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## Seasonality, water quality trends and biological responses in four streams in the Cairngorm Mountains, Scotland

C. Soulsby, R. Malcolm, C. Gibbins, and C. Dilks  
Department of Geography and Environment, University of Aberdeen, Aberdeen,  
AB24 3UF, UK  
Email for corresponding author: c.soulsby@abdn.ac.uk

**Abstract.** The chemical composition and invertebrate communities found in four streams in the Cairngorms, Scotland, were monitored between 1985-1997. Stream waters were mildly acidic (mean pH ca. 6.5), with low alkalinity (mean acid neutralising capacity varying from 35-117 meq l<sup>-1</sup>) and low ionic strength. Subtle differences in the chemistry of each stream were reflected in their invertebrate faunas. Strong seasonality in water chemistry occurred, with the most acid, low alkalinity waters observed during the winter and early spring. This was particularly marked during snowmelt between January and April. In contrast, summer flows were usually groundwater dominated and characterised by higher alkalinity and higher concentrations of most other weathering-derived solutes. Seasonality was also clear in the invertebrate data, with Canonical Correspondence Analysis (CCA) separating seasonal samples along axes related to water temperature and discharge characteristics. Inter-annual hydrological and chemical differences were marked, particularly with respect to the winter period. Invertebrate communities found in each of the streams also varied from year to year, with spring communities significantly more variable ( $P < 0.01$ ) than other seasons (quantified using Euclidean distance on CCA ordinations).

Hydrochemical trends over the study period were analysed using a seasonal Kendall test, LOcally WEighted Scatterplot Smoothing (LOWESS) and graphical techniques. These indicated that a reduction in sulphate concentrations in stream water is occurring, consistent with declining levels of atmospheric deposition. This may be matched by increases in pH and declining calcium concentrations, though available evidence is inconclusive. Other parameters, such as chloride, total organic carbon and zinc, reveal somewhat random patterns, probably reflecting irregular variations in climatic factors and/or atmospheric deposition. Previous studies have shown that the stream invertebrate communities have remained stable over this period (i.e. no significant linear trends) and show no evidence of acid-related impoverishment. Thus, over longer timescales invertebrates in these streams appear robust to the short-term (seasonal and inter-annual) environmental variability and long-term (decadal) chemical changes identified.

**Keywords:** hydrochemistry, hydrology, trends, macroinvertebrates, uplands, Cairngorms, acidification



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