The effect of management on the biodiversity of a recreated floodplain meadow in the upper Thames valley: a case study of Somerford Mead

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Summary

Somerford Mead was re-created on former arable using local meadow foxtail-great burnet (*Alopecurus pratensis-Sanguisorba officinalis*) (MG4) seed, sown in the autumn of 1986, after an exploration of the seed bank, 1985-6. It has been managed as a hay-meadow since 1987 and has received experimental aftermath (second grass crop) management since 1989. The traditional management of cutting for hay followed by cattle grazing has produced a sward which is a little more species- rich than the sheep-grazed treatments in some years but both of these treatments are richer than the ungrazed plots. Firstly the succession of species included arable annuals which disappeared after three years. Secondly, to some extent, succession was dependent upon weather. Higher plant species, tolerant of dry conditions, established themselves in the first ten years followed by those of wetter conditions. Thirdly, as early as 1993 the cow-grazed plots were seen to be richer in invertebrates and, latterly, particularly by phytophagous beetles associated with legumes. The establishment of MG4 grassland has still not been completed in Somerford Mead when compared with Rodwell's (1992) MG4 grassland.

Nomenclature of species follows Stace (2002) and of communities follows Rodwell 1992; 2002.

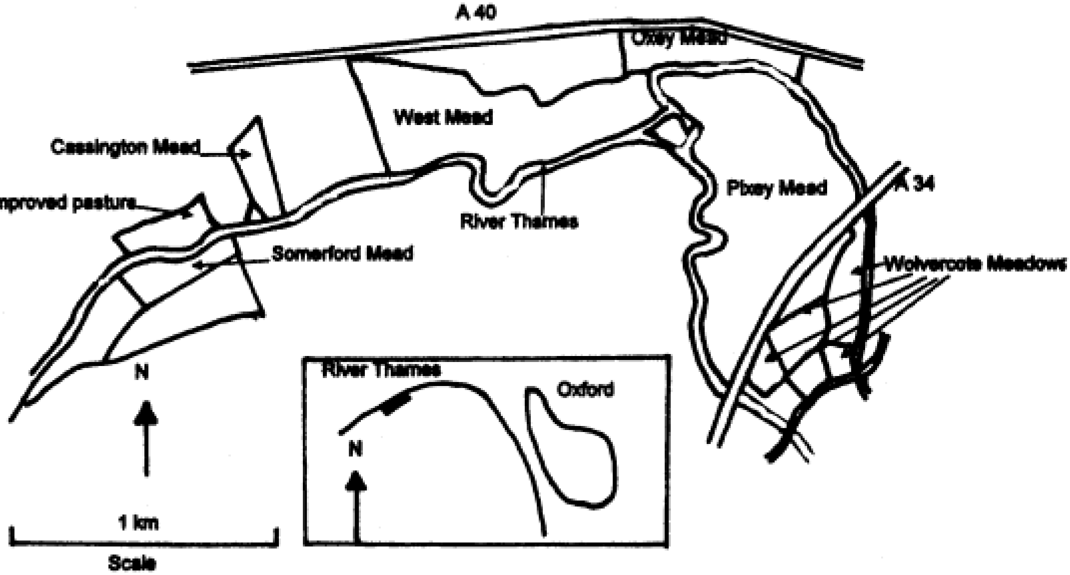

Figure 1: Map of the study area showing the location of Somerford Mead, West Mead, Oxey Mead and Picksey Mead.
Inset: The study area in relation to Oxford.

Introduction

Historically, meadow-foxtail - great burnet (*Alopecurus pratensis-Sanguisorba officinalis* (MG4) (Rodwell1992) flood meadows were created on lowland floodplains by farmers using consistent management over a thousand years. Bear in mind that

MG4 grassland is traditionally divided into one-acre strips which, until the 19th century, were cut in one day in late June/early July according to the season. Light aftermath grazing by cattle took place from early August (Lammas Day) to the 2nd November (All Souls' Day) (McDonald 2009). An individual farmer, therefore, did not know which plot of land was his until lots had been drawn to identify ownership immediately prior to cutting the hay (McDonald 2009). Under 18th and 19th century enclosure, as well as in the 20th century, improved agricultural methods and building developments, destroyed this vulnerable habitat (McDonald 2009). It is now very rare in Britain and Europe (Jefferson 2009). MG4 has no dominant species but is characterised by species-rich swards containing frequent great burnet (S*anguisorba officinalis*), Meadow Foxtail (*Alopecurus pratensis*), Red Fescue (*Festuca rubra*), Crested Dog's-tail (*Cynosurus cristatus*), Ribwort Plantain (*Plantago lanceolata*), Meadow Buttercup (*Ranunculus acris*), Common Sorrel (*Rumex acetosa*), Meadowsweet (*Filipendula ulmaria*), Dandelion (*Taraxacum officinale* agg.) and Red Clover (*Trifolium pratense*) (Class V in Rodwell's (1992) description of MG4 flood-meadow grassland). This community includes plant species which flower and usually set seed before the hay is cut, and has a specialized invertebrate fauna (Keith Porter unpubl.). It also provides breeding sites for Skylark (*Alauda arvensis*) and Curlew (*Numenius arquata*) and harbours a winter migrant avifauna. MG4 can be damaged if the water table is raised or lowered and be completely transformed or destroyed by drainage neglect, fertilizer application and silage cropping (Jefferson and Pinches 2009; McDonald 2001).

My study of Port Meadow with Wolvercote Common and Picksey Mead, Oxford, (McDonald 1984) made me aware of the scarcity of species-rich flood-meadows and the lack of understanding of their management. At that time there was little information, for example, on species recruitment from the seed bank in the soil, from seed 'rain' or brought in by grazing animals. Although it was widely known that cows, sheep and horses have different grazing and dunging habits their effect on a newly-sown sward was not understood. Nor was the size of the stocking rate and its effect on species composition known. Experience at that time was geared towards on the one hand increasing grassland productivity, and on the other, habitats for native wild species on new roadside verges and 'floriferous grasslands' (e.g. Wathern and Gilbert 1978), 'attractive amenity grasslands' (e.g. Wells et al. 1981) and creation of 'nature parks' in urban areas (Emery 1986).

It was known, however, that difficulties had arisen in attempting to grow native species on ex-arable soils and in habitat restoration (e.g. Marrs 1985). Increasing diversity by inoculating a sward with appropriate seed or transplants was considered to be very labour-intensive (Wells 1986). My concerns that the potential destruction of meadow turf, by transplantation, storage and/or transfer, would be very costly and not effective in the long-term (more than 5 years) were later justified (Bullock et al. 1995; Davies et al. 1999). Recently, a less demanding approach to the creation of species-rich meadows, by casting freshly cut hay onto various substrates, has been more successful but even this has its problems (Kerry Lock pers. com.). Finally, the effect of climate on species-composition has been shown to be very important because the MG4 plant community can be changed by flooding and by drought. Indeed, the effect of occasional flood and drought events in the growing season, on species-composition and productivity of floodplain grasslands may persist for more than ten years (Gowing et al.2002; Beltman et al. 2007; Duranel et al. 2007). Where drainage is impeded stands of MG4 can change to S7 *Carex acutiformis* stands and where agricultural improvements are made or cutting stopped it can degrade to species-poor MG7c *Lolium - Festuca – Alopecurus* flood-pasture swards. In less well-drained areas or where soils are richer in available phosphorus, MG4 can be replaced by MG6 Lolio-Cynosuretum (Gowing et al. 2002). On Picksey Mead near Oxford the water-table has been raised for more than 5 years with the result that the wet variant of MG4 has changed to a form of (M22 Blunt-flowered Rush (*Juncus subnodulosus*) –Marsh Thistle (*Cirsium palustre*), Quaking-grass - Clover (*Briza media-Trifolium* spp.) sub-community (Rodwell 1991) (McDonald 2009).

The complexity of factors affecting the establishment and growth of MG4 grassland makes long-term data sets essential to the understanding of these grasslands. A block of knowledge of the living conditions of the component plant and animal communities, both above and below ground, is needed if succession in failing MG4 grasslands is to be reversed. Particularly important is preserving the traditional management of cutting for hay and grazing the aftermath with cattle, maintaining appropriate soil nutrient and water levels and matching the geology of seed donor sites with recipient sites. In 1985 I was fortunate to be given the opportunity to try to re-create an MG4 flood-meadow community on Oxford University Field Station at Wytham, near Oxford.

Only three attempts to re-create MG4 grassland have been published so far of which this study, begun in 1985, is the oldest (Walker et al. 2004). These data are more useful than those for many MG4 sites because they arise from fixed quadrats and are collected in the same way every year. Having created an impoverished MG4 grassland from seed on an old-field site, an experiment to test the hypothesis that aftermath grazing by sheep or by cattle or no grazing had no effect on the plant communities, began in 1989. The early years of this experiment are described in McDonald (1992; 1993; 2001) and McDonald et al. (1996).

Weather

As one would expect, the highest number of hours of bright sunshine occurred in summer every year except 1990 and 1997. The years 1989, 1990, 1995 and 1996 were particularly warm but 2001, 2002, 2004, 2005 and 2006 were the warmest years recorded at the (Radcliffe Meteorological Station (RMS) since records began in 1815 (Figure 2). Spring was very warm (>500 hours/season bright sunshine) in 1989, 1990, 1995, 1997 and 2003 and, as one might expect, winter had the fewest hours of bright sunshine every year, except for 2004 which had >300 hours.

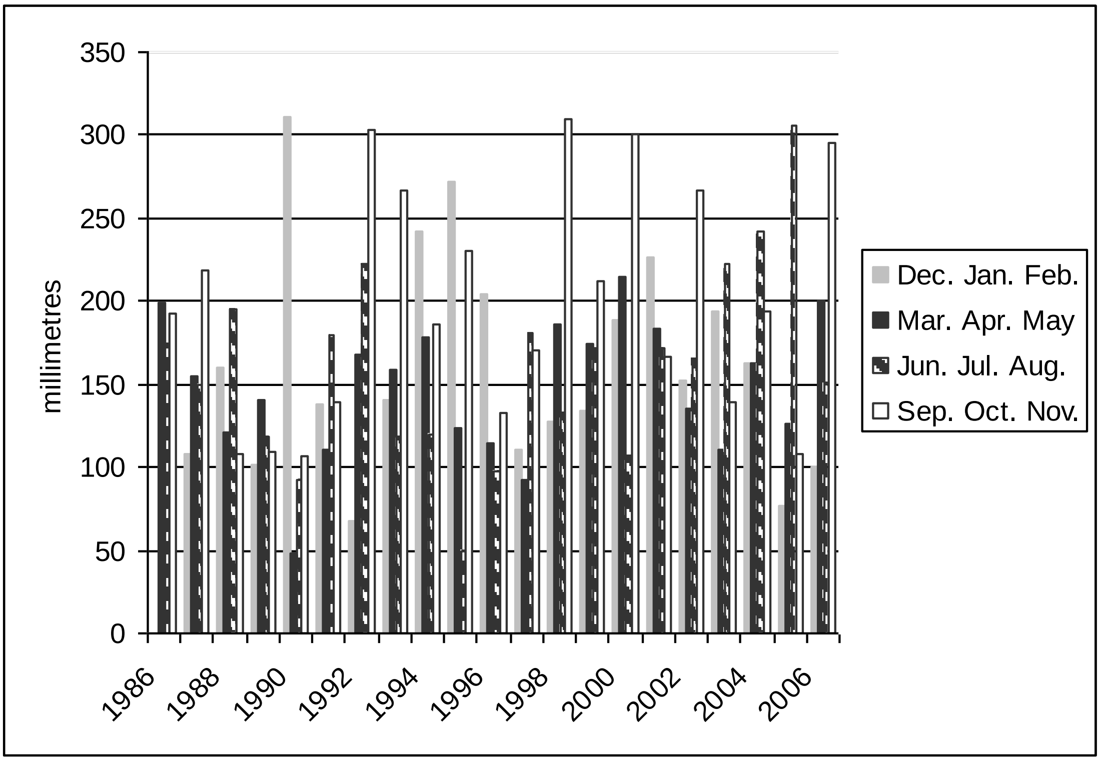

Figure 2: This graph shows the total hours of bright sunshine per season (RMS 1986-2006).

In 1986 and 1989 most rain fell in spring (Figure 3); in 1988, 1991, 1997, 2003, 2004 and, especially 2005, most rain fell in summer; in 1987, 1992, 1993, 1998, 1999, 2000, 2002 and 2006 most rain fell in autumn and in 1990, 1994,1995, 1996 and 2001 most rain fell in winter (Figure 3). Floods during the winter of 1989-90 were not sufficient to fill the aquifer and low rainfall from spring 1990 to winter 1992 produced near drought conditions. There were extensive floods during the winter 1997/1998. Rainfall was higher than average from March 1996 to June 1997 and during the years 2001, 2002 and 2004. Spring was relatively dry (<100 mm rain/season) in 1990 and 1997, and summer in 1989, 1990 and 1995. Overall, 2006 was the warmest since records began in 1815 (RMS 2006).

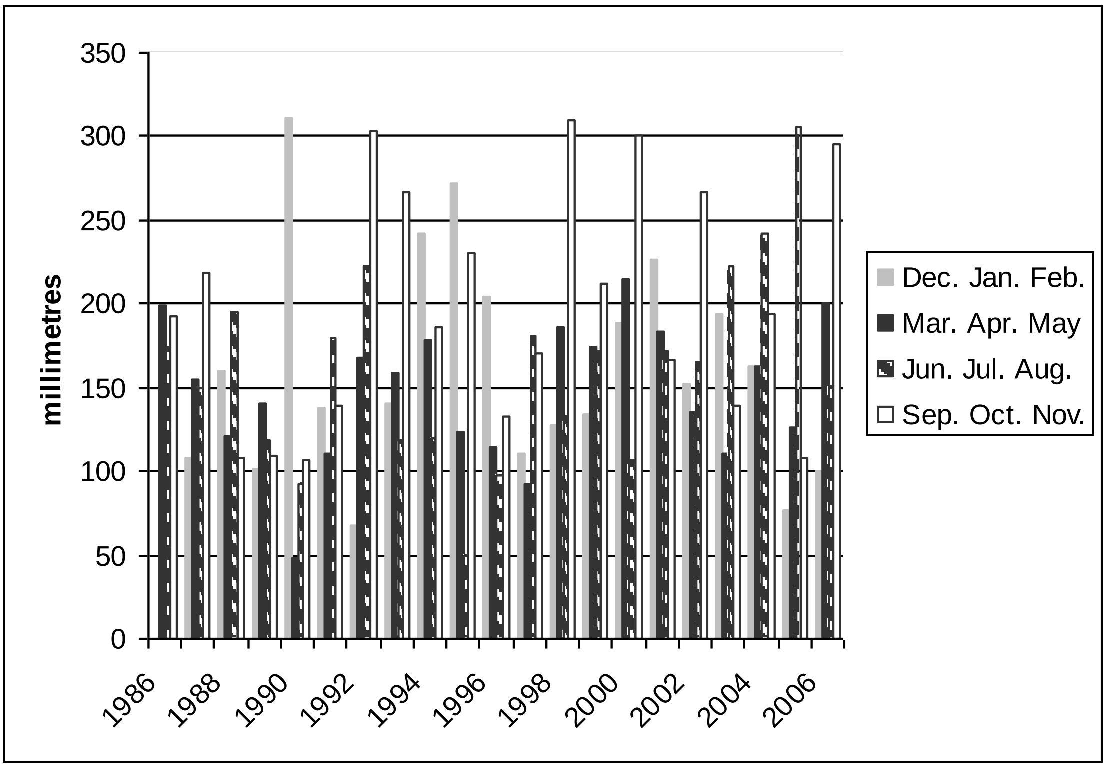

Figure 3: This graph shows the total rainfall (mm) per season (RMS 1986 – 2006).

General effects of soil and water conditions on plants.

In the upper Thames floodplain the MG4 community lies on clay-rich alluvium over limestone riverine-gravel above Oxford clay. It needs a relatively precise hydrological regime, with characteristic periodic inundation by winter floodwaters to provide adequate nutrients. A water supply for plant growth in early summer and an aerated root zone during the growing season are also necessary. Lack of oxygen to the roots, due to prolonged flooding or to inadequate surface drainage, is therefore a threat to this community (Gowing *et al.* 2002). However, mid-levels of aeration stress caused by flooding in early spring can be tolerated before growth starts in late April/early May (Gowing and Youngs 1997). It is therefore important that good drainage is maintained so that floodwater moves quickly on and off the ground in order to avoid aeration stress. This happens automatically on floodplain sites where water moves freely through the underlying gravel. Summer drought, when the water-table falls below the alluvium/gravel interface, causes less stress than might be expected once the hay is cut (Gowing and Youngs 1997).

Study area: Somerford Mead, Wytham.

Somerford Mead (6.1 ha), an old-field floodplain site, on the University of Oxford's Field Station, some 5 miles north of Oxford, was chosen for the experiment partly because it had been a species-rich flood-meadow (MG4) in the 1950s (Figure 1) (Grid ref: SP460097; Nature Conservancy 1950). It is situated on circum-neutral (pH 7.5) alluvial soils over limestone gravel of varying thickness. The fluctuating water-table is fed by water running through these floodplain gravels adjacent to the river Thames (pH 8.0). So long as the water-table remains above the interface between the gravel and alluvium, the soil remains damp. It normally dries out in the summer when the water-table falls below this interface. A levée along the bank has reduced the incidence of flooding since the 1930s. The appearance of flooding is given occasionally, however, when the water-table is raised above ground-level in winter, and at other times for short periods, but the ground-water normally lacks the nutrients associated with floodwater. Exceptionally, in July 2007, floodwater on Somerford Mead rose to 1.5 m and slowly receded over a period of some 10 days (M. Gooding, Farm Manager pers. comm.). The effect of this has yet to be discovered.

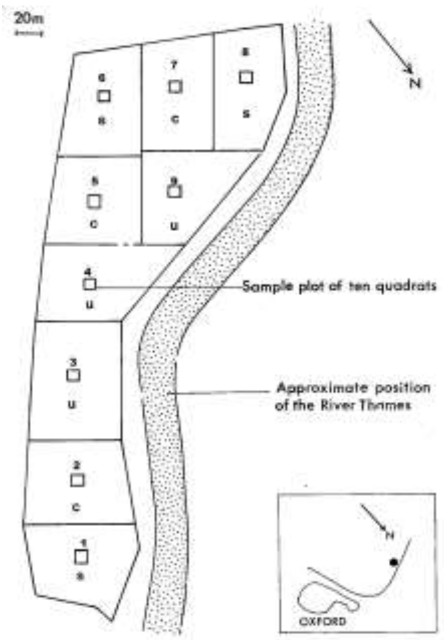

Figure 4: Diagram of Somerford Mead showing the location of the randomised plots.

Preparations for the experiment

Somerford Mead was ploughed for the first time in 1981 and three crops of barley were harvested in the following years. The fact that the top-soil was not removed to reduce soil fertility was, in retrospect, a good decision because the sterile conditions left after soil removal are not suitable for the mid or late successional species sown in a grassland seed mix for at least three years (Kardol et al. 2008). Instead, in 1985 Somerford Mead was prepared for this experiment by sowing a fourth barley crop and managing it without using agro-chemicals in a successful attempt to reduce fertility in the soil (McDonald 1993). Over the winter 1985-6 I began my study with an investigation of the seed bank which showed that most species germinating from the soil and recorded amongst the barley crop belonged to the ubiquitous (OV9) *Matricaria perforata-Stellaria media* community (Rodwell 2002) with Scentless Mayweed (*Tripleurospermum inodorum*) being the most abundant. There were few, if any, MG4 seeds remaining in the soil (McDonald et al. 1996). In 1986-7 the sown seed was slow to germinate and arable flowers derived from the seed-bank accompanied the sown grasses in almost equal numbers in the very open sward**.** In 1988 the sown species comprised two thirds, and in 1989 three quarters of the community (McDonald 1992).The standing hay was lush and tall and the soil was designated as 'requiring no additional nutrients'. By 1990, the soil was already regarded as of 'low nutrient status'. At this time it was noted that average pH had increased from 7.7 to 8.7 and that in soils with pH >7.5 there might be a tendency to lock up nutrients such as phosphate and manganese (Jealott's Hill Research Station Reports 1986; 1990; ICI Customer Service)

Methods

After the seed from Oxey Mead was sown in 1986, Somerford Mead was treated as a hay-meadow with a late June/early July hay-cut and aftermath grazing with 12 heifers (young cows) and 50 sheep. A replicated block experiment was set up in 1989 (Figure 4). The management of the three treatments included putting 10 sheep in each of three plots, two cows in each of three plots and three plots were left ungrazed, for 4 -5 weeks in October (Figure 5). All animals are removed when the first plot is grazed down to c.5 cm. For more detailed information about methods and results see McDonald (2001).

Figure 5: Cows and sheep grazing in their plots, 1989.

Plant establishment

Germination of sown grasses such as meadow brome (*Bromus hordeaceus*), Yorkshire Fog (*Holcus lanatus*), Rough-stalked Meadow-grass (*Poa trivialis*) and Perennial Rye-grass (*Lolium perenne*) was good in the first year (1987). In 1988,18 of the unsown annuals did not germinate or become established and sown species, such as Red Clover (*Trifolium pratense*), White Clover (*T. repens*) and Crested Dog's-tail (*Cynosurus cristatus*), increased in abundance whilst Red Fescue (*Festuca rubra*), Cock's-foot (*Dactylis glomerata*), and Meadow Fescue (*F. pratensis*) appeared for the first time (McDonald 1992). These few species filled the niche of primary succession and duplicated the earlier glasshouse experiment in which only 12, of a possible 57 species from the Oxey Mead seed-mix, germinated during the four-month study (McDonald 1993).

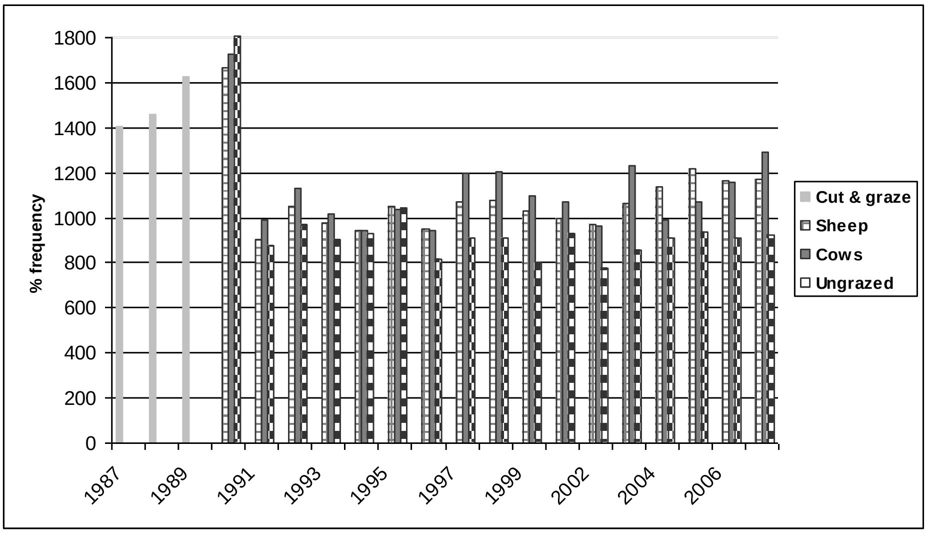

Figure 6: Total percentage frequency scores for each treatment for each year 1987 – 2007.

Early effects of the grazing experiment

After the implementation of the aftermath grazing experiment in autumn 1989, differences in the heterogeneity of the sward due to the different grazing and dunging behaviour of the animals were expected. These were first observed in spring 1990 when there was a mosaic of short and tall vegetation in the cow-grazed plots but not in the other two treatments (unpublished data). However, this was masked as sward height increased during the season. A second four-week grazing episode later, soil-biota analysis clearly showed that the soil in the ungrazed plots had become the most fertile and that in the cow-grazed plots the least (Tom Hill pers comm.). This result was, to some extent, due to the effect of cow-hooves pressing into the soil and cutting up soil-fungal hyphae. In 1990, there was also a significant difference between grazed and ungrazed plots which had the greatest species frequency (Figure 6). By the summer of 1991 the lack of fertility in the cow-grazed soil was reflected in the above-ground vegetation which then had the greatest species frequency, whilst the ungrazed plots were dominated by grass species. Figure 6 also shows that the greatest frequency was in the cow-grazed plots in nine of the following 16 years.

Effects of the weather

The distribution of some, perhaps all, species is also affected by the weather. In 1991, the frequency of most species fell by at least 50%, including Great Burnet, (*Sanguisorba officinalis*), Common Sorrel (*Rumex acetosa*), Crested Dog's-tail (*Cynosurus cristatus*), Dandelion (*Taraxacum officinale* agg.), Red Clover (*Trifolium pratense*), Tall Oat-grass (*Arrhenatherum elatius*), Creeping Buttercup (*Ranunculus repens*), Golden Oat-grass (*Trisetum flavescens*), Rough-stalked Meadow-grass (*Poa trivialis*), Meadow Brome (*Bromus commutatus*) and Greater Plantain (*Plantago major*) (Figure 7). Only Perennial Rye-grass (*Lolium perenne*) and Yorkshire Fog (*Holcus lanatus*) seemed to be unaffected by the dry conditions. This distribution of species could have been the result of the dry conditions in the winters of 1987 and 1989 which, together with the hot summers and low rainfall in 1989 and 1990, were not sufficiently offset by the floods in the winter of 1989-90 (Figures 2 and 3). The frequency of each species both within and between treatments fluctuated during the following years. Taking Soft Brome (*Bromus hordeaceus hordeaceus*) as an example of an annual species which prefers relatively dry soils, it is clear that it thrived in the year following the particularly hot temperatures in the spring and summer of 1989 and 1990, and 1996 and1997 (Figure 7). Thereafter, the weather became wetter and the population of soft brome was reduced overall.

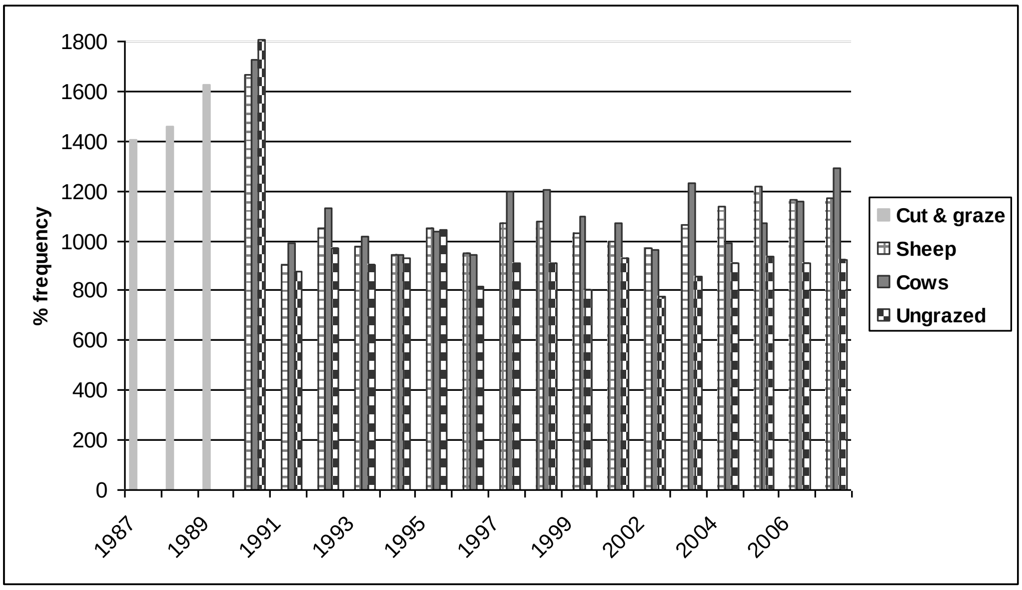

Figure 7: Distribution of *Bromus hordeaceus hordeaceus*/treatment/year. Low frequencies of this species correspond to wet springs and summers and high frequencies to years of low rainfall and high temperatures.

Another way of looking at the affect of rainfall on species-composition in Somerford Mead is to compare Ellenberg's environmental indicator values for moisture for each species (Hill et al. 2004). During the first 13 years of this experiment there was a scarcity of (Ellenberg's moisture values in brackets) MG4 species, such as Meadow Foxtail (*Alopecurus pratensis*) (5), Great Burnet (*Sanguisorba officinalis*) (7), Glaucous Sedge (*Carex flacca*) (5), Black Sedge (*C. nigra*) (8), Carnation Sedge (*C. panicea*) (8), Meadow Horsetail (*Equisetum palustre*) (8) and Meadow Barley (*Hordeum secalinum*) (6) due to the hot dry summers in the early years of the 1990's

(McDonald 2001). The relatively dry conditions may also have accounted for the absence of other species of damp places such as Bugle (*Ajuga reptans*) (6), Cuckooflower (*Cardamine pratensis*) (7), Creeping Jenny (*Lysimachia nummularia*) (6), Pepper Saxifrage (*Silaum silaus*) (7), and Meadow Rue (*Thalictrum flavum*) (8). The weather changed after 1997 and by 2007 the wetter conditions had allowed all these species to become established in the recording plots or elsewhere in Somerford Mead. Of the MG4 species noted by Rodwell (1992) only Devil's-bit Scabious (*Succisa pratensis*) (7), Fritillary (*Fritillaria meleagris*) (8) and Common Marsh Bedstraw (*Galium palustre*) (9) are still absent from the Mead despite the improved soil moisture. However, Devil's-bit Scabious (*S. pratensis*) may also be limited by insufficiently low soil-fertility as was found in a >10-year experiment at Ingleborough NNR (Smith et al. 2003).

The most prominent and characteristic species of MG4 flood meadows is Great Burnet (*Sanguisorba officinalis*) (Rodwell 1992). It germinated well in the first year after sowing (1987) but many of these seedlings died and the plants that became established were at considerable distances from each other. This plant takes many years to spread vegetatively and now covers large areas of the ancient flood meadows, Picksey, Oxey and West Meads Yarnton, but not Somerford Mead. Great burnet is known to prefer moist (F7) and relatively nutrient-poor conditions. It may not have thrived in the early years of this experiment because the soil was too dry and warm for it. It began to increase in numbers in the recording plots in 2001. By the summer of 2007 a few seedlings and small plants were seen in and out of the recording plots but the plant is still a long way from being as widespread as it is in Oxey Mead, the seed-source site, and other MG4 grasslands. Similarly, the second major MG4 species, Meadow Foxtail (*Alopecurus pratensis*), was first recorded in 1997. By 2007, when there was more rainfall, its population had increased overall but plants are still scarce in the recording plots. The vegetation in Somerford Mead is, therefore, still a long way from meeting Rodwell's criteria for MG4 grassland.

Figure 8: Somerford Mead in 1987 showing dominant annual grasses and Yellow-rattle.

Species possibly influencing succession

One species that current advisors suggest should be sown to increase biodiversity is the hemiparasite, Yellow-rattle (*Rhinanthus minor*) (Figure 8). Its large seeds enable it to germinate on its own and to produce roots which penetrate the roots of one of several grass species to obtain nutrients. This can reduce grass growth. The success of its germination depends upon sites in the sward being c.30 cm in diameter. These gaps in the sward are also expected to provide suitable micro-sites for the establishment of other grassland herbs to increase the diversity of the plant community (Westbury et al. 2006; Davies *et* al.1997). However, success for Yellow-rattle itself can depend upon grassland type e.g. traditional Yellow-rattle sites are on calcareous or neutral soils, and upon grass species not being susceptible to this semi-parasitic plant (Westbury and Dunnett 2007). Although the soil pH was not a problem, Yellow-rattle was only sparsely established in Somerford Mead in1987 and now is seen occasionally only on the boundary of grazing plots where the trampling of animals provides bare soil**.** It was not a major influence on the success of this experimental establishment of MG4 grassland.

Two species which did affect species-composition were Red Clover (*Trifolium pratense*) and White Clover (*T. repens*) which had formed large patches by 1990 thus excluding other species. Each patch was ca. 1.5 m wide and both species were recorded in between 80% and 100% of the quadrats (McDonald 2001). Subsequently their populations fluctuated, as other species spread into and broke up the patches, notably at lower levels in the un-grazed treatment. Not only can these legumes assist soil nitrogen but their association with soil fungi can also be beneficial to higher plants.

Species affected by light.

As the hay-crop grows between April and late June, light becomes the primary competitive factor for plants and rosette species may become dominant in a short spring MG4 sward (Rodwell 1992). This is not true on Somerford Mead where, for example, in spring and early summer light-demanding rosette species such as Dandelions (*Taraxacum* spp.), Hawkbits (*Leontodon* spp.), Ox-eye Daisy (*Leucanthemum vulgare*) and Cowslip (*Primula veris*) are sparsely distributed throughout the mead. It is as if their location is still dictated by the chance of their sown-seed falling into their current position and their distribution is unaffected by the aftermath management. Rosette species give way to taller species such as grasses, Great Burnet (*Sanguisorba officinalis*) and Meadowsweet (*Filipendula ulmaria*) which can grow above the main canopy to receive the most light and where there is a greater possibility of pollination by wind or passing insects.

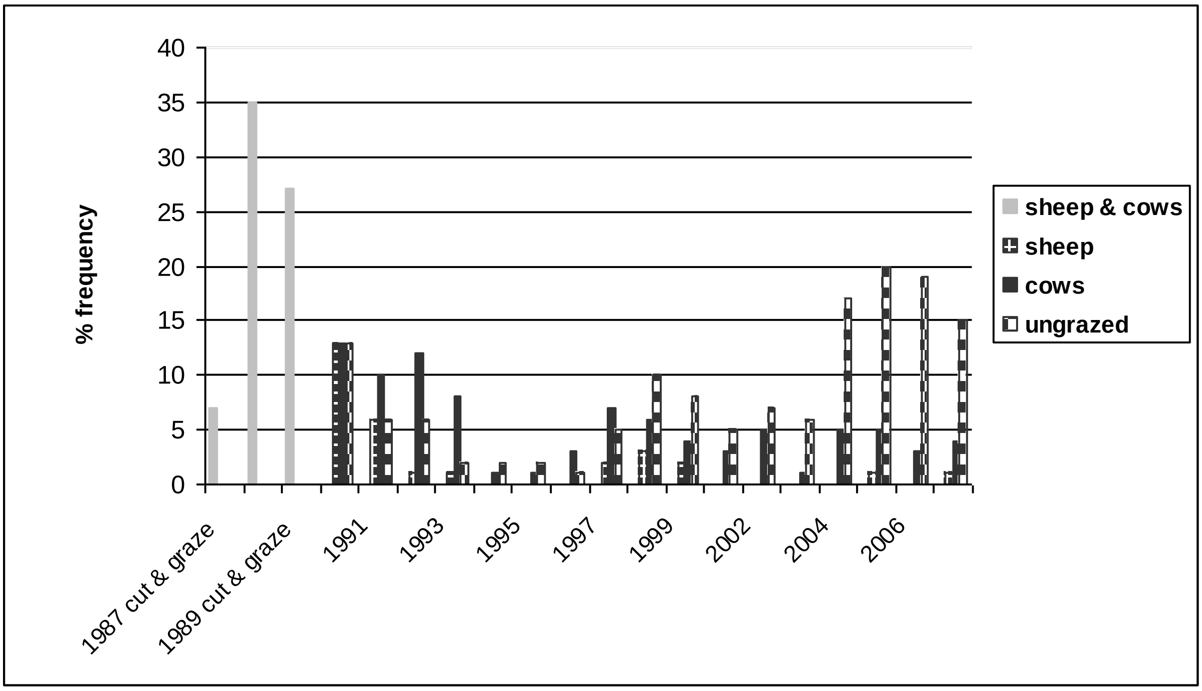

Figure 9: Distribution of *Leucanthemum vulgare*/treatment/annum. This species seems to be favoured by sheep and soon died out in those plots, doing best when left ungrazed.

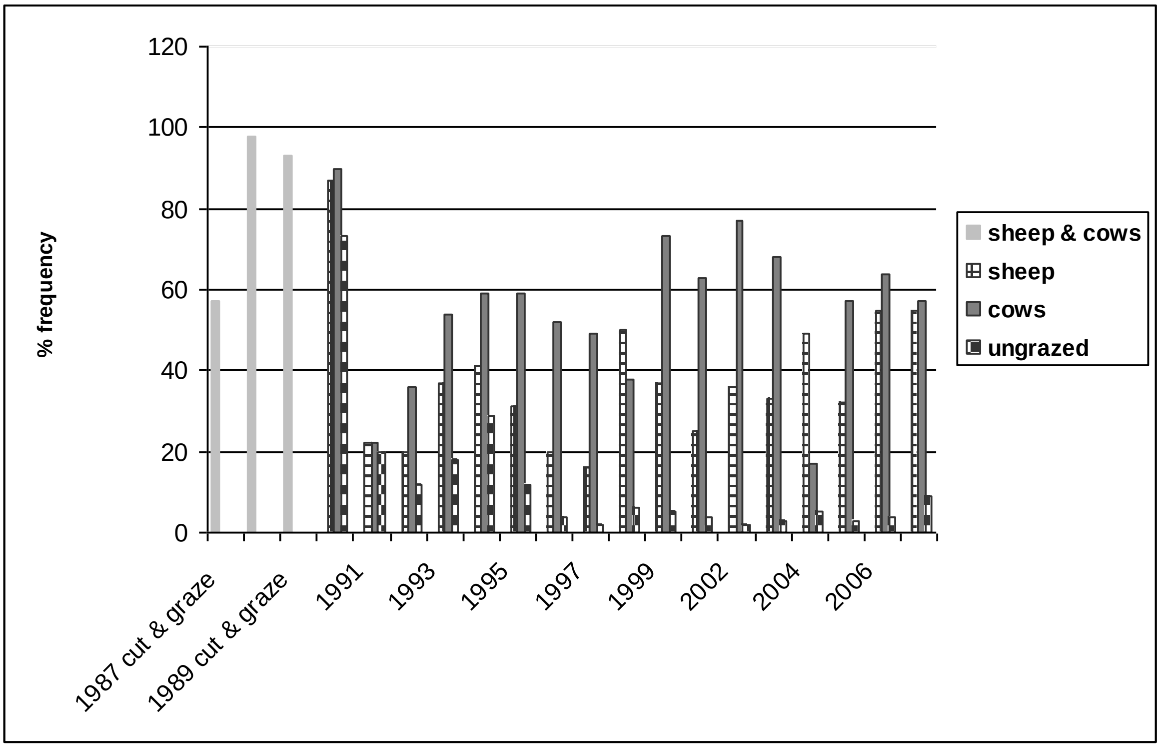

Figure 10: The distribution of *Cynosurus cristatus* per treatment per year 1987-2007. This species seems to be avoided by cows and so does best in the cow-grazed plots. It does least well where there is no grazing.

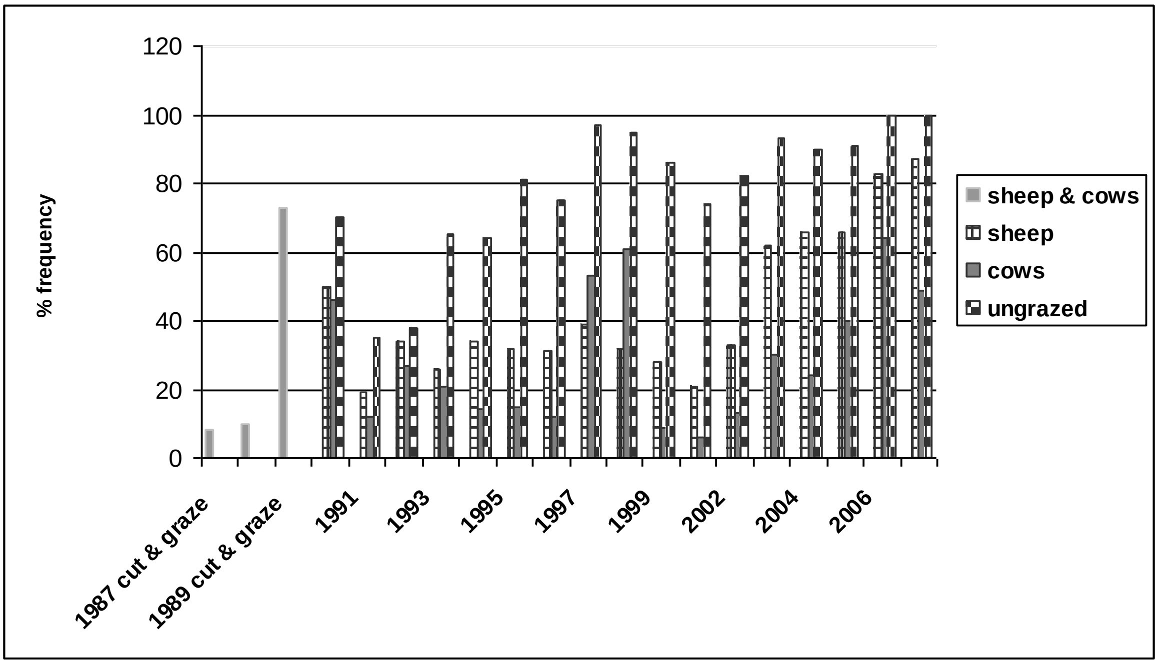

Figure 11: The distribution of *Arrhenatherum elatius*/treatment/year shows that this species thrives where there is no grazing in autumn.

Species affected by management

It was expected that the frequency of some of the species in Somerford Mead would, to a greater or lesser extent, either be enhanced by the grazing treatments or do best in the ungrazed plots (control). In 1990, for example, Ox-eye Daisy (*Leucanthemum vulgare*) (Figure 9) were equally distributed between the treatments. From 1991 this species appears to be favoured by sheep to the extent that its frequency was reduced in 1992 and 1993, and, it was not recorded in the sheep-grazed plots in 1994-6, 2001-4 and 2006. From 1992 it did better under cattle grazing. This species did not flourish in the drought years (1994-6) but from 1997 it thrived when left ungrazed. Crested Dog's-tail (*Cynosurus cristatus*) (Figure 10), is avoided to some extent by cows, whilst, as one would expect after observing road-side verges (Rodwell 1992) the distribution of Tall Oat-grass (*Arrhenatherum elatius*) suggests that these plants are favoured by being left ungrazed (Figure 11).

Biodiverse communities in the future

Somerford Mead remains an island within a sea of farmland. For the first fifteen experimental years the surrounding farmland was managed intensively with all the agrochemicals that that implies. Seven years ago the management of the farm changed hands and it has been farmed organically since then. It is now possible that seed and invertebrates from Somerford Mead could invade the surrounding land when suitable conditions arise. It is therefore timely to assess the possible research directions for Somerford Mead.

As the sward architecture in Somerford Mead became more complex over time it was of increased importance to both the diversity and abundance of invertebrates which need structures such as stems, leaves, flowers and seed-heads for various periods in their life-cycle (Gibson, Hambler and Brown 1992; Dennis, Young and Gordon 1998;

Morris 2000; Finke and Denno 2002). More particularly, since 1993 the cow-grazed plots have become the most suitable for invertebrates including plant-eating beetles (McDonald unpublished data; Woodcock 2005). Individual plant species are important from this point of view. Great Burnet (*Sanguisorba officinalis*), for example, has good genetic variation within rather than between populations (Musche, Settele and Durka 2008). Not only does it provide architectural structures for invertebrates, it also gives nectar and/or pollen to many insect pollinators including syrphid flies, muscid flies, bees, and butterflies. More information on plant/invertebrate relationships is needed.

Conclusion

An analysis of the species' frequencies in each treatment in Somerford Mead over the last twenty-three years suggests that the succession towards MG4 flood meadow is not yet complete. Annual arable species which were common in the early years have been replaced by MG4 species. As the relatively dry conditions between 1986 and 1996 changed, species of wet conditions increased their frequency or became established. Although most MG4 species in Classes V – II are present in Somerford Mead, their frequency, especially that of Meadow Foxtail (*Alopecurus pratensis*) and Great Burnet (*Sanguisorba officinalis*) is lower than expected from Rodwell's (1992) description. In terms of biodiversity the cow-grazed plots are the most diverse and currently are the best habitat for phytophagous beetles and other invertebrates. Somerford Mead is now in a position in which natural forces can 'export' flood-meadow species as soon as neighbouring fields meet the conditions required for them. It was not in their interests to apply dung to land which might not be theirs the following year. MG4 grassland is, therefore, dependent upon this management: i.e. cutting for hay in late June/early July and aftermath grazing by cattle, and on additional nutrients which arrive in the occasional floods. Farmer and land-managers should take this into account when planning the management of their own floodplain grasslands.

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