Survey, Natural Resources Report Series 85-1, U.S. National Park Service, 1985

“Visual Air Quality and the National Park Visitor” Ross, D.M. and Malm, W.C., *Park Science*, Volume 6 (2): 14-15, 1986

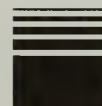
“Characteristics and Origins of Haze in the Continental U.S.,” Malm, W.C., Volume 33:1-36, *Earth Science Reviews*, Elsevier Science Publishers, B.V., Amsterdam, The Netherlands, March, 1992

Journal of the Air and Waste Management Association, One Gateway Center, Third Floor, Pittsburgh, PA 15222. (Annual Subscription rate: \$90 for nonprofit libraries and institution, \$15 postage outside the U.S.)

Atmospheric Environment, Elsevier Science Ltd., The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, U.K. (Annual Subscription Rate – North America: \$1 195-rates available on request for institutions which are library subscribers)

“Looking Through the Atmosphere” (videotape), National Park Service, December 1992

“Sites Unseen” (videotape), National Park Service, May 1993



Videotape Proceedings

All presentations given on Tuesday 6 June were recorded on videotape, one session to one tape, hence 6 tapes.

Tape 1

Opening session and national acts, agreements, policies and regulations – the U.S. Acid Rain Programme and Canadian Environmental Protection Act.

Tape 2

State and provincial acts, policies and regulations – Alberta, British Columbia and Montana.

Tape 3

Transboundary issues and national parks – the Air Quality Agreement and the two park service roles and responsibilities in air quality.

Tape 4

Other perspectives – a regional air quality partnership, U.S. Fish and Wildlife Service and U.S. Forest Service.

Tape 5

Monitoring programmes and management implications – United States National Park Service Air Quality Monitoring Programme and 2 case studies.

Tape 6

Monitoring programmes and management implications – Canadian programmes and two park case studies.

These recordings were used to prepare transcripts of some of the presentations for inclusion in these proceedings. A set of these video proceedings has been provided to each national park and regional office in Parks Canada, six copies to Environment Canada, and one copy to the Air Resources Division, United States National Park Service.

To obtain a copy of these video proceedings:

In Canada, please send 6 blank VHS T-120 tape cassettes to D. Welch, Physical Sciences Advisor, Natural Resources Branch, Parks Canada, 25 Eddy Street, 4th floor, Hull, Québec K1A 0M5.

In the United States, please send your blank tape cassettes to Erik R. Hauge, NPS-AIR, P.O. Box 25287, Denver, CO 80225-0287.

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