ACID RAIN AND FISHERIES

ACID RAIN

The problem of acid rain, variously described as "an environmental time bomb" and "unpremeditated chemical warfare against the environment", ranks as one of the top research priorities for federal fisheries scientists.

There are compelling reasons for the scientists' concern. Every day, tons of pollutants are spewed into the atmosphere from industrial smoke stacks and vehicle exhausts all across the North American continent. These airborne masses, frequently transported hundreds of kilometres across continents and oceans, provide the ingredients for acid rain which is posing a devastating threat to much of Canada's valuable inland fisheries and the Atlantic salmon.

The impact of acid rain has already been felt in various parts of the world. Mats of moss and fungus now cover the bottom of acidified lakes in Scandinavia, making the habitat unsuitable for fish or the organisms on which fish feed. Many major salmon-producing rivers of southern Norway and Sweden now produce nothing. Freshwater species have suffered a similar fate in many areas.

In Canada, the evidence of the damaging effects of acid rain is mounting and scientists are fearful of the impact on a number of fish species, particularly Atlantic salmon.

The aim of this leaflet is to summarize the known or potential effect of acid precipitation on the fishery (acid rain is also a potential threat to crops, trees, and soils, as well as being responsible for various damaging effects, such as eroding stone buildings and automobile bodies) and to detail some of the ways Fisheries and Oceans, in conjunction with other government departments, is acting to overcome or mitigate the problem.

What is Acid Rain?

The commonly-used term "acid rain" refers to precipitation (in the form of rain, hail or snow) which results when oxides of sulphur and nitrogen react chemically with oxygen and moisture in the atmosphere.

The acid content of a solution is based on the concentration of hydrogen ions and is expressed as "pH". A pH value of 7 is neutral, that is, neither acidic nor alkaline. The lower the pH value, the higher the acidity. As pH values are logarithmic, pH 5 represents ten times more acidity than pH 6.

Normal rainfall has a pH value of about 5.6. In Ontario's Muskoka-Haliburton lake country the mean pH of rainfall now ranges between 3.9 and 4.4 — about 40 times more acid than normal.

In the main, the pollutants which cause acid rain originate from the burning of coal and other fossil fuels, smelting of sulfide ores by industrial plants, and vehicle emissions. Often acid rain contains other airborne pollutants, such as lead and mercury, which cause additional contamination problems when they fall on lakes and rivers.

Canada

Scientists estimate that about half of the Canadian problem originates within national borders — the nickel smelter at Sudbury, Ontario, is a major pollution source. The remainder comes from the United States.

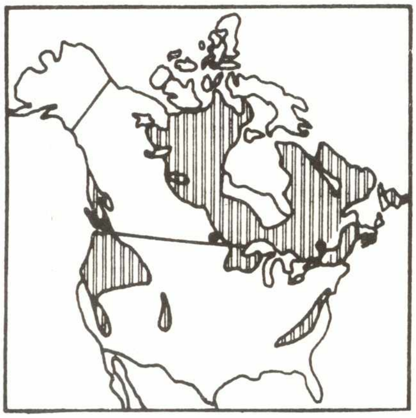
Lakes are considered to be in serious condition when their pH reaches or falls below 5.5 — the level at which many organisms on which fish feed cannot survive. By comparison, Lake Ontario has a pH of about 8.

Although acid rain has become a matter of public concern only recently, the phenomenon is not new. The first well-documented case goes back to 1852 when "corrosive rain" was reported to have sickened cows and made the land infertile near a smelter in Great Britain. However the problem has come into sharper focus in Canada with the discovery of increasing numbers of "dead" lakes in Ontario's vacation areas and escalating acidity levels in rivers and lakes in Quebec and the Maritimes.

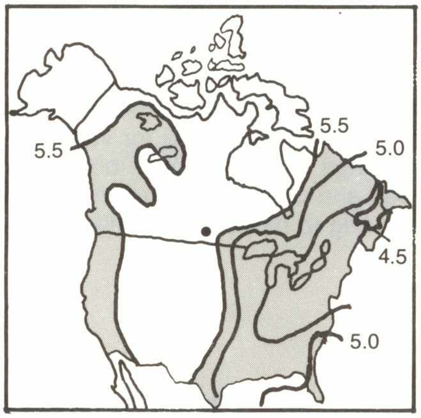
Often one of the first signals of acid stress is the failure by females to spawn. Sometimes, even if the female is successful in spawning, the hatchlings or fry are unable to survive in acid waters. This accounts for the fact that some acid lakes only have older fish in them. A good catch of adult fish in such a lake could mislead an angler into thinking that all was well.

Fish are often adversely affected by acid conditions in other ways. These include decreased growth, inability of the fish to regulate its own body chemistry, and a reduction in egg deposition. There have also been reports of certain deformities in fry as a result of growth in acid water. A fish that is constantly trying to compensate for high acidity may also be more susceptible to naturally occurring diseases.

Another perhaps less obvious way in which fish are affected by acid stress is through the food chain and from changes in its habitat. Acid stress can lead to a reduction in the kinds and supply of food fish normally depend on. It can also reduce the suitability of some sites for spawning.



Areas in N. America containing lakes sensitive to acide precipitation.



Regions with average precipitation more acidic than normal "clean" rain (i.e. below pH 5.6)

Impact on the Fisheries

There are many ways in which acidification of lakes or streams harm fish. If the water becomes suddenly highly acidic, as is possible in the spring following snowmelt and the release of accumulated pollutants built up over the winter, mass mortalities of fish can occur. Such happenings have been well documented for salmon and trout in Norway.

More often, fish gradually disappear from lakes and rivers as their environment slowly becomes intolerable. Some kinds of fish such as smallmouth bass, walleye, brook trout and salmon appear to be more sensitive to acidity than others and tend to disappear first. Even those species that appear to be surviving may be suffering from acid stress in a number of different ways.

A contributing reason for "dead" lakes is that a continuing input of acid rain frequently releases toxic metals such as mercury, aluminum, lead and manganese from the surrounding soils or lake beds. These metals affect the growth and survival of fish.

The risk of severe damage to Canada's fisheries resources is particularly acute because of the geological characteristics of a large portion of Eastern Canada. Areas of the Canadian Precambrian Shield are particularly vulnerable because of the lack of rocks or soils with a lime base which can neutralize or "buffer" the acid. In fact, more than half of Canada consists of susceptible hard rock (i.e.: granitic) areas.

Recent data indicates that parts of Quebec and Ontario are receiving precipitation up to two and three times more acidic than that which cause problems in Scandinavia. Precipitation at least as acid as that recorded in Norway and Sweden is falling even in remote areas of northern Quebec and Labrador. Increased concentrations of sulphates have even been found in polar ice caps.

Studies indicate that in Ontario as many as 48,000 lakes in the province are in imminent danger. Scientists have found that some lakes in Nova Scotia have become up to five times more acidic in the space of 20 years. Populations of Atlantic salmon have been obliterated in several eastern rivers and are endangered in several others.

It now appears certain that widespread damage will be caused to the freshwater systems in Canada and the northeastern United States over the next 5 to 20 years, unless the impact of acid rain is halted or mitigated. Threatened is a recreational and commercial fishery estimated to be worth a billion dollars annually.

What is Being Done?

The Department of Fisheries and Oceans (DFO) is working actively with Environment Canada, External Affairs and other federal and provincial agencies in seeking solutions to the problem of acid rain. Basic departmental objectives are:

i) To develop measures to reduce emissions in Canada and U.S. which contribute to acid rain and fish contaminant loads. A key goal in this regard is establishment of a Canada-U.S. air quality agreement, backed by the input of timely and accurate scientific information on the serious effects of acid rain on Canadian fisheries.

ii) To take steps to mitigate losses in the fishery caused by the impact of acid rain. Immediate emphasis will be placed on determining the cost-effectiveness of various mitigation techniques, such as adding lime to acidic lakes, and the stocking of hatchery reared fish. In general, however, DFO believes that mitigation techniques are only a stop-gap measure to limit losses and not a long-term solution to the problem.

Specific scientific programs underway or proposed by DFO include the following:

— Three lakes in northwestern Ontario are being deliberately acidified to study the effects on the habitat and on the ecology and physiology of key organisms. One of the lakes has been under study since 1974.
— Studies of the effects of acid fallout on freshwater bogs and the effects of acidification on the amount of mercury accumulated in fishes.
— Watershed investigations into the rates and mechanisms by which fisheries and habitats change in response to acid precipitation. Studies are currently underway in Ontario's Algoma area, Kejimkijik National Park, Nova Scotia, and in St. Maurice National Park, Quebec.
— Extensive monitoring of the effects of stream acidification on Atlantic salmon stocks in Nova Scotia, New Brunswick, Newfoundland and Quebec.
— Various laboratory studies to assess the impact of airborne pollutants on fish growth and behaviour.
— Establishment of a national inventory of the impact of acidification on fish and fish habitat in Canada. The information obtained will form a baseline against which future changes can be measured.

Until such time as effective emission controls can be put in place, DFO plans a mitigation program to preserve unique and valuable fish stocks, particularly Atlantic salmon. Approaches that will be pursued include:

a) Rearing fish in hatcheries until they are large enough to survive in low pH waters; and

b) Raising the pH of acidified lakes and rivers by the addition of lime and limestone.

Liming techniques, which have been used extensively in Scandinavian countries to combat low pH values, will be tested in salmon spawning areas of Nova Scotia. The technique has already proved successful at the department's Mersey River fish hatchery in Nova Scotia where a problem of declining salmon hatching success traced to a low pH level was overcome by installation of a limestone filter in the water supply.

The various elements of DFO's national acid rain program are integrated by a Scientific Advisory Committee and a Policy Committee, with general coordination undertaken by the Fish Habitat Management Branch in Ottawa. Future studies are being planned to determine the impact of acid rain on the fishery in potentially sensitive regions of British Columbia.

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