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Research and the Environment

Canada

From the Deputy Minister's office

Geneviève Sainte-Marie, Deputy Minister

I am pleased that the first issue of *Environment Update* to which I have the opportunity to contribute, is an issue devoted to scientific research. My last writing for the Department, more than ten years ago, had to do with research programmes, so it is with real interest that I accept this opportunity to comment on research from a somewhat different viewpoint.

Research, and the development of technologies and practices made possible by the new knowledge from research, provides the foundation for the services the Department offers to the Canadian public. In order to discharge our responsibilities as a Department, we must continually improve our understanding of the environment of Canada, of the effects of human activities on the environment, the consequences of environmental change, and the possibilities and further consequences of controlling unwanted changes. To obtain this understanding requires careful, focussed, and often highly sophisticated research. The examples of such research reported in this issue show the wide variety and interesting results of activities which are an essential part of Departmental programmes.

The Departmental investment in research is considerable. All in all, more than one third of our budget and of our workforce is dedicated to maintaining and improving our base of scientific information and understanding of the environment. The effectiveness of the Department as a whole is very closely tied to the pertinence, originality, and soundness of its research programmes.

The strengthening and successful management of the scientific knowledge base of the Department of the Environment in years to come presents us with many challenges, at a time when financial and personnel resources will be very tight for the foreseeable future. We must find a way of focussing adequate research efforts toward those issues that are of high public, political and economic priority today, while at the same time ensuring we undertake or have access to needed research in areas not presently in the public eye. Such research could give us advance warning of potentially serious problems before they become conspicuous.

We must find a way, in our annual justification for the Departmental budget, of recognizing that most environmental research does not lead to identifiable economic payoff in selected industries. It does, however, have enormous benefits to the country as a whole in reducing net industrial costs, in leading to more efficient use of land and renewable resources, in improving human health, and avoiding natural or human-triggered environmental catastrophes.

The Department of the Environment does not carry out its research and scientific activities in isolation. The Department's scientific units are part of the larger scientific community in Canada, and abroad. A high proportion of the Department's research is contracted to universities, non-government research institutes, and industry. In some cases, other federal sources augment the Departmental resources available for needed environmental research. Co-operative and cost sharing arrangements for research support and execution have been developed with the provinces and territories, each contributing what is most appropriate to meet the shared need for new knowledge. Close integration with other countries, particularly those with environmental problems similar to Canada's, is an essential part of our science programme.

The future holds many sobering challenges and exciting opportunities for environmental research in Canada. Each new environmental issue brings with it problems for which we cannot provide adequate answers without increased fundamental knowledge about its characteristics or processes. Our research needs are growing, at the same time that research results are more integrated with our policies, regulations, environmental information and prediction systems. Within the Department, we must find ways to meet these challenges and problems, without expectation of greatly increased resources. The examples of research presented in this issue show some of the ways that we are succeeding in this complex task to produce new knowledge which is vitally important to the Canadian environment and to all Canadians. I am pleased to bring these to your attention as examples of the wide range of the Department's work. They are a reminder of the challenge that lies ahead, and the responsibility of each employee, and indeed every Canadian, to make the best possible use of environmental knowledge.

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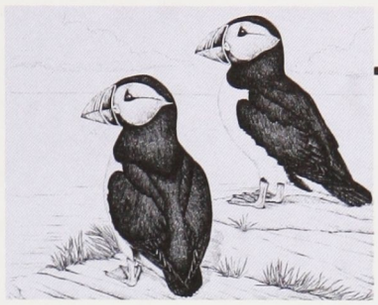

Update

The World has witnessed in the last several years, the growth of an environmental ethic. Canadians and Environment Canada have very much been a part of this growth. In keeping with its mandate, Environment Canada has always worked hand-in-hand with all those who strive to protect and to enhance the environment.

It is in this context that the Communications Directorate publishes *Environment Update* four times a year.

Each issue of *Update* features a specific environmental topic and contains articles from all parts of the country in order to highlight the various services and projects carried out by the Department. Anyone wishing to reproduce articles may do so. We ask that credit be given to this publication.

Readers who wish to comment or require further information can write to the Editor, *Environment Update*, Communications Directorate, Environment Canada, Ottawa K1A 0H3.

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Acid Rain Ducks "À la carte"

There is no doubt that acid rain is a threat to the natural balance of lakes. Such precipitation is harmful to fish and leads to profound changes in aquatic life. Acid rain also affects waterfowl by modifying the availability of food, which in turn causes significant changes in the distribution of duck populations.

Therefore, it comes as a surprise to learn after a study of 550 lakes in Québec, that some ducks actually prefer to raise their young on acid lakes. Lakes with a pH above 5.5 constitute superior breeding sites for most waterfowl, but there are exceptions!

An Experiment in the Wild

This discovery naturally, encouraged us to carry our research further. It is often by studying exceptions that one manages to shed light on a phenomenon. We, therefore, devised a research project that constitutes a true experiment in the wild. We would become "mother ducks" and raise two species of ducklings on acid and non-acid lakes in order to determine how acidity affects the birds' feeding and growth. The two species selected are the American Black Duck – a dabbler with a declining population which is known to avoid acid lakes – and the Common Goldeneye – a diving duck that seems to seek out acid lakes.

Becoming a "mother duck" was relatively simple. It involved harvesting wild duck eggs in the spring, incubating them artificially and adopting the ducklings at birth. Because they had never known their "biological mothers", the ducklings soon became imprinted to the "mothers" who warmed them in the folds of their shirts and made them feel secure by chattering to them regularly.

Once on the lakes, we had only to follow the ducklings to determine what they ate and measure their growth in each experimental setting. From early June to mid-July 1984, we monitored most of their actions on three lakes in the ZEC Batiscan-Neilson, in Portneuf County. Two of these lakes are acid: Lac au Cochon contains no fish, while Lac du Rocher supports a healthy brook trout population. The third lake, Lac Civens, contains fish and has a neutral pH. The availability of food was evaluated throughout the experiment.

"The Common Goldeneye usually raises its young on lakes where it does not have to compete with fish for food."

Initial Results

Analysis of the data gathered during the first summer shows that only the acid lake with fish was not suitable for the growth of both species of ducklings (the black duck in particular). It seems that high acidity and the presence of fish are both required to hamper duckling feeding.

The acid lake without fish was just as suitable as the neutral lake with fish for the development of both species of ducklings. Aquatic insects are usually less numerous in acid lakes and their population levels are probably too low to sustain both fish and ducks. In neutral lakes, productivity is generally sustained and aquatic insect populations are maintained despite predation by fish. The food supply is therefore sufficient to enable ducklings to develop.

Continuation of Study

In 1985, we plan to alter the food chains in both acid lakes experimentally by introducing brook trout into Lac au Cochon and by considerably reducing the brook trout population of Lac du Rocher. These changes should allow us to measure the true influence of competition with fish on the growth and feeding ecology of both species of ducklings. In a subsequent year, we intend to measure the extent of the role of acidity by liming these lakes.

Conclusion

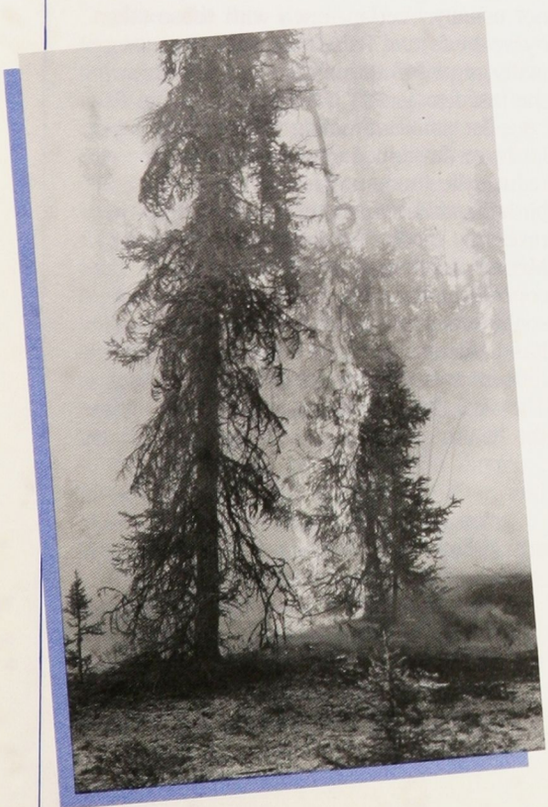
Our research shows more and more clearly that acidity contributes to reduce lake productivity. As a result, the fish exercise very tight control over aquatic insect populations. Many duck species are thus deprived of food because they eat nearly the same prey as the fish.

Because fish do not breed well in acid lakes, they tend to disappear as acid levels become excessive. When this happens, certain species of diving ducks can take advantage of the situation until acid levels reduce the aquatic insect biomass below a certain point.

The acidification of lakes in eastern North America has taken place more slowly that was initially anticipated. Most lakes affected by acid rain show signs of decline in their fish populations, but have not yet reached the stage where fish have completely disappeared. Such lakes are therefore no more suitable for ducks than for fish.

Time is running out. Acid rain must be stopped, or the fish and duck populations of the Laurentian Shield may suffer irreparable harm. ■

Caribou 100° Proof



This is Don Thomas's third year studying caribou and wildfire in the Northwest Territories. Thomas, a research scientist with the Canadian Wildlife Service, began with an ambitious list of objectives when he proposed monitoring the Beverly herd and the effects of wildfire on the herd.

These objectives, ranging from the straightforward monitoring of winter distributions to the more difficult and sensitive task of developing recommendations on fire management in the Territories, have pulled in along the way a collection of individuals, government departments and associations.

Don Thomas and his team often use students from Fort Smith to assist in their field work and they depend on the Fort Smith Hunters and Trappers Association to assist, for study purposes, in the twice-yearly hunt of caribou.

In October, as the caribou are moving from the barrenlands to the treed area, the scientists begin monthly aerial surveys to determine the movement patterns of the herd in relation to burns. In late November or early December, they go out with members of the Fort Smith Hunters and Trappers Association and sample 75 caribou killed by hunters. Hunters and Trappers Association members use the meat, while the scientists take samples from the animals, checking the body weights and stores of fat, the condition of their internal organs and the general health of the animals.

The same process is repeated in March, as the animals move from their winter range to the barrenlands. These samples and tests will determine the health of the herd and quality of the range on which the caribou wintered.

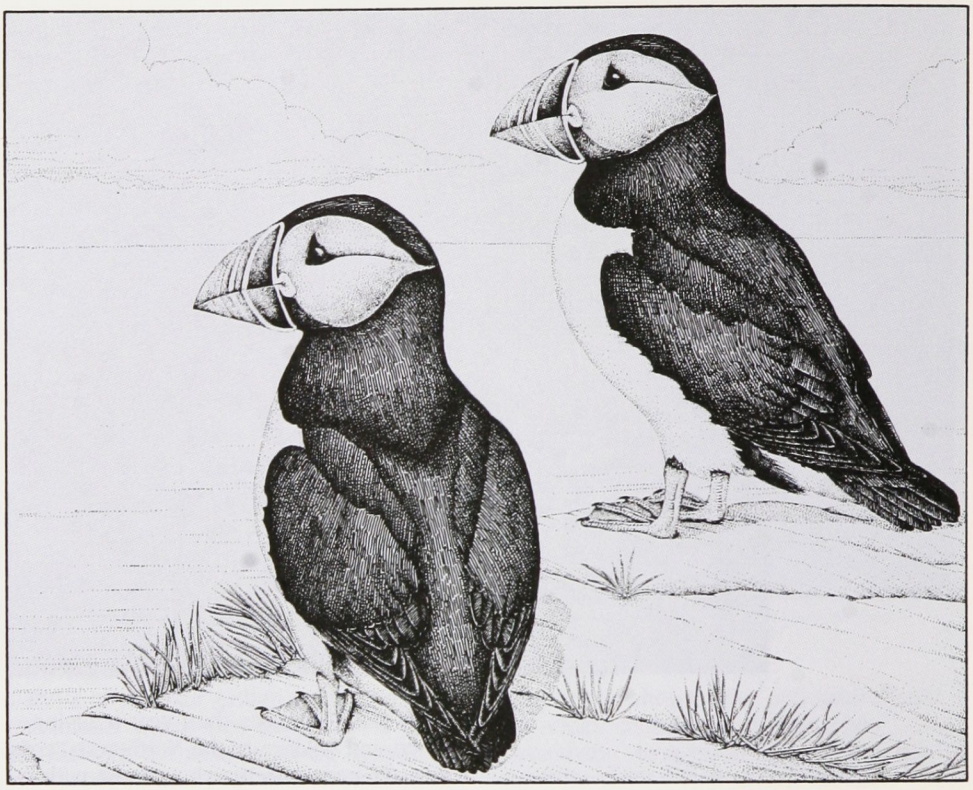
Thomas's work to date reveals that caribou migration patterns are different each year. Heavy snow conditions may have an effect on the route animals take from one range to another. There is no evidence that caribou are deflected by areas where a fire has occurred, except that caribou will not remain for long in areas burned in the last 30-40 years.

''Animals sampled to date have been in good shape with no sign of deterioration, suggesting that their present winter range is adequate for the present population of caribou'', says Thomas.

Thomas is drawing up maps showing the movement patterns of the herd during the past two winters and is drafting preliminary conclusions and recommendations. A final report is expected in March of 1987. ■

Seabirds

The Canadian Wildlife Service (CWS) has been carrying out research on seabirds since the 1950's to study the effect that hunting of seabirds in Newfoundland and Labrador was having on their numbers. Canada's coasts adjoin some of the richest fishing grounds in the world and this marine wealth supports an abundance of seabirds, mostly migratory.



Atlantic Puffin; Adults in summer.

Gannet

More recently, seabird research by CWS was extended to other parts of the country and to other aspects of the environment. Major studies have been undertaken on the large colonies in Gaspé and eastern Newfoundland, which draw thousands of visitors each year.

New threats to seabirds developed in the 1960's and 70's in the form of offshore oil exploration and the accumulation of toxic chemicals through the marine food chain. Research became oriented towards assessing the likely impact of offshore oil-spills on seabird populations and the effects of different pesticides on their reproduction.

At Bonaventure Island, in Québec, the spectacular colony of Northern Gannets showed a reduction in hatching success and a sharp drop in population in the early 1970's associated with high levels of DDT residues in their eggs. By monitoring these levels, CWS researchers have been able to determine the level of toxicity tolerated by the birds. The ban on DDT has led to a decline in residues and an improvement both in numbers hatched and on the size of the population, a remarkable success story.

Fish caught for human consumption do not usually overlap much with those taken by seabirds and fishermen have not normally regarded the birds as competitors. In the last few years, however, industrial fisheries for small schooling fish such as Capelin have developed. These threaten to reduce the food supplies on which the birds depend. Consequently, recent CWS research, much of it in collaboration with Memorial University of Newfoundland, has concentrated on the relationship between seabirds and their food supply. This work has demonstrated that seabirds play a significant role in many marine food webs. Their continued survival is a touchstone for the health of our oceans. ■

Forest and Wildlife: A Love Story?

Wildlife has long been regarded as a great Canadian heritage and as one of Canada's valuable natural resources. Wildlife, as part of the ecosystem, provides us with an insight into our own nature as well as offering us exciting experiences.

As important as wildlife is to us in sustaining our lifestyle, the forest is important to wildlife. It serves as a food source and provides much needed shelter for many species.

There is little information on the long-term effects of clear-cut logging and post-logging scarification treatment on wildlife and wildlife habitat in Canada. As a result, the Canadian Wildlife Service has been involved in research to study the effects of these forestry practices on wildlife and their habitat.

This new method entailed clearing patches of virgin, mature forest trees and shrubs.

When the first large-scale clear-cut logging operation in Alberta was initiated in 1955, a long-term forest/wildlife interaction study was initiated. The main objective of the study was to determine what effects this new method of logging, which entailed clearing patches of virgin, mature forest trees and shrubs and then disturbing the forest floor to prepare a seed bed, would have on various wildlife species and their habitats. The results would be compared with nearby clear cuts where only the merchantable spruce and pine trees would be removed and the remainder of the trees, herbs and grasses plus the soil would be left undisturbed.

Research began in 1956 within three forests of white spruce, lodgepole pine, and mixed wood. Scarification involved using large caterpillar tractors with toothed-blades to flatten any vegetation left standing after logging and then mixing the slash and moss with the underlying soil to produce a suitable seed bed for germinating coniferous seedlings. The study continued intermittently over a 27 year period to 1983. Presently, wildlife and forestry managers are making plans to ensure it continues throughout one complete timber cycle of 80-100 years.

The region that was studied is renowned for its valuable big game and furbearing resources, which include moose, elk, woodland caribou, deer, bear, lynx, fisher, marten and red squirrel.

The study showed that after the first 27 years of clear-cut logging there were increased number of deer, elk and moose as long as large patches of mature forest remained interspersed throughout the logged area. However, scarification was found to be detrimental to both wildlife habitat maintenance and wood production in the spruce and mixed wood clear-cuts, although beneficial to wood production, and to a lesser extent wildlife, in the pine clear-cuts.

It is generally known that winter wildlife habitat must provide food, escape, cover and shelter if wildlife are to survive harsh Canadian winters. Winter shelter is required to minimize wind chill, snow depth and hardness and keep the animals dry. In the scarified spruce and mixed wood areas, there was a pronounced lack of both escape and thermal cover, which did not become available for 30-35 years after clear-cutting. It did become available in the scarified pine areas within 20 years.

Unscarified clear-cuts, especially spruce and mixed wood, supported higher numbers of big game, furbearers, tree-cavity dwelling birds, insectivorous birds and mammals. However, adequate winter cover for big game species was not available in the unscarified pine clear-cuts until at least 15-20 years after logging, and not until 25-30 years in the spruce and mixed wood clear-cuts.

Residual blocks of mature forest interspersed among clear-cuts was vital in providing adequate wildlife escape cover and shelter, especially for the first 20-30 years following logging. When these mature blocks were removed about 12 years after the initial logging, big game populations declined drastically because the original clear-cuts were not old enough to provide adequate cover.

Black bears began using the clear-cuts extensively 17-25 years after logging, when the rotting stumps and logs produced an abundance of insect food and the trees and shrubs provided cool shade and escape cover. Important plant foods such as buffaloberry and Indian potato were also abundant at this time.

Furbearers such as red squirrel, lynx, coyote, marten and weasel populations were reduced to low numbers for the first 15 to 20 years following logging. However, by Year 26, red squirrels were common in all unscarified clear-cuts but only in the pine scarified clear-cuts.

Furbearers were reduced to low numbers for the first 15 to 20 years following logging.

Snowshoe hare populations were low until 25 years after logging. At this time, they were abundant within the scarified pine clear-cuts and caused extensive damage to regenerating pine. In the unscarified clear-cuts where pine densities were lower, the number of snowshoe hare was also lower.

Ruffed and spruce grouse populations remained at low levels for the first 20 years following logging, whereas small numbers of blue and sharp-tailed grouse moved into the young clear-cuts. By Year 26, ruffed grouse were still only about one third as abundant as in the mature forest. Also at this time, spruce grouse began to return to all unscarified blocks but only to the scarified pine block.

The major timber management objective is to obtain rapid and adequate spruce and pine regeneration within clear-cuts and to have maximum growth up to maturity. Scarification was expected to ensure this objective was met.

Within the spruce forest, regeneration was adequate in both clear-cuts by Year 26 but the average height and annual growth rates were about two times greater in the unscarified clear-cuts. Similarly, in the

mixed wood clear-cuts at Year 26, spruce trees were three times more abundant in the unscarified clear-cut and these trees were 30 percent taller than those in the adjacent scarified block. The average annual growth rate was 11 cm in the unscarified block and 7 cm in the scarified block. For the pine forest, the stocking rate and density of regenerating pine were higher in the scarified clear-cuts although they were adequate in both. The average height and annual growth rates were 30 percent in the scarified block.

The advantages of scarification and justification for this additional timber management cost were not apparent in the three forests studied, although it is recognized that scarification is useful in certain other situations. This study demonstrated the importance of foresters evaluating each situation carefully following logging before recommending costly scarification treatment. Scarification should not be used unless the combined timber/wildlife benefits justify it. Even then, small clumps of mature deciduous trees and unmerchantable conifers can usually be left for their wildlife value without significantly reducing timber production potential.

Recently the forest company in this region, St. Regis (Alberta) Ltd., has been working closely with the Alberta Forestry and Fish & Wildlife agencies to produce an integrated forest-wildlife management plan to replace the old timber management plan for the entire 7770 km lease area. The value of this long-term study has become apparent as timber and wildlife interests work together to produce a management plan that will benefit both renewable resources.

Both wildlife and forestry are part of Canada's heritage and valuable natural resources. It is very important, therefore, that we do not jeopardize one for the other. ■

The Polar Bear – King of the Arctic

H.P.L. Kiliaan and C. Jonkel of the CWS tagging a polar bear on Cornwallis Island, NWT.

In 1973 Canada signed the International Polar Bear Agreement with the U.S.S.R., the U.S.A. and Denmark, agreeing to conduct research programs relating to the conservation and management of polar bears and their habitat. The Canadian Wildlife Service (CWS) has studied this majestic animal since 1961, and its work is highly regarded by the international scientific community. Using aerial surveys, track counts, ear tagging, dye marking and radio-transmitting collars, the CWS has contributed much to the world's knowledge about this ''King of the Arctic''.

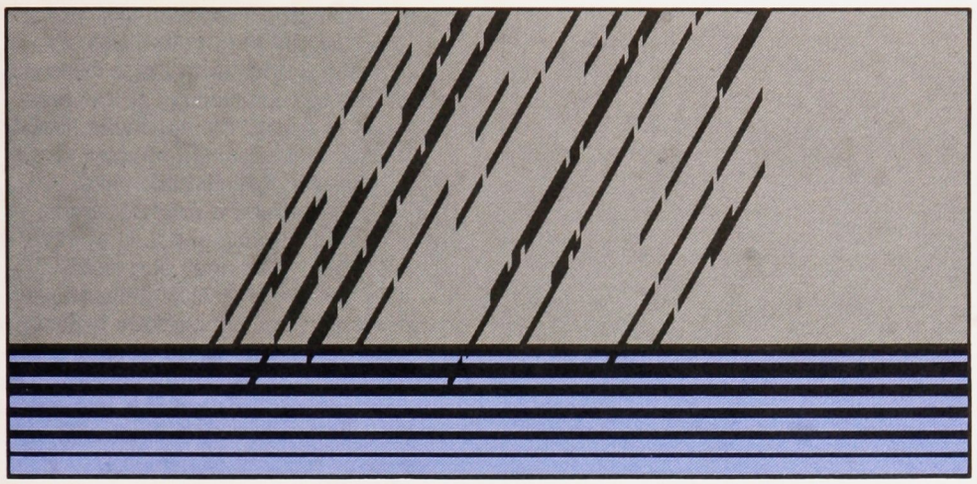
An adult polar bear can measure up to 3.8 m in length and can reach a weight of 550 kg. Polar bears are well adapted to their arctic surroundings. Their thick winter coats and the heavy layers of fat beneath their skins are ample protection against the harsh climate through which they continually migrate.

Seals are the main source of food for polar bears and they hunt them all across the Arctic – off the Alaskan coast, among Canada's arctic islands, near Greenland and around the islands off the north coast of the Soviet Union.

Recently, federal and provincial wildlife management agencies have embarked upon a joint four-year research program to take an in-depth look at the polar bear population in Foxe Basin and Hudson Bay. Population size, birth rate, and seasonal movement to and from denning areas will be examined. The research will help wildlife managers to evaluate the impact of existing harvest levels, and to protect the bears and their habitat from potentially harmful resources development projects.

The CWS is continuing its polar bear research projects as well. Some current studies focus on the importance of summer food supplements, the reproductive biology of female polar bears, and the population and distribution of polar bears. The CWS also coordinates other federal-provincial research work. ■

A Fresh Look at Acid Rain



Although Canada is firmly committed to reducing its share of the causes of acid rain, hundreds of Canadian lakes have already been seriously affected by acid precipitation. Knowing how the tiny organisms that inhabit an aquatic environment react to acid stress might provide invaluable insight into how to rehabilitate or assist the rate of recovery of the hundreds of Canadian lakes which are dying or are already dead.

This is the challenge currently facing the National Water Research Institute. Dr. Salem Rao is the study leader of a two-year project seeking to understand the ''effects of low-pH stress on the morphology and activity of bacteria from lakes receiving acid precipitation''.

What is known is that acid rain creates an overloading of sulphates and nitrates in the aquatic environment, a phenomenon known as acidification. Dr. Rao's study will assess the effects of acidification on the biodegradation of organic matter in lake water sediments; in other words, it will attempt to determine the extent of damage caused by acidification on microbial populations that are vital to a healthy aquatic environment. Leaves, dead fish, and other organic matter that drift down to the sediment must be properly broken down. Accumulation, or the failure of such materials to biodegrade in the aquatic ecosystem, inevitably leads to stagnation and the eventual biological death of an oxygen-starved body of water.

Dr. Rao explains, ''Bacterial action upon these materials is crucial to help bottom sediment remain healthy and productive. We have found from our studies that acid-stressed lakes are much less supportive than non-lakes of bacterial populations which are essential to biodegradation''.

Bacterial action upon these materials is crucial.

The team concentrated on two adjacent lakes located near Sudbury. Silver Lake was acid-stressed while nearby McFarlane Lake was considered healthy. Tests were performed on numerous samples of water taken from both locations. The resulting bacteriological data for water and sediment cores demonstrated that acid-stressed lakes supported a significantly smaller population of bacteria, thereby reducing biodegradation and presenting a threat to healthy lakes.

''We have gained valuable knowledge so we can plan new studies more practically and with better definition'', states Dr. Rao. ''This will result in increased scientific effectiveness and, in the long-term, increased cost efficiency''.

The only effective means now known of combatting the ravages of acid rain is to stop it at the source. Since this is extremely costly to industrialized nations, Dr. Rao offers this possible application of his program. ''We hope to gain the knowledge necessary to help create an environment for bacteria to flourish and function in acid-stressed lakes as they might in a normal ecosystem. With such a development, we would find a means for ailing lakes to recover in a natural manner''. ■

Algae: A Fight to the Finish

Measures taken in the early 1970's to limit phosphorous in the Great Lakes have cut the proliferation of Cladophora algae in seven Lake Ontario areas, according to researchers at Environment Canada's National Water Research Institute.

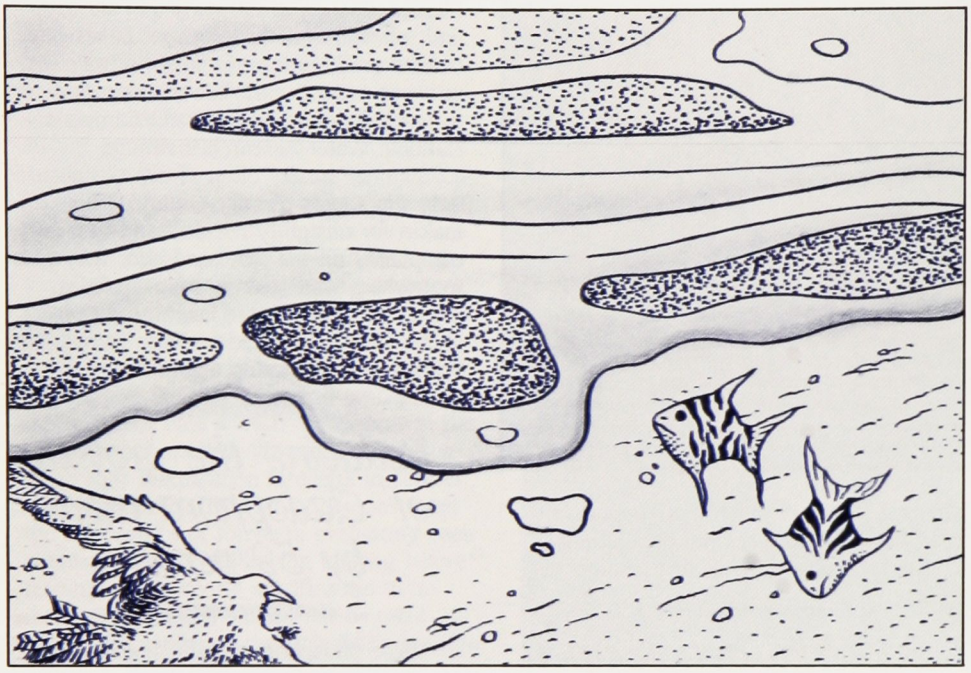
Summer storms often sweep the algae onto the shores of Lake Ontario. This makes for unsightly beaches and causes complaints on the taste and odor they give to drinking water. Many municipalities, especially those on the lake's western shore, have responded to these complaints with shoreline cleanup operations.

Reducing the growth of Cladophora algae by 59 percent.

These phosphorous reduction measures are credited with reducing the growth of Cladophora algae by 59 percent between 1972 and 1983. The situation is expected to improve if phosphorous concentrations keep decreasing.

Environment Canada is now working on a model to simulate the growth of Cladophora, in order to evaluate the consequences of phosphorous discharges and reductions in selected areas. ■

The ABC of Shoreline Protection and Cleanup



In 1978, with the prospect of offshore oil exploration and increased marine traffic, the Environmental Protection Service (EPS) became concerned about oil spills seriously damaging sensitive coastal ecosystems. In addition to harming fish, seabirds, aquatic plants and other organisms, oil can ruin oyster beds and other valuable fisheries. It can also spoil beaches, swimming and boating areas, and foul fishing gear, jetties, piers and other waterfront facilities.

The Pacific and Yukon Region began at that time to conduct preliminary studies towards producing shoreline protection and cleanup manuals that would facilitate industry and government cleanup of spills. This research would result in the preparation of three manuals, each specific to a particular environment: an open coastline, an industrial port, and a major river system.

The chief architect for this research is Fred Beech of the EPS Vancouver Office, who has developed various strategies for controlling oil spills and preventing their spread into sensitive areas.

In 1983, EPS completed the first manual, which was on Juan de Fuca Strait. Based on input from government agencies concerned, the manual identifies priority areas for immediate action in case of a spill, and provides instructions for protecting and cleaning the affected shoreline.

Protecting and cleaning the affected shoreline.

This manual is accompanied by comprehensive maps and videotapes of the shoreline, providing the next best thing to a surveillance flight in case of bad weather.

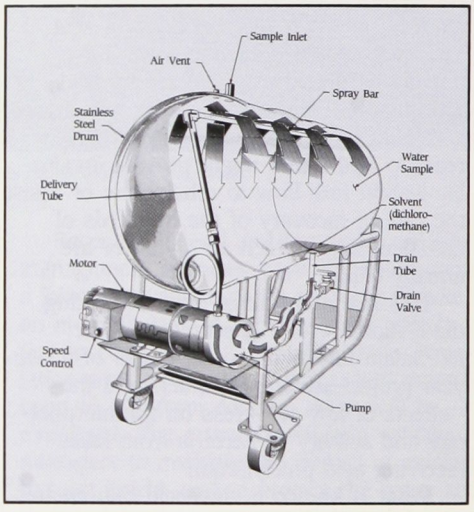
The manual identifies "sacrificial beaches" where oil would be diverted should a spill or slick threaten a shoreline. Such beaches are considered to be of low ecological value and are composed of easily cleaned materials, such as fine sand.

After the success of the Juan de Fuca Strait manual, the B.C. Petroleum Association prepared, in cooperation with EPS, a similar manual for the Port of Vancouver. The second manual lists environmental resources, high priority areas, and the habitats of fish, wildlife and flora. The third manual, for the Lower Fraser River, is underway.

"Upon completing this project, EPS will have accomplished its goal of developing the concept and implementing it in three disparate environments", says Beech. He adds that the "manuals" concept has been adopted in several other parts of Canada by industry and government agencies. ■

Aple! Have a Bite

A new contaminant extraction system has been developed by the Ontario Region's Water Quality Branch to facilitate detection and analysis of contaminants at low concentrations in water. The apparatus, called the Aqueous Phase Liquid Extractor (APLE), consists of three basic parts: a stainless-steel drum, a magnetically-driven circulating pump and a spray bar (see illustration). The drum is typically filled with water and dichloromethane, an organic solvent. Dichloromethane is denser than water and settles to the bottom of the drum where it is continuously pumped to the spray bar and dispersed in a fine spray over the sample which is then taken from the extractor and sent to the laboratory for final analysis.



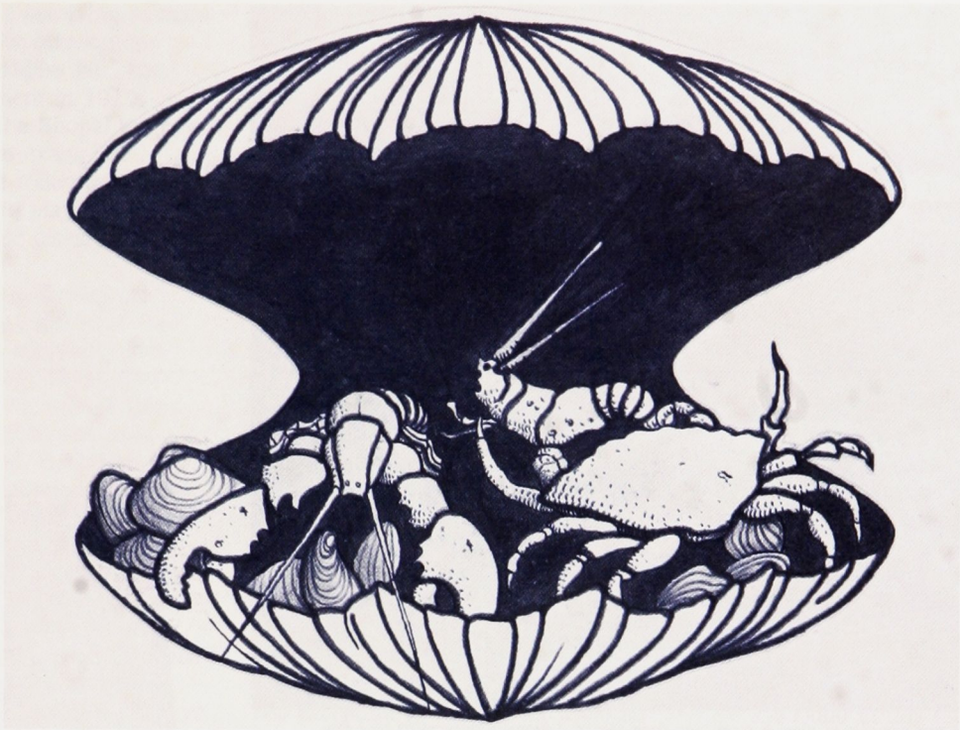
Aqueous Phase Liquid Extractor (APLE)

The APLE system has been tested for recovery of 18 organochlorine compounds including many pesticides. Over the range of concentrations investigated, the mean recovery rate has been 92 percent. The large sample volume possible with the APLE enables analysts to detect contaminants at concentrations as low as one part per quadrillion.

Studies involving use of the APLE aboard ships in the St. Lawrence River, Niagara, Detroit and St. Clair Rivers have not only allowed researchers to detect very low-level environmental contamination, but have yielded new insights into the fate and distribution of toxic substances in the lower Great Lakes region.

Several units have been built and are in use at the Canada Centre for Inland Waters and at the Ontario Ministry of the Environment, and the New York State Department of Environmental Conservation is also showing interest. ■

Selfish Shellfish



Canada's coastal waters are subject to a wide variety of environmental threats. Perhaps one of the most obvious indicators of the environment's vulnerability to these threats is the closure of shellfish harvesting areas. In British Columbia, shellfish contamination closures are generally imposed because of sewage pollution and other types of bacteriological contamination in shellfish growing areas.

They are particularly sensitive to pollutants.

Some species of shellfish accumulate and concentrate pollutants in their tissue and become a threat to the consumer, especially where disease-causing bacteria may be present in the water. Since they feed by filtering the water in which they grow they are particularly sensitive to pollutants.

In 1972, the Environmental Protection Service (EPS) embarked on a continuing program to assess the bacteriological quality of the marine waters. Studies are conducted to examine the movement of sewage plumes, river plumes and other potential sources of pollution. Current measurements, flow patterns and dye dispersion studies are some of the tools used to determine the impact of pollution on shellfish beds.

The bacteriological testing is done at the survey site. Since the test bacteria have a limited life span in marine waters, they must be cultured immediately after collection.

The quality of marine waters is tested to ensure it meets federal standards for the safe harvesting of shellfish.

Closures of shellfish growing areas have had the greatest negative impact on the recreational harvesters and tourists, since they generally occur close to urban centres and easily accessible beaches. Fortunately, most of the commercially harvested clam beaches and oyster culture areas remain free from sewage pollution.

A wider variety of bacteriological pollution sources are also cited by EPS as significant causes of shellfish closures.

This presents major challenges, not only in planning surveys of often remote coastal areas, but also in developing pollution control strategies to ensure new aquaculture areas remain free of pollution, and that shellfish areas now under closure are rehabilitated to once again allow harvesting. Such strategies must be developed through the cooperation of federal and provincial resource and pollution control agencies. ■

The Voyage of the Limnos

Biologist Horn Sloterdijk exhibits two samples of river bottom; one from the St. Lawrence River (left) and the other from the Louise basin (right).

The CSS Limnos is a floating laboratory whose mission is the pursuit of a difficult and ambitious goal: restoring, conserving and enhancing the environmental quality of the St. Lawrence Seaway. This unique vessel is being used by the National Water Research Institute to sample the waters of the St. Lawrence and identify the chemical contaminants present, their actual or possible environmental effects and, if possible, their sources.

A project of this scale goes beyond the usual analytical work carried out in conventional laboratories, because the many pollutants in the river can only be identified through detailed study. With a cargo of sophisticated equipment, and highly qualified scientists as passengers, the Limnos is proving indispensable.

The research so far has confirmed something that had previously only been suspected: chemicals discharged into the Great Lakes can travel, even as far as the St. Lawrence River.

Studies completed just a few months ago have already revealed that the concentration of heavy metals in Lake Saint-Louis have increased by 20 percent in ten years. Analyses have also been carried out to determine the distribution of toxic contaminants in lakes Deux-Montagnes, St-Pierre and St-François, the Laprairie Basin and near the Boucherville Islands.

Another study has shown that at least 40 tonnes of fish seriously contaminated by mercury, lead, polychlorinated biphenyls (PCBs) and other toxic chemicals are taken from the river each year.

Last May, a sizeable deposit of PCBs was discovered on the bottom of Lake Saint-Louis, and smaller deposits were found near Ile Perrot and the Iles-de-la-Paix.

The importance of the work being conducted by the scientists aboard the Limnos is becoming more and more apparent, especially for the many communities which draw their drinking water from the St. Lawrence River. ■

The Limnos

Silent Killers in the Air

Life threatening accidents involving releases of toxic chemicals into the atmosphere have become a fact of modern life. The Mississauga train derailment in 1979, or, on a much larger scale the Bhopal tragedy in India last year are two examples.

It is also a fact of life today that the weatherman has begun to play a crucial role in deciding how these disasters can best be handled.

Without accurate, up-to-the-minute weather information, the chances of properly responding and effectively handling accidents are severely diminished. When an accident happens, critical information is urgently needed by the emergency crews who respond. Examples of this are wind data, precipitation and temperature forecasts. Also required is information about the local terrain (e.g. hills, valleys, nearby lakes), the characteristics of the chemicals involved, especially how they react with rain or snow as well as computer projections of the directions in which the chemical clouds can travel.

In Canada, to provide the most effective response to a toxic chemical emergency, the Atmospheric Environment Service, or weather service, has developed AQPAC.

This is a set of computer programs that can be used on a mini computer in the regional weather offices across the country. The information is written in a clear and simple fashion and is easily accessible to the staff of the weather service.

AQPAC includes such vital information as: weather data (winds, temperatures, etc.); emergency procedures (agencies to contact, steps to follow, etc.) information about the characteristics of the chemicals involved; conversion function (if the data is in one form of measurement, it can immediately be converted to coincide with procedures that are written in another form, such as imperial to metric). Computer models that can estimate the direction and dispersion characteristics of the chemicals released into the atmosphere are also part of the programs.

Much of the information, particularly the weather data, can be updated constantly, as wind patterns change, precipitation occurs, or as temperatures change. While the package of programs is already at a sophisticated level of development, it is constantly being improved.

This was tragically the case in Bhopal.

The Boundary Layer

In toxic chemical accidents, many of the chemicals which are released into the atmosphere are heavier than air. That means that they will fall back down to earth or remain relatively close to the ground, rather than diffuse into the higher levels of the atmosphere. This was tragically the case with the toxic gas released from the Union Carbide plant in Bhopal.

In most cases, the toxic chemicals are released into and remain in the boundary layer of the atmosphere. This is the distance from the earth up to about one kilometre in the atmosphere. In some special weather situations, especially thunderstorms, the boundary layer can be as high as five or six kilometres from the ground. The exception to this occurs when an extremely powerful explosion accompanies the release, sending the cloud high into the atmosphere.

When told of a nuclear emergency, people usually think of an explosion. In fact, if a nuclear power plant developed a crack, there is no chance of it erupting in a mushroom cloud. The radiation would seep out and most likely remain in the boundary layer.

Because the cloud of toxic chemicals normally remains near the surface, it is much easier to observe and predict its behaviour. Unfortunately, this kind of release is much more dangerous because it remains so close and in higher concentrations.

Short-range Transport

The ''short-range'' zone surrounding the site of the accident is of primary concern. This is generally a circle with a 50 kilometre radius, but it can encompass an area up to a 100 kilometre radius from the release point. There can be significant risk to people and property in this zone.

Using what is called a Gaussian model, the weatherman is able to predict the movement of chemical clouds with accuracy. Within the ''short-range'' radius, the cloud remains largely intact and can be projected and tracked using the computer model.

While the path of the large mass of the cloud can be predicted, it is important to chart the small gusts of wind – eddies – that affect the outer areas of the cloud. For example, sudden gusts of wind can move part of the large cloud in another direction, perhaps endangering another area or requiring the immediate evacuation or protection of workers combatting the accident.

Extensive testing of the models in field work experiments have proven their value in responding accurately to the various weather situations that can arise.

Medium-range Transport

The ''medium-range'' zone takes in a radius of up to 1000 kilometres. It is more difficult to project the patterns of the chemical cloud in this radius than that of the ''short-range''. Up to about 100 kilometres, the benefits of the Gaussian model apply, but after that, the tracking and projection capabilities are diminished. A model is currently being developed to improve the medium-range predictions.

Mobile units to provide weather data on the spot.

Because there aren't always weather offices close to where an accident might happen, the weather service has in some regions mobile units that can be taken to a particular area to provide weather data and other information on the spot.

Long-range Transport

The ''long-range'' zone is the area beyond 1000 kilometres from the point of the accident. At this distance, there is rarely an immediate danger to the public or the environment. The main concern is the long-term accumulations. This is especially true for chemicals that can travel high in the atmosphere and remain there for long periods of time enabling their transport to

remote regions. The process is much like that which produces acid rain.

The chemical cloud is monitored to determine where it is travelling and how it will diffuse. This can be done accurately, using computer models.

Other Roles

Through the regional weather offices across Canada, special observing stations and specific forecasts are provided for use in other emergencies.

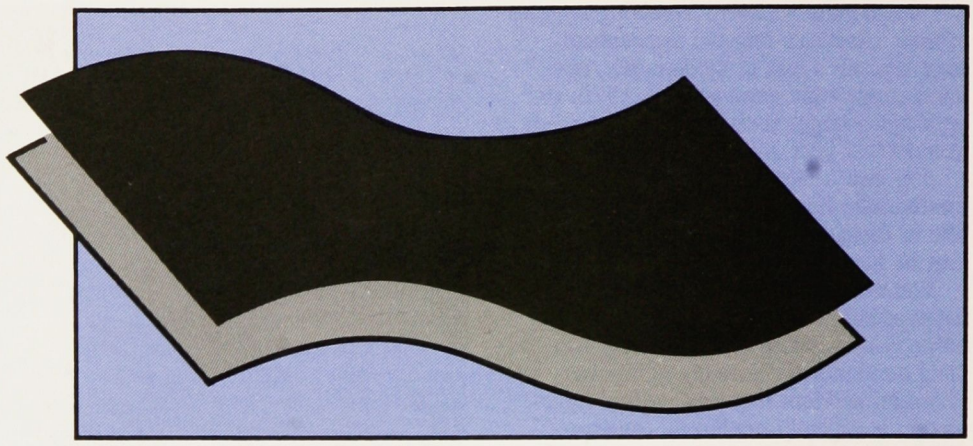
In the past, such emergencies have included: oil spills, radioactive debris from nuclear tests, crash of a nuclear powered satellite, nuclear plant failure, toxic chemical transportation accidents, and ash cloud fallout produced by volcanic eruptions. Special meteorological, sea and ice state data, including forecasts on the transport and diffusion of pollutants, are provided by some weather offices.

Oil spills, nuclear plant failures, toxic chemical transportation accidents.

Conclusion

The Weather Service is continually working to develop new procedures and improve existing programs in this field. A major priority is the modelling effort. Complex problems, such as how the chemical cloud is affected by the local terrain, are being resolved at this time. There is little data on atmospheric conditions during an emergency in the Canadian winter. Field experiments are being planned to improve response of the weather service in situations that are unique in North America. ■

Introducing the new Geotextile Membrane!



Until now, the only method available for dealing with toxic sediments in a water body has been to remove the sediments by dredging. But dredging creates its own environmental problems and, in an urban area, presents a number of other difficulties. Adequate disposal sites for the dredged sediments may not exist within a reasonable distance, and disposal on land carries the risk of groundwater contamination. Environmental standards regarding effluent quality and constraints on hazardous materials must be observed to protect the well-being of nearby populations.

This innovative approach is aimed at restoring the affected water body.

For these reasons, Environment Canada launched, in October 1984, a feasibility study on the stabilization of toxic sediments in place in bodies of water. This innovative approach is aimed at restoring the affected water body by installing a permeable geotextile membrane over the sediment and using granular material to hold it in place. Geotextile membranes have been used to separate and stabilize soils in the construction industry.

After laboratory studies were completed, an experimental basin was chosen at the Lachine Canal near Montreal to test the theory. The immediate goals of the Lachine Canal tests are to verify the effectiveness of the method, its technical reliability, and its economic feasibility.

The method works in the following way: first, bulky debris is removed from the bottom of the water body, and the geotextile membrane is anchored to the shoreline. As the membrane sinks, it captures suspended particles and seals them on the bottom. The membrane filters the water and allows gases to escape. A layer of granular material (sand, gravel) 15 to 30 cm deep is then spread over the membrane to compress the sediment and hold the membrane in place. Once the gravel is in place, the sediment is isolated for good.

Among other advantages, this technique minimizes the environmental risks associated with the handling of toxic sediments. The working time is also less than that required for conventional dredging, which reduces costs as well.

The laboratory tests compared the characteristics of ten geotextile membranes to determine the one best-suited for this application. A non-woven polyester fabric commercially available under the name Domtex P350 was selected for the Lachine Canal tests.

This research project is being managed by the Parks Service of Environment Canada, at a cost of $125 000. The Environmental Protection Service is responsible for the scientific surveillance of the tests. A report on the project is expected to be published in the spring of 1986. ■

Marc Garneau and the Space Shuttle Sunphotometer

One of the experiments on board the October '84 space shuttle, Challenger, with Canadian astronaut, Marc Garneau, was a research sunphotometer built by the Atmospheric Environment Service.

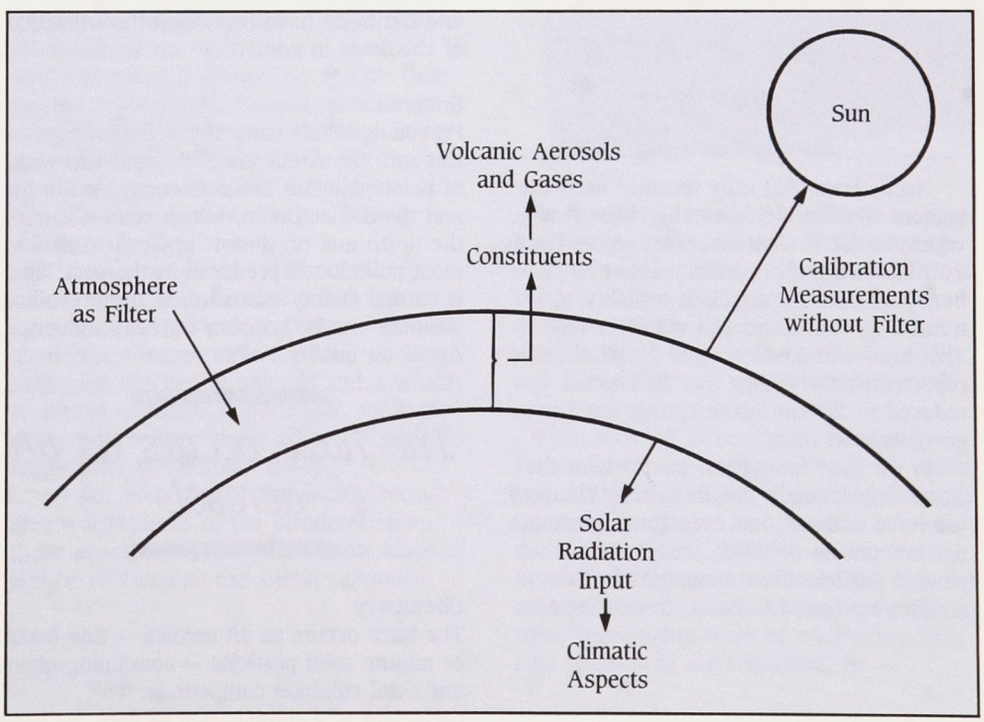
Sunphotometers measure the intensity of solar radiation at certain defined wavelengths. Normally pointed at the sun from the ground, the measurements indicate the amount of solar radiation penetrating the atmosphere and by inference, the amount of absorption that occurs. The absorption is caused by pollutants of the same type that are responsible for acid rain. Sunphotometer measurements are therefore important in the study of acid rain transport, ozone and climate, since changes in atmospheric absorption affect the climate.

Observations were taken for ozone, water vapour, nitrogen dioxide and volcanic debris. Atmospheric ozone is the gaseous layer that prevents harmful solar ultra violet radiation from reaching the ground. Measuring the distribution of ozone in the stratosphere along with nitrogen dioxide will help determine whether man's activities, such as the release of fluorocarbons from refrigerators and aerosol sprays, have a detrimental effect on it.

Volcanic debris in the atmosphere tends to affect normal atmospheric processes. Such particulate matter has a high absorption rate for solar radiation and thus, may affect climate.

The instrument used by Marc Garneau on the Challenger was a modified version of the sunphotometer marketed commercially. The experiment was carried out successfully on the space shuttle and the scientists at the Atmospheric Environment Service will continue analysing data from the sunphotometer. They will also continue to prepare for future applications of monitoring the atmospheric environment from space. ■

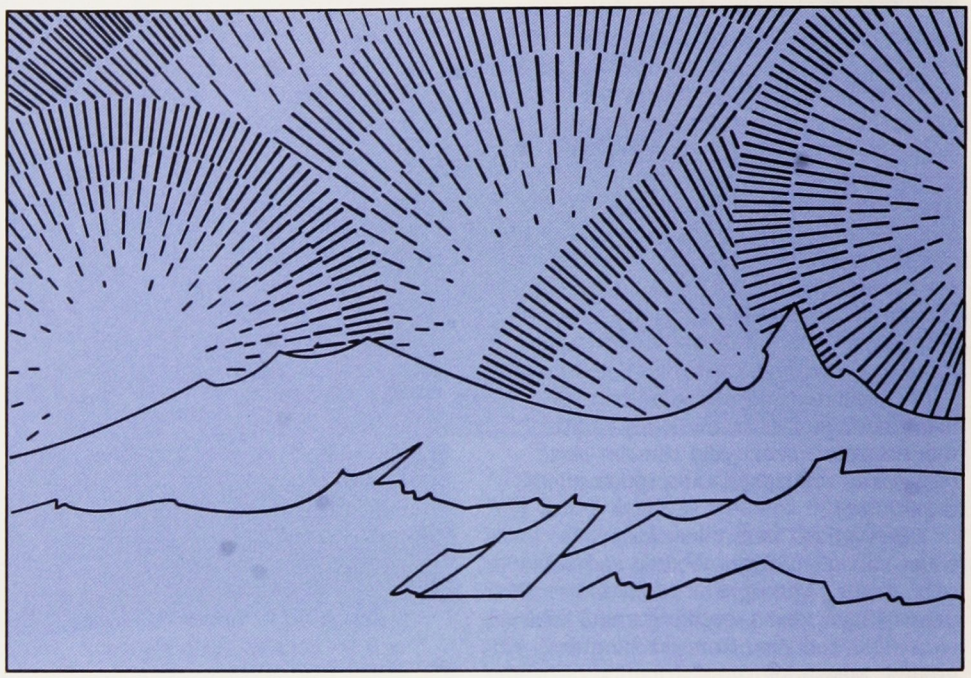
Marc Garneau using the sunphotometer



The earth atmospheric system and the sunphotometer

On a Clear Day You Can't See Forever

The Arctic has long been perceived as having clean air. Many explorers have remarked on the ability to see great distances across the tundra. In fact, this clarity has often misled arctic travellers, as apparently nearby mountain ridges have turned out to be not 10 miles away, but 100 miles or more away.



Man-made pollution from the Soviet Union, Europe and, to a lesser extent, North America is adversely affecting the climate of the Northern Hemisphere.

Theoretically, one can see as far as 200 kilometres.

Arctic Haze has only recently been the subject of scientific research. Theoretically, when the air is clear, one can see as far as 200 kilometres (125 miles). However, a heavy arctic haze can limit visibility to a mere 30 kilometres (18 miles) or less. This haze was first detected by pilots, who reported that visibility was sometimes reduced to 20 km in the spring, even in good weather.

In the past few years, our view of the Arctic environment has drastically changed. We have realized that even these areas are not immune to pollution. Levels of suspended particles from industries further south were found to be 20 to 40 times higher in winter than in summer. In winter, the weekly concentration of sulphate, a major component of these particles, is 2 to 4 micrograms per cubic metre of air, while in summer it drops to 0.1 micrograms.

Atmospheric measurements by scientists from the United States, Canada, Norway and Denmark have confirmed the existence of this haze in winter.

Sources

Prevailing winds carry the pollution particles into the Arctic air. The main pathway of polar pollution is from sources in Europe and the Soviet Union, which send it toward the north and northeast. In North America, most pollution is produced in the east, and is carried farther eastward by the prevailing westerly winds; it doesn't greatly influence Arctic air quality.

The haze occurs as an aerosol.

Chemistry

The haze occurs as an aerosol – fine liquid or minute solid particles – containing about one-third sulphate compounds. The remainder is a combination of soot, hydrocarbons, natural oceanic or soil materials and a minute amount of other pollutants.

The airborne sulphate particles consist of sulphuric acid and ammonium. The latter is produced when sulphuric acid reacts to fuels, such as coal, oil and wood.

The sulphate concentrations measured in the haze are only about 50 percent lower than in highly populated areas in eastern Canada and the United States. Correspondingly, the levels of acidity in Arctic snow are expected to be no worse than one-tenth of those in eastern Canada.

The haze has three main potential effects: climate modification, the acidification of both land and water ecosystems and a reduction in visibility. But more significantly, it shows the scope of the pollution created by industrialized countries. Will the pristine Arctic environment be the next to fall victim to our industry's waste? ■

Back to the Future 10,000 Years Ago

Archaeologist on site near Banff.

Long before the voyageurs or the European explorers adventured into the Rockies, prehistoric man gathered around a campfire near what is now the town of Banff.

The site, about five kilometres west of Banff, was discovered in the summer of 1983 by Parks Canada archeologists during a routine survey along the right-of-way for the Trans-Canada Highway.

Since then, archaeologists have spent their summers painstakingly studying the 10,000-year old site.

Many of the excavations have been unproductive, but in one area the remains of some prehistoric stone tools caused great excitement. Concentrating their efforts in the area of these finds, the archeologists opened up a larger test excavation and soon uncovered layer upon layer of evidence of human activity. A musket ball was found near the surface, layers of artifacts were found in the middle, and a hearth with the bones of butchered animals was found at the base of the pit, about two metres down.

Throughout the past 10 millenia prehistoric people hunted and gathered food on the shores of the Vermilion Lakes. At this unique site, considerable evidence of these activities has been preserved by a series of rock and mud slides, which have beautifully separated the remains of human existence in relation to several distinct former land surfaces.

''The preservation has been very good in the older levels where the slides have encapsulated the land surfaces, each of which provides a window to specific time periods,'' said Parks Canada archeologist Daryl Fedje. ''We've only explored a very small portion of the site so far but I'm sure we'll turn up much more this summer to help fill in the picture. We are finding things every day.''

The site has yielded artifacts that include spear points, atlatl points (points from darts hurled with throwing sticks), arrowheads, stone tools used for working hides, for butchering animals and a wealth of animal remains, in particular, mountain sheep which were about 10 to 15 percent larger than those found today.

So far, archeologists have only recovered a few pieces of the puzzle of how these people lived. Hopefully more clues will be revealed as the site is expanded.

''We may be able to discover what kind of structures they lived in and get more clues about the vegetation, among other things,'' Mr. Fedje said.

''The site appears to be one of the few that has a great deal of potential for showing how these mountain people lived and coped with their environment. A site with artifacts so well preserved and stratified is unique in this part of the country.''

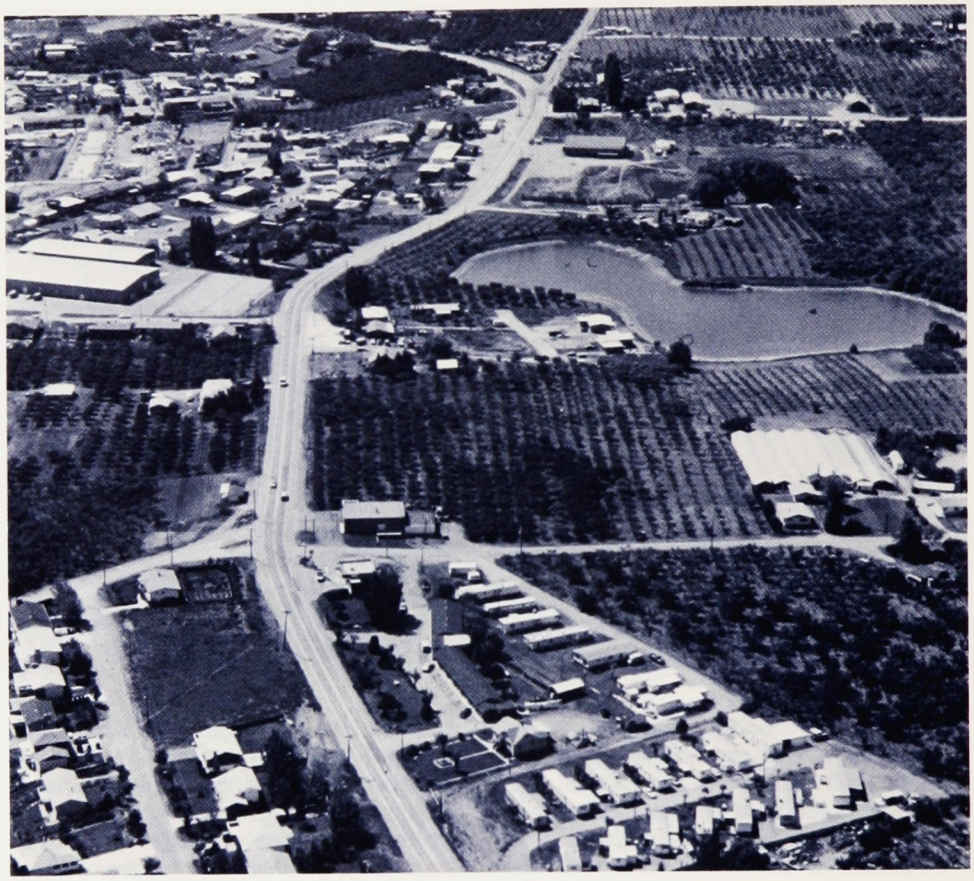
With the carbon dating carried out this past year the 10,000 to 11,000 year age of the site has been established making it one of the earliest radio-carbon dated sites of prehistoric occupation in Canada south of the Old Crow Basin in the Yukon. The area likely was free of ice about 1,000 to 2,000 years before prehistoric man took up residency there.

A modification in the highway routing has been agreed upon to avoid infringing on this very significant area. Some work is being done but efforts are being concentrated on three somewhat less significant sites to ensure that even these won't be lost to the highway project without detailed examination.

The team of archeologists headed by Mr. Fedje can be spotted at work on either side of the Trans-Canada Highway heading toward Lake Louise just past the turn-off to the town of Banff. The day-to-day work involves sifting the earth from test sites for any evidence of human occupation or the more painstaking work of excavating delicate remains of our ancestors. ■

Okanagan Fruitlands: An Uncertain Future

The Okanagan valley is one of Canada's prime fruit-growing areas. It contains 25 percent of the nation's best fruitland and produces 43 percent of its tree-fruit crop. Yet, over the past two decades, these irreplaceable fruitlands have suffered significant losses due to a variety of land-use pressures.



An aerial view of fruitland.

In fact, the Okanagan fruitlands and fruit industry face an uncertain future. Considerable pressure from other land uses and major internal economic problems threaten the viability of fruit growing as a significant use of these lands.

The upcoming report, *Okanagan Fruitlands: Land-Use Change Dynamics and the Impact of Federal Programs*, looks into this situation. It analyzes net changes of area in orchards and vineyards, cyclical variations involving the shift of land in and out of fruit production and the dynamic nature of change. The report covers three monitoring periods, 1958, 1969 and 1981, and is highlighted by maps, tables and figures.

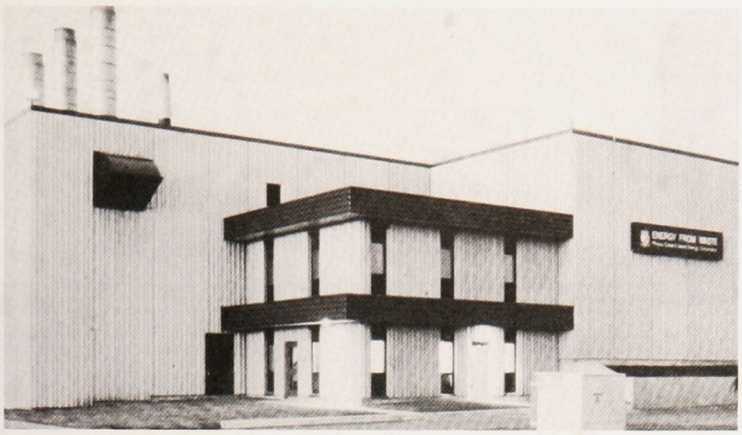
The results indicate that continued use of the Okanagan's unique fruitlands for fruit production remains in question, under present circumstances. The report shows that during the monitoring period:

- Over 3000 hectares in orchards were converted to other uses (a decline of 22 percent). Gains in vineyards have, to some extent, offset these losses.
- Overall, land in fruit production declined by 1900 hectares in this period.
- Over 7000 hectares of land were converted to built-up uses.

The study shows that in recent years, the B.C. Agricultural Land Reserve system has helped preserve fruitland in fruit production. It also documents the tremendous growth of built-up land uses in the valley, between 1958 and 1981.

Federal activities have been influential in shaping land-use changes on prime Okanagan fruitlands. An evaluation of these activities indicates that federally sponsored, development incentive programs, have helped stimulate the demand (residential, commercial and industrial) for land. At the same time, federal support for fruit-related research and other programs has clearly been essential to the continued existence of the fruit industry. The final chapter of the report summarizes trends, implications and consequences of these changes to Okanagan fruitlands. ■

Mind your Own Garbage



Energy from waste plant in Parkdale, P.E.I.

Disposing of garbage is becoming a more expensive and complex task, especially in view of the fact that the average Canadian produces about two-thirds of a tonne of garbage each year.

Despite having many advantages, recycling certain types of garbage will never be able to handle the growing quantities of household and industrial wastes.

Municipal garbage is usually landfilled, but this method falls short of today's needs. Not only are landfill sites becoming more expensive and difficult to find, but they can also cause environmental side effects such as water contamination from leaching, animal infestation and landfill gas production.

Faced with such a situation, it is not surprising that many researchers are trying to come up with new solutions to dispose of the 16 million tonnes of municipal garbage produced annually in Canada. Heading the list of popular new methods to dispose of garbage is the recovery of energy from its incineration.

Despite concerns for public health, it is possible to incinerate solid garbage efficiently without harming the environment, as was shown by the National Incinerator Testing and Evaluation Program (NITEP). This test program examines all aspects of incineration with the goal of minimizing or eliminating unacceptable emissions.

A pilot project in Prince Edward Island studied an energy recovery incinerator which permitted more in-depth studies on the matter. A recently published report by Environment Canada's Environmental Protection Service outlines this research.

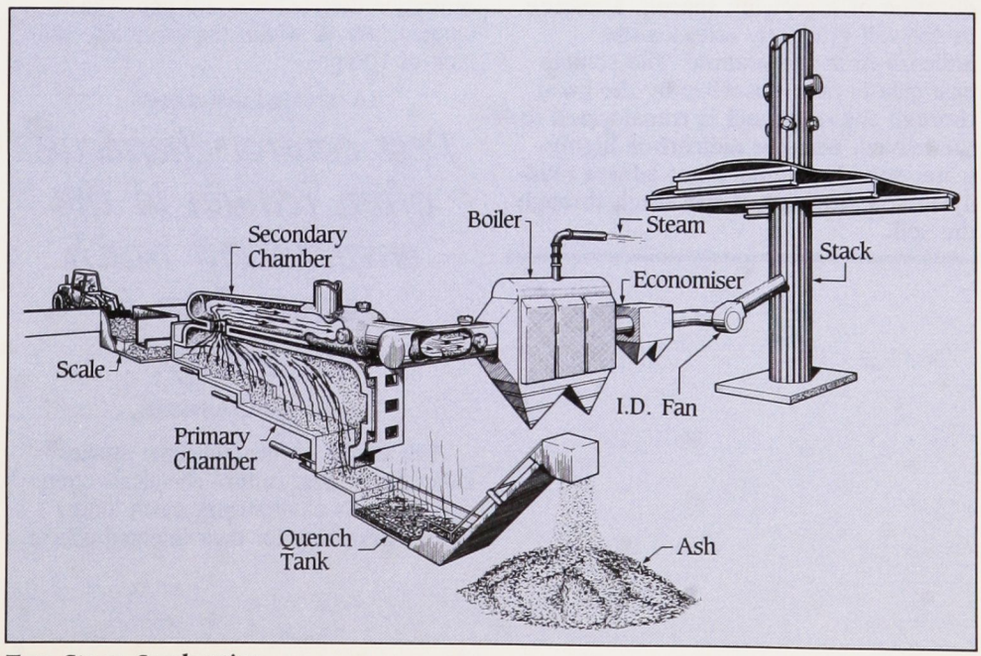
Environmentally, the toxic substances emitted by the test incinerator were well within acceptable levels. In addition to the savings in space, the incinerator's steam saved the Queen Elizabeth and Riverside hospitals about three million litres of oil per year. Perhaps most significantly, the project created 12 permanent jobs.

NITEP is scheduled to last three years. The concrete and positive results already achieved in Prince Edward Island indicate that more municipalities across the country will look into the construction of energy-recovering garbage incinerators. It also seems certain that Canadian industries will be able to produce inexpensive, non-polluting garbage incinerators for energy recovery, for use in Canada and abroad.

Environment Canada is certain that incinerators such as these will be of great interest to environment-conscious municipal officials who want to save energy while creating jobs.

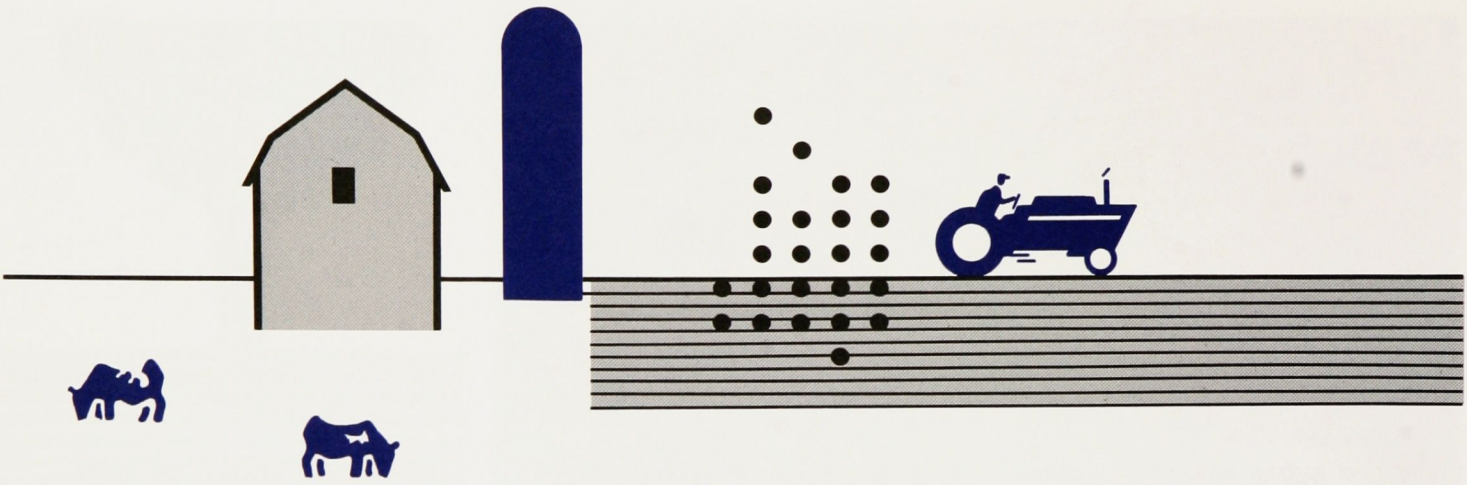
In addition to these innovations, we cannot ignore the progress made by the Wastewater Technology Center in Burlington, Ontario, where researchers are working continually on new methods for disposing of domestic and industrial wastes.

This Centre's considerable achievements have already greatly contributed to industry: among them, a system which produces heating oil from sewage, bacteria which convert organic waste from paper into natural gas, as well as the development of a computerized municipal wastewater treatment plant. Once ready, these projects are left to the municipalities and industries, who greatly benefit from them. ■



Two Stage Combustion

Pesticides, Potatoes and Acid Rain



In Atlantic Canada, toxic chemicals are principally used in the application of large quantities of agricultural pesticides. For the past several years, the Environmental Protection Service has been involved in research to evaluate the growing risk of potential environmental problems associated with pesticide use.

In some instances, this research helps provincial governments protect public health, as was the case with aldicarb use in Prince Edward Island. Aldicarb, sold under the brand name TEMIK, is one of the chemicals used by the potato industry to control Colorado potato beetles, aphids and other harmful insects. This highly toxic insecticide is applied in granular form during the planting process and is effective for the duration of a growing season. Moisture in the soil gradually releases the aldicarb from the granule. The soluble pesticide is then absorbed by the plant through the roots and is translocated to the leaves. Because aldicarb is highly water soluble and does not adhere readily to soil particles, it can leach through the soil.

Prince Edward Island's potable water supply is entirely groundwater dependent. The capital city of Charlottetown derives all its water from large well fields in the surrounding area.

In June 1983, the Environmental Protection Service and the P.E.I. Department of Community and Cultural Affairs initiated a survey to determine if aldicarb was contaminating the Island's groundwater supplies.

Over two growing seasons, samples were collected from 70 wells, in areas immediately adjacent to those where aldicarb was applied. This allowed a comparison of aldicarb concentrations from one growing season to the next. In 16% of the total well water analyses, aldicarb concentrations were above the detection limit of 1 ppb (parts per billion). The average concentration detected was 2.0 ppb. These amounts are all within the acceptable safe limit of 10 ppb.

Pest control chemicals often remain in the environment much longer than is necessary.

The results of this and other studies indicate that pest control chemicals often remain in the environment much longer than is necessary for their intented effects. To monitor their indirect effects as they travel through the ecosystem and react with various ongoing processes is, therefore, important.

Acid rain, in particular, has hit the Atlantic provinces hard. In many of the region's lakes and streams, low pH levels occurring naturally and those caused by acid rain threaten fish populations. Studies were conducted by EPS to determine the effects of water pH on the toxicity of pesticides to fish.

Three commonly used pesticides, fenitrothion, aminocarb and 2,4-D were recently tested for toxicity to rainbow trout. Changes in water pH had no effect on the toxicity of the insecticide fenitrothion. Aminocarb, however, was over 10 times more toxic at pH 8.5 than it was at pH 4.5. The toxicity of the herbicide 2,4-D was altered by changing pH in the opposite way; it was much more lethal at the lowest pH tested.

Research such as the aldicarb survey and the acid rain/pesticide project is an essential means by which we can deal with the use of toxic chemicals, their disposal and distribution in the environment. ■