



Conservation management in fens: Do large tracked mowers impact functional plant diversity?



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ABSTRACT

Cessation of traditional mowing management has been the main threat to fen biodiversity for many decades; shrubs and trees expand and target plant and animal species decline. In Biebrza National Park (BNP), the EU's largest conservation area of alkaline fens, abandonment has affected more than 300 km². To combat unwanted succession, tracked mowers were developed based on snow grooming vehicles and are increasingly used in BNP and some other European fens. While effects on bird populations seemed promising, the impact on botanical diversity remained yet unknown. We assessed the effects of this management on vegetation by comparing 12 pairs of mown and unmown plots (percentage cover recorded from 4 m² for all species and 25 m² for rare species) spread over several km². We found that tracked vehicles suppressed some species, which are likely to facilitate others by providing shelters above groundwater level (hummock mosses, tussock sedges and shrubs) and enhanced species with effective clonal spread and high specific leaf area. An even stronger increase was observed in forbs, which share effective clonal spread and flood tolerance (high Ellenberg F value). Analysis of functional diversity indices based on all measured traits showed a decrease of functional divergence due to mowing (indicating convergence of traits) and no response of functional richness, evenness and functional dispersion. Mowing has also decreased the number of rare species. We associate these changes with the reduction of micro-topography by caterpillar tracks. Tracked mowers should therefore be avoided in those fens, in which microtopography contributes to unique botanical diversity.

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1. Introduction

The conservation of fens (minerotrophic peatlands) for biodiversity is to a large extent related to maintaining their open (treeless) character and undisturbed hydrological regimes (Moen, 1995; Middleton et al., 2006; Van Diggelen et al., 2006; ŠeffEROVÁ-StanOVÁ et al., 2008). Although natural fen systems can incorporate both herbaceous plant communities and woodlands (e.g. Jabłońska et al., 2011), particularly the former ones are inhabited by many endangered species, especially low-competitive herbaceous plants and mosses (Wheeler and Shaw, 1991; Moen, 1995), and wetland birds (Dyrcz et al., 1985; Tanneberger et al., 2010). Expansion of trees and shrubs on open fens follows cessation of mowing practices, that were common in fens (especially in Europe) until the second half of the 20th century. Those successional processes can partly be explained by the natural return of woodlands to places where they have been removed by man, but it also commonly

occurs in originally treeless systems, which lost resilience in effects of drainage and eutrophication (Van Diggelen et al., 2006).

Because successional changes in fens have caused dramatic losses in biodiversity during the last few decades (Dyrcz et al., 1985; PaCzyński, 1985; Moen, 1995; Jensen and Schrautzer, 1999), counteracting succession has become a widely accepted aim in fen conservation (Middleton et al., 2006; ŠeffEROVÁ-StanOVÁ et al., 2008). However, as management of large fen areas is problematic, due to high costs of hand mowing and the inaccessibility of wet peatlands for conventional agricultural machines, alternative solutions are being explored, such as the use of specialised mowing machinery that exert low ground pressure, grazing, cutting woody species or burning. The effects of these conservation measures are still little-studied in fens, especially with regard to the fine-scale impact on plant communities and fen ecosystem functioning. In this study we focus on the use of tracked mowing vehicles, which are among the most commonly applied tools in fen conservation (Diack et al., 2011). Recently, tracked mowers, developed from alpine snow groomers, were introduced in the largest conservation area of alkaline fens in the European Union, the Biebrza National Park (also protected as a Natura 2000 site,

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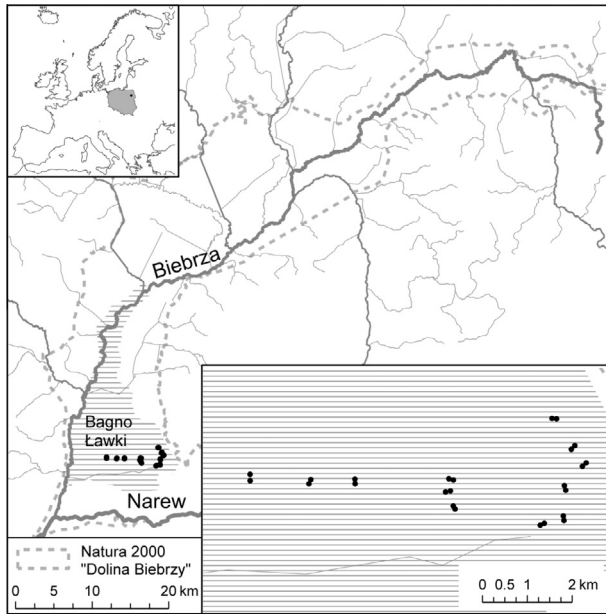


Fig. 1. Biebrza valley – location in Europe, location of the study site “Bagno Ławki” within the Natura 2000 area and distribution of study plots in the investigated fen.

Fig. 1) in NE Poland and, because of economic and logistic advantages, lately applied also in other European fens, e.g. in Germany (Tanneberger et al., 2012), Wales (Hanson, 2011), and Belarus (Malashevich, 2012).

The only published study about the impact of tracked mowers on a fen ecosystem was carried out by Güsewell and Le Nédic (2004) in a *Cladium mariscus*-dominated fen and indicated a shift to semi-aquatic communities, due to compaction of the sward and the upper peat layer. No similar research have been conducted in sedge-moss fens (*Scheuchzeria-Caricetea nigrae*). Our initial observations in such communities in the Biebrza National Park indicated that caterpillar tracks may reduce micro-topography by pressing sedge tussocks and moss hummocks into the peat. Such structures are important microhabitats in fens (Peach and Zedler, 2006), allowing many species to escape from a waterlogged environment or intensive shade by plant litter between the tussocks (Crain and Bertness, 2005; Smith et al., 2012). Therefore, it is likely that reduction of the hummock-forming plant species reduces species richness and plant functional diversity, especially suppressing species that are sensitive to flooding or soil anoxia.

Our aim in this study was to check how adapted snow groomers affect vegetation of an alkaline fen. To assess the impact on fen microtopography, we analyse the response of the structurally most important functional groups of plants. Further, we examine the response of individual plant traits, which may respond to changes in fen structure (architectural traits, growth form, clonal spread ability and an indication of flooding tolerance) and indices of functional diversity (Villéger et al., 2008) derived from those traits, in order to inform about functional shifts of plant communities. Finally, we test whether the investigated management technique affects species richness and the number of rare plant species in the community.

2. Methods

2.1. Study area

The Biebrza National Park is located in NE Poland (centroid of the Biebrza NP area: N 53°30'13, 50", E 22°45'27.04"), in the region

of temperate continental climate, with a mean annual temperature of 6.8 °C, a mean annual rainfall of 583 mm, a growing period of c. 200 days and severe snowy winters (Górniak, 2000). Biebrza NP, with a total area of c. 600 km², contains over 10 % of the EU's protected alkaline fens (i.e. covered by Natura 2000 network, Šefferová-Stanová et al., 2008) and hosts 75% of EU population (20% of the global population) of aquatic warbler (*Acrocephalus paludicola*), Europe's rarest migratory bird (Lachman et al., 2010). Large areas of Biebrza fens have been used for haymaking since the mid-16th century; sedges were mown by scythe, stacked and removed during winter (Bartoszuk and Kotowski, 2009). Abandonment started in the Biebrza Valley in the 1970s, leading to the encroachment of downy birch (*Betula pubescens*), willows (*Salix spp.*) and common reed (*Phragmites australis*) onto previously open fens dominated by small sedges and brown mosses (Oświt, 1973).

Our investigations were carried out in the southern part of the Biebrza Valley, within the Ławki Mire (Polish: Bagno Ławki), extending between the village of Szorce and the Biebrza River (Fig. 1). This is a soligenous fen, with a total surface of c. 46 km². Peat deposits are up to 4 m, but on average c. 1.5 m deep (Oświt, 1973) and, within the area of our research, mainly of sedge-moss origin in the upper horizon, underlain by alder peat. Peatland developed directly on moraine sands, only locally small deposits of gyttja occur. Vegetation is structured in a zonation pattern consisting of a narrow zone of birch and alder woodlands at the valley edge, followed by a c. 12 km-broad zone of sedge-moss alkaline fens and a c. 2 km-wide zone of tall sedge marshes and reedbeds near the river. Our investigations were carried out in the middle zone of open or semi-open alkaline fens dominated by sedges (mainly *Carex elata*, *C. appropinquata*, *C. chordorrhizza*, *C. lasiocarpa*, *C. diandra*), brown mosses (mostly *Calliergonella cuspidata*, *Hamatocaulis vernicosus*, *Climacium dendroides*, *Helodium blandowii*, *Calliergon cordifolium*) and forbs (e.g. *Menyanthes trifoliata*, *Potentilla palustris*). Groundwater feeding the fen is moderately calcareous (Wassen et al., 1990), with a pH of 6.4–6.8, not varying much over the study area (Piórkowski, 2003). This area retained relatively good hydrological conditions, mean annual groundwater levels measured in two piezometers in 2007–2010 were 1 cm to 15 cm above the mire surface and yearly fluctuations did not exceed 30 cm (unpublished data of the Biebrza NP). These high water levels are due to recent overgrowing of old drainage ditches, which were dug here during the 19th century to facilitate haying, which was practiced in this part of the Biebrza valley until 1970–1980s. After abandonment, *B. pubescens* and *P. australis* expanded in parts of the area. However, it is important to recognise that successional processes were not very advanced here and have not caused displacement of characteristic mire species. Scattered trees and patches of reed were however considered the major threat to the local population of aquatic warbler, which at the end of the 1990s was the main stimulus to remove trees and reintroduce mowing management. Due to lack of financing and suitable technology, conservational management was applied on a very small scale until mid-2000s, when accession of Poland to the EU enabled financial support of fen management from agri-environmental subsidies, which stimulated development of new mowing technology.

2.2. Mowing machinery and management

In 2006, new mowing machines were developed based on alpine snow groomers, originally used for the preparation of ski runs (Fig. 2). The ground pressure of their caterpillar tracks is below 30 g cm⁻² (Lachman et al., 2010). Between 2006 and 2011 mowing by these vehicles was gradually applied on the area under study, partly preceded by hand removal of trees and larger shrubs, which were cut by chainsaws at the base; smaller shrubs and trees were

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