Extended abstract No. 359

PLANT COVER AND STATE OF TREELESS FEN COMMUNITIES IN ESTONIA

Laimdota Truus[1], Mati Ilomets, Raimo Pajula, Kairi Sepp

Institute of Ecology at Tallinn University
Uus-Sadama 5, 10120 Tallinn, Estonia
[1] Corresponding author, +372 5054457, laimdota.truus@tlu.ee

SUMMARY

In Estonia, agricultural management and afforestation lead to disappearance of extensive areas of fen ecosystems. Some 10 – 20% of fens area remained, either too small or too far for be profitable to drain. Great part of them are subject to weak but long-lasting influence of drainage that lead to vegetation change, especially through afforestation.
We studied plant cover and mire water and upper peat properties on some 60 open fen sites still possessing the near-natural state over Estonia. In the five main plant assamblages distiguished the peat water pH was about 6 – 7, electrical conductivity varied between 80 to 700 µS cm^{-1}, and Ca content from 10 to 260 mg l^{-1}. We concluded that (1) fens that have been remained open are quite similar in their plant cover and water conditions; (2) because of fragmentation and undirect drainage impact many sites are impoverished in their species composition and are increasingly afforesting.

KEY WORDS: afforestation, fragmentation, low-intensity drainage, mire water, vegetation change

INTRODUCTION

Historically some 30% of Estonian mires have been covered with different minerotrophic open fen vegetation, of which about 75 000 ha belonged to Ca-rich fen, 150 000 ha to Ca-poor fen and ca 83 000 ha to floodplain fen type, respectively (Laasimer, 1965). During the 20th century some 80-90% of open fens have been drained for agricultural purposes. Thus, large fen areas have disappeared. Drained mire forests separate still existing open fens and dense tree cover occurs on the fen margins. Both, drainage of forest margins and rised evapotranspiration on treed fen margins give rise the increased drainage and constriction of open fen areas. Nowadays, fens are highly valued so that over 5% of the Estonia’s territory is designated as alkaline fen site type (7230) of Natura 2000 (Management of Natura 2000 habitats, 2008).

A drop of water level and an increase in its seasonal fluctuation result in complete desiccation of the topsoil. This influences the redox status – the nitrogen availability increases, but phosphorus availability does not increase because of limited decomposition (Boomer and Bedford, 2008).

Electrical conductivity decreases as recharged groundwater dilutes with precipitation but pH remains stable until the bicarbonate buffer system functions (Lamers et al., 1989). The water level drawdown is responsible for the decrease in plant species diversity as many specialist species are outcompeted by a few generalists like *Molinia caerulea* (Trass, 1957, 1986; Villems, 1996; Mälson et al., 2008) and for the encroachment of woody species (Middleton, 2002; Bootsma and Wassen, 1996; Mälson et al., 2008).

We studied some 60 open fen sites that are still preserved in near-natural state. Plant cover, depth to water level, mire water pH, electrical conductivity and Ca, Mg, Fe, K, Na content, also bulk density, N, P content of the surface peat (uppermost 20 cm) were found. In the five main vegetation clusters distiguished the mire water pH was about 6–7, electrical conductivity varied between 80 to 700 $\mu S\ cm^{-1}$, and Ca content from 10 to 260 $mg\ l^{-1}$.

Our objective was to characterise the present status of open-fen vegetation and its relation with hydrological conditions and peat properties. We selected the best preserved extensive open-fen sites over Estonia. We made plant cover analyses, sampled fen surface water and uppermost peat properties to characterise fen site conditions. The analyses of collected data permits us to understand more deeply about present status of fen vegetation.

MATERIALS AND METHODS

Vegetation sampling

During three vegetation periods (2009 – 2011) we investigated 64 still remaining open-fen sites with the size about 1 – 2 ha (poor fens) to over 10 ha (rich fens) over Estonia. In homogenuous vegetation with size of at least ca 10 m (radius) we analysed a 2 x 2 m plot divided into 4 subplots by 1 x 1 m. Plant species list was completed and species coverage estimated. Mean height of hummocks and percentage cover of hummocks were found.

Pore water sampling

Depth to water level (DWL) from the ground surface between tussocks was measured and the pore water samples were taken from piezometers close to each relevé and pH (Handylab pH11/SET, SCOTT Instruments GmbH) and electrical conductivity (EC) (Conductivity meter Micrometer 900) were measured. Ca, Mg, Fe, K, Na content, also bulk density, N, P content of the surface peat was analysed.

Peat sampling

Peat samples for bulk density and N and P content were taken close to every relevé from the depth 2 – 7 cm (living moss layer previously removed, if this existed) and 12 – 17 cm. Bulk density, N and P content of the surface peat were analysed.

Data analyses

The classification and ordination of field layer plant cover data were performed by PC-ORD software (McCune and Grace, 2002). Based on two-way cluster analysis of species cover data for all plots, five plant assemblages were identified. Cover data of relevés were clustered using Ward's method. Species that were found per one plot were excluded from the analyses.

RESULTS

Vascular plant species assamblages

First group of analyses distinguished on the 7% level of information remaining (*Cluster 5*) and the rest four clusters on the 5% to 3% level of information remaining.

Cluster 1 (17% of sites) was an assamblage of *Carex lasiocarpa* with some *Carex davalliana, C. panicea, Schoenus ferrugineus, Menyanthes trifoliata* and *Phragmites australis*. The sites were permanently inundated (water level above soil surface) but had lowest pH and EC and mineral content (Table) among clusters. According to the habitat classification the cluster belongs to the poor fen site type (Paal, 2004).

The other clusters (cluster 2 to 5) could be classified as rich fen.

Cluster 2 (7% of sites) was dominated by *Molinia caerulea* and *Myrica gale* that were accompanied by different fen species (*Schoenus ferrugineus*, *Carex panicea*, *C appropinquata*, *C. flacca*, *C. hirta*, *C. davalliana*, *C. elata*), and *Phragmites australis*. The water table was at the surface between tussocks.

Cluster 3 was the most widely distributed community type (54 % of sites). Vegetation was composed mainly by low tussock graminoids (*Schoenus ferrugineus, Carex davalliana, C. panicea*). Although several orchids, *Primula farinosa, Tofieldia calyculata* participated, they were scarse, in contrast to the earlier distribution (Trass, 1955).
High tussock species *Molinia caerulea* was co-dominating in cluster 2 and on drier relevés of cluster 3. This indicates about indirect drainage influence (Ilomets et al., 2010) on great part of fens (on ca 40% of sites).

Cluster 4 (22 % of sites) was dominated by *Schoenus ferrugineus* with some *Carex panicea, Molinia caerulea, Phragmites australis* and *Succisa pratense*. The sites had the highest pH and EC.

Cluster 5 (10 % of sites) was strongly dominated by *Menyanthes trifoliata* that was accompanied by *Schoenus ferrugineus* and low tussock formating but also stoloniferous sedges (*Carex panicea, C. disticha, C. rostrata*). *Phragmites australis* was also common.
Rare fen species like orchids (*Dactylorhiza incarnata, D. russowii, Epipactis palustris, Gymnagenia conopsea*) and previously characteristic species that are scares nowadays (*Primula farinosa, Parnassia palustris, Tofieldia calyculata*) are common in clusters 3 and 4 where *Schoenus ferrugineus* and *Molinia caerulea* tussocks prevale in vegetation.

Vegetation data clusters arranged along differences in pH, EC and mineral content (Table) although these differences were not statistically significant.

Table. Water level (WL) and peat (**A**) and water (**B**) properties of the vegetation clusters. Means with StDev in gaps.

Cluster	WL, cm	Bulk density of 0-10 cm peat, g cm^{-3}	Bulk density of 10-20 cm peat, g cm^{-3}	Dry matter content of 0-10 cm peat, %	Dry matter content of 10-20 cm peat, %	N in 0-10 cm peat, % (d.w.)	P in 0-10 cm peat, % (d.w.)	P in 10-20 cm peat, % (d.w.)	N in 10-20 cm peat, % (d.w.)
1	7 (2)	86.9 (16.9)	137.6 (91.5)	10.8 (1.5)	14.9 (7.8)	2.4 (0.40)	0.08 (0.03)	0.1 (0.01)	2.5 (0.96)
2	3	143.2	145.4	14.7	15.0	3.41	0.08	0.20	2.10
3	-3 (10)	139.9 (52.5)	153.5 (60.9)	14.2 (4.4)	15.4 (4.9)	2.5 (0.74)	0.09 (0.02)	0.1 (0.02)	2.8 (0.86)
4	-4 (7)	214.3 (128.2)	292.5 (176.7)	21.7 (11.6)	25.1 (11.3)	2.0 (0.99)	0.07 (0.02)	0.1 (0.00)	2.0 (1.28)
5	-0.5 (14)	107.7 (13.6)	388.5 (430.2)	12.4 (1.1)	27.5 (23.5)	2.4 (0.34)	0.1 (0.02)	0.1 (0.03)	3.1 (0.10)

Cluster	pH	EC, µS cm^{-1}	Ca, mg l^{-1}	Mg, mg l^{-1}	Fe, mg l^{-1}	K, mg l^{-1}	Na, mg l^{-1}	SUM, mg l^{-1}	Ca/Mg	Na/K
1	6.05 (0.19)	213 (104)	23.0 (9.5)	2.1 (0.7)	0.396 (0.678)	0.60 (0.30)	5.6 (2.4)	31.7 (11.5)	11.8 (5.4)	9.9 (3.9)
2	6.71	324	18.1	1.4	0.075	0.02	1.5	21.2	12.6	80.0
3	6.70 (0.32)	409 (166)	87.5 (66.8)	10.5 (6.2)	0.066 0.107)	0.91 (0.72)	10.0 (5.7)	109.0 (71.0)	10.8 (9.9)	19.9 (21.1)
4	7.0 (0.21)	624 (100)	77.7 (66.0)	8.7 (6.4)	0.062 (0.021)	3.34 (4.48)	8.9 (7.0)	98.6 (77.1)	11.5 (10.8)	7.6 (7.4)
5	6.70 (0.20)	383 (188)	56.5 (52.8)	11.9 (12.4	0.049 (0.046)	1.16 (1.24)	5.4 (2)	74.9 (54.1)	12.7 (20.3)	8.9 (6.2)

DISCUSSION

The composition of wetland vegetation is mostly controlled by the water level (WL) (Bootsma and Wassen, 1996; Hájková et al., 2004; Barry et al., 2008) and even more by the water level amplitude between dry and wet seasons (WLA) (Wilcox and Nichols, 2008; Ilomets et al., 2010). The open rich fen vegetation assamblages (clusters 2 – 5) distinguished were quite similar, combinations of tussock-forming graminoids and rhizomous plants between tussocks. There were no clear differences in WL measured between tussocks. Thus, *Menyanthes trifoliata* – the submerged species – was common in all five clusters in wet gaps. Although, indirect weak but long-lasting drainage leads to distributon of high-tussock forming *Molinia caerulea* (especially in cluster 3). The presence of characteristic fen species (*Parnassia palustris, Tofieldia calyculata*) and rare species (*Selaginella selaginoides*, *Pinguicula alpina*, orchids) were correlated with dominance of low-tussock life-form. They were quite frequent previously in *Schoenus ferrugineus* and *Sesleria caerulea* dominating fen communities (Trass, 1955) but are scarse nowadays. Impoverishment of fen communities happens probably because of indirect influence of drainage that leads to shorten the high water period and increase tussock height and coverage, and because of extinction of fens on larger areas and the resulting fragmentated distribution of still preserved areas.

ACKNOWLEDGEMENTS

The research was supported by Estonian Environmental Fund project No. 55 „ Rehabilitation and restoration of species rich fens“ and grant No. 0280009s07 of the Estonian State Foundation “Impact of disturbances on wetland ecosystems in Estonia”.

REFERENCES

Barry, M.J., Andreas, B.K. and De Szalay, F.A. (2008). Long-term plant community changes in managed fens in Ohio, USA. *Aquat. Conserv*., **18**, 392–407.
Boomer, K.M.B. and Bedford, B.L. (2008). Influence of nested groundwater systems on reduction-oxidation and alkalinity gradients with implications for plant nutrient availability in four New York fens. *J. Hydrol*., **351**, 107–125.
Bootsma, M. C. and Wassen, M. J. (1996). Environmental conditions and fen vegetation in three lowland mires. **Vegetatio**, **127**, 173–189.
Hájková, P., Wolf, P. and Hájek, M. (2004). Environmental factors and Carpathian spring fen vegetation: the importance of scale and temporal variation. *Ann. Bot. Fenn*., **41**, 249–262.
Ilomets, M., Truus, L., Pajula, R., Sepp, K. (2010). Species composition and structure of vascular plants and bryophytes on the water level gradient within a calcareous fen in North Estonia. *Estonian J. Ecol*, **59**, 1, 19–38.
Laasimer, L. (1965). *Eesti NSV taimkate*. Valgus, Tallinn.
Lamers, L. P. M., van Roozendaal, S. M. E. and Roelofs, J. G. M. (1998). Acidification of freshwater wetlands: Combined effects of non-airborne sulphur pollution and desiccation. *Water Air Soil Pollut.,* **105**, 95–106.
Mälson K., Backeus I. and Rydin, H. (2008). Long-term effects of drainage and initial effects lowland mires. *Vegetatio*, **127**, 173-189.
Management of Natura 2000 habitats. (2008). Alkaline fens 7230. Directive 92/43/EEC on the conservation of natural habitats and wild fauna and flora. European Commission Technical Report 2008 20/24.
McCune, B. and Grace, J.B. (2002). *Alalyses of Ecological Communities. Gleneden Beach*, Oregon.
Middleton, B. A. (2002). Nonequilibrium dynamics of sedge meadows grazed by cattle in Southern Wisconsin. *Plant Ecol*., **16**, 89–110.
Paal, J. (2004). *„Loodusdirektiivi“ elupaigatüüpide käsiraamat*. Digimap OÜ, Tallinn.
Trass, H. (1955). *Lääne-Eesti madalsoode floora ja vegetatsioon*. Dissertation in the Library of Tartu University.
Trass, H. (1957). Sepsika-sood Eesti NSV-s. *Eesti NSV TA Toim., Biol*. **6**, 1–14.
Trass, H. (1986). Anthropogenic dynamics of the fen flora and vegetation in western Estonia. In: *Wetland vegetation of coastal Baltics.* (Ksenofontova T., ed), pp. 31–43. Academy of Sciences of the Estonian SSR, Institute of Zoology and Botany, Tallinn.
Villems, H. (1996). Vegetation of species-rich fens on Saaremaa Island, West-Estonian archipelago. *Proc. Estonian Acad. Sci. Ecol*., **6**, 1/2, 1–14.

Wilcox, D.A. and Nichols, S.J. (2008). The effect of water-level fluctuations on vegetation in a Lake Huron wetland. *Wetlands*, **28**, 2, 487–501.