# Restoring peat-accumulating function on cutaway peatlands

**Martha Graf[1] and Line Rochefort[2]**

[1] Peatland Ecology Research Group (PERG) and Centre d'études nordiques, Karl-Grüneklee Str. 1, 37077 Göttingen, Germany
Phone: +49 551 2778877, e-mail: martha-darling.graf.1@ulaval.ca
[2] Peatland Ecology Research Group (PERG), Centre d'études nordiques and Département de phytologie, Université Laval, 2425, rue de l'Agriculture, Québec, Québec, G1V 0A6, Canada
Phone: +1 418 656 2131, ext. 3595, Fax: +1 418 656 7856, e-mail: Line.Rochefort@fsaa.ulaval.ca

## Summary

In order to focus restoration efforts towards specific vegetation groups in fen restoration, knowledge of the peat-accumulating potential of dominant fen species is critical. Historical information (macrofossil analyses) was examined and summarised to characterise fen peat of North American boreal peatlands. Cyperaceae and *Sphagnum* species were found to be important vegetation groups for accumulating organic matter. Additionally, the decomposition rates of vegetation on both a cutaway peatland and an undisturbed fen were examined. Litter type (leaves, roots/rhizomes or moss fragment) had a larger impact on the decomposition rates than differing environmental conditions. The two bryophytes tested had significantly lower mass losses (between 20-25% for *Polytrichum strictum* and 11% for *Sphagnum centrale*) than the vascular plant litter (between 39-64%). Bryophytes should be an important component of fen restoration, due to their superior peat accumulating capacity, even on cutaway sites.

**Key index words**: fens, restoration, reference information, North America

## Introduction

Fen-community restoration of cutaway peatlands with minerotrophic residual peat has recently begun in North America (Cooper and MacDonald, 2000; Cobbaert *et al.*, 2004). These restoration projects aim to restore fen communities on peatlands that were previously bogs. Although much research has been done on fen restoration in Europe, (Wheeler and Shaw, 1995; Kratz and Pfadenhauer, 2001; Lamers *et al.*, 2002), little can be transferred to North America due to differences in starting conditions, vegetation types and differing restoration goals. Often plant diversity is the main goal of European restoration projects (Wheeler and Shaw, 1995; Kratz and Pfadenhauer, 2001; Lamers *et al.*, 2002), while peat-accumulation is an important long-term goal in North America (Rochefort, 2000).

It is known that species are important in the peat-accumulation of an ecosystem (Johnson and Damman, 1993); however, there is little agreement on which species are most important to peat accumulation in fens. Some believe that vascular plants are important (Roth, 1999; Chimner *et al.*, 2002), while others believe bryophytes are more important (Vitt, 2000). Currently, fen restoration projects in North America focus on restoring vascular plant vegetation (Cooper and MacDonald, 2000; Cobbaert *et al.*, 2004).

The goal of this project was to identify which vegetation groups are important in returning the peat-accumulating function of a fen. The first approach was an investigative approach where vegetation from undisturbed fens was surveyed, macrofossils were sampled and summarised. The second approach to identifying target vegetation was experimental. The decomposition rates of six species were compared after two growing seasons on both an undisturbed fen and a cutaway peatland with minerotrophic residual peat.

## Targeting desired vegetation: an investigative approach

Several sources of data are available when targeting vegetation for restoration projects (Table 1, adapted from White and Walker (1997)). In the case of cutaway peatlands, vegetation surveys of nearby undisturbed fens, macrofossil analyses from the residual peat of the cutaway peatlands and macrofossil analyses from fens in North America all provide reference information.

A study of 11 undisturbed fens in close proximity to cutaway peatlands and with similar peat chemistry to cutaway peatlands showed that *Carex* and *Sphagnum* species dominate (25% and 30% mean cover, respectively; Graf *et al.*, in press). The macrofossil analysis of residual peat from 28 cutaway peatlands in North America showed that the residual peat consisted of 27% roots/rootlets, 27% wood, 19% *Sphagnum*, 16% Cyperaceae, and 5% brown mosses (Graf *et al.*, in press).

Palaeoecological studies of peatlands in North America show a wide range of plant composition in fen peat. After examining 341 peatland cores across North America, Vitt

**Table 1**. Sources of reference information for the restoration of cutaway peatlands with residual minerotrophic peat in North America (adapted from White and Walker,1997).

| | Same place | Different place |
|---|---|---|
| Same time | Vegetation surveys before peat harvesting* | Vegetation surveys of nearby undisturbed fens |
| Different time | Macrofossil analysis from residual peat of restoration sites | Macrofossil analyses from fens in North America |

*This is not feasible because restoration sites were previously bogs; therefore, this vegetation is not appropriate for the new site conditions (Wind-Mulder *et al*., 1996).

(2000) found the major component of fen peat was bryophytes. *Sphagnum* species were found in poor fens and brown mosses in rich fens. However, Lavoie and Richard (2000a) Lavoie and Richard (2000b), Nicholson and Vitt (1990) and Kubiw *et al.* (1989) found vascular plants and bryophytes to be equally important components of fen peat, while Hu and Davis (1994), Warner *et al.* (1991) and Griffin (1977) found fen peat to be dominated by vascular plants.

These sources of reference information show that *Sphagnum* and Cyperaceae are important components of poor to moderate-rich fen communities. However, we do not know which vegetation group is the most efficient in accumulating peat. Due to increasing human pressure on landscapes, restoration sites become important landscapes to manipulate so as to maximize the desired ecosystem functions. In the face of climate change, restoring harvested fens should aim to restore species most efficient in accumulating peat

## Targeting desired vegetation: an experimental approach

The use of historical data to determine restoration goals is often limited because present environmental conditions may differ greatly from those prevalent during the formation of the system. In the case of cutaway peatlands, the hydrology of the restoration sites differs substantially from the hydrology of natural peatlands (Price *et al.*, 2003). The vegetation of the cutaway peatlands also differs from the vegetation common to undisturbed fens (Graf *et al.*, in press). The spontaneous vegetation on cutaway peatlands can be characterised as wetland species, dominated by *Scirpus cyperinus*, *Juncus* sp. and other forbs (Graf *et al.*, in press). Although the community structure and species of the harvested fens is different from undisturbed fens, it is not known whether this will signify differences in the peat-accumulating potential of the sites.

In order to compare the ability of various plants to accumulate peat in a fen system, a litterbag experiment was set up on a cutaway peatland and an undisturbed fen (Graf, 2008). The decomposition rates of three species which frequently spontaneously recolonize cutaway peatlands were compared with the decomposition rates of three species common to undisturbed fens. The decomposition rates were measured over two growing seasons on both an undisturbed fen and cutaway peatland.

The averaged two year mass loss for all litter on the undisturbed fen was slightly lower (39% ± 3; mean ± SD) than that observed on the cutaway peatland (43% ±3) (Graf, 2008). When the individual litter types were compared, the same mass loss patterns were observed on both sites (Fig. 1). The difference between litter types was more pronounced than differences between sites.

The moss species had significantly lower mass losses than the vascular plants on both sites (Fig. 1). The decomposition of *Sphagnum centrale* was substantially lower than all other tested litter material and did not differ between sites (Fig. 1). Among the litter types of vascular plants, the leaves of the vascular species (except *Scirpus cyperinus*) had the highest mass losses (Fig. 1). The mass losses for the roots of the vascular plants were slightly lower than those of the leaves (Fig. 1; Graf, 2008).

## Conclusion

The sources for reference information show that *Carex* and moderate rich-fen *Sphagnum* species are important target groups for cutaway peatlands with minerotrophic residual peat in North America. In the experimental study, bryophytes had significantly lower mass losses than the vascular plants. This study highlights the importance of re-establishing peat-accumulating species such as bryophytes if this ecological function is a main goal of restoration.

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