Handling excess nitrates

SIR—Because modern agriculture practices are now widely recognized as a significant source of nitrate pollution, it is time to consider ways in which land can be managed to absorb the lost nitrate before surface water becomes contaminated.

Traditionally, floodplains in Britain were not vigorously farmed, but land drainage now allows these zones to be ploughed up or managed more intensively as grassland. The unforeseen consequence of this activity is that nitrate-contaminated ground water, which was once allowed to drain slowly through the floodplain, is now conducted rapidly across the floodplain into the stream or river via ditches or tile drains. Nitrate-rich subsurface water that enters an 'undrained' floodplain soil zone is likely to lose most of its nitrate load through processes such as denitrification and assimilation[1,2].

Our work in the upper Thames basin, southern England, shows that a grass-covered floodplain retains the ability to reduce significantly the nitrate concentration of ground water throughout the winter (mean loss of nitrate of 82% for the winter of 1989–90). Our work also demonstrates that the reduction processes seem to operate for different types of surface vegetation, in that the loss of nitrate has occurred in both poplar and grass-covered floodplains. For a major runoff event in January 1990, the nitrate concentration of ground water increased by about 400%, but the grassed floodplain still maintained a nitrate-buffering capacity close to its mean level. The reduction of nitrate in the floodplain has not been accompanied by the excessive production of ammonium ions, which could be one of the indirect consequences when nitrate-rich ground water enters a surface water system.

We conclude that floodplains need to be preserved in (or returned to) their undrained state as these areas sustain a potential to reduce nitrate concentrations in ground water throughout the year. By optimizing the role of floodplains as buffer zones, and thereby preventing ground water rich in nitrate from entering the stream, the quality of drinking water will be improved, and the risk of excessive macrophyte growth (and the consequent problems associated with the decay of those plants in the autumn) will be reduced.

We believe that an undrained 'green corridor' on either side of streams and rivers (especially in headwater catchments) should be preserved as the first line of defence for aquatic ecosystems. Cleaner surface water in headwater catchments will provide greater flexibility on river use, and will have significant benefit for the management of estuarine and marine environments.

NICHOLAS HAYCOCK
TIM BURT

School of Geography,
University of Oxford,
Mansfield Road,
Oxford OX1 3TB, UK

1. Haycock, N.E. & Burt, T.P. in *Hydrological Research Basins and the Environment* (eds Hooghart, J.C., Posthumus, C.W.S. & Warmerdam, P.M.M.) 335–339 (TNO Committee on Hydrological Research, The Hague, 1990).
2. Pinay, G. & Décamps, H. *Regulated Rivers* **2**, 507–516 (1989).

Making sense of information

SIR—Greene's study[1] of colonial ospreys (*Pandion haliaetus*) in Nova Scotia is one of six that strongly supports the 'information centre' hypothesis[2]. Greene suggested that members of a colony of these birds obtained information on the location of ephemeral schools of fish from other members. Greene's conclusions have since been challenged[3] and here I interpret some of his data in a different way.

My colleagues and I have also examined osprey social foraging in Nova Scotia. We found that colonial ospreys at the foraging area directly observed where conspecifics were foraging and used that information to find food themselves, a strategy called local enhancement[4]. To determine why our conclusions were different from Greene's, I visited the same area as that studied by Greene, as well as analysing the data in his thesis[5].

During the period when there were pollock (*Pollachius virens*, schooling species) in Cow Bay and Cole Harbour estuaries, Greene made most of his observations at Cow Bay[5], which was visible from the osprey colony. Thus, the observation that ospreys fly in the direction from which pollock were delivered within 10 min of delivery can be most simply explained by a local enhancement strategy. For deliveries of pollock, the data collected at Cow Bay should therefore be excluded from the analysis, and only then can an assessment be made of whether information was transferred.

Local enhancement can also explain the response to ospreys that made conspicuous flight displays on discovering a school of fish. As all ospreys at the colony flew to the displaying bird, they must have been able to observe it foraging, otherwise how did these birds 'know' to initiate hunting near where the fish had been caught[1]? Although the display directed attention to the school, information was individually acquired.

Greene reported[5] that the other two schooling species in the area, smelt (*Osmerus mordax*) and alewife (*Clupeus harengus*), were highly localized in a few freshwater spawning sites and, therefore, distributed predictably. If these sites were being used by ospreys (as seems likely), then with the resulting preferred foraging destinations, angles of departure were bound to retrace those of arriving birds. To analyse these data appropriately would require omitting departure and arrival angles corresponding to these sites.

Foraging at freshwater spawning sites also provides an alternative explanation of how ospreys located distant schools solely on the basis of incoming flight directions. Finding the same school requires that it remain stationary long enough for the successful forager to return to the colony, plus up to 10 min before departure (using Greene's methodology), plus the time required to return to the school. This seems unlikely for distant schools because of the long time period required. Perhaps what Greene thought were distant schools were in fact stable spawning sites. Indeed, the spawning site 5 km from the colony[5] corresponds to the maximum recruited foraging distances he reported[1].

I conclude that Greene's results can be interpreted in other ways. Reanalysis is required before concluding that the osprey colony he observed functioned as an information centre.

STEPHEN P. FLEMMING

Department of Biology,
Queen's University,
Kingston, Ontario K7L 3N6, Canada

GREENE REPLIES—I have reanalysed my data, excluding all fish caught within sight of the Cow Bay colony or in the ocean between a point of land about 1.5 km to the east of the colony and one 1.75 km south. The percentage of fish caught out of sight of the colony varied among fish species: 34.0% of pollock, 50.8% of alewife, 83.7% of smelt and 66.0% of flounder. Ospreys that departed within 10 min of another bird returning from out of sight with a pollock tended to fly in the direction from which the successful bird had arrived. By contrast, birds leaving the colony within 10 min of another bird returning from out of sight with a winter flounder did not tend to fly in that direction.

Alewife and smelt are anadromous fish, spawning during April to June in two freshwater systems that flow into Cow Bay. If ospreys from the colony were foraging at stable spawning aggregations, then a correlation between arrival and departure directions could arise even in the absence of the transfer of information about distant food sources. Alewife and smelt can be found anywhere along the streams and in lakes up to 5 km from the colony. However, ospreys returning to the colony with these fish tended to return from only two compass directions (roughly 280° and 320°, corresponding to the directions of the months of the streams). On