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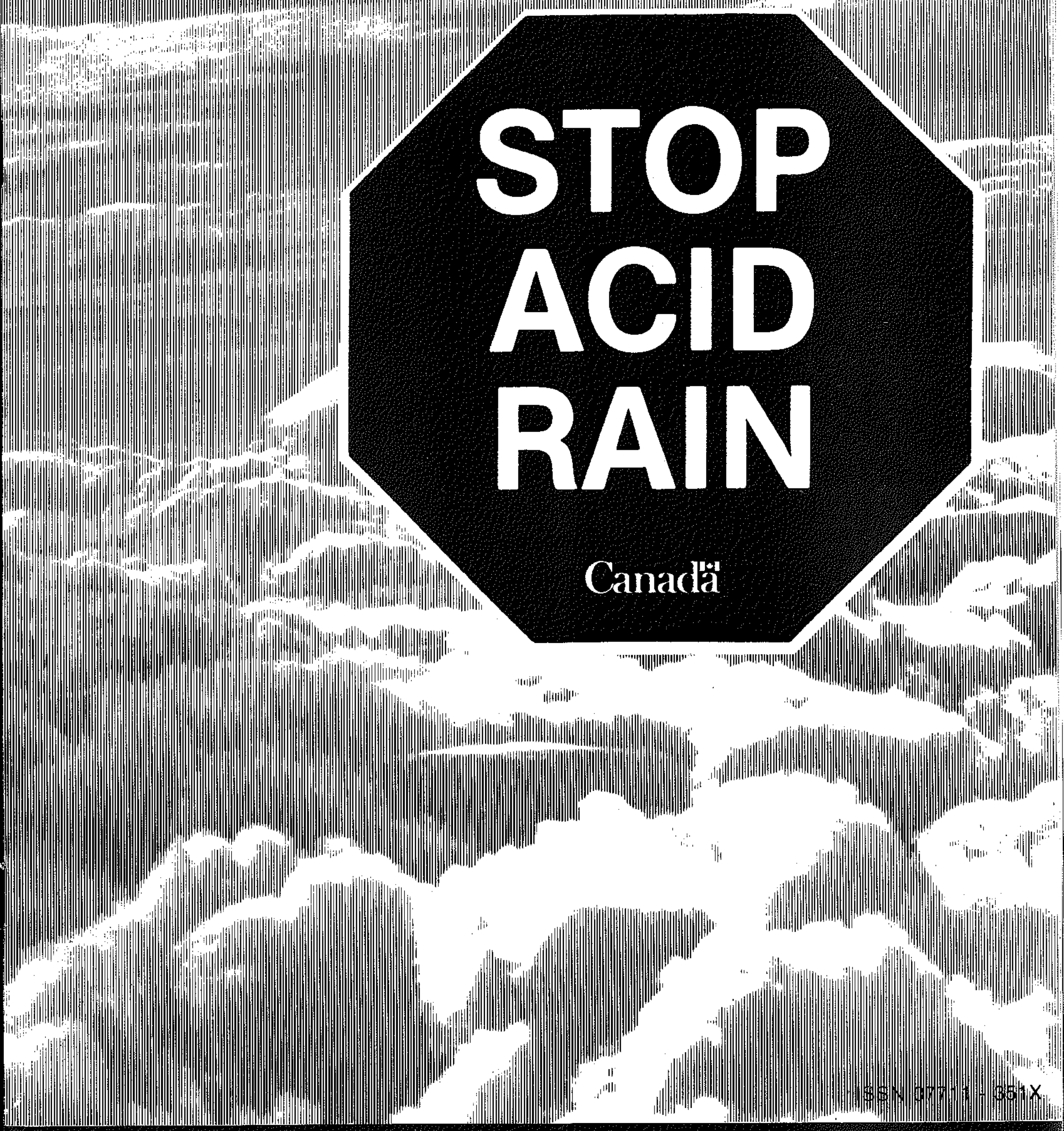

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Contents

From The Editorial Desk

Acid Rain has been and still is one of the paramount environmental issues in the Great Lakes Basin. To address the question ANEE is devoted to attempting to present at least two sides of the argument. The articles, some reprinted with permission, some solicited from C.O.E.O. members are printed with the hopes that teachers will use them to discuss and debate the issue. It is hoped that the articles will adaquately represent the differing views.

This approach to an environmental issue has been taken because of the sincere conviction that both sides of an issue need to be known in order to have students make intelligent decisions. Environmental Studies teachers have a responsibility to present information in a fair unbiased way, and to lead their students to use their minds to make creative choices to improve our environment.

Because of the profound influences teachers have over their students we must see this challenge as both a responsibility and a treasured right.

The Council Of Outdoor Educators Of Ontario

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OCTOBER 84
Proceedings from the Annual Conference and Pre-conference in Sudbury.

DECEMBER 84
The Great Lakes - Problems with water quality and quantity. Publication date - November 15, 1984.

FEBRUARY 85
Urban Studies - Programs and Activities. Sub Theme - Maple Syrup - programs for students of all ages. Publication date January 20, 1985.

APRIL 85
Tripping - How, Where, Why and When. Places to go, equipment and preparation. Please send us some of your thoughts on your successful trips. Publication date March 25, 1985.

All members are invited to submit articles and ideas. We would also like to have some themes or feature topics submitted.

Acid Rain Bitter Rain

Martin De Harte

Former Canadian Environment Minister John Roberts calls it "a cancer at the heart of the bioshpere." Norway's Minister of Environment, Eric Lykke, refers to it as "humanity's greatest peril - a potential ecological disaster."

The two men use this frightening terminology when referring to the acid rain problem in their countries. (Acid rain, or acid precipitation, is the term given to the results of sulfur dioxide and nitrogen oxides released into the atmosphere, where some of the gases are transformed into sulfuric acid and nitric acid, returning to earth in rain, snow, sleet, hail, frost, or dew.-EDS.) In the eastern Canadian provinces of Ontario, Quebec, and Nova Scotia, acid rain is accused of rendering thousands of lakes barren of aquatic life. Eastern Canada's huge forest industry - worth about $24 billion annually - may be in jeopardy, say environmentalists and government officials. Norway reports that 80 percent of the lakes and 50 percent of the rivers in the southern part of the country are now devoid of fish.

Norway, Sweden, and Denmark have been trying to combat the effects of acid rain for 15 years.

"We have not made any appreciable progress in the war against acid rain," says Dr. Erik Nyholm, of Sweden's University of Lund. "We are currently adding lime to our lakes and soils in an attempt to neutralize the harmful acids, but that approach is like prescribing aspirin for a patient who has cancer."

Dr. Nyholm also notes that in the summer of 1982, southern Sweden received an acid drenching 1,000 times more acidic than usual rainfall. In previous years it has been up to 100 times more acidic than average.

Beyond Scandinavia, 11 other European nations report severe ecological damage from acid precipitation.

Now add the U.S.A. to the list. Thousands of lakes there have become acidified, and many environmentalists and scientists say acid rain is the chief culprit. Some economists, including Thomas D. Crocker of the Univeristy of Wyoming, estimate that acid rain causes $5 billion damage each year to vehicles and structures alone in that country. The damage done to forests, crops and drinking water supplies may be that much or more. Dr. Leonard Hamilton and other researchers at Brookhaven National Laboratory, Long Island, New York, think dry deposition - atomspheric sulfate - may cause 21,000 deaths annually in the eastern part of the U.S.A., by inducing chronic bronchitis and emphysema. But many government and industry officials do not recognize acid rain as a serious threat. Some say that the "jury is still out."

However, something seems to have gone wrong in the atmosphere. Throughout much of the world, the precipitation has turned acidic.

Acid deposition, both wet and dry, results mostly from the worldwide burning of coal, oil and gasoline. Tall smokestacks of electrical generating plants, metal smelters, and industrial boilers vent sulfur dioxide and nitrogen oxides into the air. Motor vehicles emit nitrogen oxides into the atmosphere. Once aloft, and often carried for long distances by prevailing winds, a good percentage of the pollutant molecules interact chemically with air, water, and sunlight, and change into other compounds of sulfur and nitrogen. Just how the transformation into other compounds occurs is not fully understood by atmospheric chemists. The compounds are often entrapped within clouds, later deposited as acid rain, acid snow or acid fog. The sulfur and nitrogen compounds which are not caught within a cloud eventually fall back to earth as gases or dry particles. There, some of them await the first rain, snow or dew to tranform them into droplets of acid.

Acid precipitation has also been recorded in the Arctic, Bermuda, Greece, South America - and even in the People's Republic of China.

The amount of acidity a body of water will absorb depends on the quantity of buffering compounds in the surrounding soil mantle. Substances such as limestone aid in neutralizing the acid. Areas having thin soils on bedrock, lacking calcium carbonate, the main ingredient of limestone, are extremely sensitive to acid rain.

Some scientists, including Dr. Thomas Hutchinson of the University of Toronto, believe that acid rain often mobilizes aluminum, mercury, and other toxic metals from a lake's surrounding soils, resulting in massive fishkills. The metals - especially aluminum - can impair the vertebrate's intake of oxygen. Very damaging, too, can be the first spring snow or ice melt, a process that synchronizes with the spawning and hatching season. The "acid shock" in conjunction with the possible mobilization of toxic metals can prohibit the egg-hatching process. Important food fish begin to die even in moderately acidic waters, with a pH value of only 5.0.

The growing acid rain situation may soon affect the health of hundreds of millions of people. Already the corrosive precipitation has entered drinking water supplies in some areas of the U.S.A., Canada, England, and western Europe. Some public reservoirs - such as the Quabbin reservoir in Boston, Massachusetts, U.S.A. - have become so acidic that they must be treated at great expense, and money is one item many cities lack.

It is no longer safe to eat fish in some parts of the world, since they may contain dangerous concentrations of aluminum and mercury. For example, any remaining fish in the inland waters of southern Norway are considered unfit for human consumption. In the state of New York, U.S.A., some health officials urge pregnant women and children not to eat any fish taken from inland lakes.

Medical authorities also are concerned by the microscopic particulates emitted into the atmosphere from towering smokestacks of coal-burning power plants and other industries. The tiny sulfuric soots are released along with the acid rain precursors. Inhalation of the particles may contribute to heart and circulatory complications. Health officials note twice as many cancer patients in locales receiving heavy acid deposition, but a direct link between the two is yet to be established.

Of all the nations ravaged by acid rain, Norway, Sweden and Denmark have surely suffered the most. Dr. Hans Hultburg of Sweden's Water and Air Pollution Research Institute explains why the Scandinavian countries receive so much acid precipitation. "Several years ago we began plotting the paths of storms that brought rain and snow to our region. Some storms were born in the Atlantic, southwest of the United Kingdom. While collecting their acid-forming pollutants, the storms would often sweep across the U.K. and continue on to dump their acid precipitation upon various parts of Scandinavia. Other times the storms would pass over the U.K. and continue to sweep across the Netherlands and West Germany before turning into Scandinavia with their heavy load of acid. Storms which hit us after passing over Europe's worst polluters - the U.K., The Netherlands, Czechoslovakia, and East and West Germany - almost always bring precipitation that is 1,000 times more acidic than usual."

Back in North America, Canada claims to receive about 80 percent of the air-borne pollutants generated in the U.S.A. Canadian industrial activity, in turn, accounts for a mere 10 to 15 percent of acid deposition falling upon the U.S.A. The acid rain situation has sparked some bitter environmental disputes between the two long-time friends, and the trouble may just be starting. Canadian government officials have set strict anti-pollution guidelines for their industry aiming to reduce provincial sulfur emissions 26 percent by 1990. The U.S.A., on the other hand, arguing for independence from imported oil, has eased restrictions which allow the burning of high-sulfur coal. Also, a federal law bans the use of natural gas in all industrial boilers by 1990.

A recent report from the U.S.A.-Canada Research Group warns that the damage to both nations could easily become irreversible by 1995.

Why has the U.S. been reluctant to tackle acid rain? Having run on a platform of economic relief and deregulation of industry, President Reagan would find it very difficult to call for stricter controls regarding emissions. Working with a heavy lobbying campaign by utility and coal companies, the Regan administration killed a strict acid rain bill in 1983. Opponents of the bill maintained that not enough research has been done to warrant a costly ($100 billion) regulatory program, which would require old plants to be fitted with new anti-pollution equipment.

Federal law now requires only new power plants to be equipped with "scrubbers," costly devices to remove about 90 percent of the sulfur dioxides from smokestack emissions. Old plants and those converted from fuel oil or gas to coal are exempt. Thus, only 15 percent of the nation's 1,990 coal-fired power plants have scrubbers.

Japan, where over 1,000 scrubbers have been installed, shows that there may be a solution to the acid rain dilemma.

"By 1965 acid deposition was strangling my country," says Kenjiro Nakamura, a Tokyo industrialist. "Most of our lakes were 1,000 times more acidic than average rainwater. The dry deposition was responsible for many deaths, especially among the elderly. The corrosive precipitation would eat the paint off a new car within six months. In 1968, the Japanese government issued stringent regulations to all polluters, especially to the power industry: install scrubbers in all the coal-fired plants, and use only low-sulfur coal. We soon reduced our emissions by 50 percent, even as our energy consumption doubled."

Japan's success in combatting acid rain is remarkable. By 1985, their power industry must reduce acid rain precursors by another 25 percent. No other industrial nation, save Canada, has yet stabilized emissions, let alone reduced them.

William D. Ruckelshaus, head of the U.S. Environmental Protection Agency, in a November 1983 television interview, says he has suggested several acid rain options to the cabinet and presidential advisers, but, "So far, a consensus has escaped us." The chief difficulty: who will pay for the cleanup. Nevertheless, he expects a definite acid rain policy to be developed early in 1984.

Time may be running out for the U.S.A. Fifteen states east of the Mississippi River are extremely vulnerable to the harmful effects of the corrosive precipitation. Several others are under a moderate threat. The Colorado Rockies and the Pacific Northwest are in trouble also, according to John Harte, a physicist from the University of California at Berkeley. Some mountainous lakes are already devoid of aquatic life. A report from the National Wildlife Federation warns: "It can't be long until every state in the union is vulnerable."

The Allegheny Mountains in central Pennsylvania, Maryland, West Virginia, and Virginia, along with other limestone regions, enjoy natural buffering from the effects of acid precipitation - or acid from the forest floor, which some scientists consider as "guilty" as acid rain. Some areas in the West have air-borne alkaline dust that can neutralize acid before it falls to the ground. Other scientists say, however, that it is only a matter of time before the natural buffering is exhausted.

"We have recently documented the existence of massive swirling weather systems that can move in any direction - not just west to east," says Dr. Walt Lyons, a meterologist for the E.P.A. "St. Louis, Missouri's emissions often end up in the pristine lakes of Colorado. The Ohio River Valley's sulfur dioxides and nitrogen oxides infrequently become Wisconsin's and Minnesota's acid deposition. The Eastern part of the country, where 50 percent of the pollution is generated is responsible for most of the acid deposition falling on Canada."

Each year. internationally, human activity releases over 100 million metric tons of sulfur dioxide and 40 million metric tons of nitrogen into an already polluted atmosphere (excluding the Soviet Union where the amount of emissions is not known). Most researchers blame coal-fired power plants for at least 80 percent of the acid-forming emissions. One large coal-burning plant can emit enough sulfur dioxide pollutants within a year's operation to equal those released by the awesome May 1980 eruption of Washington State's Mount St. Helens volcano - a whopping 400,000 metric tons.

Public opinion has taken notice of acid rain - and not just in Canada, Sweden and Norway. A recent survey conducted in North Carolina, U.S.A., showed that 83 percent of the respondents would be willing to pay higher utility bills in order to support tighter pollution controls. Seventy percent of those polled rated acid rain as a "very serious" problem. Power companies also realize the significance of acid rain as a public policy issue. The Florida Electric Power Coordinating Group, for instance, in 1980, commissioned an independent $3.2 million study of acid rain in Florida. By mid-1985, FGG expects "solid answers to Florida's acid rain situation," says communications officer Ron Spinka. In New York, the electric utility industry is contributing $3.52 million to a three-year study of water quality and fish in 1,200 Adirondack lakes.

Scientists are trying to discover other alternatives to conventional coal combustion, but technologies developed so far require more energy and cost than the energy and cost savings they yield.

Formidable technical, economic, and political obstructions must be solved before the world can counter acid rain. But the solutions must come soon, say many environmentalists and scientists - or acid rain will produce a bitter harvest.

Martin de Harte, The Rotarian, March 1984
Reprinted with permission, The Rotarian April 1984

THE REAL FACTS ABOUT ACID RAIN

Is acid rain really responsible for the dead lakes and dying forests in the northeastern United States and southeastern Canada - and in Scandinavia and Europe? With so many reports in the media about environmental damage due to acid rain, even skeptical people tend to apply the old saying: "Where there's smoke, there must be fire." But what are the real facts now on acidity in the rain and its impact on the environment?

Much of what has been written in newspapers and magazines has been based on opinions and expectations that seemed reasonable when they were proposed some years ago. Developed from impressions, theories, and partial information, they were subject to testing and verification to confirm their soundness. But the acid rain controversy brought many hundreds of scientists into the fray, to re-examine the old data and to conduct new experiments to better understand the origins and effects of acidity on the realities of acid rain. This has not been widely described in the popular media.

To what extent has the acidity of rain increased in recent years? According to the 1983 report of the U.S. National Academy of Sciences, the best evidence is from Hubbard Brook, New Hampshire, where the data for the acidity of rain show no significant long-term trends, either increasing or decreasing, from 1964 to 1977. The N.A.S. report also noted the evidence from the U.S. Geological Survey for nine sites around New York; the data were considered slightly less reliable than those from Hubbard Brook, but confirmed the New Hampshire conclusions - no significant long-term trend in New York. And both studies show a decrease in sulphur concentrations, amounting to around 30 percent over the 14-year period.

So the general impression that the rain in recent years is more acidic than formerly is not supported by the best evidence available. The record does show that rain in the 1970's was more acidic than in the 1950's - at least for the test states of Virginia, Pennsylvania, and Illinois. Acidities increased by 74 percent, 216 percent, and 27,000 percent respectively in those three states, according to analysis from the Illinois State Water Survey. But the same data bases also show that sulfates dropped three percent in Virginia and 23 percent in Pennsylvania, and increased by only 22 percent in Illinois - a fraction of the amount of acidity increase. The best explanations for the increases in acidity is the lower levels of calcium and other acid neutralizers found in the wind-blown particles that come from soils, particularly the farmland and plains west of the Mississippi River. It is now increasingly evident that sulfates created by fossil fuel combustion are not the causes of variations in the acidity of rain.

If the rain has not really become more acidic, what about surface waters? The best evidence tells us that there have been no significant long-term trends there either. But this does not mean lake and stream waters are not acidic. Soil scientists have known for a long time that the organic matter on the forest floor develops highly acidic mulch and humus - a rich source of acid for rainfall and snowmelt percolating through. Below the organic layer, however, is the mineral soil, whose constituents are acid-neutralizing. So the rain and snowmelt, regardless of their own acidity, pick up considerable additional acidity as they filter through the organic layer on the forest floor (but then give up some of the acquired acidity as they continue on through the mineral soil below).

The general principles have been known for 50 years. Norwegian soil scientist I. Th. Rosenquist has shown that the forest floor phenomenon rather than the rain explains the principle source of acidity reaching streams and lakes in his country. In the last two or three years, experiments in the U.S. have confirmed the soil science teachings. In the spring of 1983, researchers from the Tennessee Valley Authority reported on fishkills in trout-rearing facilities adjacent to Raven Fork Creek in North Carolina. The researchers expected to find that acid rain was the cause of the fishkills, but their careful investigation provided a different answer. The river water was indeed more acidic following heavy rainfalls, but the acidity was of the organinc acid type associated with the forest floor. There was no increase in the sulfate acidity that would point to the rain as its origin.

Additional data from investigations in the forests and watersheds of the Adirondack Mountains in New York illustrate with remarkable consistency the effect of the forest floor's separate layers in midifying the acidity of rainfall as it percolates through the organic layer and then the mineral one below. A yet unpublished report from the Congressional Office of Technology Assessment also specifies the forest floor rather than the skies as the principal and determining source of acidity that reaches mountain lakes and streams.

What about the damage said to be caused by acid rain? In 1981, New York state convened the Acid Precipitation Research Needs Conference, which concluded that it could not find verified evidence of acid rain damage to New York's soil, crops, forests, or aquatic resources. In 1983, the Connecticut Acid Rain Task Force reported similar findings. And in June 1983, the Interagency Task Force of Acid Precipitation reported to the president and congress that it could not find confirmed evidence to damage to soils, crops, forests, or lakes attributable to atmospheric acidity.

If acid rain has not damaged susceptible environmtnts, what of the stories that fish have disappeared from lakes in the Adirondacks and elsewhere? Dr. C.E. Johnson, director of the Roosevelt Wild Life Station in the Adirondacks, wrote about the matter this way: "The fact that certain streams which a few years ago were among 'the best trout streams in the Adirondacks' are now depleted, may or may not be explained satifactorily by the presence of beaver dams." His discussion of beavers as a possible explanation for trout losses was written in 1927! He also noted the problems that Canadians were having in stocking lakes in Ontario, citing losses of 98.5 percent and 100 percent of the trout fry and fingerlings "planted" there is 1923 and 1924. New York and Canada were having serious troubles with sport fish in their lakes long before anyone thought of blaming it on fossil emissions or even on the rain.

To sustain good fishing, New York's fisheries and conservation departments kept Adirondacks lakes and ponds stocked with trout and other species from the 1930's onward. The records show a variety of problems in keeping up the fish populations even with annual restocking. And for some lakes, such as Big Moose, the records show a peak in the stocking activity in the 1940's, with reductions from time to time until 1975. Official records show no fish added to Big Moose Lake since that year.

DDT is another culprit. In the 1940's and 1950's the insecticide was used in a successful campaign to rid the Adirondacks of black flies. Forest Ranger Bill Marleau tells it this way: "Little did we know the havoc we would create. We were assured that DDT was safe and would only destroy black fly larvae." Instead, it turned out that DDT "destroyed the food supply for the fish, the frogs, and the birds. In turn, the fish and the birds were prevented from reproducing."

The facts about acidity and the environment are not yet all in, and much of what is established has not been widely reported. In fact, the story is available only in bits and pieces. But as more research is done and reported, the more it appears that the widely held beliefs that once seemed logical and 'scientific' are being replaced by new understandings. Certainly, the general impression that emissions from coal-burning facilities are killing fish in lakes hundreds of kilometres away simply doesn't hold up anymore. In fact, there remains little basis now for believing that the proposals for major cutbacks in sulfur dioxide emissions will produce significant changes in the acidity of rain in any country or confer any benefits to fish in any lakes or rivers.

It is too early to dismiss concerns about the environment. But where people are concerned about fishing or forest productivity, the facts already at hand suggest that the familiar headlines and calls for action are not supported by reality. The enormous effort by scientific specialists should result in a revised view of acidity and alter public opinion. There is little that is more wasteful than a cure for which there is no disease.

Written by Alan W. Katzenstein, member of the Rotary Club of Larchmont, New York U.S.A.

HYDRO TO CREATE MORE ACID RAIN THAN EVER DESPITE PROMISED REDUCTIONS

Ontario Hydro told us today that, rather than reducing it sulphur dioxide and nitrogen oxide emissions this year will be at a record high.

With this admission, Hydro, the second largest sources of acid rain in the province, has made it patently clear that it has abandoned any real attempts to control its significant contribution to the problem.

Hydro now expects to increase its total emissions this year, at precisely the same time it predicted it would be decreasing them. Emissions have been going up over the last few years, with only a slight decrease in 1983.

Hydro is predicting that total emissions for 1984 will range from 540,000 to 600,000 tonnes. This means emissions will be at an all-time high.

Hydro came up with $700 million for retubing two nuclear reactors. Yet it continues to claim scrubbers are an unreasonable expense. The cost of scrubbers for two 500 megawatt units - the equivalent of Pickering Units 1 and 2 - is only $290 million. But Hydro says this is unnecessary in spite of the fact that coal-fired stations such as Nanticoke are being used more than ever before and setting capacity records.

Hydro's track record and the Ministry of Environment's ineffectual controls do not show any serious commitment to saving Ontario's lakes and forests from the devastating impact of acid rain. It is time the public relations efforts were dropped in favour of real technological controls on emissions.

We cannot afford the hypocrisy of control programs that are announced but never followed through on. The time for a serious crackdown on our major polluters - and on Ontario Hydro, in particular - is now, not years down the road when the damage is irreversible.

Bob Rae, Leader April 4, 1984
Brian Charlton, Environment Critic

Acid Rain: A Summary

- Acid rain—the label given to both wet and dry acidic deposits—occurs within, and downwind of, areas of major industrial emission of sulfur dioxide (SO_2) and the oxides of nitrogens (NO_x).

- 1980 sulfur dioxide emissions

Canada	4.7 million tonnes
United States	24.1 million tonnes

1980 nitrogen oxides emissions

Canada	1.8 million tonnes
United States	20.0 million tonnes

- After SO_2 and NO_x are emitted into the atmosphere, they are transformed into sulfate or nitrate particles and by combining with water vapor, into mild sulfuric or nitric acids. They are transported, sometimes great distances, by the prevailing winds. In eastern North America these winds come mainly from the West and South-West.

- Right now it is the SO_2 emissions that cause the most measurable damage to the environment.

- The vast majority of vulnerable areas would be protected if wet sulfate deposition was at levels of less than 20 kilograms/per hectare/per year (18 lbs per acre per year). Canadian emission reductions alone cannot achieve this in sensitive areas of Canada. U.S. emission reductions are needed as well.

- A 1980 Study prepared at the University of Wyoming for the U.S. Environmental Protection Agency estimated the cost of damage to natural and man-made resources from acid rain, in the eastern one-third of the United States, at $5 billion per year.

- Important evergreen species and other plants exposed to high doses of acid rain show damage to their foliage, sometimes at levels such as pH 4.6. Growth of the whole plant is adversely affected.

- The U.S. Congress Office of Technology Assessment estimates the direct cost of a 10-million-ton reduction in SO_2 emissions at about $2.5 to $4.7 billion per year, representing $9 to $20 for each American.

- The direct cost of controlling SO_2 emissions in Canada is estimated at perhaps $1 billion per year or $40 for each Canadian.

- By 1990 Canada is already committed to reduce by 25 percent the total 1980 allowable SO_2 emissions in the eastern provinces, and will undertake additional reductions—up to 50 percent—to achieve the environmental target in concert with control programs in the U.S. This is in addition to the SO_2 controls that both countries undertook in the 1970s to meet local air pollution standards.

- If there is no tightening of current environmental regulations, emissions are expected to increase. Any reduction of emissions would reduce future damage.

- The technology does exist to substantially reduce emissions of SO_2 and NO_x now.

- The pH scale is used to determine the degree of acidity or alkalinity of a solution. "Clean rain" is slightly acidic with a pH level of about 5.6. Below this level precipitation is considered abnormally acidic.

- More than two million square kilometres of North America now receive rain with a pH of 4.6 or lower, that is 10 or more times as acidic as "clean rain".

- Lake and river waters with a pH below 4.5 will not support fish populations. Even at pH 5.0 only limited fish populations can survive; frogs, salamanders and many other creatures are decimated.

- Some 75 federal and 133 provincial stations form the integrated acid rain monitoring network in Canada. These stations provide a regular assessment of rain acidity and deposition.

- Relatively high sulfate and nitrate deposits in remote wilderness areas demonstrate the reality of long range transport of airborne pollutants.

- In the eastern United States and Canada, emissions from man-made sources of SO_2 are 10 to 20 times greater than emissions from natural sources.

- In eastern Canada, major resources threatened with damage from acid rain are sport fishing, tourism and the forest products industry. These sectors generate eight percent of Canada's GNP.

- Fish taken from waters which are becoming acidic exhibit high concentrations of mercury and other toxic metals in their tissues—presumably leached out of soils and bedrock. Drinking water from acidic lakes and rivers have elevated concentrations of toxic metals too.

The Acid Rain Story-
Environment Canada (1984)

History of a Lake

This large experimental lake is referred to simply as LAKE 223, a lake in northwestern Ontario, typical of thousands in North America. Since this experiment started 10 years ago, scientists have been artificially increasing the acidity of this lake while studying in great detail the attendant chemical and biological changes. By adding sulfuric acid to LAKE 223, scientists have lowered its pH value and have documented the acidification stages as follows.

1976
pH 6.8

1977
pH 6.1

- *increase in bacterial activity*
- *increase in invertebrate acquatic animals, small animals which are food for larval fish, insects and large crustaceans*
- *increase of green algae*
- *decrease of brown algae, which is normally dominant*
- *increase of insects*

1978
pH 5.8

- *disappearance of one type of copepod, a crustacean species*
- *reproductive failure of the fathead minnow*
- *increase in deaths of lake trout embryos*
- *decrease in slimy sculpin*

1979
pH 5.6

- *increased plant production in depths of lake*
- *development of mats of algae along shoreline*
- *disappearance of opossum shrimp, a major food source for lake trout*
- *decrease in hardness of crayfish exoskeleton*
- *severe decline in fathead minnow*
- *decrease in white sucker abundance*
- *decrease in lake trout abundance*

1980
pH 5.4

- *disappearance of another copepod*
- *infestation of parasites in crayfish*
- *decreased reproduction and abundance of crayfish*
- *increase of pearl dace, a small minnow*
- *reproductive failure of lake trout*

1981
pH 5.1

- *reproductive failure of white sucker*

At present, LAKE 223 acidity is being maintained at pH 5.1 to study further developments. Although the experiment is artificial manipulation and does not occur in nature, it provides very valuable guidance in the process which might be expected in thousands of lakes now becoming acidified.

Effects on surface water and fish

The most vulnerable areas of our continent are those where the soils are thin and the bedrock is granite. They cannot counteract the action of the acids. The hardest hit areas are Ontario, Québec, and Nova Scotia, Maine, Vermont, New Hampshire, New York, Massachusetts, New Jersey and Pennsylvania.

Effects are also appearing in Michigan and Minnesota, as well as a few more westerly states. Major parts of the southeastern States are vulnerable, and mountain lakes in Colorado and California are becoming acidic.

- About a dozen rivers in Nova Scotia—far removed from local upwind pollution sources no longer support healthy populations of Atlantic salmon.
- About 200 lakes in the Adirondacks no longer support fish life and thousands more are slowly losing their capacity to buffer acid rain.
- To date, 4 016 lakes have been tested in the province of Ontario. Of these, 155 or four percent, were found to be acidified with their ability to support aquatic life extremely limited. A total of 2 896 lakes had some susceptibility to acidification.
- A U.S. government study estimated that 55 percent of the lakes and 42 percent of stream-miles in the eastern U.S. are currently being subjected to acidic deposition which will eventually lead to deterioration.
- Canadian and U.S. scientists cooperated in the Technical Work Groups established under the **1980 Memorandum of Intent** concerning transboundary air pollution. The Memorandum states the intention of both nations to vigorously enforce air pollution legislation and to work for development of a bilateral agreement on transboundary air pollution.

The scientists agreed that damages are observed in sensitive areas where sulphate is above the level of 20 kg/ha/yr (18 pounds per acre per year).

The Acid Rain Story–
Environment Canada (1984)

How Acid Rain Affects our Forests

The environmental and economic value of Canada's forests cannot be overestimated

- they regulate the flow of many of our lake and river systems
- they prevent soil erosion
- they are a home to a highly diversified range of wildlife.

In addition, our forests provide a unique setting for a multi-billion dollar recreation and tourism industry.

Canada's forestry sector produces $23 billion worth of shipments annually. Net exports amount to $13 billion per year. No other industry contributes so much to Canada's balance of payments. Forestry employs, directly and indirectly, one million persons. This is approximately one in every 10 jobs in Canada and is the support of some 3 000 one-industry communities.

Any threat to Canadian forests must be carefully watched. Acid rain poses an insidious and potentially devastating threat to our forests. A recent study has shown that seedlings can be damaged by moderately acidic rain (pH 4.6). The cumulative effect of sulfuric acid in rain and snow building up season after season in the forest soils is now being studied.

Researchers are beginning to evaluate the role of acid rain in increasing the vulnerability of trees to disease and insects. Acid rain may also interfere with the decomposition of plant litter on the forest floor. This would alter the natural cycle of growth and decay which replenishes the soil and feeds the trees.

Many forestry scientists in both Canada and the United States are expecting serious, possibly irreversible, soil and forest effects over the next 25 to 100 years if acid levels being deposited remain constant or increase.

The Acid Rain Story -
Environment Canada (1984)

Fourth Annual Cathy Morris Memorial Workshop

This event originated in 1980 as a lasting tribute to an energetic, talented, wonderfully warm leader lost to us in her first year as an outdoor education professional. The workshop's philosophy is one of belief:

-that sensitive, effective outdoor personnel work from a set of identifiable principles of outdoor leadership,
-that personal growth of the "students", "clients", "campers", is central to all outdoor education, outdoor recreation and organized camping,
-that all of us in the broad outdoor field or studying to be in the outdoor field have something to learn and something to offer in a leadership workshop

If you want to "buy in" to a physically and intellectually active experience predicated on these philosophic touchings, read on.

The method is one of doing some creative outdoor lessons then analyzing not what was done but how and why. This approach has successfully allowed participants to share their perceptions of the outdoor leadership modelled. These perceptions then get clarified and extended by meaningful small group banter and discussion. We feel a good balance of active doing and thoughtful discussion is achieved. The what (content) is well-covered with handout resource material so that the need to learn on that level is met.

So from the Friday night "get acquainted" activity through to Sunday's time for personal reflection, people do and talk and eat and enjoy and share-while "light-bulbs" of new understanding continually wink on.

Group leaders for the workshop are active, skilled professionals drawn from camping, outdoor education, and outdoor recreation circles who share a humanistic approach to outdoor teaching/leadership.

The setting is Albion Hills Field Centre, north of Bolton. Albion's mixed woods will be in full autumn spendour on the October 12-14 weekend. All meals from Friday supper to Sunday lunch are provided.

Accomodation is in dormitory rooms. A registration form is below. The maximum accepted is 35. Consider this weekend for personal/professional renewal and growth.

Workshop Core Committee

John Jorgenson, Tawingo Outdoor Centre
Clare Magee, Seneca College, Outdoor Recreation
Bud Smiley, Mohawk College, Outdoor Recreation
Jean Wansbrough, Outdoor Consultant

Acid Rain

An interview with Dr. J. Stuart Warner Vice-President Inco Limited.

Adapted from an interview that appeared in the November-December 1979 edition of the Inco Triangle, a magazine for Inco's Ontario Division Employees.

Acid rain is a controversial subject that has made news headlines around the world. In an effort to better understand this complex subject the Triangle recently talked with Dr. J. Stuart Warner, a vice-president with Inco Limited who has corporate responsibility for environmental and occupational health policies and programs.

He joined Inco in 1966 and was director of the Company's J. Roy Gordon Research Laboratory from September, 1969 until April, 1976 when he was appointed assistant vice-president, Inco Limited. He was appointed vice-president in November, 1976.

Dr. Warner has appeared as an expert guest on several national TV programs including, "Canada AM", "The Fifth Estate", and "Point Blank". He holds several degrees from Columbia University including a Doctor of Engineering Science. He was an instructor and an assistant professor at Columbia's Henry Krumb School of Mines from 1960 until 1968, where he specialized in teaching thermodynamics and kinetics as applied to extractive metallurgy.

Dr. Warner is also the author of various technical papers and is co-inventor of pyrometallurgical processes for the recovery of nickel from sulphide ores.

Triangle
Just what is "acid rain"?

Dr. J. Stuart Warner
I think it would be helpful to talk about "normal rain" first. This is rain which has absorbed small amounts of the carbon dioxide in the air. As a result, normal rain contains 25 times more acid than does pure water. "Acid rain" is rain that contains even more acid than does normal rain. Rain falling in large areas of north-eastern North America is frequently 25 times more acidic than normal rain. This acid may be present as sulphuric, nitric or hydrochloric acids.

Triangle
Do these three acids play equal roles in making acid rain more acidic than normal rain?

Warner
No. Their roles vary from place to place and from time to time but, in general, it appears that sulphuric acid is responsible for roughly two-thirds of the acid in acid rain in eastern North America. Nitric acid appears to contribute only about one-third of the acid but its contribution is growing rapidly. In fact, some studies indicate that the increased amount of nitric acid in the air is responsible for most of the increase in the acidity of the rain that has been observed in the last two decades. Hydrochloric acid usually contributes less than five per cent of the acid in acid rain.

Triangle
Where do these acids come from?

Warner
They are sometimes emitted directly into the atmosphere as a byproduct of various human activities. However, most of the sulphuric and nitric acids are formed from airborne sulphur dioxide and oxides of nitrogen. Just how these gases are changed into acids is not well understood but the reactions seem to depend on factors such as temperature, humidity, the intensity of sunlight and the presence of other substances such as metallic compounds, ammonia, urban smog, etc.

On a global basis, man and nature emit roughly equal quantities of sulphur dioxide. However, in heavily industrialized areas such as eastern North America and western Europe, man is probably responsible for 90 per cent of this gas.

The first report of the United States-Canada Research Consultation Group estimated that in 1975, Canada emitted 5 million metric tons of sulphur dioxide while the US emitted 25.7 million metric tons. During the same period oxides of nitrogen emissions were estimated to be 1.9 million metric tons for Canada and 22.2 million metric tons for the US. The largest source of sulphur dioxide in Canada was the non-ferrous smelting industry (44 per cent) while coal and oil fired electrical generating stations in the US accounted for 65 per cent of its sulphur dioxide emissions. Transportation is the largest source of oxides of nitrogen in both countries -63 per cent in Canada and 45 per cent in the US but electrical generating stations also contributed 27 per cent of the US oxides of nitrogen emissions.

Triangle
Do emissions from Inco's Copper Cliff smelter contribute to the acidity of the rain?

Warner
The sulphur dioxide we emit at Copper Cliff is no different from the sulphur dioxide which anyone else emits so it can be oxidized to sulphuric acid and thus contribute to the acidity of rain and snow. Chemical theory suggests and actual measurements made in the superstack plume indicate that our sulphur dioxide is not oxidized as rapidly as it would be if it were emitted in, say, the Ohio River Valley. This is a result of the atmospheric conditions that usually prevail in Ontario.

It is important to recognize that our smelter emits essentially **no** oxides of nitrogen.

Triangle
A recent Scientific American article said the smelter emits about 1 per cent of the total annual emissions of sulphur throughout the world. Is this so?

Warner
It's impossible to be precise but I believe that estimate is reasonable. The smelter is, so far as we know, the largest point source of manmade sulphur dioxide in the world. Triangle readers may be interested to know that nature has at least one point source of comparable size - Mount Etna, a volcano in Sicily.

Another interesting fact is that Inco is not the largest corporate emitter of sulphur dioxide. I raise the point because if it's acidic rain you're concerned about, it doesn't matter whether pollutants are emitted from one stack or from many. Even if you add the emissions from Inco's Thompson and Copper Cliff smelters, they are considerably smaller than the combined emissions of the 14 fuel fired electric generating stations operated by the Tennessee Valley Authority, an agency of the US government. The American Electric Power Co. Inc., a private US company, is roughly comparable to Inco relative to sulphur dioxide emissions. Both these utilities emit large quantities of oxides of nitrogen where Inco emits essentially none.

Triangle
What effect does acid rain have on the environment?

Warner
We have talked exclusively about acid rain but this might be a good time to point out that snow can also be acidic. It may produce more serious environmental impacts than acid rain in the cold Canadian climate. That is because snow accumulates for long periods and then releases all its stored acid to the environment in one surge when it melts. It is probably better to talk about "acidic precipitation" meaning both rain and snow.

The most obvious environmental impact of acidic precipitation is on fish and other aquatic life. It can affect them in at least two ways: by making the water too acid or by leaching toxic metals from rock and soils. Lakes in the Canadian Shield are susceptible to this kind of damage because the underlying rock is not able to neutralize the acid in precipitation - at least not without releasing toxic amounts of metals such as aluminum and manganese.

It also seems clear that acidic precipitation can hasten the deterioration of metal, masonry, paint, etc., exposed to it.

There is a **potential** for reductions in forest productivity and for damage to agricultural crops but so far such effects have been observed only under laboratory conditions and at levels of acidity well above those normally observed in the field.

Confusing statements are being made in the literature about health effects. Most of the quoted studies and reports actually deal with sulphur dioxide and oxides of nitrogen, the raw materials from which acidic precipitation is made. So far as I know, the only possible health effects that could stem from acidic precipitation itself would be due to contamination of drinking water by metals released from rock, soil or plumbing.

Triangle
Is the problem going to diminish now that there is widespread awareness of the adverse effects of acidic precipitation?

Warner
No. As a matter of fact, it may get worse before it gets better. The US Environmental Protection Agency has projected that even with tight emission controls on new plants, sulphur dioxide emissions will actually increase for the next couple of decades. This increase is the expected result of increased reliance on coal to generate electrical power. Sometime in the next century sulphur dioxide emissions are expected to begin to decrease as old plants are replaced by new ones subject to stringent emission controls.

The EPA also forecasts a significant increase in oxides of nitrogen emissions so nitric acid will contribute increasingly to the acidity of precipitation. If more attention isn't paid to this problem, we might solve the sulphur dioxide problem and find that acidic precipitation carries on almost as it does now.

I don't know what Canadian projections for oxides of nitrogen emissions are but I believe sulphur dioxide emissions have decreased substantially over the years and will continue to do so.

If damage is occurring at present emission rates, it does not appear that things will improve for at least two decades. We could expect to see continued damage to aquatic systems in Canada during this period.

Triangle
Is cutting back production at Copper Cliff a good way to reduce our sulphur dioxide emission?

Warner
We do not think this is an attractive option for anyone. We believe that - given the necessary time - we can find ways to make further reductions in emissions and still keep the Sudbury operation competitive with other producers of nickel. This will not happen overnight and it will not be cheap, but we are confident it can be done.

Triangle
What do you think should be done?

Warner
There are a number of actions that should be taken. First of all, a treaty between Canada and the US is an absolute must. Second, both countries should establish and rigorously enforce stringent emission performance standards for new plants of all kinds. Third, existing sources of sulphur dioxide and oxides of nitrogen should be examined on an individual basis to see whether additional abatement is technically and economically feasible. Fourth, we must also develop new technology to reduce emissions of oxides of nitrogen.

However, these actions will not happen soon enough to prevent further damage to our lakes **if** the preliminary estimates of their capacity to withstand further acid inputs are correct. I believe measures must be developed and implemented to protect the lakes until the problem, excessive emissions of sulphur dioxide and oxides of nitrogen, is attacked at its many sources.

Triangle
What will Inco do to help solve this problem?

Warner
Let's talk for a moment about what Inco has already done. Some people say that what we've done in the past doesn't matter - that all that counts is that the smelter is still the largest manmade point source of sulphur dioxide in the world. I say it does matter. If we had never been able and willing to reduce our emissions in the past, it would be harder to believe our public commitment to do it again in the future.

Control of sulphur dioxide emissions began at Copper Cliff before environmental concern became a popular public issue and long before anyone was aware of acidic precipitation. Development of the Inco oxygen flash furnace technology for copper smelting provided a strong gas stream for the production of liquid sulphur dioxide. About 100,000 tons of liquid sulphur dioxide has been produced each year since the early 1950s.

Also during the 1950s development of the technology to separate pyrrhotite from the nickel and copper concentrates led to a major secondary industry - the Iron Ore Recovery Plant and CIL's associated sulphuric acid plants. Currently more than 500,000 tons per year of sulphur dioxide are converted to sulphuric acid. Completion of the Clarabelle mill in 1972 led to further pyrrhotite separation from smelter feed and a 40 per cent reduction in our sulphur dioxide emissions, a major achievement by any standard. At present, only 30 per cent of the sulphur in the ore is discharged from the smelter as sulphur dioxide.

Inco also worked hard at some projects that did not pay off. We spent nine years and $14 million on a hydrometallurgical process that would avoid the formation of sulphur dioxide but were forced to conclude it would not be a satisfactory solution. We also spent $9 million on developing methods to capture strong sulphur dioxide from the existing converters in order to make sulphuric acid from it. However, the water-cooled hoods and special flue systems installed on three modified converters have not yet lived up to our expectations.

Triangle
Inco's emissions may be small on a global or a continental scale but they are a very large proportion of the sulphur dioxide emitted in Ontario or in Canada. Don't they have a major influence on the acidity of rain in the province?

Warner
The Ontario Ministry of the Environment sampled the precipitation around Sudbury and in the Haliburton-Muskoka area during the six-week summer shutdown of Inco and Falconbridge in 1978. The acidity of the rain did not decrease even in the absence of the Sudbury emissions. These preliminary data did **not** prove that Inco made no contribution to the acidity of rain but they clearly refuted those who claimed Inco was the **major** source of acid rain in Ontario.

More recently, the Ministry published three more extensive studies of precipitation in these two areas. The samples were collected for various periods from 1976 through 1979; some were taken when the smelter was operating and some were collected during the 8½-month strike in 1978-79. The data indicated that Inco contributed very little to the acidity of precipitation in the Haliburton-Muskoka area and only about 10-20 per cent in the Sudbury area.

Triangle
Well then where did the acid come from?

Warner
The Ministry's data did not answer this question for the Sudbury area but did indicate that most of the acid in rain falling in the Haliburton-Muskoka area came from southerly directions. That is why both Dr. Parrott, (Minister of the Environment, Ontario) and Mr. Roberts, (Minister of the Environment, Canada) have emphasized that Canada is unable to solve its problem alone. International cooperation is essential.

Triangle
Are you sure Inco's sulphur dioxide wasn't oxidized and deposited as acid rain in locations outside Ontario?

Warner
One of the reasons it is so difficult to plan effective strategies to control acidic precipitation is that we don't know how to link acid rain in one area with a specific source of sulphur dioxide or oxides of nitrogen a long distance away. We may never know the ultimate fate of our emissions.

I did however, examine data on the acidity of precipitation in samples collected by the federal government at numerous stations in Quebec and the Maritime provinces during Inco's shutdown and strike. The data is not conclusive because of the way it was collected but I did not observe any decrease in acidity when Inco was not emitting.

Triangle
What is Inco trying now that will reduce emissions in the future?

Warner
We continue to hope that more pyrrhotite can be rejected with no significant penalty in metal losses. We have spent more than six years on basic flotation research at the J. Roy Gordon Research Laboratory and it has provided some promising leads. These are now being tried out in the Mineral Dressing Test Centre in Copper Cliff. If all the problems related to this development can be overcome, it could produce a 25 per cent reduction in emissions.

Even if more pyrrhotite can be rejected, we will still have a great deal of sulphur to contend with in the nickel and copper concentrates. The only practical way we see to deal with this sulphur is to convert it to sulphuric acid. We are looking for other ways to conduct the roasting-smelting-converting processes so as to provide access to the bulk of the sulphur dioxide at a strength suitable for making acid. We are now spending $17 million to conduct a commercial scale test of such a system at our smelter in Thompson, Manitoba. The process should also improve working conditions within the smelter.

If the new process proves to be technically and economically feasible, we will still be faced with the difficult problem of marketing sulphuric acid. We have asked the government to think about ways to ease this problem as we have so far not been able to find customers for this large additional tonnage of acid.

Federation Of Ontario Naturalists

The Federation of Ontario Naturalists
Lee Symmes Award

The Laurel Creek Outdoor Education Centre was the recipient of this prestigious award.

The award recognizes the joint efforts of the Waterloo County Separate and Public Boards of Education and the Grand River Conservation Authority in establishing an effective, model system of nature centres. The Awards Committee and Board of Directors felt that the farsighted measures plan for the future, by building sound understanding and conservation attitudes within "today's youth - tommorrow's decision-makers" was significant.

Jack Davis first recipient of Energy Educator Award

The 800 members of the Association of Energy Educators of Ontario have named the Energy Educator of the Year Award after Mr. Jack Davis, its first recipient.

The award, which was created to recognize outstanding contributions to energy education in Ontario, was presented to Jack by the Honourable Philip Andrewes, Minister of Energy, at the fifth annual Energy Educators Conference in Orillia in February.

Expressing his pleasure in receiving the award, Jack said: "I consider that the highest honour a teacher can receive is to be given professional recognition by his or her colleagues. This award is, for me, the icing on the cake. The cake has been the opportunity of working with, and getting to know, people who have contributed in large measure to energy education. This includes fellow teachers and colleagues in both the Ministries of Education and of Colleges and Universities and in the Ministry of Energy."

Jack is described by his peers as a pioneer in the field of energy education and as a professional who has made a significant contribution to energy education, in co-operation with other government officials, both federal and provincial, as well as with members of the private sector. His contributions include the development of curriculum materials, teacher aids, and energy publications and the planning and encouragement of workshops and seminars for teachers over the past eleven years (since the first energy crisis in 1973).

Some little-known facts about Canada's acid rain and Inco's emissions.

FACT: There are literally millions of sources of emissions that can lead to acid rain.

Acid rain is a worldwide phenomenon. It's caused by emissions of sulphur dioxide and oxides of nitrogen. One or both of these may be emitted from fossil fuel electric power plants, the exhausts of cars, trucks and buses, smelters, natural gas processing operations, oil refineries and pulping plants.

FACT: Most of Canada's acid rain comes from outside Canada.

In the Muskoka-Haliburton region, for example, Ontario government studies of environmental data show that some 90% of airborne acidic chemicals come from the south. Inco's Sudbury operations are north of this region.

FACT: Even when our Sudbury operations were shut down completely there was no significant change in acid rain.

During the 1978-79 shut down at Inco which lasted eight and a half months, the Ontario Ministry of the Environment found that the acidity of the precipitation did not change significantly either in the Sudbury area or in the Muskoka-Haliburton area.

FACT: At Inco we've reduced our emissions significantly.

Since the mid-sixties Inco emissions at Sudbury have been reduced by over half. From almost 7,000 tons per day to about 2,500 at current production rates.

FACT: As a direct result of Inco research we now contain 70% of the sulphur in the ore we mine.

For every pound of nickel in the ore we mine there are eight pounds of sulphur. Decades of research have enabled us to capture almost three-quarters of it, rather than emit it to the atmosphere.

FACT: At Inco we're committed to doing even better.

We've reduced our emissions significantly. And we intend to keep right on working to reduce them even further. But the simple truth is that acid rain is a complex international problem. A solution will require action in many places.

INCO

CONFERENCE '84' REGISTRATION FORM

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surname ____________________ given name ____________________

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1985 COEO membership number ____________________ COEO region ____________________

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Minimum deposit $30.00 ____

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SPEECH DISCOURS

Notes for an address by: Charles Caccia
Minister of the Environment
Government of Canada
at the Canada-Europe Ministerial Conference on Acid Rain, in Ottawa, March 20, 1984.

Fellow Delegates:

As we meet here today, people in Canada and around the world are increasingly concerned about the future of our planet. Our world faces difficult political, economic and developmental energy issues, food and agriculture questions, economic matters and environmental concerns - all preoccupy people and governments in many nations. I believe all of us here today recognize the need for concerted international action to address environmental problems. In Canada, where our economy is so heavily dependent on a natural resource base, we know that the maintenance of the quality of our water, our air and our soil is essential to our long-term development and the quality of life to which that development must contribute. We regard economic and environmental interests as complementary to each other. We see environmental policies as essential planning tools to sustainable economic development.

Over the next two days, we will focus our attention on the acid rain problem - an environmental issue whose economic consequences are formidable.

I would like to describe the acid rain situation in Canada and our policy to deal with the problem.

Acid rain poses a threat to the basic economic resources of my country: forests, lakes, and rivers, fish, agriculture and wildlife.

There are increasingly strong fears that acid deposition is retarding the regeneration of our forests. Canada's forest industry is a major contributor to our economy, employing one in ten Canadians, directly or indirectly. Shipments of forest products from eastern Canada amount to about $15 billion a year.

Of the lakes surveyed in the province of Ontario, 43% are vulnerable to acidification; in many of them, there are already critical signs of reduced neutralizing capacity. A similar situation exists in the province of Quebec. The salmon fishery in our Atlantic provinces is suffering the impact of acid rain. In Nova Scotia, salmon no longer run in nine former salmon rivers, and there are initial signs of acidification in twice as many again. Sports fishing in eastern Canada is a one billion dollar a year industry. It is at risk.

Building erosion and decay from acid rain and its precursors costs hundreds of millions of dallars each year.

The natural resource base at risk due to acid rain sustains vital components of the economy and lifestyle in much of eastern Canada. The revenues from these threatened resources account for about 8% of Canada's Gross National Product.

It is not surprising that public opinion surveys show that eight out of ten Canadians consider acid rain a serious problem.

Canada's policy on acid rain is to obtain reductions in sulphur dioxide emissions in order to eliminate damaging loadings to our environment. In February 1982, Federal and Provincial Environment Ministers agreed to an environmental objective - we are committed to limiting wet sulphate deposition to no more than 20 kilograms per hectare per year, which, according to our scientists, is the level needed to prevent damage to moderately sensitive lakes and rivers.

Allowable SO_2 emissions in eastern Canada in 1980 totalled about 4.5 million tonnes. The major source of emissions is the nickel and copper smelting industry which produced about 60% of the SO_2 emissions. Utilities produce about 16% and non-utility fuel use about 13%. Any acid rain control program in Canada will have to focus primarily on the smelting industry but these other sources are also important.

We have agreed to reduce our SO_2 emissions in the eastern part of Canada by 50% by 1994. As a result of programs, regulations and commitments by provincial governments and the Federal government, a 25% reduction in SO_2 emissions from 1980 base case levels will be in place by 1990. These reductions inclued:

1) significant cutbacks in emissions at the INCO nickel smelter in Sudbury, Ontario, through processes involving increased pyrrhotite rejection;

2) a 40% reduction in SO_2 emissions from the copper smelter in Noranda, Québec;

3) a 43% reduction in SO_2 emissions from Ontario Hydro, Canada's largest utility, through process changes such as coal washing, blending fuel and increased use of nuclear generated power;

4) a 300,000 tonne reduction in SO_2 emissions as a result of switching from coal and oil to natural gas in many non-utility burners and upgrading of light and heavy oils.

We have set up a working group of Federal and Provincial ministers to develop a specific plan to achieve the additional 25% by 1994.

A 50% reduction will mean that total annual emissions of SO_2 from the eastern part of our country after 1994 will be about 2.3 million tonnes. This level of emissions will mean that many areas of Canada will receive less than 20 kilograms of wet sulphate per hectare per year.

However, even if Canadian SO_2 emissions were to cease altogether, we could not protect all sensitive regions in Canada - deposition would still exceed 20 Kg/Ha/Yr in some areas. This demonstrates the significance of the contribution of SO_2 from sources beyond our borders. More than 50% of Canada's acid rain problem originates in the United States. At the same time ten to fifteen percent of the acid rain problem in the north-eastern USA comes from Canadian emissions.

Canada has been working with the U.S. since 1978 to resolve this particulate transboundary air pollution problem. In 1980, we agreed on a set of principles, which have been used by our two countries, in the form of both law and convention, to successfully manage bilateral air pollution issues. We also agreed on and put to work the negotiating machinery which would resolve outstanding technical questions and produce the bilateral agreement to reduce acid-causing emissions.

We have long recognized the need for a joint solution. Our lakes, rivers, forests and wildlife will recover only when it becomes a reality. The inevitable question is therefore, what will happen to us if we do not stop acid rain?

• • •

FINAL COMMUNIQUE

Deeply concerned about long-range dispersion of air pollutants, especially the alarming problem of acid rain, the Environment Ministers of ten countries met in Ottawa, March 20-21, 1984. These countries - Austria, Canada, Denmark, Federal Republic of Germany, Finland France, the Netherlands, Norway, Sweden and Switzerland - committee themselves to undertake reductions of national annual sulphur emissions by at least 30% as soon as possible, and at the latest by 1993.

They also agreed to urge that other Signatories to the Convention on Long Range Transboundary Air Pollution of the UN Economic Commission for Europe (ECE) take similar action. The ECE encompasses the whole of Europe, USA and Canada, and the Convention was signed in Geneva in 1979 to provide a framework for cooperation on acid rain and related problems.

The countries, represented in Ottawa, recognized that a further reduction in sulphur emissions beyond the agreed 30% is, or may prove, necessary as environmental conditions warrant. Effective reductions of emissions of nitrogen oxides (NO_x) from stationary and mobile sources as soon as possible, but not later than 1993, will be undertaken by these countries.

The ten countries are actively engaged in trying to strengthen and accelerate implementation of the ECE Convention. They are aware that present emissions of air pollutants in Europe and North America are causing widespread damage to natural resources of vital importance, such as forests, agriculture, water and fish, are damaging to materials, historic monuments and works of art, and may have harmful health effects. These damages are causing major economic losses.

The predominant sources of air pollution that contribute to acidification of the environment were recognized as the combustion of fossil fuels for energy production, industrial boilers and processes, smelters, individual house-heating and motor vehicles, which result in emissions of sulphur dioxide and nitrogen oxides.

The Ministers agreed that a major objective over the next few years will be to enourage other countries in the ECE to agree to national reductions in acid-causing emissions. They expect that the multilateral environmental conference to be held in Munich in June 1984, to which all Signatories of the Convention are invited, will lend additional impetus to reduction of air pollution in the framework of the Convention. Furthermore, at the second session of the Executive Body of the Convention which will meet in Geneva in September, the Ottawa Conference participants will call on other countries to join them in their commitment to reduce acid-causing emissions.

Acid Rain

Acid precipitation is increasingly an important national and international issue with stronf financial and emotional overtones. Abundant examples of deleterious effects have been cited, but there is wide disagreement among sincere people as to mechanisms of damage, who is responsible, and how the problem should be ameliorated.

The phenomenon of acid rain is not new. It has been active for more than a billion years. In addition to carbon dioxide, other substances contribute to acidity. About as much sulfur compounds are released worldwide to the atmosphere naturally each year as are put there by humans. In islands thousands of kilmeters removed from industrial activity and presumably unaffected by it, rain with pH 4.7 is common. Soils having a pH of 3.5 are formed without human participation in the process.

What is new from a geological standpoint is large-scale burning of fossil fuels. This activity and its effects are concentrated in a relatively small area of the globe. There the anthropogenic contribution of sulfur oxides exceeds that of nature by factors of 10 to 20. Annual precipitation is often equivalent to 20 to 50 kilograms of sulfate per hectare. Nitric oxides play an important role in the conversion of sulfur dioxide into sulfuric acid and they contribute about a third of the total acidity of the rain.

The most noticeable effect from acid rain is a lowering of pH in thousands of lakes in Scandinavia and eastern North America. Accompanying this have been substantial increases in dissolved aluminum, which is toxic to fish. As a result, some lakes are virtually dead: others are dying. Recently an additional phenomenon has raised great concern. Substantial areas of forest in West Germany are dying. The matter has become a hot political internal issue among the various German states.

In the United States concern is growing about the health, present and future, of forests in the Northeast. Instances of pathology attributable to acid rain have been noted in the Adirondacks. Were this pathology to become more intense and widespread, the eventual damage would be great.

Some people in agriculture have spoken of acid rain as free fertilizer since it furnishes needed nutrients. Ordinarily, farmers add ground limestone ($CaCO_3$) to their soils. An application of 6 metric tons per hectare will increase the pH of a heavy soil from 3.5 to about 6.5. The 50 kilograms of sulfate per year from acid rain has little effect on a soil after such a treatment. Adding ground limestone to lakes has resulted in restoration of fish populations. The Swedes are now spending $40 million a year for this purpose. In North America some lakes are being treated, but those that are relatively inaccessible are neglected.

Considerable political steam has been building up, particularly in Canada, about acid rain. They export acidic gases to us, but they import far more from us. The imbalance is causing regrettable bad feeling. In addition, people in the northeast United States take the position that coal-fired utility plants in the Midwest are a principal source of the acid in the rain that has been falling on them. In consequence of these two factors, legislation has been introduced into Congress that would require that emissions from plants in the Midwest be reduced by more than 50 percent. Annual costs for this have been estimated at $5 billion to $8 billion, which would be borne by electricity users. A large number of studies, however, have shown that the Northeast is itself responsible for a large share of its pollution. Indeed, everyone who drives an automobile is a contributor to acid rain.

If long-term damage from acid rain is to be reduced, it will not suffice to use a single scapegoat. Rather, there must be more conservation, better analysis of how to manage, and the development of technologies that effectively reduce emissions while not creating additional environmental problems.

Written by Philip H. Abelson
Science, Vol. 221, 8 July 1983.

Learning To Live With Acid Rain

This summer, the Ontario Ministry of the Environment will drop about 150 metric tonnes of pulverized lime into Trout Lake near North Bay. It's part of a 5-year study being carried out for the Ministry by Booth Aquatic Research of Toronto. Last year, in a similar experiment, the pH of Bowland Lake, 70 km north of Sudbury, was raised from 4.9 to 6.8.

The purpose for the study is to provide scientists with biological as well as chemical information on the effects of liming. Tom Brydges, of Environment Ontario's Acidic Precipitation in Ontario Study, is quoted in the Winter '83/84 edition of the Ministry's magazine, Legacy, as saying: "We hope that this experiment will put us in a position to be able to use the liming tool ourselves, and to allow a cottage associations to use it in an environmentally safe manner."

Whether or not cottage assocations can afford to bear the costs of liming lakes remains to be seen. The lime to be used in Trout Lake will be extremely fine grained (about 4 microns), which will prevent it from settling too fast. As with Bowland Lake, it will be dropped by plane at a cost of about $500 each trip. In total the entire operation is expected to cost $70,000 to $75,000.

Factors influencing the cost for any given lake include: lake size, the existing degree of acidity and accessibility. For this reason the actual cost varies. Cottage associations could reduce the cost significantly by using more labour intensive methods and a cheaper grade of lime, or by only partially liming their lake, but this would also reduce its effectiveness.

For the moment, the best bet for most associations appears to be to wait and see how the Ministry reacts to the results of the study and what kind of liming programs they will propose in the future.

From Conservation Council of Ontario,
Volume 11, No. 6., April 1984

There Is More To "Acid Rain" Than Rain

Significant amounts of acid and other pollutants reach the ground without the aid of precipitation, but most of it goes unrecorded.

Scientists are not happy with the term "acid rain." It serves well in newspaper headlines and as a catchword for a growing international pollution problem. But "acid rain" neglects a part of the acid that has left mountain lakes barren of fish and corrodes car finishes. Some of that acid and numerous toxic chemicals, spewed from smokestacks and tail pipes, are being deposited on lakes, streams, trees, and fields without being washed out of the air by rain or snow.

The proportions of dry and wet deposition depend on the distance from the source of pollution and the wetness of the climate, but some scientists estimate that 10 to 30 percent of the acid problem may result from dry deposition. In some places, the figure seems to be at times greater than 50 percent. Researchers also agree that the dry deposition of pollutants, especially acid, is monitored crudely at best. While research on practical monitoring methods slowly progresses, a dispute continues about the usefulness of present methods, which were developed in the 1950's to deal with radioactive fallout.

One problem with measuring dry deposition is that acid, lead, arsenic, cadmium, and other pollutants do not always simply fall out of the sky, like raindrops or motes of dust. If they did, researchers could simply put out a bucket to catch them. Instead, some pollutants form particles so small that they fall slowly or, for all practical purposes, do not fall at all. A 0.1-micrometer particle, which can be formed by the chemical reactions of combustion gases, will be wafted around a flat surfact rather than fall on it. Gases that can produce acid when dissolved in water, such as sulfur diozide, do not fall at all.

Such finely divided particles and gases may not 'fall out' onto the landscape, but they still reach the gound without being washed out by precipitation, apparently because natural surfaces can 'catch' pollutants that a bucket cannot. In southern Ontario, near the ore smelting industry in Sudbury, conventional collectors miss as much as 60 percent of the sulfate - and presumably much of the sulfuric acid - entering lakes there, according to Peter Dillon of the Ontario Ministry of the Environment in Rexdale. He concludes that not all of the inputs of sulfur have been accounted for because more sulfate flows out of lakes than appears to enter them. Also, too little measured acid enters a watershed to account for the observed chemical compositions of lakes and streams. Much of the missing sulfur must add acid to a lake's watershed, Dillon says, because more calcium, magnesium, sodium, and potassium, which are leached from rocks and soil by acids, leave the lake than could be accounted for by the measured input of acid. The missing sources of sulfate amount to more than 60 percent of the total in watersheds 5 kilometers from the source at Sudbury, 40 percent at 10 kilometers, and 30 percent at 40 kilometers.

Most of the sulfur not collected by samplers as it enters the watersheds seems to be in the form of sulfur dioxide. That gas would not be collected efficiently by the wet deposition sampler - a pot that opens only during precipitation - or by the bulk sampler, a pot that remains open at all times to

Is All Acid Rain Polluted

Richard Kerr

Acid rain is falling on some of the most remote, isolated places on Earth. Whether this scourge of industrial pollution has spanned unexpected distances or whether rain can be acidified naturally, scientists cannot say yet. But they have already traced a 5000-kilometer pathway between Asian sources and the Pacific that carries pollutants in much the same way as the polluted air entering the Arctic.

A thoroughly documented case of acid rain in the Hawaiian Islands has been developed by National Oceanic and Atmospheric Administration researchers John Miller (Air Resources Laboratory, Silver Spring, Maryland) and Alan Yoshinaga (Mauna Loa Observatory, Hilo, Hawaii). Since 1974, they have analyzed more than 1700 rainwater samples collected at nine sites on the island of Hawaii at altitudes of 1 to 3400 meters. Most of the rain collected was acid rain, according to the rule that acid rain has a pH below 5.6 - the pH of pure water acidified by atmospheric carbon dioxide. The pH of rain decreased with increasing altitude, averaging 5.2 at sea level and 4.3 at 2500 meters. The annual average pH of the northeast United States is also about 4.3. The observed pH in the Hawaii samples ranged from about 3.7 to about 5.7.

Miller and Yoshinaga found that the primary acid in the rain was sulfuric acid, the principal acid in polluted rain. But they could not find a sufficient source anywhere on the islands for the sulfuric acid found at their sites. In addition to ascertaining that Hawaii's active valcanoes are insignificant sources, Miller and Yoshinaga set up a collection site on the island of Kauai, 500 kilometers northwest of the island of Hawaii. Kauai has a smaller population, is upwind of the rest of the major islands, and has no active volcanoes. Even so, the annual average pH at the site was 4.8, the same as at a Hawaii site at the same altitude.

Acid rain also falls in the central Indian Ocean. On Amsterdam Island, midway between Australia, South Africa, India, and Antarctica, the pH of rain ranges from about 4.5 to 5, according to James Galloway of the University of Virginia, who is studying remote sites with Miller and Gene Likens of Cornell University. As in Hawaii, the Amsterdam Island samples had been acidified by sulfuric acid.

In contrast, the average pH of 26 samples of rain on Samoa in the South Pacific was 5.6, the calculated pH of uncontaminated rain, according to Robert Duce and Alex Pszenny of the University of Rhode Island, Duce heads the Sea-Air Exchange (SEAREX) program studying the transport of pollutant and natural substances over the oceans. Although rain pH has not been measured at another Pacific SEAREX site on Enewetak, north of the equator, the air there is much dirtier than at Samoa. In addition to desert dust from Asia, it contains pollutant lead and synthetic organic chemicals. The difference between the two sites, Duce says, is that pollution from the Northern Hemisphere, the dirtier of the two, has trouble crossing the equator, where the trade winds converge.

If the sulfuric acid in the rain of Hawaii and Amsterdam Island has a pollutant source, it may be transported thousands of kilometers in the same way that Asian dust reaches Enewetak. It travels at altitudes of at least several kilometers, where contact with the surface cannot remove it and less rain occurs to wash it out of the air. Pollution on its way to the Arctic from nothern industrial centers also excapes removal during winter and spring because of the small amount of precipitation there, even though it travels near the surface. The high-altitude air masses crossing the Pacific eventually subside toward the surface, Duce notes. Miller and Yoshinaga suggest that in Hawaii convenctive rainstorms may actually reach up into the mid-torposphere and wash out the acid.

If some or all of the observed remote acid rain has a natural origin, the ocean may be its source. Duce points out that some evidence suggests that biological processes in the ocean produce reduced sulfur compounds, such as dimethyl sulfide. This compound could oxidize in that atmosphere to form sulfuric acid. If so, researchers and politicians will have to distinguish between natural and man-made acid rain.

Richard A. Kerr,
Science

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Acid Rain And The Forests

"It takes quite a while to study a phenomenon such as this, to document it and then the time it takes to publish it is in the order of six months to a year. So in the two years since we more or less have seen this (spruce dieback) no papers have been published, so that we're looking at a lag time of perhaps three years to get this information out before the scientific community and generally accepted..."
(Arthur Johnson, University of Pennsylvania)

Those who attended the Nov.30, 1983 meeting of Council may recall the above quote from the slide show on acid rain screened at that meeting. At the time of the interview in 1981 Dr. Johnson was researching the effect of acid rain on Red Spruce on Camel's Hump, Vermont. He had been able to demonstrate a noticeable reduction in growth and was trying to pinpoint the exact cause. The results of his research are now published in the Environmental Science and Technology article, "Acid Deposition and Forest Decline" (Vol. 17, No.7, 1983).

The task of finding conclusive evidence on the effects of acid rain and other pollutants is, unfortunately, becoming easier. As the European forests in particular are showing signs of a rapid decline, it is becoming increasingly evident that acidity from man-made sources is impacting on the natural environment. Scientists, such as West Germany's Dr. Bernhard Ulrich, have been able to identify areas where a significant dieback has occurred, but to identify the root cause is a far more complex problem.

Gradually, however, the evidence is beginning to come forward. The March Worldwatch Paper, "Air Pollution, Acid Rain and the Future of the Forests", by Sandra Postel (No.58), is an excellent review of the current literature on forest decline, its economic impact and the prospects for reducing emissions of sulphur dioxide and other pollutants: "A comprehensive look at worldwide forest damage reveals multiple pollutants - including acid-forming sulfates and nitrates, gaseous sulfur dioxide, ozone, and heavy metals - that acting alone or together place forests under severe stress. Needles and leaves yellow and drop prematurely from branches, tree crowns progressively thin and, ultimately, trees die. Even trees that show no visible sign of damage may be declining in growth and productivity. Moreover, acid rain's tendency to leach nutrients from sensitive soils may undermine the health and productivity of forests long into the future. Taken together, these direct and indirect effects threaten not only future wood supplies but the integrity of whole ecosystems on which society depends.

North Americans must travel to isolated mountain peaks in the eastern U.S. to see the kind of massive tree disease and death now spreading throughout central Europe. The loss of West Germany's woodlands is now a potent political and emotional issue among that nation's citizenry. 'Waldsterben' - literally forest death - is now a household word. A survey in the summer of 1983 showed that West Germans were more concerned about the fate of their forests than about the Pershing missiles to be placed on their land later that year. Environmental scientists in Poland and Czechoslovakia warn that forests may become wastelands if plans for increased burning of their high-sulfur coal go unchecked.

Although scientists cannot yet fully explain how this forest destruction is occurring, air pollutants and acid rain are apparently stressing sensitive forests beyond their ability to cope. Weakened by air pollutants, acidic and impoverished soils, or toxic metals, trees lose their resistance to natural events such as drought, insect attacks, and frost. In some cases the pollutants alone cause injury or growth declines. The mechanisms are complex and may take decades of additional research to fully understand. But this growing body of circumstntial evidence is one more telling sign that fossil-fuel combustion has ecological limits, and that society will pay a price for overstepping them." (Worldwatch Paper No.58, pp.6,7.)

From Conservation Council of Ontario,
Volume 11, No.6., April 1984

Acid Rain

Acid rain is not just rain. It is also hail, snow, fog, gases and dry particles -- collectively called "acid deposition". Water in the atmosphere initially exists as a weak acid because carbon dioxide, a natural constituent of air, dissolves to form carbonic acid. If nothing else were present, "pure" rainwater would have a "pH" -- a term used to denote acidity -- of about 5.6 (pH 7 is neutral).

But other substances reaching the atmosphere tend to shift the pH higher (more alkaline) or lower (more acidic). Many of these substances result from naturally occurring processes. Dust and debris carrying slightly alkaline soil particles are swept from the ground into the air; volcanic eruptions spew sulfur dioxide and hydrogen sulfide, both of which react to form sulfuric acid; lightning creates nitrogen oxides which in turn form nitric acid. Decay of organic matter, sea spray and fires also add rain-altering chemicals.

In the North Temperate regions of the world, however, the real assault on the atmosphere comes from man, not Mother Nature. The main culprits appear to be sulfur dioxide and nitrogen oxide gases injected into the air from the burning of fossil fuels by utilities, boilers of all kinds and vehicles.

In the atmosphere, a host of chemical reactions -- only some of which are well understood -- occurs, transforming these gases into acides. The acids fall to Earth as wet and dry deposition, a process that probably has been going on since the Industrial Revolution.

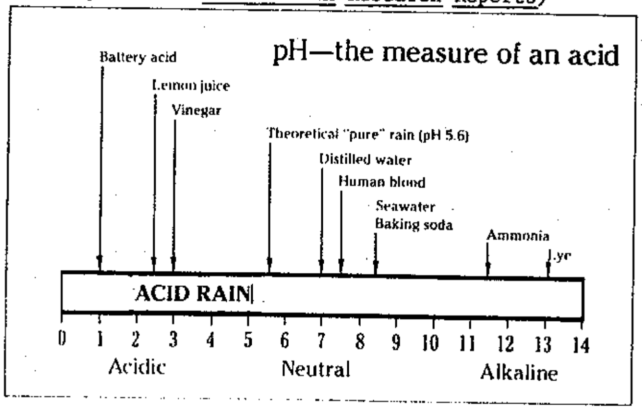
Recently, however, the situation may have been aggravated by super-tall smokestacks constructed to comply with the Clean Air Act of 1970 to reduce local air pollution. These stacks discharge emissions high into the atmosphere where they hitch rides on the prevailing westerly winds, perhaps for hundreds of miles and many days, before they rain down.

Although much has been said about the damage to fish populations, acid rain may also seriously strip soil of key nutrients.

Time is believed to be a crucial factor and if the loss of critical elements continues we are going to be seeing dead forests and lakes within a few years or decades.

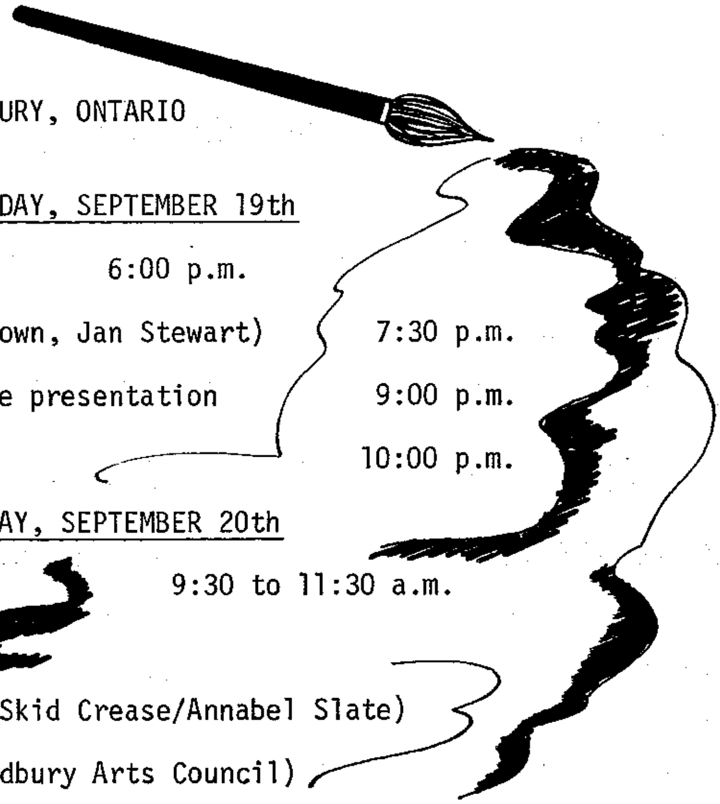
The acid rain controversy is unlikely to go away, but all scientists agree that much additional research is needed to resolve the uncertainties about the nature, causes, extent and effects of acid rain. Such research is in process - but must we wait until that is completed?

(exerpted from Smithsonian Research Reports)



The acidity of water is often indicated by quoting its "pH." The lower the pH, the more acidic the solution. On the pH sc each one unit decrease in pH represents a tenfold increase in acidity. Thus, rain with a pH of 4 is 10 times more acidic than rain with a pH of 5

CREATIVITY USING THE OUTDOORS



SEPTEMBER 19 - 21, 1984 SUDBURY, ONTARIO

PROGRAM PLANNING WEDNESDAY, SEPTEMBER 19th

Registration opens 6:00 p.m.

Icebreakers (Skid Crease, Sue Brown, Jan Stewart) 7:30 p.m.

The Creativity Connection - slide presentation 9:00 p.m.

Wine & Cheese 10:00 p.m.

THURSDAY, SEPTEMBER 20th

MORNING SESSIONS 9:30 to 11:30 a.m.

Photography (Len Cobb)

Language Arts and the Outdoors (Skid Crease/Annabel Slate)

Arts--Visual, Music, Carving (Sudbury Arts Council)

AFTERNOON SESSIONS 1:00 to 4:00 p.m.

The Art of Storytelling (Marylyn Perringer)

Photography (Len Cobb)

Arts--Visual, Music, Carving (Sudbury Arts Council)

New Games Festival (Sue Brown, Jan Stewart) 4:00 p.m.

EVENING SESSIONS

Mountain Majesty (Len Cobb) 7:00 p.m.

Marylyn Perringer tells Stories of the Outdoors 8:30 p.m.

Dancin' 10:00 p.m.

FRIDAY, SEPTEMBER 21st

MORNING SESSIONS 9:30 to 11:30 a.m.

Outdoor Discovery Techniques and Recording (Ralph Ingleton)

Pioneer Arts & Crafts (Joan Thompson)

Logs and Journals and Trips (Bob Henderson/Skid Crease)

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collect precipitation plus any particles that settle out. Sulfur dioxide would dissolve in the lake and in moisture on vegetation or in the soil, and it can be taken up directly by vegetation. Enough was in the air over the area to account roughly for much of the missing sulfur, Dillon says.

Farther from sulfur sources, the apparent contribution of sulfur dioxide decreases. Dry deposition remains significant, however, because the farther polluted air travels, the more sulfur dioxide gas is chemically transformed into sulfuric acid that forms submicrometer droplets or coats other particles. If not washed out of the atmosphere by precipitation or neutralized by basic substances, these particles can also carry acid to the surface. In the Haliburton-Muskoka area of southern Ontario, 200 kilometers from any large urban or industrial centers, about 20 percent of the acid was collected in bulk samplers, but not in wet-only samplers, according to a report by Wolfgang Scheider, Warren Snyder, and Bev Clark of the Ontario Ministry of the Environment.

Researchers have found that other watersheds having different climates and different sources of pollution also receive significant amounts of pollutants through dry deposition. The Hubbard Brook watershed in northern New Hampshire receives about one-third of its sulfur in a dry form says Gene Likens of Cornell University. Most of it arrives as acid-forming sulfur dioxide, he suspects. In the Adirondack Mountains of upstate New York, where the Integrated Lake Watershed Acidification Study is being conducted, about one-third of the sulfate deposition is also dry, according to Carl Chen of Tetra Tech. Inc., of Lafayette, California.

Although bulk deposition samplers and even entire watersheds have been used to collect dry deposition, no one is particularly satified with present estimates of the magnitude of that deposition or current understanding of how it occurs. Watershed studies do not allow the processes involving different types of dry deposition to be separated, and an open pot is not a leaf, piece of bark, blade of grass, or lake, where the actual deposition occurs. The difference is significant. The deposition of a particle may depend on whether the surface is sticky or hard, wet or dry, rough or smooth, featureless or prickly with microscopic hairs, or hot or cold.

Among the first attempts to measure dry deposition using an artificial, or surrogate, surface was one in which researchers studying radioactive fallout set out stainless steel soup bowls. No one thought that they resembled natural surfaces, but the bowls did seem to collect reasonable amounts of fallout. Fancy versions of the orginal soup pots are now being used by the National Atmospheric Deposition Program (NADP), the largest U.S. deposition monitoring effort, to supplement measurements of acid precipitation. But most researchers, including NADP personnel, do not think they know how the data collected so far should be interpreted. In addition to theoretical questions about how a pot compares to natural vegetation, the contamination problem appears to be extensive, according to Bruce Hicks of Argonne National Laboratory, who is chairman of a NADP technical committee. He found that during the 2-month sampling periods, bird droppings contaminated 50 percent of the sites 50 percent of the time. Other contamination included twigs, insects, and, once, a dead bird.

A recent Environmental Protection Agency workshop report[1] condemned the use of surrogate surfaces for the measurement of dry deposition; "...present capabilities to monitor dry deposition in a practical, yet accurate, manner are inadequate," it concluded. "Techniques to measure, let alone (routinely) monitor, fluxes of species associated with acid deposition are presently deficient." The only point in continuing the use of the NADP dry collectors, it said, might be to determine long-term treand in the deposition of relatively large particles, which are less affected by the nature of the collecting surface.

A minority of those attending the workshop of disagreed. The report's summary notes that "20 to 30 percent" of the specilaists present "feel that the use of surrogate surfaces should be pursued in some fasion." Like the majority, most of these researchers do not know exactly what to do with NADP's data from the current sampling of dry deposition. They do have some hope of learning enough about how particles and gases are deposited on natural and surrogate surfaces should be pursued in some fashion." Like the majority, most of these researchers do not know exactly what to do with NADP's data from the current sampling of dry deposition. They do have some hope of learning enough about how particles and gases are deposited on natural and surrogate surfaces to be able to relate the two. Steven Lindberg of Oak Ridge National Laboratory and Cliff Davidson of Carnegie-Mellon University, who coauthored a dissenting view as an appendix to the workshop report, argue that surrogate surfaces such as Teflon, polyethylene, or filter paper can at times behave somewhat like natural vegetation.

As an example of the possibilities, Lindberg and his group compared the performance of polyethylene petri dishes and chestnut oak leaves. They suspended clean dishes in the upper branches of a tree near leaves that had been cleaned by washing. Analyses of dish and leaf washings a few days later showed that the dishes had collected sulfate, manganese, cadmium, and zinc at the same rate as the leaves, within a factor of 2. The deposition rates for lead differed by a factor of 10, perhaps because of absorption of lead by the leaves, Lindberg says. Lindberg and Davidson believe that such evidence, limited as it may be, should encourage further comparisons of deposition on surrogate and natural surfaces, especially in light of the expected long wait for alternative monitoring methods.

Many researchers do not see much future in that approach or prefer working on alternative techniques that promise more direct measurements of dry deposition. The techniques recommended in the workshop report for continued attention are micrometeorological methods in which small-scale meteorological observations are made along with measurements of the concentration of a pollutant. Some of these techniques are being used in research projects, but none is accurate enough or practical enough to be used in routine monitoring programs. Ian Galbally of the CSIRO Division of Atmospheric Physics, Victoria, Australia, John Garland of the AERE Environmental and Medical Sciences Division, Harwell, England, and M.J.G. Wilson of Imperial College, London, have demonstrated one such method for dry sulfur deposition. They measured the vertical wind speed and the concentration of sulfur near the surface, both of which varied as turbulent breezes carried gaseous and particulate sulfur into and out of the vegetation. By calculating the net changes, they found that the air lost sulfur three times faster over farmland than over a forest of Scotch pine. If the latter rate of deposition were to apply over the English and Scottish uplands, they say, dry deposition would constitute 10 to 30 percent of the total sulphur deposited there per year. The absolute accuracy of these flux measurements, the groups reports, is on the order of ± 50 percent.

Similar measurements of the dry deposition of acid, even with that kind of accuracy, are impossible at the moment. The workshop report claims that most micrometeorological methods require precise (1 to 10 percent accuracy) or rapid (once per second) analyses of chemical composition, or both. In the case of most substances, especially the various forms of sulfuric and nitric acids, such sensors do not exist. The prospects for directly measuring the dry deposition of acid are "bleak, absolutely bleak," according to Hicks. About dry deposition in general, Hicks is more optimistic: "We can get there. We're only crawling, not walking, but we're crawling very well."

Footnote

1. Critique of Methods to Measure Dry Deposition, B.B. Hicks, M. Wesely, J.L. Durham EPA-600/980-050 (Environment Protection Agency, Washington, D.C., September 1980).

Written by Richard A. Kerr,
Science, Vol. 211, 13 February 1981 p.692-3

Journal of Great Lakes Research

The Journal of Great Lakes Research, published by the International Association for Great Lakes Research, is devoted to research on the Great Lakes of North America and other large lakes of the world. A complete 24-issue set, containing volumes 1-8 of the journal (1975-82) is available for $120 (U.S. currency). The journal index is available for $5 (U.S.) or free with orders of $50 (U.S.) or more. Regular journal issues to special topics are described below:

Niagara River Pollution Problem
1983; 232 pp.; Sediments, water quality, biota, chlorinated hydrocarbons, trace organics $5

Contaminants and Surface Films
1982; 137 pp.; Physical-chemical interactions, pesticides, PCB, metals, biotic impacts, modeling. $5

Ecology of Filamentous Algae
1982; 237 pp.; Bangia, Cladophora, Ulothrix field ecology, applied studies - modeling, remote sensing, PCB, annotated bibliography. $15

Long Point Bay - Nanticoke
1981; 162 pp.; Baseline impact analysis for power generating plant, steel mill, oil refinery on Lake Erie; ecosystem characterization. $5

Limnology of Lake Superior
1978; 308 pp.; Historical developments, sediments, climate, energy/water budgets, circulation, transparency, water chemistry, ion loadings, plankton, benthos, fish. $5

Atmospheric Contribution
1976; 225 pp.; Pollutant pathways, sampling and measurement techniques, nutrients, metals, biotic impacts, acid rain. $5

Membership in the International Association for Great Lakes Research includes the journal and is available in several categories: member ($25), student ($15), and library ($50). Membership applications and orders for back issues of the journal should be directed to: Mr. William L. Richardson, U.S. EPA, Large Lakes Research Station, 9311 Groh Road, Grosse Ile, MI 48138. Payment should accompany all orders

Courses

If some of your students are enquiring about university programs of environmental studies you may wish to direct them to the University of Waterloo's Department of Man-Environment Studies. This is one of the first programs of its kind designed specifically for undergraduates. Recently the department has initiated a co-operative program option that gives students the opportunity of alternating school terms with work terms to provide them with on-the-job experience and the funding needed to pay for their education. The department has also concentrated its own teaching into three elective streams:

1)Energy management and policy analysis;
2)Environmental and social impact analysis; and
3)Natural area management.

Students who have received the Bachelor of Environmental Studies degree from this program at Waterloo have gone into a wide range of related careers in government, business and industry; becoming everything from environmental planners to employees in occupational health units in industry; to teachers; to self employed entrepreneurs of tourist operations and insulation companies.

The Department of Man-Environment Studies is in the Faculty of Environmental Studies along with the Department of Geography, the School of Architecture, and the School of Urban and Regional Planning. You and your students are invited to visit us to get a taste of university lectures and labs and tour some of our facilities. Worth seeing, for example, is the computer for 'reading' remote sensing imagery, the design studios, the map library, and ecological cartographic laboratories.

As a department we would welcome the opportunity to discuss with you the provision of specialized services for you be it in the way of Professional Development Day workshops, special lectures, field trips and/or demonstrations. Hopefully such undertakings could be tailored in such a way as to provide you with material that could be taken back to the classroom and would leave us with a better appreciation of current activity and development within your membership and the schools.

If you know students you think might be interested in this type of honours program, have them get in touch with Dr. George Priddle, Chairman; or Sally Lerner, Undergraduate Officer, c/o Man-Environment Studies, University of Waterloo, Waterloo, Ontario, N2L 3G1, (519) 885-1211, Ext. 2762 or 3060 for more information. An informal visit to the department for further discussion can also be arranged.

Counter Point: The Real Facts About Acid Rain

Is acid rain really responsible for the dead lakes and dying forests in the northeastern United States and southeastern Canada - and in Scandinavia and Europe? With so many reports in the media about environmental damage due to acid rain, even skeptical people tend to apply the old saying: "Where there's smoke, there must be fire." But what are the real facts now an acidity in the rain and its impact on the environment?

Much of what has been written in ne spapers and magazines has been based on opinions and expectations that seemed reasonable when they were proposed some years ago. Developed from impressions, theories, and partial information, they were subject to testing and verficiation to confirm their soundness. But the acid rain controversy brought may hundreds of scientists into the fray, to re-examine the old data and to conduct new experiments to better understand the origins and effects of acidity on the environment. Research activity exploded around 1980, and the evidence today creates a new view of the realities of acid rain. This has not been widely described in the popular media.

To what extent has the acidity of rain increased in recent years? According to the 1983 report of the U.S. National Academy of Sciences, the best evidence is from Hubbard Brook, New Hampshire, where the data for the acidity of rain show no significant long-term trands, either increasing or decreasing, from 1964 to 1977. The N.A.S. report also noted the evidence from the U.S. Geological Sruvey for nine sites around New York; the data were considered slightly less reliable than those from Hubbard Brook, but confirmed the New Hampshire conclusions - no significant long-term trend in New York. And both studies show a decrease in sulfur concentrations, amounting to around 30 percent over the 14-year period.

So the general impression that the rain in recent years is more acidic than formerly is not supported by the best evidence available. The record does show that rain in the 1970's was more acidic than in the 1950's - at least for the test states of Virginia, Pennsylvania, and Illinois. Acidities increased by 74 percent, 216 percent, and 27,000 percent respectively in those three states, according to analyses from the Illinois State Water Survey. But the same data bases also show that sulfates dropped three percent in Virginia and 23 percent in Pennsylvania, and increased by only 22 percent in Illinois- a fraction of the amount of acidity increase. The best explanations for the increases in acidity is the lower levels of calcium and other acid neutralizers found in the windblown particles that come from soils, particularly the farmland and plains west of the Mississippi River. It is now increasingly evident that sulfates created by fossil fuel combustion are not the causes of variations in the acidity of rain.

If the rain has not really become more acidic, what about surface waters? The best evidence tells us that there have been no significant long-term trends there either. But this does not mean lake and stream waters are not acidic. Soil scientists have known for a long time that the organic matter on the forest floor develops highly acidic mulch and humus - a rich source of acid for rainfall and snowmelt percolating through. Below the organic layer, however, is the mineral soil, whose constituents are acid-neutralizing. So the rain and snowmelt, regardless of their own acidity, pick up considerable additional acidity as they filter through the organic layer on the forest floor (but then give up some of the acquired acidity as they continue on through the mineral soil below).

The general principles have been known for 50 years. Norwegian soil scientist I. Th. Rosenquist has shown that the forest floor phenomenon rather than the rain explains the principle source of acidity reaching streams and lakes in his country. In the last two or three years, experiemtns in the U.S. have confirmed the soil science teachings. In the spring of 1983, researchers from the Tennessee Valley Authority reported on fishkills in trout-rearing facilities adjacent to Raven Fork Creek in North Carolina. The researchers expected to find that acid rain was the cause of the fishkills, but their careful investigation provided a different answer. The river water was indeed more acidic following heavy rainfalls, but the acidity was of the organic acid type associated with the forest floor. There was no increase in the sulfate acidity that would point to the rain as its origin.

Additional data from investigations in the forests and watersheds of the Adirondack Mountains in New York illustrate with remarkable consistency the effect of the forest floor's separate layers in modifying the acidity of rainfall as it percolates through the organic layer and then the mineral one below. A yet unpublished report from the Congressional Office of Technology Assessment also specifies the forest floor rather than the skies as the principal and determining source of acidity that reaches mountain lakes and streams.

What about the damage said to be cause by acid rain? In 1981, New York state convened the Acid Precipitation Research Needs Conference, which concluded that it could not find verified evidence of acid rain damage to New York's soils, crops, forests, or lakes attributable to atmosperic acidity.

If acid rain has not damaged susceptible environments, what of the stories that fish have disappeared from lakes in the Adirondacks and elsewhere? Dr. C.E. Johnson, director of the Roosevelt Wild Life Station in the Adirondacks, wrote about the matter this way: "The fact that certain streams which a few years ago were among 'the best trout streams in the Adirondacks' are now depleted, may or may not be explained satisfactorily by the presence of beaver dams." His discussion of beavers as a possible explanation for trout losses was written in 1927! He also noted the problems that Canadians were having in stocking lakes in Ontario, citing losses of 98.5 percent and 100 percent of the trout fry and fingerlings "planted" there in 1923 and 1924. New York and Canada were having serious troubles with sport fish in their lakes long before anyone thought of blaming it on fossil emissions or even on the rain.

To sustain good fishing, New York's fisheries and conservation departments kept Adirondack lakes and ponds stocked with trout and other species from the 1930's onward. The records show a variety of problems in keeping up the fish populations even with annual restocking. And for some lakes, such as Big Moose, the records show a peak in the stocking activity in the 1940's, with reductions from time to time until 1975. Official records show no fish added to Big Moose Lake since that year.

DDT is another culprit. In the 1940's and 1950's the insecticide was used in a successful campaign to rid the Adirondacks of black flies. Forest Ranger Bill Marleau tells it this way: "Little did we know the havoc we would create. We were assured that DDT was safe and would only destroy black fly larvae." Instead, it turned out that DDT "destroyed the food supply for the fish, the frogs, and the birds. In turn, the fish and the birds were prevented from reproducing."

The facts about acidity and the environment are not yet all in, and much of what is established has not been widely reported. In fact, the story is available only in bits and pieces. But as more research is done and reported, the more it appears that the widely held beliefs that once seemed logical and "scientific" are being replaced by new understandings. Certainly, the general impression that emissions from coal-burning facilities are killing fish in lakes hundreds of kilometres away simply doesn't hold up anymore. In fact, there remains little basis now for believing that the proposals for major cutbacks in sulfur dioxide emissions will produce significant changes in the acidity of rain in any country or confer any benefits to fish in any lakes or rivers.

It is too early to dismiss concerns about the environment. But where people are concerned about fishing or forest productivity, the facts already at hand suggest that the familiar headlines and calls for action are not supported by reality. The enormous effort by scientific specialists should result in a revised view of acidity and alter public opinion. There is little that is more wasteful than a cure for which there is no disease.

Reprinted with permission The Rotarian, April 1984

Administration Views on Acid Rain Assailed

A new report asserts that acid rain is a serious problem in need of prompt regulation.

An expert panel of the National Research Council has issued what amounts to an indirect rebuke of the Reagan Administration over the issue of acid rain. Taking the opposite side in the current debate over amendments to the national Clean Air act, the panel concludes that the acid rain picture "is disturbing enough to merit prompt tightening of restrictions on atmospheric emissions of fossil fuels and other large sources." Emissions of sulfur dioxide, one of the precursors of acid rain, should be cut by at least 50 percent, the panel says, while emissions of nitrogen oxides, another precursor, must also be sharply cut.

The report[1] is likely to assume considerable importance in the growing controversy over the Administration's willingness to seek only continued study of the acid rain problem. EPA Administrator Anne Forsuch has justified this stance with a claim that the sources of acid rain remain uncertain and the extent of its damage unknown. The policy has been pleasing to the utility and coal industries, which the research council report says are responsible for 88 percent of sulfur dioxide emissions and a huge portion of the emissions of nitrogen oxides. The bulk of this pollution is generated in Ohio, Pennsylvania, and Indiana.

But the policy has greatly angered the citizens of Canada, who must endure the adverse economic effects of American-caused acid rain on their crops, lakes and forests. Residents of New England are similarly upset, and their representatives in Congress have begun to agitate for changes in the law that would cost power companies in the Ohio River valley billions of dollars.

The research panel argues in favor of these changes, noting that "continued emissions of sulfur and nitrogen oxides at current or accelerated rates, in the face of clear evidence of serious hazard to human health and to the bioshpere, will be extremely risky." But the Administration apparently wants to head in the other direction. Drafts of its clean air amendments that have been leaked to Capitol Hill include a host of provisions of acid rain. Utilities, for example, would no longer have to install sulfur dioxide emission controls on power plants that shift from oil to coal. Deadlines for compliance with existing sulfur dioxide and nitrogen dioxide standards would be extended. Provisions allowing New England states to force tighter controls on pollution generated outside of their region would be weakened.

One Administration proposal seems particularly remarkable in light of the details of the research panel's report. Forsuch has proposed to double the statutory limit on emissions of nitrogen oxide from automobiles in 1983 and beyond. This reform can be accomplished "without significant harm to air quality goals," she says. The justification is that it will reduce the sticker price of a new auto by $60, which will in turn supposedly help out Detroit. But the relaxation will undoubtedly accelerate the increase in nitrogen oxide emissions that is anticipated as the result of increased burning of coal. Ambient levels of nitrogen oxides have already tripled over the last 25 years, the report says. And in the absence of further controls, "their emissions will exceed emission of sulfur oxides by the turn of the century." Most of the increase is occurring in the Boston to Washington corridor and in the Ohio region. Scientists are apparently less certain of the ecological effects of nitrogen oxide than they are of the effects of sulfur dioxide. But the panel says that in addition to boosting acid rain production, the pollutant could be causing runoff of nitrate from soils into drinking water in hazardous amounts.

The report generally highlights the relationship of coal-burning to the release of toxic metals into the environment - a secondary phenomenon of acid rain that has only recently attracted scientific notice. As the rain acidifies lakes and streams, for example, it leads to the release of aluminum from sediment and nearby soils. In the spring, when ice melts, the accumulated acid precipitate boosts aluminum concentrations so high that massive fish kills result. Manganese, zinc, nickel, lead, and cadmium also appear to be washed into lakes and streams as a result of acid rain, the panel says. Scientific models suggest that "in Lake Michigan both cadmium and zinc will reach concentrations toxic to zooplankton within the next 30 to 80 years."

The concern is that acid rain exacerbates the effects of direct emissions of toxic metals. It increases the amount and toxicity of mercury in fish, for example. "At present, there is no satisfactory technology for controlling large-scale emissions of mercury....Its continued or accelerated release, especially in view of its synergism with acid deposition, may cause chronic problems in many areas in years to come," the panel says. On land, deposited nitrogen and sulfur may result in a short-term enhancement of plant growth, but "over the long term acid precipitation is likely to accelerate natural processes of soil leaching that lead to impoverishment of plant nutrients."

The utility and coal industries' response to such concerns is that others are responsible, and that the problem has not appreciably worsened in recent years anyway. William Pundstone of the Consolidation Coal Company told a congressional committee several months ago that "there is no good data or evidence linking sulfur emissions to alleged increases in acidity of rainfall in the Eastern United States. An examination of the amount of coal burned in this country during the same time span that acid rainfall allegedly increased - 1955 to 1973 - reveals very little change in the total sulfur dioxide levels."

The research panel, which was led by David Schindler, an American researcher at the Freshwater Institute in Winnepeg, Manitoba, challenges these assertions directly. "Although claims have been made that the direct evidence linking power-plant emissions to the production of acid rain is inconclusive, we find the circumstantial evidence for their role overwhelming," it stated.

The panel also casts doubt on the usefulness of a remedy to acid rain frequently suggested by the utility industry - the liming of lakes through airborne dumping of phosphorus and calcium carbonate. The procedure is too expensive can can cover only a small region, the report says. It concludes that "in the long run, only decreased reliance on fossil fuel or improved control of a wide spectrum of pollutants can reduce the risk that our descendants will suffer food shortages, impaired health, and a damaged environment."

Written by R. Jeffrey Smith,
Science, Vol.214, 2 October 1983
1. Committe on the Atmosphere and the Biosphere, Atmosphere-Biosphere Interactions:Toward a Better Understanding of the Ecological Consequences of Fossil Fuel Combustion (National Academy Press, 1981)

Acid Rain

It's raining over a lake. The lake's water is clear and blue. But there are no fish and few plants in the lake. The rain killed the fish. It was acid rain.

Acid rain won't burn you. Each drop has only a tiny bit of acid in it. But after a while, a lot of acid rain can hurt fish. It wears down statues and buildings. It ruins car and house paint.

Acid rain is caused by pollution. Coal-burning power plants, factories, and cars give off smoke. The smoke is filled with chemicals. Wind carries the smoke into the atmosphere (air around the earth). The chemicals mix with water in the air. This forms acids. The acids can fall to earth as rain, snow, sleet, and fog. The chemicals may travel hundreds of miles before they fall.

Acid rain turns water acid. That means the water is like vinegar or lemon juice. The acid kills some fish. The acid also damages the fish eggs. Most eggs won't hatch. The fry that hatch are often deformed. All the animals in the lake die. Most of the plants do too. Animals around the lake that eat fish can't find any. Many of them die too.

Some lakes have limestone in the soil around and under them. This rock buffers (weakens) the acid. But many lakes aren't near limestone. Lakes in the mountains are easily hurt by acid rain.

A lot of acid rain comes from factories in Ohio, Illinois, Indiana, New York, and Sudbury, Canada. But the acid rain falls in the mountains of the eastern United States and Canada. These mountains have beautiful lakes. Many people used to vacation at the lakes. But now the fish are gone. Many people in Canada are angry about acid rain from the United States.

There are ways to clean up acid rain. Coal can be washed before it is burned. Chemicals like sulfur can be taken out when the coal is burned. Smoke stacks can filter (clean) smoke. People can use cars less. The government can order car companies to control the amount of pollution made by their cars.

But many companies won't do these things until the government tells them to . The United States government doesn't understand how important it is to stop acid rain. You can write to your U.S. Senator or Representative. (Look in the phone book under United States.) Ask them to help stop acid rain.

Reprinted from Tracks, Volume 6, Issue 7, March 1984.

Michigan United Conservation Clubs.

Acid Rain

British chemist Robert Angus Smith first used the term "Acid Rain" in 1872 in a 600 page treatise examining links between the sooty skies over Manchester England and the acidity he discovered in local precipitation.

Acid Rain

Joan Millard

As a phys. ed graduate, I dare not present myself as a scientific expert qualified to lecture on the subject of acid rain. However, I have been following the problem rather closely for about eight years and Brent asked me to prepare a summary for ANEE, so here goes.

I first became aware of the acid rain problem when I met Dr. James Kramer a geology professor at McMaster University. His son was a member of my outers' club and when Dr. Kramer needed some canoeists to take water and soil samples in the Quetico Park region I was luck enough to get the job. We spent a month gathering data for this acid rain study and during that time I became curious about what our samples were showing and about the whole acid rain question. This lead to a lot of discussions, readings and subsequently to petition writing and an interview with Dr. Harry Parrott (Then Ontario's Minister of the Environment). No dramatic results have ensued but I remain optimistic that concerned environmentalists will mobilize positive action before it is too late.

The Problem:

Acid rain has been referred to by alarmists as the 'rain of death' and by Outdoor Canada as the 'tears of success'. I find the latter description more apt for acid rain is the price we are currently paying for our heavy reliance on fossil fuels. As we burn fossil fuels sulphur and nitrogen oxides are emitted and these substances are transformed into acidic compounds in the atmosphere. These compounds then fall as snow, rain or solid substances on the land and water.

Normal rain has a PH of 5.6 but in large areas of the eastern United States and south eastern Canada the average PH of precipitation ranges from 4 to 4.5 - 10x more acidic than normal rain. Limestone will act to buffer the effects of acid rain but areas low in limestone, such as the pre-Cambrian Shield and the Atlantic provinces, are very susceptible to damage. Some areas in Ontario currently are suffering the effects of acid rain are - Killarney Park, Muskoka, Haliburton and Atikoken.

Aquatic ecosystems are the most sensitive to acid precipitation. As a lake becomes more acidic the phytoplankton die and the lake looks perfectly clear. Adult fish survive adding to the impression of a health lake but they lose their ability to reproduce or they give birth to deformed offspring. As the fish gradually disappear changes take place at all levels of the food chain. In the spring the first melt accentuates the problem and we see what is termed acid shcock- extremely high levels of acid in lakes, rivers and soils and a crucial time period.

There are also concerns that the increased acid in the lakes leaches natural mercury and aluminum from the soil. These toxic chemicals are injested by the fish (aluminum on the gills causes death) and find their way up to the food chain. The fish have been compared to the canaries in the mines. Perhaps they are warning us of potential hazards to our own health. Human health hazards are not completely understood but sulphur emissions have been linked to respiratory problems. We already know that acid rain harms fish, salamanders, buildings and cars. Maybe it is time to be concerned about ourselves.

Although this has not been well documented, there are also indications that acid rain can have adverse effects on plants and forests. The forestry industry is vital to our economy and we can ill afford to see it damaged. It has been estimated that we could lose $600 million annually in N. Ont. and Quebec if acid rain adversely affects sport fishing. These two factors alone should motivate us to seek soluations quickly.

Solutions?

In 1981 in Ontario, 140 lakes were listed as dead and approximately 48,000 were listed as threatened with death in the next ten years. Once a lake dies the process is almost irreversible (despite experimentation with lime dumping). The need for action is obvious but unfortunately no state or province can act alone - acid rain is a continental problem. As such it demands an international solution.

Sulphur emissions come mainly from the smelting industry (i.e. INCO) and coal fired generating stations (i.e. Nanticoke). In the 50's sulphur emissions were considered a local problem and taller smokestacks were viewed as the soluation. Unfortunately this only dumped the problem in someone else's backyard. Acidic precipitation repects no borders and obeys only the wind.

In 1980 Canada and the United States signed an agreement to negotiate a clean air pact. However, on June 7, 1984 a Canadian all party parliamentary committee released a report called "Time Lost, A Demand for Action on Acid Rain". Mr. Irwin, Chairman of the committee said, "Since then (1980), there has been almost four years of rhetoric, but almost no reduction in polluation" (Globe and Mail June 8, 1984).

The technology exists to reduce or eliminate nitrate and sulphate emissions but the soluations are expensive. We could burn low sulphate coal (Ontario Hydro tries to do this) but in some areas this is not readily available and the local economy depends upon selling high sulphur coal. Sulphur can be removed from the ore before smelting. Technology exists to wash the coal and the U.S. Dept. of Energy recently announced that a process to use microwaves to cook sulphur out of coal may be ready for commercial use by the mid-1990's. Both these processes are expensive but potentially below the cost os oil. Scrubbers can also be installed to reduce sulphate emissions by almost 90% but again they are expensive. (Ontario Hydro built Nanticoke without them and Atikokan will not have them either!).

Any of these processes could become more popular and economically more feasible if we can generate a demand for the sulphur by-products that result. They can be used in acid production, fertilizer, asphalt compounds etc but currently there is not enough demand for these products - at least not in the quantities that would be produced. The parliamentary committee referred to earlier has recommended tax breaks and financial incentives to encourage industry clean up. Ontario Hydro, Inco and US industry have all argued that they cannot afford severe restrictions on their emissions but perhaps tax breaks would encourage action.

Nitrate and sulphate emissions can also be reduced by conservation-reducing our demand for energy and fossil fuels. Here Canadians have a long way to go for we currently produce twice as much sulphur dioxide per capita as Americans. Our government also allows higher hitrogen emissions from cars than do our American counterparts. According to the Hamilton Spectator "This country generates half of its own acid rain - and it isn't doing much about is except yelp at the Americans" (Spectator, June 11, 1984).

Other proposed solutions - breeding acid tolerant fish and crops, liming lakes, coating valuable structures and artwork cannot be seen as long term solutions. We need measures which will reduce sulphur and mitrate emissions. President Reagan claims he needs more research and Canada's Environment Minister Charles Caccia claims the U.S. is dragging its feet when it comes to an international agreement on acid rain. It is time to cut through the verbal smokescreen and demand action.

Solutions are expensive but the potential cost of inaction - reduced tourism, decreased fishing, lower agricultural yields, damage to forests, buidings and cars and the possible human health hazards - outweighs this. The short tems costs will be more than balanced by the long term effects. The choice is ours. Rhetoric won't do it and we must push for action on both sides of the border. I urge all C.O.E.O. members to write letters demanding just that.

TOP 47 POLLUTING COAL-FIRED POWER PLANTS IN EASTERN U.S. RANKED ACCORDING TO TOTAL SO_2 EMISSIONS IN 1979

Rank	Plant/State	SO_2 Emissions Metric Tonnes/ year
1	Paradise, Kentucky	372,500
2	Muskingum, Ohio	340,200
3	Gavin, Ohio	339,500
4	Cumberland, Tenn.	289,700
5	Monroe, Michigan	263,800
6	CliftyCreek, Indiana	263,700
7	Gibson, Indiana	261,100
8	Baldwin, Illinois	257,900
9	Labadie, Missouri	224,000
10	Kyger Creek, Ohio	205,500
11	Bowen, Georgia	202,600
12	Conesville, Ohio	186,800
13	Mitchell, W. Va.	186,200
14	Matfields, Penn.	167,300
15	New Madrid, Missouri	164,000
16	Sammis, Ohio	160,700
17	Wansley, Georgia	159,700
18	Homer city, Penn.	159,100
19	Johnsonville, Tenn.	157,900
20	Gaston Ec. Alabama	154,800
21	Montrose, Missouri	147,100
22	Harrison, W. Va.	142,800
23	Brunner Isl., Penn.	142,000
24	Coffeen, Illinois	141,800
25	Cardinal, Ohio	140,800
26	Eastlake, Ohio	137,400
27	Kammer, W. Va.	136,800
28	Kincaid, Illinoi	136,300
29	Keystone, Penn.	127,200
30	Stuart J.M., Ohio	125,600
31	Cayuga, Indiana	121,700
32	Shawnee, Kentucky	111,000
33	Gallatin, Tennessee	110,600
34	Montour, Penn.	109,400
35	Big Bend, Florida	109,200
36	Conemaugh, Penn.	108,900
37	Widows Creek, Alabama	106,000
38	Amos, W. Va	105,200
39	Thomas Hill, Missouri	104,900
40	Joppa Steam, Illinois	104,400
41	Mt. Storm, W. Va.	102,500
42	Petersburg, Indiana	100,700
43	Beckjord, Ohio	99,700
44	Avon Lake, Ohio	98,000
45	Fort Martin, W. Va.	94,600
46	Miami Fort, Ohio	94,200
47	Yates, Georgia	88,800

TOP 16 POLLUTING INDUSTRIES IN CANADA RANKED ACCORDING TO TOTAL SO_2 EMISSIONS IN 1979

RANK	INDUSTRY	SO_2 METRIC TONNES/YR
1.	INCO Ltd. c/o Mr. Newman, Pres. Copper Cliff, Ont. POM 1NO	886,000
2.	Noranda Mines Ltd. Mr. Fowlard, Manager C.P. 4000 Noranda, Quebec J9X 5B6	538,000
3.	Ontario-Hydro 700 University St. Toronto, Ontario M5G 1X5	410,000
4.	INCO LTD. Thompson, Manitoba	359,000
5.	Hudson Bay Mining and Smelting Co. Ltd. Mines Office Flin Flan, Manitoba R8A 1N9	212,000
6.	Algoma Steel Corp. Ltd. Head Office 503 Queen Street East Sault-Ste-Marie, Ont. T6A 5P2	141,000
7.	Falconbridge Nickel Mines Ltd. Mines Office Falconbridge, Ont. POM 1F0	122,000
8.	Nova Scotia Power Corp. Barrington Street Scotia Square P.O. Box 910 Halifax, Nova Scotia B3G 2W5	115,000
9.	Suncor Inc. Oil Sands Division Fort McMurray, Alberta	93,000
10.	Gaspe Mines Mr. Lefebvre, Manager Holland Township Murdochville, Quebec G0E 1W0	91,000
11.	New Brunswick Power Commission New Brunswick	85,000
12.	Aquitaine Co. of Canada Ram River, Alberta	58,000
13.	Westcoast Transmission Co. Fort Nelson British Columbia	51,000
14.	Syncrude Canada Ltd. Fort McMurray Alberta	41,000
15.	Tembec Inc. Mr. Petty, Pres. Temiscamingue, Quebec J0Z 3R0	33,000
16.	Alcan Ltd. Mr. Caron, Manager C.P. 500 Jonquiere, Quebec G7S 4L2	28,000

SOURCE: ENVIRONMENT CANADA

Reaction to the new reports was fairly predictable. The National Clean Air Coalition was particularly pleased, taking the Calvert report as vindication of its campaign to reduce sulfur emissions by 50 percent. The president of the National Coal Association, Carl Bagge, read the report in just the opposite way, finding that it confirmed that "the sources of acid rain cannot be pinpointed," leading to his conclusion that "it is premature to impose additional emission

Emission reduction will help, but the panel could not say where it would be most effective. At a press conference Jack Calvert, a chemist at the National Center for Atmospheric Research and chairman of the committee, explained why the panel could not be more specific. "Based on our analyses of both the available data and currently available computer models of long-range transport, we conclude that the relative importance of long-range and nearby souces to the acidification of sensitive areas cannot be determined with reasonable certainty at this time." The current models are "very approximate" and "are not formulated from first principles of physics and chemistry." In addition, field observations are too limited to validate models sufficiently.

Modelers of long-range transport tend to think that their present, admittedly simple, models are not all that bad. The differing perceptions seem to go back to a comparison of the performance of nine models during the tehnical work for the memorandum of understanding (MOI) between Canada and the United States. Both the NRC committee and the White House-appointed MOI review panel, which also holds modeling in low esteem, appear to have leaned heavily on the MOI analysis. Neither group includes any modelers, but those modelers contacted by Science believe that the MOI analysis had severe limitations. They include the limited 1978 data used for validation the unusual meterological conditions during part of 1978 and the comparison of models of varying sophistication and differing intended uses.

Despite these problems notes Sampson, the relative importance of various source regions was similar from model to model. James Young, the Canadian technical coordinator for the MOI model comparison, says that model validation with the more extensive and reliable data from 1980 has been considerably more successful than that included in the earlier MOI work. All in all, many modelers believe that if the proper model is run enough times, they can now determine with some confidence the relative importance of a major source region in the transport of acid into a distant region. How much confidence will be enough in the political process of policy-making remains to be seen.

Written by Richard A. Kerr,
Science, Vol. 221, 15 July 1983

WHAT'S AN ARBORETUM?

☐An outdoor labratory?

☐A leisure park?

☐A nature centre?

☐A conservation area?

Yes! All of the above.

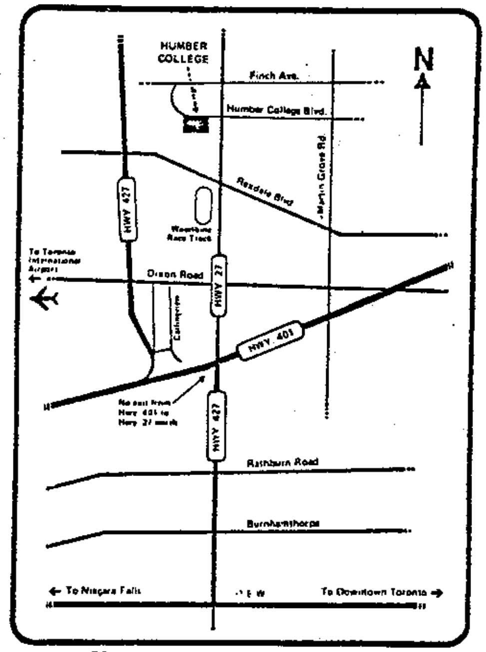
Humber Arboretum and Humber College welcome you and your family to an Open House on Saturday, October 20, 1984. Come and learn more about an Arboretum and a new program Humber College is offering. There will be a family program and a complimentary lunch provided.

HUMBER ARBORETUM offers a professional Nature Studies Program to school groups all across Toronto and outlying regions. Students can participate in creek and pond activities, bird watching, pollution and orienteering studies, to name a few. Here's where the family can join in for some good wholesome fun.

HUMBER COLLEGE is offering a Nature Interpreters Program commencing January 1985. Come and find out what this course can offer you in terms of training or upgrading skills. Come and review the material and offer your input to the program.

<u>SATURDAY, OCTOBER 20, 1984</u>

10:00 a.m.	Meeting and Greeting (at Arboretum Orientation Centre)
10:30 a.m.	Family Program - Tour of Humber Arboretum Program for Young and Old!
12:00 noon	Complimentary Lunch
1:00 p.m.	Open Forum - Topic: Nature Interpreters Program Note : Children will be entertained by staff naturalists during this time.
2:30 p.m.	Wrap-up and Conclusions



Humber College North Campus
205 Humber College Blvd.,
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University of Guelph

AT A GLANCE...............

Nature Centre open every weekend.

Sundays - 2:00 p.m. to 4:00 p.m. Sunday Afternoon Walks.

<u>July 4 & 18</u> - 7:00 p.m. Wed. Evening Excursions.

<u>July 10</u> - 6:45 p.m. Scenes for a Summer Evening.

<u>Aug. 1, 15 & 29</u> - 7:00 p.m. Wed. Evening Excursions.

<u>Sept. 15</u> - 8:00 a.m. Those Confusing Fall Warblers.

<u>Sept. 23</u> - 2:30 p.m. Leaves From the Past; A Fall Celebration.

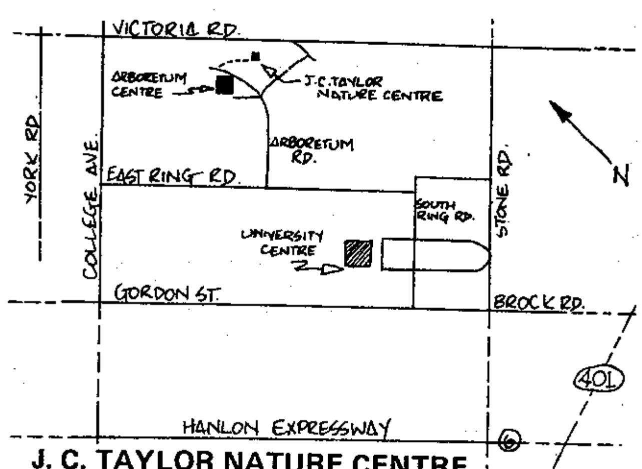
<u>Oct. 14</u> - 2:30 p.m. (concert) Autumn Day in the Arboretum.

<u>Oct. 20</u> - 1:00 p.m.* Get High With A Kite*

<u>Nov. 3</u> - 1:00 p.m. Bird Feed and Feeders.

<u>Dec. 1</u> - 1:00 p.m. Natural Christmas Ornaments.

*PLEASE REGISTER FOR THIS EVENT.



J. C. TAYLOR NATURE CENTRE
UNIVERSITY OF GUELPH ARBORETUM
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N1G 2W1 (519) 824 - 4120 ext. 3932

Acid Rain — A Year Later

Close scrutiny by several technical groups had not made the problem go away, just made the case for regulation stronger.

The Administration's policy of non-regulation of acid rain seems to have collapsed. It was propped up for more than a year on the rationale that the problem was too vaguely understood to be remedied. Now some scientific reports have kicked the prop away, and William Ruckelshaus, director of the Environmental Protection Agency (EPA), is aiming to develop a new strategy by 1 August.

Several independent groups in recent weeks have described the problem with considerable clarity and reached the same general conclusions, as follows. In the northeastern United States, acid rain (used here to mean dry and wet deposition) derives chiefly from man-made pollutants. The acid is doing significant damage to the environment, among other things, killing off species of freshwater fish. Controls on sulfur pollution before it enters the atmosphere would reduce this damage.

The most thorough of the reports, also the most recent, was issued on 29 June by the National Research Council, the report-writing arm of the National Academy of Sciences (see p.254). The review was funded entirely by the the Academy after an expected government grant failed to come through. The chairman of the report committee, Jack Calvery, director of the National Center for Atmospheric Research in Boulder, Colorado, said that "a more competent and widely representative committee would be very difficult to assemble." It was his way of saying that this will be the definitive study on acid rain for many years.

The group concluded unanimously that 90-95 percent of the Northeast's acid rain comes from man-made sources, such as industrial smoke and car exhausts. The scientists found that sulfur compounds are a more significant part of the problem than nitrogen compounds. They concluded that the acid in acid rain varies in direct proportion to the amount of sulfur in air pollution. The importance of their finding is that it makes regulatory action look more attractive. The government can be confident that a given effort to control pollution will bring about a like improvement in the environment.

The Calvert panel also concluded that the area in which acid formation and deposition takes place is large, perhaps, 1000 kilometers across. Most of the rain, like most weather formations in the Northeast, arrives coming from the south or southwest. Beyond this, however, the panel could say little about the sources of pollution. Because there is no good way as yet to identify the exact origin of the chemicals landing in a particular spot, there is no way of determining which of many polluters in the 1000 kilometer mixing area are most responsible for the damage. The process can be described only on a regional scale. Thus, in broad terms, the report says that the more sulfur one releases into this northeastward-moving pollution, the more one contributes to acid rain. The panel made no policy recommendations.

Earlier in the week, on 27 June, a review panel created by White House science adviser George Keyworth released some strong opinions of its own on acid rain. The chairman, William A. Nierenberg, director of the Scripps Institution of Oceanography, and one panel member, Kenneth Rahn of the University of Rhode Island, controls." The Edison Electric Institute stressed the cost of controls, reporting that a survey of 24 eastern utilities found that the per-household cost of electricity will rise by several hundred dollars in the first year if proposed legislation is put into effect. These cost figures are challenged by the environmental groups and by the sponsors of acid rain bills. They are going to be closely analyzed and debated this year as Congress begins to consider in earnest the prospect of a major new environmental program.

Although several proposals were offered last year, none passed either house of Congress. The bill with the most seniority is the one introduced by Senator George Mitchell (D-Me.). It has been modified and adopted by the Senate Environment and Public Works Committee again this year. It aims to prevent the creation of new sources of pollution and to reduce SO_2 emissions by 8 million tons below the 1980 level (estimated to be 22.5 million tons). This would be done through a complex agreement formed among the 31 states east of the Mississippi, either voluntarily within 18 months or by federal fiat afterwards. The cleanup is due to be finished by 1995.

Another major proposal was introduced in the House on 27 June by Representatives Gerry Sikorski (D-Minn.), Judd Gregg (R-N.H.), and Henry Waxman (D-Calif.), chairman of the subcommittee on health and the environment. Their approach is broader and more direct. Copying the model of the nuclear waste cleanup program, they would impose a 1 mil-per-kilowatt-hour fee on nonnuclear electricity, creating an acid rain trust fund. They would use the money to carry out a mandatory scrubber installment program on the 50 largest SO_2 emitting utilities in the 48 contaminous states. The states would also be required to develop a program of their own to reduce emissions of 3 million tons, all of which is to be done by 1995.

Neither of these approaches has support in the utility industry. And environmental groups, although supportive, agree that the programs would move too slowly. Given the attention the subject is getting, however, Congress could adopt one of these proposals this year.

Eliot Marshal.
Science

Emission Control Will Control Acid Rain

An expert panel finds that emission reductions will produce proportionate reductions in acid deposition, but it says there is a catch.

A panel of the National Research Council (NRC) has concluded that, contrary to industry claims, a 50 percent reduction in the emissions of sulfur and nitrogen gases will produce about a 50 percent reduction in the acids falling on the land and water downwind of the emissions source. That clears a major roadblock to the formulation of a control policy - every dollar invested in emission control should generate the maximum return in the reduction of acid deposition and the damage it causes.

The catch, says the panel, is that scientists cannot be specific about exactly where the reduction in deposition will occur. The computer models that simulate the atmospheric transport and deposition of acid are too inaccurate to say where in eastern North America emissions will end up, the panel found. The modelers doing the research, who were not represented on the eight-man panel,[1] tend to disagree.

The panel based its conclusion - that there is a nearly proportionate or linear relation between emissions and deposition - on both historical and laboratory data. The panel cast doubt on any computer simulations of the transformation of sulfur dioxide gas into sulfuric acid that do not regenerate intermediate chemical species essential to the continued oxidation of the sulfur dioxide. Some combinations of chemical reactions seemed to oxidize sulfur dioxide while consuming reactive hydroxyl radicals in the atmosphere, which would allow additional sulfur dioxide to accumulate. Reductions in emission would thus tend to reduce the accumulation of sulfur dioxide but not the production of acid. A similar nonlinear relationship complicates the control of ozone production in urban smog. But the panel suggested that the reasonable replacement of one of the 19 chemical reactions with one that allows the regeneration of reactive intermediates would make the transformation linear. Recent laboratory experiments support the existence of such linear reactions in the atmosphere, the panel said.

Historical records of acid deposition at the Hubbard Brook Experimental Forest in New Hampshire, the only North American site offering a reliable, longterm record, also suggest that acid deposition responds in full measure to changes in emission. More extensive records in Eurpoe have indicated that increasing emissions there have not led to proportionate increases in deposition. But the panel noted that the deposition of sulfate at Hubbard Brook has decreased about 33 percent since 1965 while sulfur emissions in the eastern United States decreased 8 percent and emissions in the Northeast decreased about 40 percent. "The nitrate deposition data also appear to reflect emission trends in the Northeast," noted the panel report. The panel also cited the relative uniformity of the proportions of sulfate and nitrate deposited across the eastern United States as evidence of the linearity of the chemical reactions involved. The oxidation reactions of some proposed nonlinear schemes predict a preference for the production of nitric acid over sulfuric acid with increasing distance downwind.

briefed reporters on some advice they are volunteering to Keyworth. As Nierenberg explained it, the group had been called together to review the quality of acid rain papers going into a joint U.S.-Canadian treaty document. Somewhere along the line, "We began to wonder whether it wouldn't be helpful to the Administration for us to make some general recommendations." Nierenberg said, Keyworth agreed, and as a result, the report (due this fall) will include not just a critique of the treaty documents but also comments on policy and specific recommendations for future research. It may favor more money for economic impact research and less for computer modeling.

The general comments on policy were released on 27 June, obviously because the subject was ripe for comment. Nierenberg explained when asked about this that the section was being released early because the whole report was long overdue, and panel members wanted to have their say.

The panel concluded that although the science is weak on some points, the indications of potential trouble are so numerous that "steps should be taken now which will result in meaningful reductions in the emissions of sulfur compounds into the admosphere, beginning with those steps which are most cost effective in reducing total deposition." As an example, the group suggested using "fuel of different sulfur content during different seasons, since the efficiency for wet sulfuric acid depositions seems to be much less in winter in North America." The panel also suggested more intensified coal washing and proposed that emissions from nonferrous smelters be reduced.

The scientist recommended strong measures. Nierenberg said, because some of the effects of acid rain may be severe, possibly irreversible. Apparently, many committee members were concerned about the effects of acid on the microorganisms in soil that degrade natural wastes, essential for recycling nitrogen and carbon in the food chain. This is such a "worrisome thing," according to Nierenber, that "you're not going to sit around and wait for 20 years" to get conclusive proof of the danger.

The Nierenberg panel's statement was preceded by a report several weeks earlier from the federal Interagency Task Force on Acid Precipitation. Although far more cautious, it also concluded that man-made pollution was the chief source of trouble (Science, 24 June p.1359).

None of these reports spells out a strategy for controlling the problem. However, attention is focused on the electric utilities more than other polluters. There are several reasons. As burners of sulfur-laden coal, they contribute significantly to acid rain, dumping over 16 million tons of SO_2 into the atmosphere east of the Mississippi each year, over 70 percent of the total SO_2 in the East. From a managerial and economic point of view, it is simpler to regulate what comes out of several scores of smokestacks than to control millions of automobiles. Politically, as well, it would be easier to impose controls on the utilities than on the family car.

SPRING CELEBRATION

The first spring C.O.E.O. conference "Spring Celebration" sponsored by Northern Region was held at the Leslie M. Frost Natural Resources Centre on May 11 to 13, 1984.

Over 75 participants and 25 resource people joined for workshops on a variety of subjects.

Some of the sessions offered specialized information. Bob Stinson of Bushwackers Outfitters presented new outdoor gear for this spring. Rick Hay from the Scarborough Outdoor Education Centre explained everything there is to know about "the enemy" in his session on "anti-bug strategy."

Other sessions allowed visitors to the Northern Region to do some exploring. One group spent Saturday in Algonquin Park where they were fortunate to see 8 moose and several deer, while others drove a short distance to the Kanawa Canoe Museum to see North America's largest collection of canoes.

For serious natural historians there were a diverse selection of sessions including a morning bird walk with Ron Pittaway of the Frost Centre, a talk on spring tonics by Allen Foster of the Kortright Centre for Conservation, or a walk through the rugged Haliburton Highlands to study geomorphology with Susan Gesner also of the Frost Centre.

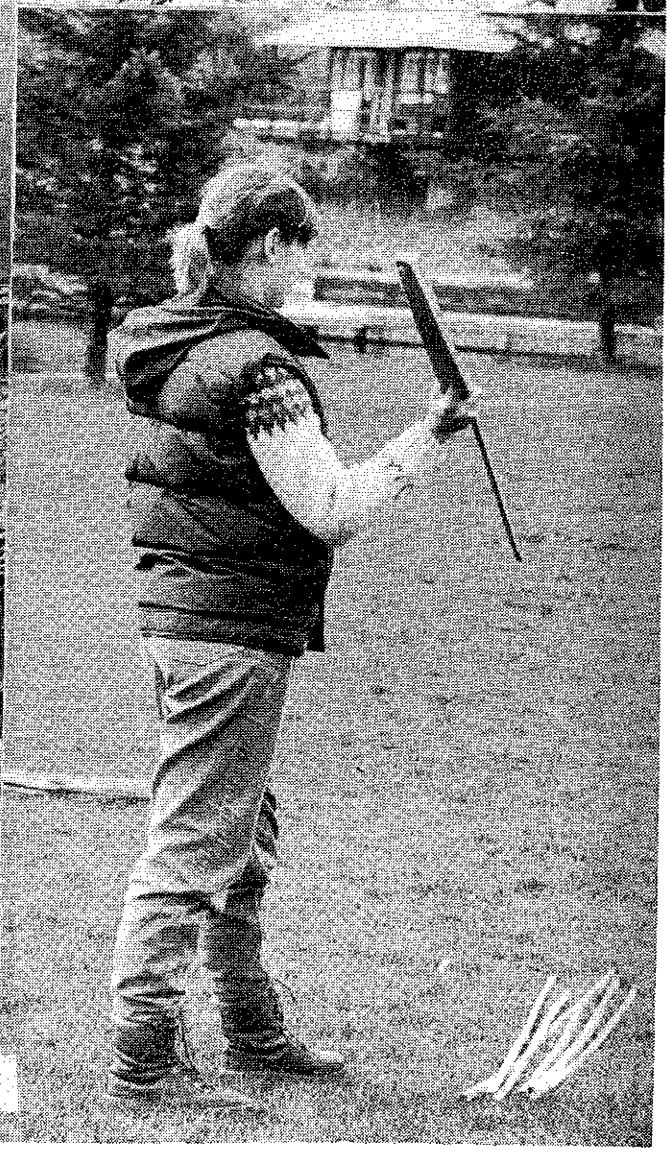
There were opportunities for rock climbing, canoeing, orienteering and kayaking for the beginner and for those with experience.

These were only a few of the many sessions offered during the day - all in all there was something for everyone.

The evenings were also packed with activities. You could watch the woodcock's famous mating behaviour, search for spring stars or learn new activities for campfire programmes. And Jack Zoubie inspired some fancy footwork at the Saturday evening square dance.

Comments from participants and the response from the written evaluation indicates the conference was a tremendous success.

The planning committee has no choice but to consider holding another "Spring Celebration" next year (tentatively scheduled for May 10 to 12, 1985). Be sure to mark it on your calendar.



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The Nature Conservancy of Canada is the only national non-profit, trustee-governed conservation organization whose resources are solely devoted to the preservation of ecologically and environmentally significant land. It is involved in projects in every province of Canada and through its action many thousands of acres of woodlands, swamps, marshes, paririe, seashores, and islands are being preserved.

Lands are used for scientific research, outdoor education and other non-destructive public uses, depending on the fragility of the area involved.

Lands are acquired through purchase with funds raised locally and nationally and through co-operative programs with other public and private conservation groups.

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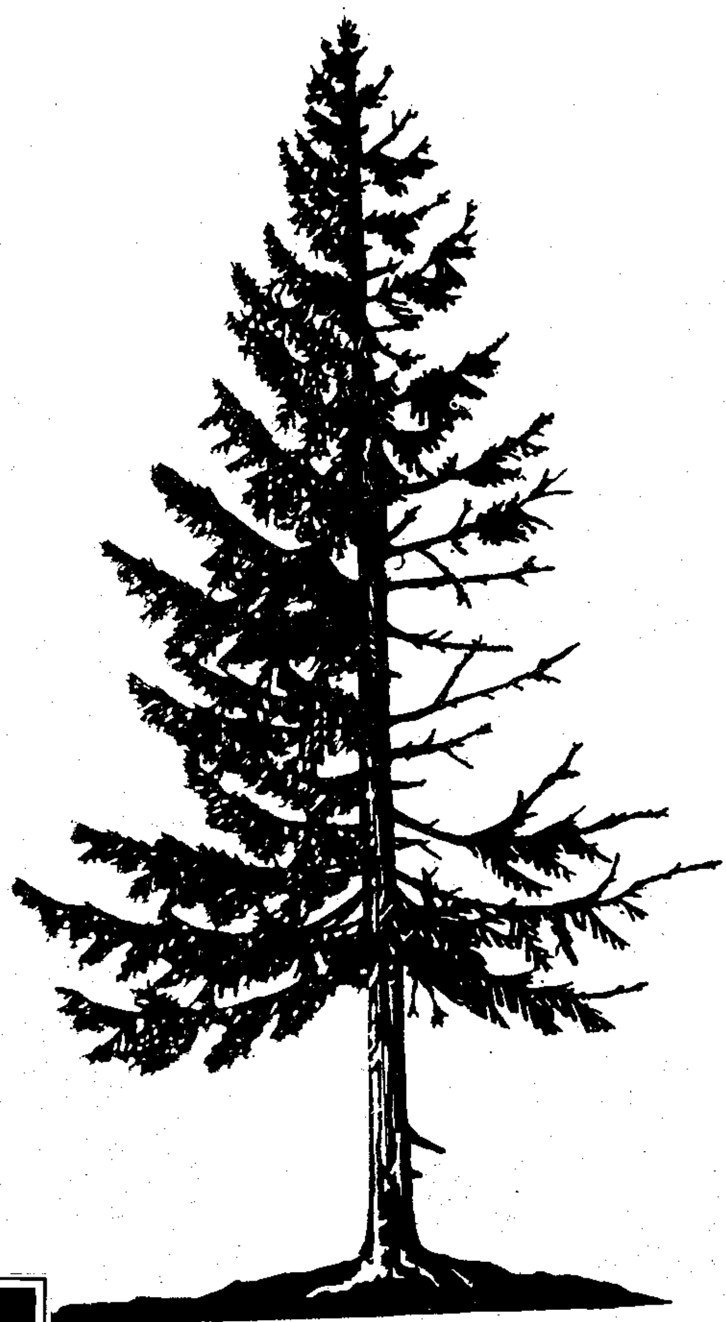
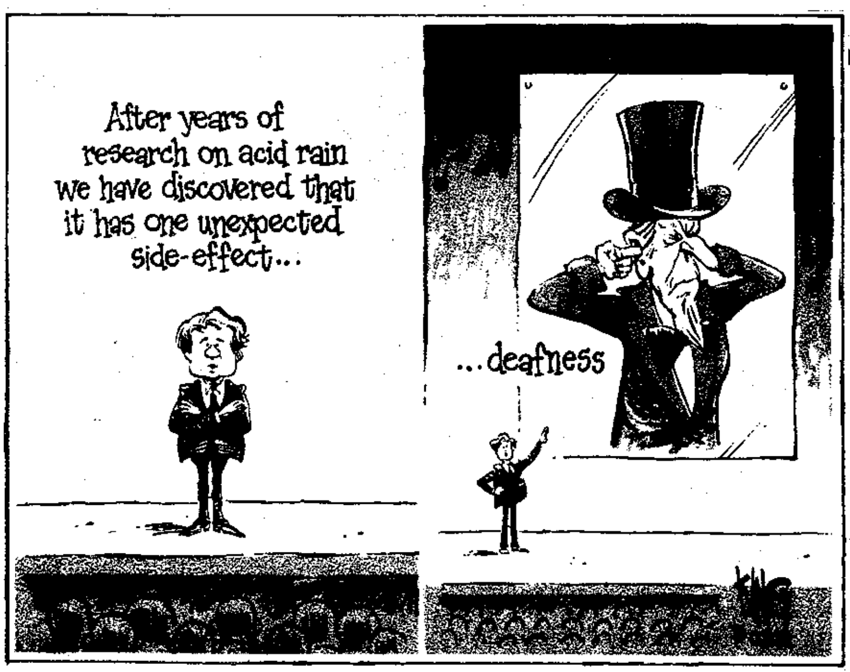
Gifts of funds, securities and land are tax-deductible to the limit prescribed by law.

For further information contact: The Nature Conservancy of Canada, Suite 611, 2200 Yonge Street, Toronto M4S 2E1, (416) 486-1011





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