present in most lakes, including those with a pH as low as 4.1. Other species are restricted to lakes with a pH of 4.6 or more. Within Keji, brook trout and white perch were not found in lakes with a pH of 4.7 or less.

When it comes to trees and soils, there is as yet no firm data which would indicate direct effects of acid rain on terrestrial systems. Related laboratory studies of the effects of acid rain on tree growth and development are being carried out at the Maritimes Forest Research Centre in Fredericton, N.B. They indicate that pH threshold limits for injury in many tree species occur at around pH 4.6; below this level significant alterations in growth and plant form can occur. Since precipitation in Kejimkujik Park and throughout the Maritimes can regularly be more acidic than pH 4.6, research and monitoring carried out at Keji are very important to the Canadian forest industry.

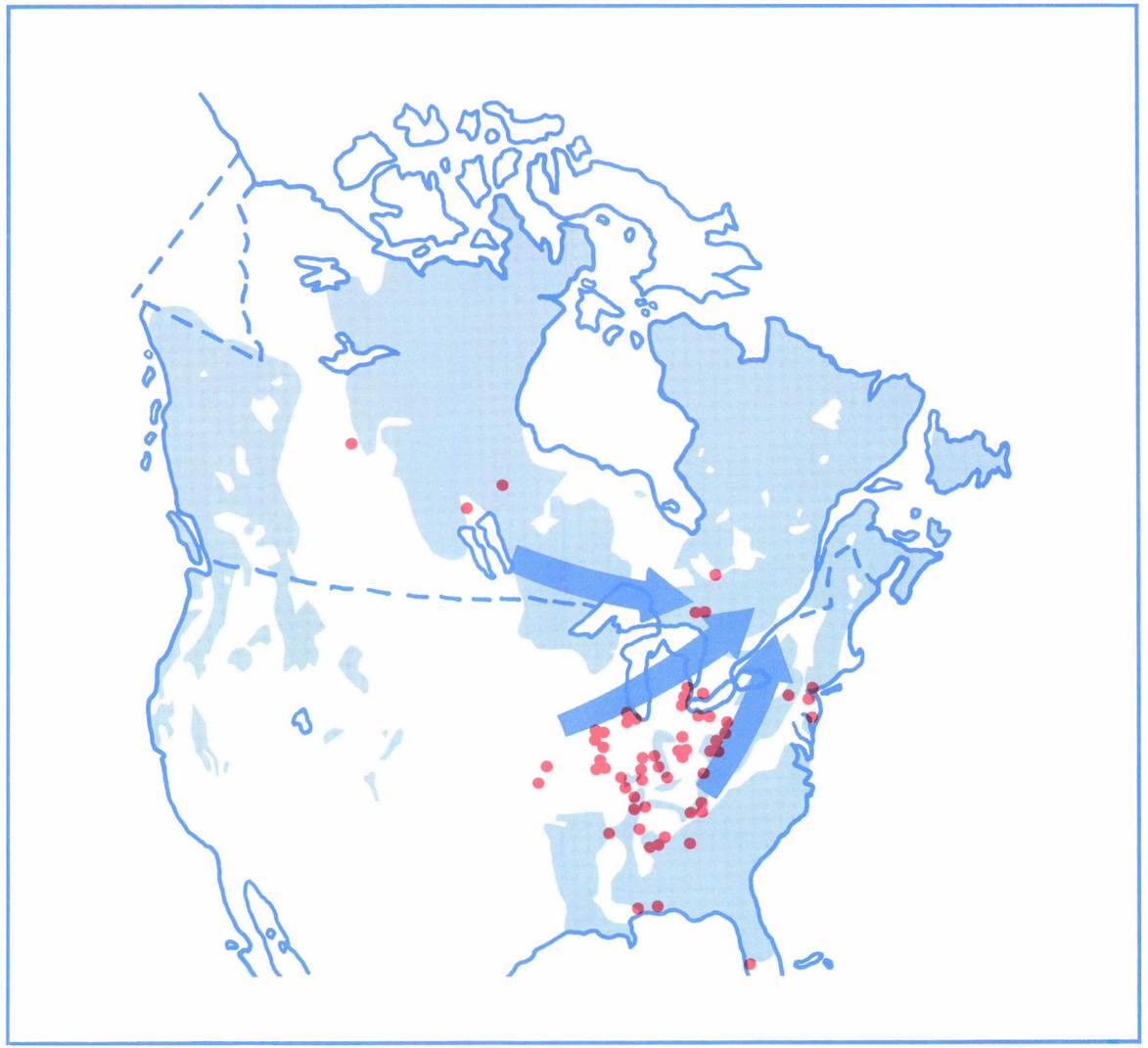
CONCLUSION

One of the most upsetting things about acid rain is that its effects are often felt in places far removed from its sources. Thus polluters may be reluctant to take clean-up actions when the results of those actions may be felt elsewhere. They continue to pollute, literally dumping their refuse into their neighbors' yards. There is also a reluctance to reduce emissions until their bad effects can be convincingly and scientifically demonstrated.

Acid rain research being carried out at Kejimkujik Park can document those effects, and help build the case for acid rain controls. Much of the evidence currently available is fragmentary and circumstantial; long-term scientific programs such as the one at Keji will help make acid rain control programs as efficient and effective as possible. The knowledge being gained can also help alleviate the effects of acid rain, by exploring such things as liming and the development of acid-resistant trees.

As weather data from Keji is collated with other information gathered across Canada and the United States, a clear picture of the sources and pathways of acid rain is emerging. Controlling acid rain will be an extremely costly proposition, yet Canadians have repeatedly demonstrated their willingness to pay their fair share of the costs. By establishing where the pollution is coming from, as well as its effects, controls can be implemented with the least disruption.

- Areas having SO_2 emissions greater than 100 kilotonnes per year
- Areas most sensitive to acid precipitation
- Important storm paths



This map clearly illustrates why Canada's efforts to control acid rain are concentrated in the seven eastern provinces, from Manitoba east. Most major Canadian sources of SO_2 emissions are located within this area and much of it is quite sensitive to acid precipitation. In addition, prevailing winds transport the pollution towards the eastern portions of the country.

Environment Canada Environnement Canada

ACID RAIN AND KEJIMKUJIK NATIONAL PARK

KEJIMKUJIK NATIONAL PARK

Visitors to Kejimkujik National Park soon agree that it is a unique place. The park has many streams and lakes, rolling forests, a lively wildlife population, and some typical Maritime bogs — all of which help make it one of Canada's most beautiful national parks.

At first glance "Keji" seems like an unspoiled wilderness. Yet unlikely as it may appear to a casual observer, this safe and remote haven is threatened by the same silent but dangerous killer that has put many of Canada's wilderness areas at risk: acid rain.

ACID RAIN: WHAT IT IS AND WHAT IT DOES

Acid rain has been called the greatest environmental threat Canada has faced as a nation. The rains and snows that were once thought of as cleansing and pristine have now become, as a result of human activity, dangerously acidic and destructive. Two unfortunate and all-too-common byproducts of our modern industrial lifestyle are sulphur and nitrogen oxides. When these are discharged into the atmosphere they can become subject to a complex variety of chemical reactions, which can transform them into sulphuric and nitric acid, respectively. These acids can be carried along by various weather systems, so that the damaging fallout occurs many many miles from the original source of pollution.

These acids ultimately fall back to earth in various kinds of precipitation, including rain and snow. The main sources of sulphur oxide emissions in North America are coal-fired power generating stations and non-ferrous ore smelters. The main sources of nitrogen oxide emissions are automobiles and other vehicles.

Acid precipitation can have many harmful effects. It can increase the acidity of lakes and streams to a point where fish and other aquatic creatures such as frogs and salamanders cannot reproduce. Ultimately, they become extinct in overly acidified bodies of water. Acid rain can also increase the acidity of soils, and particularly in combination with other atmospheric pollutants such as ozone, is suspected of slowing down the growth rate of trees, or weakening them and making them more vulnerable to disease or naturally occurring threats. Acid rain even attacks man-made structures such as buildings and monuments, including those of cultural significance, causing millions of dollars' worth of damage annually.

THE BIG PICTURE: ACID RAIN AND KEJIMKUJIK PARK

Acid rain is both a national and international problem, since atmospheric pollutants do not respect those artificial lines on maps that humans call boundaries. About 50 per cent of the acid rain that falls in Canada originates in the United States. Canada in turn is responsible for 10 to 20 per cent of the acidic precipitation that falls in some parts of the United States, in places such as New England and the Adirondacks.

Acid rain is a widespread and complicated series of events, but its effects must be studied locally, in specific areas. Every region has its own particular climate and conditions, which make its response to acid rain unique. By gathering data at specific places and by collating that information we can gain an understanding of the general phenomenon of acid rain, in addition to finding out what specific effects it is having at various locations around the country. All this information is necessary if we are to fight acid rain in the most effective way.

In general, Nova Scotia is highly sensitive to acid rain, and in 1978 a major site for the study of acid rain was set up by the federal government in Kejimkujik Park. All precipitation is checked carefully for acidity, and the effects of that acidity on the park and its wildlife are precisely noted. The Kejimkujik site is one of a network of five regionally representative study areas across Canada.

WORK IN THE PARK

Everyone knows that it rains a lot in the Maritimes. Precipitation amounts in Nova Scotia are among the highest in Canada. Average annual total precipitation at Keji is slightly more than 1400 mm, of which nearly 280 mm falls as snow. Of course precipitation levels can vary greatly from year to year.

Samples of rain or snow are collected on a daily basis at a number of sites in the park. Other data, such as temperature, humidity, wind strength and direction are also noted. In this way a continuous series of "weather snapshots" of the Park is being taken. These "snapshots" are combined with acidity measurements to determine the atmospheric conditions that bring acid rain to Keji. Subsequently the weather systems that bring acidic fallout are traced to determine the origins of the pollution.

Streams and lakes within the Park are sampled on a regular basis, as is Keji's fish population. A systematic study of vegetation and soils is also being carried out. The effects of acid rain on tree growth and soil chemistry are also under study. Various "study lakes" are being examined in great detail, down to the smallest plants, insects and organisms.

FINDINGS

Over the past 15 to 20 years Kejimkujik Park has gradually become more and more acidified. There are so many complex variables involved that it is difficult to say with scientific certainty exactly what the effects of that acidification are: it is because of this that Keji is being subjected to such intensive study in the first place. Nevertheless, some things are beginning to become clear.

Acidic pollutants are almost always present in the atmosphere, and acidic fallout — "deposition" — can be either wet (during precipitation) or dry (in the absence of precipitation). Seventy to eighty per cent of acidic deposition in Kejimkujik Park is wet. Ten to fifteen per cent of Keji's acidic precipitation comes from sources within Canada's Maritime provinces. The remaining 85-90 per cent originates mostly in the northeastern United States, although some comes from sources in central Canada as well. Wet deposition generally arrives as a result of air masses from the south, southwest, and west. It is not uncommon for airborne pollutants to have travelled all the way from the Ohio Valley, northern Ontario, or even farther afield.

Acidity accumulates in the snowpack over the course of an entire winter. During the winter and spring snowmelt, lakes and streams receive a jolt of concentrated acidity. Preliminary data indicate that Kejimkujik Park might be particularly vulnerable to the shock of such acidic pulses. Strong snowmelt effects have been demonstrated, which could lead to serious ecological problems.

Aquatic life is particularly at risk from acid rain. Problems affecting salmon in the Mersey River flowing out of Kejimkujik Park are attributable to recent increases in acidification. High mortality rates at a salmon hatchery on the Mersey River below the Park have been significantly reduced by liming, which lowers the acidity of water. Research on salmon and other fish mortality rates, acidification and liming has great relevance throughout the Maritimes and across Canada.

As lakes and streams within the Park have become acidified, certain trends have been noted. Acid-tolerant species such as the yellow perch and the American eel have been

WHAT IS THE pH SCALE?

When scientists talk about harmful precipitation, they refer to it in terms of its acidity. The scale used to measure soil or liquid acidity is known as the pH scale (pH for potential hydrogen ion concentration). It ranges from 0, which is the maximum acidity, to 14, which is the maximum alkalinity. "Clean" precipitation has a pH value of 5.6. It is not uncommon in Canada to find readings of 4.0. Because the scale is logarithmic, this represents a dramatic increase in acidity: a drop from 5.6 to 4.0 indicates that acidity has increased 40 times. Vinegar has a pH value of 2.2. In 1974, a rain fell on Pitlochry, Scotland that had a value of 2.4.