

Fig. 1 Inferred pH (index B)² in Loch Enoch from Fig. 2 of ref. 1 (closed circles). Dates are taken from ref. 1 and, by inference, from the 1982 core (in parentheses). The estimated standard error of the method² is shown below. Sulphur deposition at Eskdalemuir³ 80 km distant (crosses) and UK SO_2 emissions³ (open circles) are also shown.

It is difficult to see how such diverse behaviour implies acidification followed by recovery, particularly as the three tracks in Fig. 4 of ref. 1 occupy different positions in two-dimensional space.

The chemical evidence presented by Batterbee *et al.*¹ appears more compelling, particularly as the 'non-marine' sulphate has decreased roughly in parallel with deposition, implying that these catchments do not store or release sulphur. However, only two or three samples per year were taken and there have clearly been influences on water chemistry other than sulphur deposition. The 45–60 per cent increase in Cl^- between the 1978 and 1984 samples shows there were one or more sea-salt episodes influencing the chemistry of the later period. The non-marine calcium has doubled in one loch, a result completely at variance with correct understanding of acidification and deacidification processes⁵, which would predict a decrease in Ca^{2+} with reducing SO_4^{2-} . Has there been some increase in calcium input to these catchments or some catchment disturbance (which would also account for the increase in sedimentation rate¹)? I conclude from the paper¹ that diatom-core data have no rapid recovery resulting from reduction in SO_4^{2-} deposition, but that direct chemical data show intriguing patterns for further investigation.

RICHARD SKEFFINGTON

Central Electricity Research Laboratory,
Kelvin Avenue, Leatherhead,
Surrey KT22 7SE, UK

BATTARBEE *ET AL.* REPLY—Skeffington's attempt to dismiss our evidence for the reversibility of lake acidification seems to be based on a misreading or misunderstanding of our paper¹. First, we do not argue for a rapid recovery, rather for "little delay ... in the response... to a decrease in acid deposition". The extent of the recovery is quite minor.

Second, we argue that the sensitivity of diatom- pH reconstruction models is too low to be of value in this context where the change is about 0.1–0.2 pH units, yet Skeffington presents such a reconstruction.

Third, we argue for floristic reversal as a more sensitive indicator and the ordinations presented clearly show that present

the pH of surface waters. Therefore, contrary to Skeffington's implied argument that the higher sea-salt concentrations in the 1984–85 data set would reduce the pH difference between the sampling periods, the differences would have been greater if the 1978 values had been maintained.

Sixth, it is not relevant to use the usual sea-salt ratios to calculate non-marine calcium because cation exchange processes can also produce elevated calcium levels as well as lower pH values in surface waters with sodium being retained on soil-exchange sites⁹.

Contrary to Skeffington's view, both the floristic and chemical data presented in our paper¹ can only be interpreted as

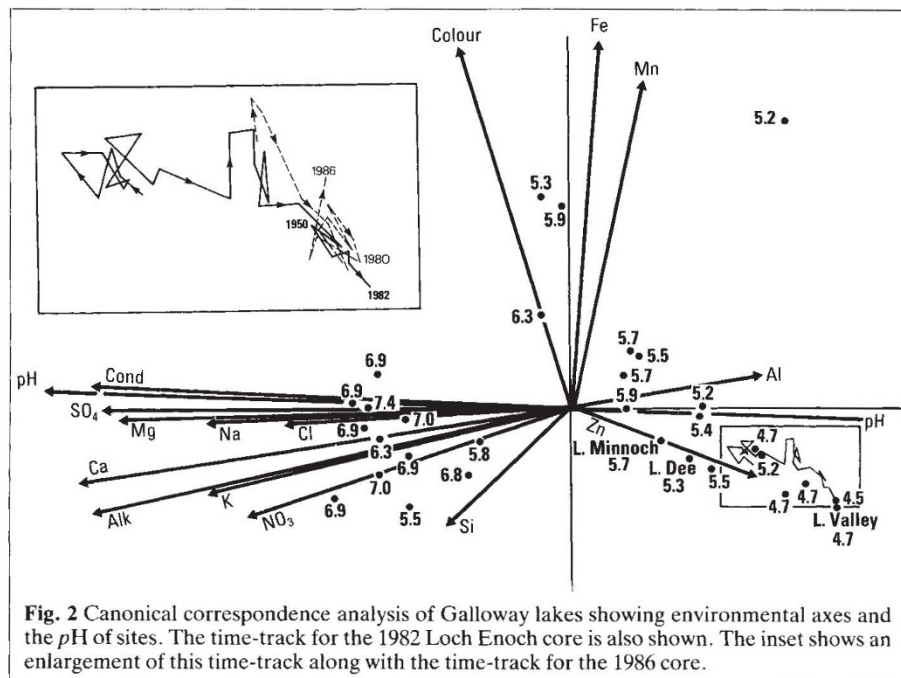


Fig. 2 Canonical correspondence analysis of Galloway lakes showing environmental axes and the pH of sites. The time-track for the 1982 Loch Enoch core is also shown. The inset shows an enlargement of this time-track along with the time-track for the 1986 core.

diatom assemblages are similar to pre-1970 floras. It is not necessary to show that the axis is a pH one as the acidification histories of both these sites are already known^{6,7}. To demonstrate this point, we use in Fig. 2 a canonical correspondence analysis⁸ of the Loch Enoch data as before, but here constrained by the modern chemistry and diatom assemblages of other Galloway lakes. The first axis is clearly identified as a pH -related axis.

Fourth, Skeffington has misread the frequency of chemical sampling. Samples were taken at 2–3-month intervals, not 2–3 times per year.

Fifth, increases in sea-salt inputs reduce

evidence for reversibility. It would be useful to assess whether similar responses have occurred at other sites with differing catchment characteristics, and to consider the extent to which reversals can be sustained if sulphate deposition were not further reduced¹⁰.

RICHARD W. BATTARBEE
ROGER FLOWER
TONY STEVENSON

Palaeoecology Research Unit,
University College London,
26 Bedford Way,
London WC1H 0AP, UK

RON HARRIMAN

Freshwater Fisheries Laboratory,
Pitlochry, Perthshire PH16 5LB, UK

Whale correction

In the letter¹ by K. Ralls and R. Brownell Jr, refs 4–6 were omitted from the reference list. They are reproduced below.

- Ralls, K. & Brownell, R.L. Jr *Nature* **336**, 116 (1988).
- Jones, M.L. & Swart, S.L. in *The Gray Whale Eschrichtius robustus* (Academic, Orlando, 1984).
- Brownell, R.L., Jr & Ralls, K. *Rep. int. Whal. Commun. (Spec. Iss. 8)*, 97–112 (1986).
- Smith, R.L. (ed.) *Sperm Competition and the Evolution of Animal Mating Systems* (Academic, Orlando, Florida, 1984).

- Battarbee, R.W. *et al. Nature* **332**, 530–532 (1988).
- Battarbee, R.W. *Phil. Trans. R. Soc. B* **305**, 451 (1984).
- Barrett, C.F. *et al. Acid Deposition in the United Kingdom 1981–1985* (Warren Spring Laboratory, Stevenage, 1987).
- Gauch, H.G. *Multivariate Analysis in Community Ecology* (Cambridge, 1982).
- Reuss, J.O. *et al. Nature* **329**, 27–32 (1987).
- Flower, R.J. & Battarbee, R.W. *Nature* **305**, 130 (1983).
- Flower, R.J. *et al. Journal of Ecology* **75**, 797–824.
- Harriman, R. & Wells, D. *Journal of Water Pollution Control* **84**, 215 (1985).
- ter Braak, C.J.F. *Ecology* **67**, 1167–1179 (1986).
- Neal, C., Whitehead, P. & Jenkins, A. *Nature* **334**, 109 (1988).