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Reduced Inputs of Phosphorus to Loch Leven: Effects on Nutrient Concentrations and Phytoplankton

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REDUCED INPUTS OF PHOSPHORUS TO LOCH LEVEN:
EFFECTS ON NUTRIENT CONCENTRATIONS AND PHYTOPLANKTON

The industrial (woollen mill) point-source of phosphorus (P) to the loch is now much reduced compared to previous years. As a consequence, total P (TP) concentrations in the lower reaches of the stream receiving the effluent varied between, for example, 10 and 50 µg l^{-1} (except for three occasions with readings of ca 70, 150 and 450 µg l^{-1}) over the period 1 January to 1 September. These values contrast with those of 80 to > 1000 µg l^{-1} commonly recorded before the reduction. Indeed, no mill effluent has entered the Loch Leven system following the construction of a new holding tank in September 1989.

As agreed during negotiations over this contract, and in anticipation of it being finalised, we started to measure at 8-day intervals P and other nutrients in the South Queich and the loch, and phytoplankton abundance in the loch in mid-December 1988. This proved extremely fortunate (underlying the value of long-term surveillance programmes) in that we were able to monitor events over the unusually warm winter. The broad, shallow water mass of Loch Leven is especially sensitive to the weather - itself a highly variable regime in Northern Britain - and ample evidence of this was obtained over this period. It is not easy to distinguish between the effects of elevated temperatures per se (with e.g. 8°C being recorded in mid-January 1989), and those of the accompanying windy weather, but the unusual mass occurrence of the 'heavy', filamentous diatom Melosira italica is indicative of very efficient mixing of the water column. This resulted in a peak chlorophyll a concentration in January of ca 55 µg l^{-1} - high in comparison with those attained in the same month in many recent years. However, as a consequence of the unusually early utilisation of nutrients by such growths, the subsequent populations of diatoms comprising the 'normal' late winter- early spring maxima, were rather less dense than usual, i.e. equivalent also to ca 55 µg l^{-1} cf values of 2 and 3 times this in previous years.

In keeping with firstly, the high temperatures that were maintained more-or-less continuously after mid-March (following a brief cold spell in mid-February with 2°C), and secondly, the low flushing rates due to low rainfall, the rest of the period under review, also saw relatively high algal levels. These were equivalent to chlorophyll concentrations in the range 20 to 80 µg l^{-1}. However, as large algae e.g. Melosira granulata and the blue-green Oscillatoria (Limnothrix) were prominent - although invariably accompanied by 30 or more other relatively common species - the water remained somewhat clearer, i.e. with Secchi disc readings remaining consistently above 1 m) than commonly experienced. Indeed, while other blue-green algae such as Anabaena were also recorded later (e.g. September), this classically eutrophic waterbody has not produced in this year of all years, the massive, potentially troublesome and unsightly populations so evident in many other GB lakes and reservoirs.

On this basis, it is suggested that the P reduction is having some beneficial effect. However, it is difficult in any event in the short term, to quantify the effects of the loading control, and particularly over a period marked by such unusual weather. In this respect, the results of the work to be carried out over the remaining 18 months of this contract are eagerly awaited.

At long last, in addition to the routine chemical and algological work referred to above, we have obtained information on the nutrient (including P) status of the sediments of Loch Leven. Data include the amounts and vertical

distribution of particulate and dissolved (interstitial water) P fractions in deposits at various water depths. P concentrations in interstitial water are high (eg 10^{2}-10^{3} µg P l^{-1}) and this water comprises between 65 and 95% of the sediment volume. Nevertheless, even if all of this dissolved fraction of P in the uppermost 10 cm of the sediments were suddenly mixed with the overlying water column (mean depth 3.9 m), it would raise the P concentrations there by only a few microgrammes per litre. These, albeit preliminary findings highlight the importance of processes of desorption of soluble P from particulate P components, and/or solubilisation of these components - which must be invoked to explain high rates of release of phosphorus from sediments in the laboratory and occasionally observed in the field. We are continuing with these investigations.