

are created as a result of a failure of snow to accumulate on certain parts of the bog surface, so allowing ice penetration of those parts to be deeper. In winter, the wind blows the snow unevenly over the mire and, when temperatures fall to less than -40°C , frost may penetrate to depths of 1 m.

If this explanation is correct, then it should be possible to create palsas experimentally by regular snow removal. Seppälä has contrived such an experiment and has kept experimental

plots clear of snow during the past two winters. In the first winter, frost penetrated to 85 cm in the cleared area and only to 45 cm in the control. By mid August the control was ice free but the experimental plot was still frozen to a depth of 45 cm. In the second winter the artificial palsa had an ice core 100 cm deep and ice was still surviving to about 60 cm this September. The expansion of the ice core has now led to the surface of the mire in the cleared area being elevated

20 cm above its surroundings. This in turn has resulted in a natural wind clearance of the winter snow leading to more rapid palsa growth.

Studies such as these, together with lichen productivity, reindeer ecology and arctic nutrient cycling processes, all being carried out in Lapland's research stations, will undoubtedly contribute much to our lamentably poor understanding of the ecosystems of the far north. □

Down in a Polish forest, something is stirring . . .

SOUTHERN Poland, from an ecologist's point of view, could well be a nightmare—a jumble of conurbations, industrial enterprises and national parks, stretching in a wide belt across the country, while the high Sudeten-Carpathian mountain barrier effectively inhibits north-south ventilation. Not surprisingly, the forests of the area have deteriorated, and research into their management has been ranked as a "key" project.

In 1976, a detailed survey was begun into the management of these forests, with the participation of thirteen research institutions—four from the Polish Academy of Sciences, seven from the Jagellonian University and other academic institutions in Krakow, and two non-academic institutions (the Institute of Meteorology and Water Management and the Institute of Environmental Protection.) Some 70 senior research workers are involved in the project, ranging from ecologists and dendrologists to geochemists and economists.

The area chosen for study was the Niepolomice forest, some 30 km east of Krakow. The forest consists of two sections, a northern, deciduous part (~ 3,000 ha) and a southern coniferous part (~ 8,000 ha) mostly pine. Conifers are the most susceptible to pollution.

The forest, formerly a royal hunting park, is of considerable historical and touristic significance. It is ecologically unfortunate, therefore, that in the late 1940s, the new industrial town of Nowa Huta, with a steel mill still the largest in Poland, was established between Krakow and the Niepolomice forest. The prevailing wind is from the west, so that the forest receives the major proportion of industrial emission from Nowa Huta.

The siting of Nowa Huta was apparently primarily a politico-demographic decision, at a time when large-scale enterprises were seen to be the answer to the problem of rebuilding a war-shattered economy, at a time when

no government anywhere was more than dimly aware of the concept of ecology as a planning factor.

After 25 years, however, the Niepolomice Forest was unhealthy, and a five-year project was undertaken, not only to find a remedy for Niepolomice, but also to establish a detailed mathematical model of the forest eco-system, and to propose methods of forest management in urban environments which could be extended to similar systems elsewhere.

On the basis of this computer model, a number of parameters were selected for field study, including dust-fall, wet and dry deposition of sulphur, heavy metal contamination, acidification of tree bark, loss of photosynthetic efficiency of pine-needles, energy flow via small consumers and predators, and the quality of roe-deer antlers. The situation was found to be far from promising: dust fall 45–80 tonnes/km²-yr, wet and dry sulphur deposition 3.6–6.4 tonnes/km²-yr, potential photosynthetic activity of pine-needles decreased by 13–18%. The total energy flow diagram revealed a slowing down of decomposition, producing a "carpet effect" under the trees, since the pine litter takes up to 10 years to break down completely, instead of the usual two, apparently due to inhibition of microbial activity, possibly due to heavy metal pollution.

Recent introduction of electrostatic precipitators in the Nowa Huta factories is improving the dust situation to a certain extent, but the problem of wet and dry sulphur deposition remains, so far, virtually insoluble. One proposal made by the research team is aerial spraying of the forest with lime, neutralising the sulphurous and sulphuric acid. This is being introduced into the nutrient spraying programme which has been carried out over the last three years and which is already proving a palliative—the timber increment has increased somewhat and the overall condition of the pines is im-

proving. (Unfortunately, there is also the side effect of increased weed-growth and the eutrophication of the small river Drivnka).

In addition to this spraying, the team have put forward several other draft proposals. The forest stands, they say, should be rebuilt into a mixed forest with the possible introduction of exotic species such as black pine and Japanese larch at the western edge. (It is hoped in the course of the next ten years to determine the most resistant strains). The water-table should be raised by regulating the drainage channels in order to provide more available nutrients for the roots. Wild-life management (roe deer, red deer, wild boar), should be optimised, and steps should be taken to reduce tourist pressure by organising 'nature trails' on the British model.

A number of major problems still, of course, remain. For example, the net sulphur intake of the total biomass is still ~2 kg/year and the well-being of the forest can only finally be ensured by the radical control of industrial emissions. Nevertheless, the valuable contributions of the multidisciplinary team towards containing this problem is already effecting some amelioration, and at the same time has produced a valuable spin-off in the form of a number of published papers, and a book now in production, dealing with basic concepts of forest ecology and management.

Vera Rich

