# Acidification & Recovery of Freshwater Systems

Acid Rain Toll on British Trees

The Guardian, July 8, 1989

Minister admits acid rain guilt: UK power station emissions 'have damaged Norway's lakes'

The Guardian, March 20, 1986

Salmon and trout rivers 'ruined by acid rain'

The Independent, March 5, 1990

Role of car exhausts in 'acid rain' controversy

The Times, October 2 1986

There were prominent headlines of the 1980s and 1990s in Europe and North America, when air pollutants from highly industrialised regions caused widespread damage to freshwater ecosystems far downwind. In Europe about 30 countries took part in tough negotiations that finally brought about international treaties to reduce emissions of sulphur and nitrogen oxides. Sulphur deposition declined by more than 50% from 1980 to 2000, and some lakes and streams have begun to recover as a result. But recovery is slow and the process may be increasingly influenced by climate change.

## What is acidification?

Acidification is a process in which pollution from factories and car exhausts is converted into acidic chemical compounds in the atmosphere, the best known being acid rain. Acidification of soils and water is caused by acid rain. Sulphur makes the largest contribution, but nitrogen compounds are also important.

## Where did the problem come from?

The problem began in the 1850s with the onset of the Industrial Revolution and the accompanying surge in burning fossil fuels. This caused a steady rise in the emission of acidic pollutants to the atmosphere. Legislations such as the Clean Air Act were introduced through the 1950s and 1960s to reduce emissions, but regulations really took off in the late 1970s, when Scandinavia targeted the UK as being responsible for the acidification of their soils and lakes.

## What are the consequences?

During the 1970s and 1980s, acidification was a serious threat to aquatic life as well as the health of soils and fisheries. This decline in environmental quality had significant implications for countries whose economies depended on forests and fisheries.

When sulphur and nitrogen are deposited on soil, the water draining from these soils into water systems contributes to the acidification of the water. The presence of forests and the nature of the surrounding soils and geology also affect the acidification levels in a particular area.

### Lakes and rivers

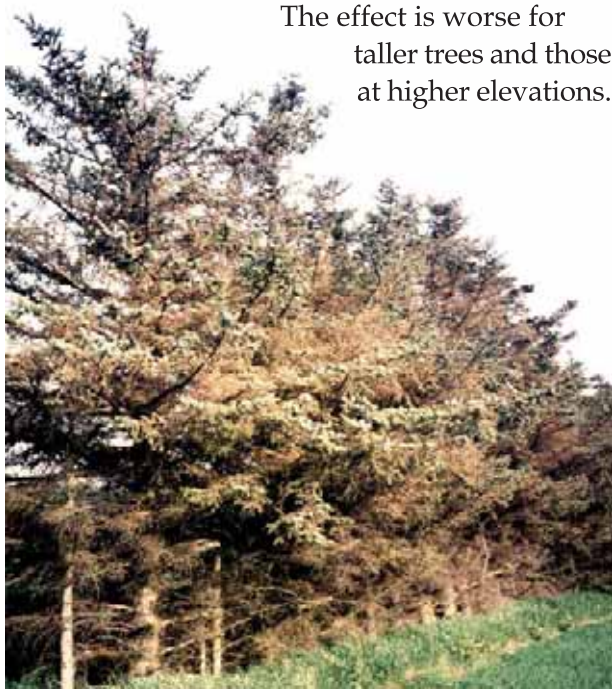
Lakes polluted by acid rain can support only the hardiest species. Acidification damages entire freshwater ecosystems by killing fish and upsetting the food web within the system. When fish die this removes the main food for birds. Birds can also die from eating toxic fish and insects, and fish can die from eating toxic animals too. Acid rain can even kill fish before they are born.

**Acidification damages entire freshwater ecosystems by killing fish and upsetting the food chain**

Acid rain shows its effects on lakes mostly in the springtime, when fish lay their eggs. If the eggs come into contact with the acid, an entire generation can be killed. Fish usually die only when the acidification levels in a lake are high. Under lower levels, they can still become sick, suffer stunted growth, or lose their ability to reproduce.

### Forests

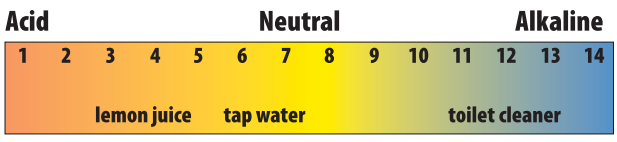
Forests promote the acidification of soils and subsequently surface water in areas of high acidic deposition by a process known as scavenging, in which oxides of sulphur and nitrogen in clouds and mist are captured by forest canopies. In this way, forests actually increase the deposition of acidifying particles and gases from the atmosphere. The effect is worse for taller trees and those at higher elevations.



### Soils and Geology

Not all lakes that are exposed to acid rain become acidified. Some are naturally able to cope with the acidification by neutralising the acidity. This is mainly due to the types of rock in the catchment. For example limestone areas are can neutralize the acid, whereas granite or sandstone areas cannot. Unfortunately, a significant area of the Scottish uplands - where most acid rain falls - has a lot of granite rock and lochs and rivers are therefore very vulnerable to acidification.

In heavily acidified areas, such as Galloway, in south western Scotland, acid runoff comes from soils which cannot neutralise acid rain. Generally speaking, soils which are deep, well-developed and rich in minerals are better at neutralising than organic rich, peaty soils. Areas receiving acid rain which have organic soils are therefore more vulnerable to acidification.



## A Tale of Acid Attacks, Death and Survival in Scottish Waters

Galloway is the area most affected by acidification in Scotland. There are a number of reasons for this:

- The area experiences high rainfall.
- The location in the south west corner of Scotland ensures it is a prime target for air pollutants being blown across from Northern Ireland.
- The geology of the area is mainly granite.
- Soils in the area are either thin and poorly developed or organic rich.

### Recovery in Galloway

Annual sampling of sixty lochs in Galloway began in 1979 so it has been possible to keep a close record of their acidity. With the reduction in acid rain, the acidification levels of the lochs have decreased slowly, and over the last 20 years, the fish catches have increased as a result. Sampling also shows that the soils are recovering and the forests are more productive.

### Time is of the essence…

The problem with all these efforts is that the rate of recovery can be much slower than the original rate of decline. Often, it takes a long time to notice the effects of recovery, such as increased fish stocks after reduced pollution levels. Removing the source of pollution does not immediately improve the situation – it takes many years for smaller organisms to re-populate the loch, and re-establish the food chain.

### Where are we today?

Recovery from surface water acidification is one of the big environmental success stories of the $20^{th}$ century. The majority of surface waters throughout Europe and North America have shown significant recovery from the effects of acidification through tight controls on emissions from factories and cars. The biodiversity of our streams, rivers and lakes is slowly returning and our forests are showing signs of improving health and productivity.

The concern for the future lies with Asia and China where dramatic economic development and population growth is resulting in uncontrolled emissions of sulphur and nitrogen. If emissions continue at the current rate, the soils and waters of Asia and China will acidify, with serious environmental and social consequences. We need to hope that lessons can be learnt from the European and North American experience!