Institution: The Open University

Unit of Assessment: B7 Earth Systems and Environment Sciences

Title of case study: Enhancement of wetland biodiversity through improved water management

1. Summary of the impact

Professor Gowing and his associates' research demonstrated the sensitivity of grassland species to soil moisture regime. They developed a method for quantifying the relationship between plant community composition and soil moisture regime which showed that controlling water levels in traditional ways led to conservation of important plant species and/or enhanced diversity. This research led to the Environment Agency issuing practical guidelines to site managers for these internationally important sites, with a lead section written by Gowing. Advice has been given directly to owners and managers via the Floodplain Meadows Partnership led by the OU, engendering parallel studies abroad.

2. Underpinning research

The key insight into declining diversity in floodplain meadows was recognising that species growing in diverse communities subdivide the available hydrological niche between them, thereby reducing direct competition. This was discovered while undertaking applied research for river engineering projects funded by MAFF (now Defra). The new understanding suggests that no one species manages to dominate a wet grassland plant community through competitive exclusion because the soil moisture environment is so variable, in both space and time. This variability allows numerous species to coexist because each is favoured by a particular set of hydrological conditions.

Our research has quantified the hydrological preferences of many species and has demonstrated that their overlap in 'hydrological niche space' is significantly lower than would be expected by chance.

The early stages of this research were published by Gowing with funding from Defra (formerly MAFF) and other government agencies (e.g. National Rivers Authority, English Nature). The key paper describing the ecological implications of the work was published from The Open University by Silvertown, Gowing and colleagues in 1999. This paper challenged the prevailing neutral theory of biodiversity and provided concrete evidence for the niche-based hypothesis for coexistence. It has been cited over 200 times. Funding from Defra was renewed and a series of openly available reports to guide its environmental schemes was produced. The Environment Agency funded the production and publication of guidelines for nature conservation managers in 2004, which are still regarded as best available information today.

Subsequent projects building on these initial insights have been funded by the UK research councils to integrate this understanding with a holistic approach to floodplain management, by the Leverhulme Trust to apply the water level control methods developed to habitats of conservation importance in South Africa, and by NERC urgency grants to consider the impacts of major events (floods or fires) on the responses of the studied communities. Five PhD students have undertaken research on applying the new insights to different systems and situations.

The first phase of the work was conducted in a consortium of research groups (Cranfield University, The Open University and the Institute for Terrestrial Ecology/Centre for Ecology and Hydrology) during the period 1994–99. The more detailed studies undertaken in 2000–04 were led by Gowing, then a senior lecturer at The Open University, but still involving all the partners. Application of similar methods to sites overseas was funded for 2005–10 (South Africa) and 2008–

10 (Spain). The main dissemination phase of the work started in 2007 with the establishment of the Floodplain Meadows Partnership, which still continues today.

3. References to the research

Papers published in date order:

Gowing, D.J.G., Spoor, G., Mountford, J.O. and Youngs, E.G. (1994) *The Water-regime Requirements of Lowland Wet-grassland Plants*, Report to Ministry of Agriculture, Fisheries and Food Flood and Coastal Defence Division, London.

Gowing, D.J.G, Youngs, E.G., Gilbert, J.C. and Spoor, G. (1998) 'Predicting the effect of change in water regime on plant communities' in Wheater, H. and Kirby, C. (eds) *Hydrology in a Changing Environment*, vol. 1. John Wiley & Sons, Chichester, pp. 473–83.

Silvertown, J., Dodd, M.E., **Gowing, D.J.G.** and Mountford J.O. (1999) 'Hydrologically-defined niches reveal a basis for species richness in plant communities', *Nature*, vol. 400, pp. 61–3.

Silvertown, J., McConway, K., **Gowing, D.J.G**., Dodd, M.E., Fay, M., Joseph, J. and Dolphin, K. (2006) 'Absence of phylogenetic signal in the niche structure of meadow plant communities', *Proceedings of the Royal Society of London*, *Series B*, vol. 273, pp. 39–44.

Rouquette, J.R., Posthumus, H., **Gowing, D.J.G.**, Tucker, G., Dawson, Q.L., Hess, T.M. and Morris, J. (2009) 'Valuing nature-conservation interests on agricultural floodplains', *Journal of Applied Ecology*, vol. 46, pp. 289–96.

Araya, Y.N., Silvertown J., **Gowing, D.J.G**., McConway K.J., Linder H.P. and Midgley, G. (2010) 'A fundamental, eco-hydrological basis for niche segregation in plant communities', *New Phytologist,* vol. 189, pp. 253–8.

Grants

1997–2002: £429,534 grant awarded by Defra (Conservation Management Division), London (Project BD1310) to Dr David Gowing (Cranfield University until March 2000 then Open University) for a project entitled 'The water-regime requirements and the response to hydrological change of grassland plant communities'.

2003–04: £17,500 grant awarded by Environment Agency (Anglian Region) to Dr David Gowing (Open University) in collaboration with Dr Bryan Wheeler (Sheffield University) and Owen Mountford (CEH) for a project entitled 'Production of ecohydrological guidelines for lowland wetland plant communities'.

2005–07: £84,192 awarded by The Leverhulme Trust to Prof. Jonathan Silvertown (Open University) for a project entitled 'Soil moisture gradients and the biodiversity of the Cape Flora'.

2008–13: £205,000 awarded by the Esmée Fairbairn Foundation to Dr David Gowing (Open University) as Floodplain Meadows Partnership co-ordinator.

4. Details of the impact

The pursuit of pure ecological research into the functioning of hydrological niches has not only advanced ecological theory, but has provided practical benefits to society. It has enabled the impacts of water abstraction on sites of conservation interest to be objectively assessed, water management of nature conservation sites to be based on scientific knowledge, and both the practitioner community and interested members of the public to understand how climate drives the species composition of wet meadows.

The need to designate and manage the few surviving remnants of species-rich wet grassland in England was recognised in 1973. Numerous sites were subsequently designated and managed for their nature conservation importance. Initially, presumably because they were labelled 'wet grasslands', their managers strove to retain water on them by building bunds and blocking ditches.

This mindset was reflected in the management prescriptions of agri-environment schemes in which landowners were paid to raise water levels. Against this background, our research showed unexpected results (e.g. Gowing et al., 2002). The evidence was that species richness in these systems was greatest where drainage was at its most efficient. Further research confirmed these findings (e.g. Gowing et al., 2005) and allowed specific advice to be produced for people wishing to conserve particular features of nature conservation interest. Specifically, the pattern of water availability over the year could be prescribed to favour a particular species or community of interest. Often this practice involved holding water tables as high as possible during summer, but low enough to drain excess water in winter and spring.

The research team at The Open University regularly advised organisations such as the Environment Agency (EA) and Natural England (NE) on a site-by-site basis during the period 2000–05 (e.g. outputs 5 and 8 below.) During this period the EA identified the need for general guidance to all managers of wet grassland of conservation interest. It formally commissioned a publication entitled 'Ecohydrological guidelines for lowland wetland plant communities' in 2004 and approached The Open University to write the lead section on grasslands. The effect on the ground of this work was to alter the mindset of managers to the extent that where they had previously built bunds and blocked ditches on sites of nature conservation importance, they were now removing bunds and clearing ditches to safeguard the biodiversity of their sites (e.g. culverting and bund removal works at North Meadow Special Area for Conservation (SAC), Cricklade, Wilts.). The guidelines have become a standard reference work for wetland managers and the EA paid for them to be updated in 2010.

Another route to impact was advice given to the EA on the appropriate assessments it needed to undertake on sites designated as SACs under the European Habitats Directive. Floodplain Meadows were designated under this directive and The Open University team produced a series of reports (e.g. outputs 4 and 7) to identify the risks posed to these sites from external influences. The EA recognised that many of its Area Offices were commissioning similar advice and therefore suggested The Open University host a national project in partnership with a range of relevant organisations to coordinate the monitoring, analysis and communication of information relating to floodplain meadows. The Floodplain Meadow Partnership was therefore set up in 2007 and since then has proactively interacted with practitioners to implement the new understanding arising from our group's research.

Since 2007, The Open University has worked in partnership with seven other organisations (see list of contacts below for details), all of which are involved in the conservation of this threatened habitat. The partnership, hosted by The Open University, and funded by environmental charities, seeks to support practitioners within the member organisations and beyond via an interactive website, regular newsletters, workshops, field visits, guided walks, public lectures and a conference. The workshops are aimed at site mangers, who are taught practical skills allowing them to assess their own sites and amend their management to enhance biodiversity. Over 100 managers have been trained in this way, representing the majority of people managing designated sites in this category.

Since 2008, the research team has visited 93 sites across England and Wales both to gather data and to provide advice. Many of these have had their management altered in response to the evidence provided by the earlier research, including all five of the sites designated as being of international importance under the Habitats Directive. In seven cases drainage channels were reinstated to facilitate removal of flood waters, which avoided species loss through episodes of anoxia. The Partnership is the first point of contact for people with questions about the management of floodplain meadows; we have over 650 people requesting our newsletter, have

had over 2500 unique visitors to the interactive website and have reached over 8000 people at face-to-face events over the past six years. Feedback received from participants describes how they have altered practices, such as cutting dates, following their interaction with the University research.

5. Sources to corroborate the impact

External sources corroborating impact:

1. Gowing, D.J.G., Tallowin, J.R.B., Dise, N.B., Goodyear, J., Dodd, M.E. and Lodge, R.J. (2002) 'A review of the ecology, hydrology and nutrient dynamics of floodplain meadows in England', English Nature Research Report 446, Peterborough.

2. Gilbert, J.C., Gowing, D.J.G. and Youngs, E.G. (2000) 'Blackwater Valley SSSI: Hydrological investigations and management recommendations to conserve MG5 grassland communities', Report to English Nature (Thames and Chilterns Team, Newbury).

3. Gowing, D.J.G. (2000) 'Impact of various abstraction scenarios upon North Meadow SAC', Report prepared for the Environment Agency (Thames Region), Wallingford.

4. Gowing, D.J.G. and Youngs, E.G. (2005) 'The requirements of *Apium repens* – an ecohydrological assessment', Report to the Environment Agency (Thames Region), Reading.

5. Gowing, D.J.G., Lawson, C.S., Barber, K.R. and Youngs, E.G. (2005) 'Response of grassland plant communities to altered hydrological management', Final report to Defra (Conservation Management Division), London, Project BD1321.

6. Gowing, D.J.G., Lawson, C.S., Youngs, E.G., Barber, K.R., Prosser, M.V., Wallace, H., Rodwell, J.S., Mountford, J.O. and Spoor, G. (2002) 'The water-regime requirements and the response to hydrological change of grassland plant communities', Final report to Defra (Conservation Management Division), London, Project BD1310.

Beneficiaries who could be contacted to corroborate impact:

7. National Conservation Advisor, Environment Agency, Bristol
8. Head of Wetland section, Centre for Ecology and Hydrology, Wallingford
9. Head of Biodiversity, Field Studies Council, Shrewsbury
10. Senior Ecologist, Footprint Ecology, Wareham, Dorset
11. Water for Wildlife Project Director, The Wildlife Trusts, Newark