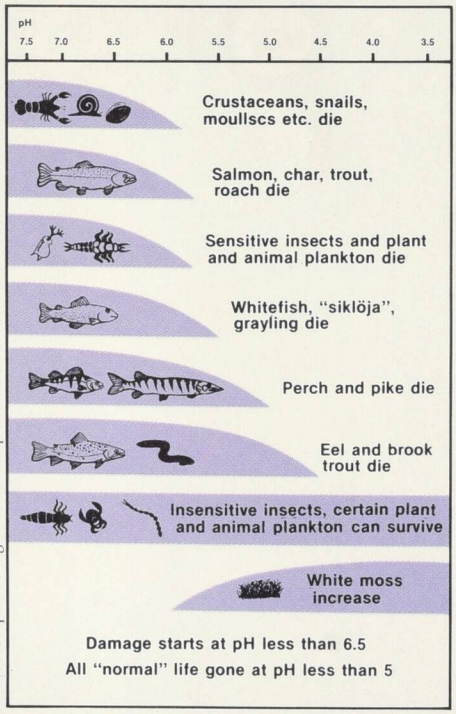
growth area on which the rains fall is the outdoor control plot. The computer-controlled huts have nozzle systems which permit spraying with various mixtures of water, from a height sufficient to get proper droplet velocity.

The work at Brampton is providing information on the sensitivity and resistance of various crop species and cultivars, as well as effects of pollutants on growth and yield.

But, far too little is known yet of the effects of acid rain on crops. For some sulphur-deficient soils in Western Canada, the addition of atmospheric sulphur dioxide can actually help increase plant productivity but high exposures cause injury and eventual death. It has been shown that cations (positively charged atoms and molecules), plant growth-regulating substances, and other materials are leached from growing plants by acid rainfall, and the rate of this removal increases for many materials as the pH decreases.

"In Alberta," reported the Canadian House of Commons Subcommittee on Acid Rain in 1981, "the presence of sulphur dioxide in the atmosphere has been associated with selenium deficiences, which can cause severe physiological disease in cattle," because the animals eat plant matter high in sulphur.

The sensitivity of aquatic organisms to a lowered pH in fresh water



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Scrutinizing the Atmosphere

No one suggests that acidic materials are likely to change the weather, but major research is underway because the atmosphere is acid rain's transport medium. "This work is really in three main areas," explains Dr. Doug Whelpdale of Environment Canada's Atmospheric Environment Service. "About one-third relates to the activity of monitoring networks, about a third to the creation of atmospheric models, and the remaining third involves research into the processes that go on in the atmosphere."

In 1982, the National Research Council's Associate Committee on Scientific Criteria for Environmental Quality sponsored a symposium on the monitoring and assessment of airborne pollutants with emphasis on the long-range transport and deposition of acidic materials. The aim of the meeting was to exchange ideas on methods of sampling and analysing airborne pollutants and to improve the national monitoring networks.

Monitoring is basically a procedure of routine measurement, in this case the composition of precipitation. There are about 20 networks in Canada, with about 150 stations, the network of AES being the largest with some 50 stations. They are located in regionally representative sites, with care taken that they are not affected by the immediate environment of cities. The networks regularly sample for acidic constituents, primarily sulphate, nitrate, and hydrogen ions, and the analytical data are used to map the scope and geographical extent of deposition, as well as the frequency and time trends of the phenomenon. "We extract as much meaning from the data as we can," says Whelpdale.

"We started back in 1976 and now have a good spatial definition of the acid deposition problem. We pretty well know the magnitude and amounts of acid in rain and snow falling over Canada, as well as the seasonal variability and composition in terms of the proportion of sulphates and nitrates. Now, the main question we're looking at is the change with time. Definitive answers are difficult because meteorological observations are quite 'noisy' due to the natural or background variability. Hard though it may be, it is very important because we want to compare the deposition changes with changes in emissions."

Whelpdale estimates that about two-thirds of what is emitted in eastern North America, the main problem area, returns to the surface in eastern North America. The rest, presumably, is dissipated over the Atlantic Ocean. "So far, we're only measuring wet acid depositions, actual acid rain," he says, "but about half the material deposited in eastern North America does so as dry deposition. This is hard to measure routinely, and has to be estimated on the basis of air concentration measurements in a few, select places."

The work in modelling aims at simulations of the whole pathway, starting with the major emissions, through atmospheric transportation, diffusion, the chemical processes in the atmosphere, and finally the acid deposition as rain or dry matter. "Up to about 10 or 15 years ago," says Whelpdale, "pollution was primarily a local, high impact problem. Now we know its effects can extend over much larger areas. Several types of long-range transport model exist, although we have primarily used one known as the Lagrangian model. It simply follows a parcel of air as it moves across the continent. It is reasonably inexpensive to run on the computer, and tends to do an adequate job of matching up with observations."

"The big challenge is to continue this work with models to the point where we can use them to predict as well as interpret. Most people feel we haven't yet reached this prediction level, and we have to before calling for control scenarios that could cost many millions of dollars."

Work is about half way toward the development of the next generation of model, known as the Eulerian model, in a project involving the AES, Ontario's Ministry of the Environment, and the Federal Republic of Germany. Instead of focussing on a moving parcel of air, the Eulerian model looks at what is happening in individual grid squares over the entire domain being modelled.

Making the calculations in each "square" is time consuming, but the model gives a more accurate repre-