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Contrasting response to mowing in two abandoned rich fen plant communities

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ABSTRACT

Globally important U.K. fens are in poor condition, principally due to abandonment, following cessation of traditional mowing and grazing in recent decades. In the absence of management, rich fen flora are displaced as a result of succession. This leads to an increase in competitive species and subsequent biomass accumulation. In order to reverse this trajectory and increase species richness, management consisting of a single mowing event was employed. Mowing was conducted in two degraded fen communities in north-west Wales (U.K.) across three sites: (i) a species rich, tussock alkaline mire, dominated by *Schoenus nigricans* and *Juncus subnodulosus* (SN community) and (ii) a species poor basin mire *Cladio-Molinietum* dominated by *Cladium mariscus* (CM community). The early vegetation responses were monitored over two years. Results show a large treatment effect on species richness in the CM community, where mean species richness increased by 51% in the second year following mowing. Consequently, total species number across all sites increased to 74 in the treatment compared to 44 in the control. Mowing reduced vegetation height and litter cover and increased bare ground. These treatment effects combined with a reduction in graminoid and shrub cover collectively contributed to the initial stages of rehabilitation. Conversely, the SN community showed no increase in species richness, in spite of a reduction in litter cover and increased bare ground. Strong site heterogeneity and a sustained canopy height caused by rapid re-growth of the dominant graminoid *S. nigricans* may have impeded treatment effects. Therefore, increased mowing frequency in alternate years, switching between autumn and summer would be necessary to develop species richness in the SN community. Ongoing intervention in each fen community is needed to achieve an optimal trajectory of increased rich fen and reduction of secondary succession species.

1. Introduction

Globally, it is estimated that fens comprise 26% of all wetlands and 42% of all peatlands, which equates to an area of 1.5 million km^2 (Joosten, 2002; Ramsar Convention and Secretariat, 2013). Fens are distributed throughout the northern hemisphere and are well represented in North America, Russia, Scandinavia and Central Europe (Lamers et al., 2014). The term 'rich' fen refers to minerotrophic peatlands which are base 'rich', due to a high concentration of base cations (calcium and magnesium) and are nutrient poor (oligo-mesotrophic) with pH values between 6.0 and 8.0, which subsequently leads to botanically diverse stress tolerant communities (Sjörs, 1950; Wheeler, 1980a; Wheeler and Proctor, 2000). Furthermore, U.K. fens are quite rare and make up just 10% of all British peatlands (JNCC, 2011b). The fens which are the focus for this study, are situated off the north-west coast of Wales (U.K.) on the island of Anglesey, are internationally significant and are designated as Ramsar sites (Jones et al., 2013). In the case of rich fens, their disjunct distribution supports their rarity, as these ground water dependent (GWD) wetlands have strict hydro-geological requirements (Joosten, 2002; Bedford and Godwin, 2003; JNCC, 2011b). It is these unique requirements which characterise the vegetation (Wheeler and Proctor, 2000) and render rich fens to be amongst the most species rich, low production wetlands in the world (Ilomets et al., 2010). Fens also support essential ecosystem services such as water purification, flood protection and climate regulation (Gorham, 1991; Zedler and Kercher, 2005; Lamers et al., 2014) in which their contribution is disproportionate to their size (Bedford and Godwin, 2003).

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Historically, U.K. fens were economically important areas in the landscape, where agriculture, peat harvesting and biomass production for thatching ensured these systems experienced regular disturbance regimes. However, in the absence of management, rich fen plant communities have shifted from low competition/stress tolerant plant communities, with a complex assemblage of herbs, low stature sedges and bryophytes, to degraded plant communities which are dominated by graminoids and shrubs (Rodwell, 1992; Billeter et al., 2007; JNCC, 2011b). This change in trajectory from a low to high production community has also led to biomass accumulation from fast growing species, which is deleterious to maintaining fen species richness (Bergamini et al., 2001; White and Jentsch, 2001; Hajkova, 2003; Middleton et al., 2006b). Abandonment also leads to litter accumulation, which covers the peat surface and impedes seedling establishment (Ruprecht et al., 2010). To reverse succession to an earlier sere and increase biodiversity, partial or total removal of biomass is required, which addresses the physical barrier to restoration (Brewer et al., 1997). Mowing increases the space available for species to establish and increases light penetration to the peat surface (Schaffers, 2002; Billeter et al., 2007). Successful re-colonisation by small stature fen plant species is also dependent on the proximity of the restored plant community to a seed source, seed dispersal capability of favoured species and presence of a viable seed bank (Wheeler and Shaw, 1991; Billeter et al., 2003; Levine and Murrell, 2003; Kolos and Banaszuk, 2013). Therefore, rich fen species can only persist where traditional management has been maintained or is reinstated (Westhoff, 1971; Tilman, 1996; Middleton et al., 2006a; Šefferová et al., 2008).

This research was conducted in collaboration with the Anglesey and Llŷn fens EU LIFE project, whose main aim was to rehabilitate 751 ha of degraded fens, in support of improving habitat quality for plants and animals, as well as enhancing recreation value to the local community. The intention for this research was to examine the botanical response to mowing in these previously abandoned fens. The focus was on two European Annexe 1 plant communities, designated for their ecological importance and rarity (Saltmarsh et al., 2006). The first is *Cladio-Molinietum* (CM plant community), which is a species poor swamp community, situated within topographic depressions within valley floors and is dominated by tall sedge, *Cladium mariscus* (CM community). The second plant community is located around the fen margin, dominated by *Schoenus nigricans* and *Juncus subnodulosus* (SN plant community). *S. nigricans* is an ecologically important component as it produces elevated tussocks and consequential runnels (shaded channels around the tussock stools) that support a complex suite of fen species that include sedges, distinctive dicotyledonous herbs and an ecological group of "brown mosses" in the families of Amblystegiaceae and Calliergonaceae (Rodwell, 1992; Bedford and Godwin, 2003; Hedenas, 2003).

However due to abandonment, the CM and SN plant communities have reduced in species richness due to an increase in cover from each of the dominant graminoid species *C. mariscus* and *S. nigricans* and so machine mowing and hand cutting was selected for each plant community respectively. These methods of management were chosen due to the sensitive nature of fen habitat (Middleton et al., 2006b; Van Andel and Grootjans, 2006; Šefferová et al., 2008). In contrast to North America, burning is not common practice in U.K. fens. It is only undertaken with caution, where fire management has been used historically. This is probably due to their small areal size, which is disproportionate to high conservation value and as many species are associated with the plant litter which is being burnt (e.g. invertebrates, small mammals and amphibians) the risk to biodiversity is high (Middleton, 2002; SNH, 2011).

The aim of this study was to examine the response to mowing in two derelict rich fen communities employing a single mowing application. It was proposed that mowing would encourage colonisation by calcicole (calcium-loving) rich fen plant species, which are tolerant of a low phosphate concentration, associated with the presence of calcium carbonate found in the mineral rich groundwater (Clymo, 1962; Boyer and Wheeler, 1989; Wassen et al., 2005). It was expected that following mowing, species richness would increase due to a reduction in canopy height, standing biomass and litter cover which consequently will increase exposed peat. It was also proposed that mowing would reduce dominant vegetation components, as a reduction in graminoid and shrub cover is expected to be associated with increased herb and bryophyte cover. Therefore, it is hypothesised that due to the mechanisms described above, treatment effects would produce optimum conditions to meet the conservation aim to reduce robust late succession species and increase overall species richness in each plant community.

2. Materials and methods

2.1. Site descriptions

The study was conducted within the Anglesey fens Special Area of Conservation (SAC) which comprises 7 Sites of Special Scientific Interest (SSSI) covering 467 ha and which form part of the Anglesey and Llŷn fens Ramsar site (Jones et al., 2013). All experimental sites were situated on the island of Anglesey, which is located off the coast of mainland north-west Wales, United Kingdom. The three study sites comprise: (i) Cors Erddreiniog (53.3125 N, −4.29670 E), a valley head fen system, comprising three peat basins, and which is the largest of the three sites at 200 ha (Prosser and Wallace, 1995; Jones et al., 2013), (ii) Cors Goch (53.3075 N, −4.2575 E), a basin fen comprising 67 ha of which 25 ha are wetland and (iii) Cors Bodeilio (53.2726 N, −4.2507 E), which is the smallest site, at 39.28 ha, situated on shallow peat within a limestone valley (Jones et al., 2013). These sites are influenced by an oceanic climate with a mean annual temperature of 9.4 °C and total mean annual rainfall of 625 mm (calculated from the Cors Erddreiniog automated weather station (http://environmental-change.ccw.gov.uk/) from data collected between 2007 and 2013).

Paired plots were used to ensure that hydrological and topographical conditions were as comparable as possible. One half of each paired plot (10 m^2) was randomly assigned as treatment, the other as control. Within each control and treatment plot, a set of 5 quadrats (2 m by 2 m) were established. Co-ordinates for each randomly assigned quadrat were generated, utilising an online random number generator (Random.org) and quadrats were positioned within each 10 m^2 plot. The locations of the paired 10 m^2 plots were permanently marked by placing steel marker pegs in the peat at each corner of the plot, to allow for re-location with a metal detector after cutting. A Leica 1200 RTK digital global positioning system (dGPS) was employed to permanently locate plots and quadrat centroids and post processing was undertaken using Leica Geo Office together with RINEX data and Holyhead reference station, downloaded from the Ordinance survey GPS website (http://www.ordnancesurvey.co.uk/gps/os-net-rinex-data/). Bamboo canes were also used for ease of re-location of quadrats and plots, but were temporarily removed or pushed into the peat during mowing. Treatment and control conditions included a 5 m buffer zone beyond the perimeter of each paired plot to allow for edge effects.

2.2. Plant communities

The *Cladio-Molinietum* (CM community) is a tall herb community found in base-rich (pH 6.0–7.5) peatlands, and characterised as topogenous due to its location on valley floors, where water