Project name: Hydrological niches on a Siberian floodplain
Project acronym: Siber-Niche
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Site of research: Mukhrino Field Station (Khanty-Mansiysk, Russia)
Duration of the project: 48 man days, 1 July – 14 July 2013
Date of the specific Interact call: summer 2013 and winter 2013/2014 field seasons

Background

1) Significance for the research nationally and internationally.

Floodplains across Europe support diverse plant communities that underpin important assemblages of other taxa. The nature-conservation importance of this habitat was recognised in the European Habitats Directive (EC, 1992). In addition to supporting high biodiversity, these systems provide a range of important ecosystem functions, including sustainable hay production, flood storage, sediment trapping, recreational and cultural services. Changes in land use and farming practice during the twentieth century have led to these traditional meadow communities becoming rare. The remaining stands in Western Europe are now managed primarily for their conservation interest and detailed research has investigated their environmental requirements and tolerances (e.g. Holzel & Otte, 2003.). An environmental variable of particular relevance was found to be soil-moisture regime (Silvertown et al, 1999.) Recent research has aimed to describe the hydrological niches of individual species or communities to aid their conservation management (e.g. Stroh *et al*., 2012). The assumptions made in these studies, particularly the relative importance of water regime in summer versus winter and the role of management (cutting, grazing) in determining the hydrological niche, need to be examined in other environments. To test these assumptions adequately, it is necessary to study a system with a contrasting climate and a contrasting management regime. The floodplain grasslands of W. Siberia provide the ideal opportunity for such a test. Whilst having some botanical similarity to the floodplain meadows of W. Europe, they have a markedly contrasting growing season (May-September compared to March-October in UK) and almost no management (occasional burning in spring as compared to annual mowing and grazing in the UK.). Data describing the hydrological niches of species in Siberia will either act to confirm that the current approach to quantifying niches is robust and suitable for use across a range of climatic zones and a variety of vegetation-management regimes; or they will reveal weaknesses in the assumptions that can be used to re-assess our current conception of the hydrological niche. The data will also prove a valuable resource for looking at the evolutionary development of niche segregation using the techniques employed by Silvertown *et al.,* 2001. Meadow communities in W. Europe show no consistent pattern of niche specialisation with time, probably as a result of the degree to which the dispersal and management of the plant communities has been affected by anthropogenic factors. The floodplain grasslands of W. Siberia offer an interesting contrast as their plant communities are likely to have been less affected by human activity and evolution of species in terms of their water-regime requirements may show a clearer temporal pattern.

2) Previous research pertaining to the topic.

The research topic is based on the finding of Silvertown *et al* (1999,) which suggested hydrological niches were fundamental to the maintenance of species-rich communities in floodplain grassland. This paper has been widely cited as empirical evidence opposing the unified neutral theory of biodiversity (Hubbell, 2001.) The advance of Silvertown *et al* relies on an ability to quantify the hydrological niches of species and communities. Their approach has been supported by recent work in South Africa (Araya *et al*., 2011) and in the Iberian mountains (Garcia-Baquero *et al*., 2013) but

there was little or no overlap in the species pool between these regions, so direct comparisons could not be made.

3) How the research project links to other research by the group leader.

The Ecology and Conservation Research Group at the Open University (Gowing, Araya, Dodd, Silvertown, Stevens) has been researching the factors involved in structuring the community composition of grasslands, particularly those on floodplains, for more than 20 years and have produced over 100 scientific articles in international journals. The group sustains long-term monitoring of some of the best examples of species-rich grassland in U.K., providing data for analysis of plant-community dynamics. These analytical techniques will be applied to the Siberian data. Past research into conservation management of floodplains (Rouquette *et al*., 2011) and atmospheric nitrogen deposition (Stevens *et al*., 2004, 2011) will also allow parallels to be drawn between British and Siberian grasslands. Another aspect of the group's research is the evolutionary development of niche-segregation patters, which have been analysed in both British meadows and South African Fynbos (Silvertown *et al*., 2006; Araya *et al*., 2011.) Again the approach can be usefully applied to the Siberian data.

Objectives

We plan to test the following hypotheses:
H1. Plant species in Siberian floodplains are segregated into quantifiable hydrological niches.
H2. For those species that occur in both W. Europe and W. Siberia, the hydrological niches in the two regions are closely aligned, when scaled appropriately for length of growing season.
To test these hypotheses, we propose to gather a data set of botanical releves and to characterise the hydrological regime of the sampled sites using past records and current monitoring data.
The group has not previously applied to the INTERACT programme. The group has one PhD student; Sonia Newman

Research methods, permits, Risk management

Our approach will be to characterise the hydrology of one portion of the floodplain (exact location to be selected during initial reconnaissance visit) The high-quality meteorological data and river-stage data currently held by organisations in the area (and accessed via collaborators at the Mukhrino field station) combined with a physical analysis of the soil and piezometer observations, will allow a basic hydrological model of the floodplain to be developed, allowing past water regime to be simulated. Overlaying the present distribution of plant species onto a modelled hydrological layer, will allow the hydrological tolerances (realised niches) of the species to be determined (as in Silvertown *et al*., 1999.)
Research methods include botanical survey of the vegetation located along three transects crossing different geomorphological features on the selected portion of the floodplain, encompassing a range of flood durations.
Soil samples will be collected from along each transect and will be analysed for both physical properties (e.g. soil moisture release curves) and nutrient content (extractable phosphorus & pH.)
Six piezometers will be installed along the transects to measure ground water eleveantion. These will be instrumented with automated pressure-tranducer loggers (Diver, Schlumberger)
All locations of vegetation survey, soil sampling and hydrological measurements will be recorded with high accuracy differential GPS.

Access permission to work on the floodplain of the rivers Ob and Irtish will be provided by Mukhrino Field Station. A risk assessment of the fieldwork has been undertaken in liaison with the Station manager at the Mukhrino Field Station. A number of hazards have been identified and the risks can be

mitigated by staying within proximity of a vehicle and carrying mobile phones, life vests and appropriate clothing. A more detailed assessment will be undertaken on Day 2 of the fieldwork, following a reconnaissance visit to the transect locations. All fieldwork will be undertaken in a group of two or more researchers – there will be no lone working.

5. Timetable for the research

01 July – Flight and arrival in Khanty-Mansiysk and travel to Mukhrino Field Station.
02 July - Reconnaissance visit to the field site. Detailed risk assessment, selection of study area
03 July - Selection and topographic survey of suitable transects across the floodplain
04 - 06 July inclusive - Instrumentation of transects with six soil piezometers with automated loggers
07 - 10 July -. Botanical survey of 100 vegetation samples (2m x 2m)
11- 12 July – Sampling soils and biomass for analyses.
13 July – Packing of samples and departure from Field station
14 July Return flight via Moscow and London for onward journey to Milton Keynes.
In total, there will be 48 person.days of fieldwork at Mukhrino Field Station in 2013, plus two days of travel for each person. A total of 58 person.days of effort. Exact dates may vary depending on timing of floods

Travel and logistics costs (all amounts are in Euros)

Name	**Travel to airport**	**Air tickets London-Moscow, return**	**Moscow-Khanty-Mansiysk, return**	**Local logistics (50 Euro per day)**	**Visa**	**Permits**	**Total per person**
David Gowing	110	650	850	300	135	50	2095
Michael Dodd	110	650	850	600	135		2345
Irina Tatarenko	110	650	850	600			2210
Sonia Newman	110	650	850	600	135		2345
NK	110	650	850	300	135		2045
Total for the group	550	3250	4250	2400	540	50	11040

6. Expected results and possible risks

Expected scientific and societal impact of the research. The data collected will demonstrate whether hydrological niches in Siberia can be quantified using the approach developed in UK. The expectation is that species will show strong segregation as has been seen in UK and South Africa. If species behave as expected, it will encourage researchers across the globe to apply this technique to other vegetation stands and to seek a general relationship between vegetation diversity and hydrological variation. If species fail to segregate, it will prompt us to re-visit our assumptions behind our method for quantifying hydrological niches.
A comparison between highly managed grassland systems (UK) and largely unmanaged systems (Siberia) with hydrological variation considered as a covariate will give insight into the role of management in promoting the species richness of these systems.
A phylogenetic analysis of niche-segregation patterns will indicate whether species co-evolved (as in South African fynbos) or whether they are a conglomerate from different sources (as in UK meadows)
Potential for scientific breakthroughs and identification of risks. If the assumptions being tested by the fieldwork are not substantiated, then we will need to seek a new generalisable approach to quantifying hydrological niches. If, however, the assumptions are substantiated in the Siberian system, then the approach can be proposed as a general one for wetland systems and vegetation ecologists can feel more confident in applying it to other vegetation types.
The hydrological data obtained from the site will be of potential use to ecologists and environmental scientists working within the Siberian river systems and should give rise to other lines of enquiry. The proposed research relates to the composition of botanical communities, but once the soil hydrology has been characterised, parallel research on other taxa and trophic levels would be possible.

Applicability and feasibility of the research results. A more complete understanding of how hydrological variation (whether stochastic or managed) can underpin ecological diversity on floodplains will aid the management of these systems for nature-conservation. Results from previous research are currently being adopted by government agencies in the UK and the results of this study may help European member states to fulfil their obligations under the Habitats Directive with respect to floodplain-grassland habitats. The comparison of highly managed habitats in W. Europe with largely unmanaged ones in Siberia may also give insight into appropriate "reference sites" as required by the European Water-Framework Directive (EU, 2000.)

Publishing of results. The results will be submitted to an international scientific journal in 2014 and presented at the UK Floodplain Meadow Conference in Swindon (June 2014.) Other opportunities to present the work to the scientific community will be sought. The conclusions and their implications for conservation-management practitioners will be published on the Floodplain Meadow Partnership website (www.floodplainmeadows.org.uk) and in the Partnership's regular newsletters that is circulated to landowners, farmers, managers and conservation bodies.

Data access. The data will be included into the Floodplain Meadow Database hosted by the Open University (UK) and will be available to any researcher upon request. We will also explore lodging the data with the data archive maintained by the Natural Environment Research Council (UK,) which is able to make data available over the web to anyone registering on their system.

7. Key literature

Five most relevant publications of the user group

Araya, Y.N., Silvertown J., **Gowing, D.J.G**., McConway K.J., Linder H.P. and Midgley, G. (2011) A fundamental, eco-hydrological basis for niche segregation in plant communities. *New Phytologist*, **189**, 253-258

Bartelheimer, M., **Gowing, D.J.G**., Silvertown, J. (2010) Explaining hydrological niches: the decisive role of below-ground competition in two closely related *Senecio* species. *Journal of Ecology*, **98,** 126-136

Michalcova D., Gilbert J.C., Lawson C.S., **Gowing, D.J.G**. and Marrs R.H. (2011) The combined effect of waterlogging, extractable P and soil pH on alpha-diversity: a case study on mesotrophic grasslands in the UK. *Plant Ecology*, **212**, 879-888.

Silvertown, J. Dodd, M. and **Gowing,D.J.G.** (2001). Phylogeny and niche structure of meadow plant communities. *Journal of Ecology*, **89**, 428-435.

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*, **400**, 61-63.

List of other references used in the research plan

EC (2000) Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy *Official Journal* L 327 , 22/12/2000 P. 0001 - 0073

EEC (1992) Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. *Official Journal* L 206 , 22/07/1992 P. 0007 - 0050

Garcia-Baquero, G. et al. (2013)

Hölzel, N. & Otte, A. (2003): Restoration of a species-rich flood-meadow by topsoil removal and diaspore transfer with plant material. *Applied Vegetation Science*, **6**: 131-140.

Hubbell, S.P. (2001) The unified neutral theory of biodiversity and biogeography. Princeton Univeristy Press. 448 pp.

Rouquette, J.R., Posthumus, H., Morris, J., Hess, T.M., Dawson Q.L. & **Gowing D.J.G.** (2011): Synergies and trade-offs in the management of lowland rural floodplains: an ecosystem services approach, *Hydrological Sciences Journal*, **56**, 1566-1581.

Silvertown, J., Dodd, M. E., **Gowing, D. J.G.**, Lawson, C., and McConway, K. J. (2006). Phylogeny and the hierarchical organization of plant diversity. *Ecology*, **87**, S39-S49.

Stevens C. J.; C. Dupre; E. Dorland; C. Gaudnik; **D.J.G. Gowing**; A. Bleeker; M. Diekmann; D. Alard; R. Bobbink; D. Fowler; E. Corcket; J.O. Mountford; V. Vandvik; P. A. Aarrestad; S. Muller; N. B. Dise (2011) The impact of nitrogen deposition on acid grasslands in the Atlantic region of Europe *Environmental Pollution* **159,** 2243-2250

Stroh, P.A., Mountford, J.O., Araya, Y.N. and Hughes, F.R. (2013) Quantifying soil hydrology to explain the development of vegetation aat an ex-arable site. Wetlands. Doi 10.1007/s13157-013-0385-1