Extended abstract No. 264

ESTABLISHING VASCULAR PLANTS FROM SEEDS AROUND POOL MARGINS IN RESTORED PEATLANDS

Poulin M[1], Landry T[1], Laberge V[1], Rochefort L[1]

[1]Peatland Ecology Research Group, 2425, rue de l'Agriculture, Université Laval, Québec, Québec, G1V 0A6, Canada.
*corresponding author: Monique.poulin@fsaa.ulaval.ca

SUMMARY

Pools increase the ecological value of restored peatlands. We conducted greenhouse and field experiments on the following vascular plant species: *Carex limosa, C. magellanica, C. oligosperma, C. pauciflora, Drosera intermedia, Eriophorum virginicum, Rhychospora alba,* and *Scheuchzeria palustris*. For most species, germination was greater with water level near the surface (0 cm) and on seedbed composed of bare peat or *Sphagnum* carpets instead of liverwort mats composed of *Cladopodiella fluitans*.

The substrate stability around pools can be improved by planting *Ericaceae,* which reduced frost heaving and in turn increased *Sphagnum* establishment. Introducing seeds simultaneously with *Sphagnum* fragments appears to be a better option than waiting for a complete establishment of mosses. These results will help restoration practices by identifying the best ecological conditions for the successful establishment of pool edge species.

KEYWORDS: seed germination, substrate conditions, *Cyperaceae*, biodiversity, plant nursery

INTRODUCTION

The moss layer transfer technique is being extensively used in North America for restoring cutover bogs after horticultural peat mining. This technique has proven very efficient in establishing a moss cover rapidly and bringing back peatland plants (Poulin *et al.*, Submitted). However, it creates uniform vegetation devoid of microtopographical gradient, at least for the first 10 to 20 years (Pouliot *et al.*, 2011). As pool increase biodiversity in natural peatlands (Fontaine *et al*., 2007), their creation should raise their ecological value of restored sites. In that regard, Poulin *et al.* (2011) has shown that the moss layer transfer technique (Rochefort *et al*., 2003) can be used to establish *Sphagnum* associated with hollows and pools but that vascular plants typical of these microhabitats are not favoured. Their density at the donor site may be too low or their roots and rhizomes too deep to be efficiently transferred by this technique. Introducing these vascular plants by seeds may be a good option, especially for promoting genetic diversity. Seedling requirements in terms of seedbed and water level need to be evaluated in order to target the right conditions in which to introduce these seeds along created pool margins. We present both greenhouse and field experiments in order to evaluate the optimal conditions promoting seed germination and seedling growth for vascular plant species typical of pool edges.

MATERIAL AND METHODS

Green house experiment

We conducted a greenhouse experiment on the following species: *Carex limosa* L., *C. magellanica* L. subsp. *irrigua* (Wahlenburg) Hultén, *C. oligosperma* Michx, *C. pauciflora* Lightf., *Drosera intermedia* Hayne, *Rhychospora alba* (L.) Vahl., and *Scheuchzeria palustris* L.. We tested the effect of three seedbeds (a carpet of the liverwort *Cladopodiella fluitans*, a carpet of *Sphagnum*, and bare peat) and 2 water levels (at the surface (0 cm) and 10 cm below the surface) with 6 replicates in a completely randomized block design (36 experimental units). Each experimental unit was set up in small mesocosms filled with peat where the water level was controlled with a vertical pipe perforated to drain exceeded water. After establishing the main seedbeds and weeding them for four months, we introduced seeds of the seven species into each mesocosm. Seeds of the same species were segregated with plastic pots (bottom removed). We counted germinants three times a week for the first six weeks and then once a week until the end of the experiment (91 days). The first five plants to germinate were allowed to grow and their vertical length was measured monthly but subsequent plants were removed to avoid competition. Above-ground biomass was collected after 3 months of growth and dry weighted.

Germination and above-ground biomass data were analyzed with a two-way ANOVA for a completely randomized block design using the SAS GLM procedure (version 9.3.1, SAS Institute, Inc.). When an interaction was significant, the option SLICE was used in conjunction with LSMEANS.

Field experiment 1: impact of Ericaceous

A first field experiment was conducted to evaluate the impact of *Ericaceae* to stabilize peat substrate along pool margins as well as their influence on the establishment of *Sphagnum* and on seed germination of the following species: *Carex oligosperma*, C. *magellanica*, *C. pauciflora*, *Eriophorum virginicum* L., *Rhynchospora alba*, et *Scheuchzeria palustris* (Fig.1). In turn, the impact of *Sphagnum* on seed germination was also evaluated. Six pools in a cut-over restored peatland served as six replicates of the following treatments: presence (or not) of *Ericaceous*, presence (or not) of *Sphagnum* and three distances from the pool water's edge (0.5, 2 and 3.5 m), all tested in full combination for a total of 12 treatments. They were set up according to a split-split-block design where *Ericaceae* and *Sphagnum* were introduced alone or in combination in the main plots and the distance to the water pool edge was evaluated in subplots. A mixture of two *Ericaceae* species was used: *Andromeda glaucophylla* and *Vaccinium macrocarpon* at a density of 25 and 50 plants/m^2, respectively. *Sphagnum majus* was introduced as fragments to cover 50% of the soil surface initially. A straw mulch was added to protect *Sphagnum* diaspores from dessication. A large mesh plastic net was installed to limit straw movement. One hundred seeds of each vascular plant species were introduced for each experimental unit (except at distance 2 m). Net cylinders were used to segregate species.

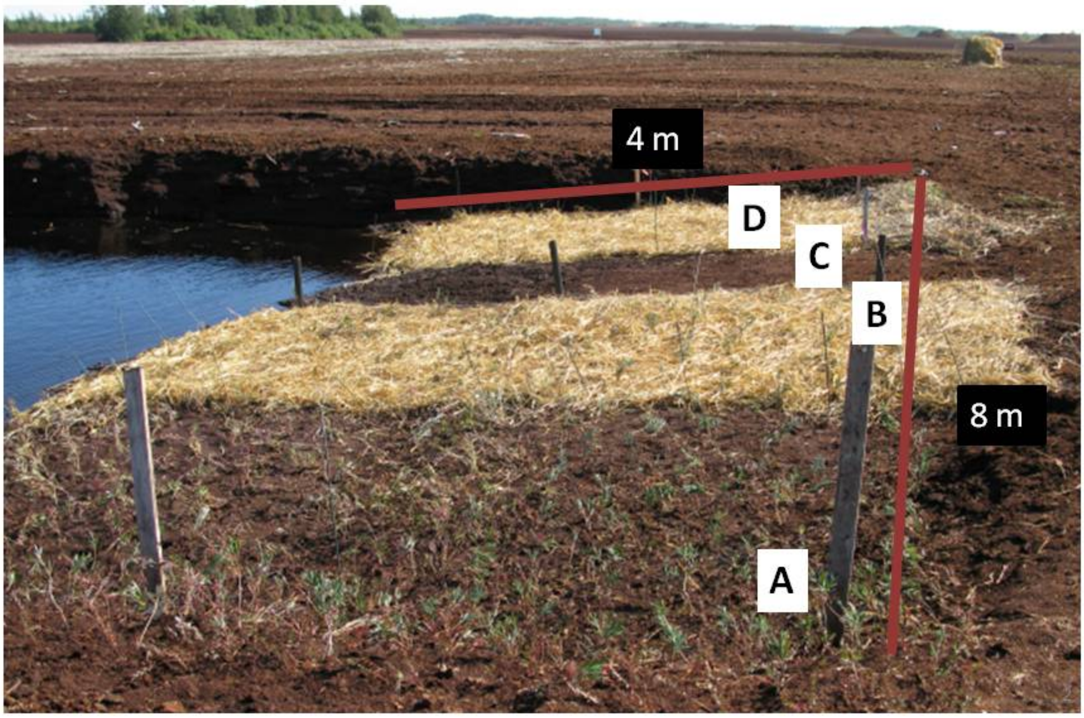

Fig. 1. Experimental set up of the field experiment 1, testing the impact of *Ericaceae* on peat stability, *Sphagnum* establishment and germination and seedling growth of vascular species associated with pools. The substrate was characterized by A) *Ericaceae*, B) *Ericaceae* + and *Sphagnum*, C) Bare peat, and D) *Sphagnum*.

To evaluate frost heaving (peat stability), the vertical movement of wooden sticks (n=20 per experimental unit) compared to a fixed horizontal reference wire was measured 18 weeks after the set up of the vegetation treatments, during fall (early November). *Sphagnum* cover was evaluated after 10 weeks after their introduction, in two plots of 25 x 25 cm for each experimental unit. Seedlings of introduced vascular plants were counted at the end of the growing season and vertical growth measured.

Statistical analyses was conducted with the procedure Mixed of SAS. When an interaction was significant, the option SLICE was used in conjunction with LSMEANS. For *Sphagnum* establishment, the effect of *Ericaceae* and distance to water's edge was analysed with a two-way ANOVA with a split-plot model where distance to water was considered in subplots and *Ericaceae* in main plots. A three-way ANOVA with a split-split-block was used to evaluate frost heaving, where *Ericaceae* and *Sphagnum* cover was considered in main plots whereas the distance to water's edge was considered in subplot. The same analysis was conducted for the germination data but distance to water had only two levels (as seeds were not introduced at mid-distance).

Field experiment 2: impact of development stage of the seedbed

A second field experiment was set up to test the influence of the type and the development stage of the seedbeds on seed germination of the four following vascular plants: *Carex limosa, C. magellanica, Carex oligosperma,* et *Scheuchzeria palustris.* We tested two stages: freshly established *Sphagnum* fragments covered with straw and well established carpets without straw. Two *Sphagnum* species (*S. cuspidatum* and *S. magellanicum*) were tested as well as one liverwort (*Cladopodiella fluitans*). The experiment was set up in three trenches of a former block-cut peatland, where water table was close to surface. Six basins (2 per trench) of 18 x 2 m were used as replicates (36 experimental units set up in a completely randomized experimental block design). Percent cover for bryophytes was 50 and 100% for the freshly and fully established carpets, respectively. One hundred seeds of each vascular plant species were introduced for each experimental unit. Net cylinders were used to segregate seeds of different species.

We conducted two-way ANOVA with a complete randomized block design (bryophytes * stage) for a total of six treatments. When an interaction was significant, the option SLICE was used in conjunction with LSMEANS. Statistical analyses were conducted by using the GLM procedure of SAS (version 9.2, SAS Cary, NC, USA, ©2010) for germination data and the MIXED procedure for the growth data.

RESULTS

Greenhouse experiment

In general, a water level close to the surface favoured the germination of vascular species associated with pools in peatlands. Also, introducing seeds on bare peat or *Sphagnum* carpets led to higher germination compared to *Cladopodiella* substrate. Germination periods were generally longer when seeds were submitted to drier conditions and placed on *C. fluitans* carpets. Conditions favouring biomass production were more variable among species

Field experiment 1: impact of Ericaceous

Frost heaving was 63% more active close to the water's edge compared to what was measured at 2 and 3.5 m from water's edge . Frost heaving was two times less severe when a cover of vegetation was present, no matter if it was *Ericaceae*, *Sphagnum* or both. The presence of *Ericaceae* favoured *Sphagnum* establishment but only close to water's edge where *Sphagnum* cover was four times higher under *Ericaceae* than without protection. In general, *Ericaceae* did not affect seed germination and seedling growth. Vascular plant establishment was however affected by the presence of *Sphagnum* and the distance to water's edge. Seedling growth was better close to water's edge, no matter the cover type and it was favoured by the presence of *Sphagnum*.

Field experiment 2: impact of development stage of the seedbed

Seed germination was not influenced by the development stage of the different seedbeds. Yet, seedling growth was favoured by a freshly established seedbed when introduced on *Cladopodiella fluitans* or *Sphagnum cuspidatum*. *S. magellanicum* promoted a better establishment of vascular plants no matter its stage of development.

CONCLUSION AND DISCUSSION

When establishing vascular plant species associated with pools, we should introduce seeds in wetter areas as we have shown in greenhouse tests that seeds had higher germination rates when the water level was close to the surface rather than when it was 10 cm below the surface. However, as frost heaving is more active close to water's edge, the plantation of *Ericaceae* should help in keeping the peat substrate in place and improving stability for seedling establishment. It also seemed to help *Sphagnum* establishment close to water's edge by avoiding the negative impact of waves and water movement. Vascular plant establishment was not affected by *Ericaceae* but other shrubs densities should be tested before recommending their planting when introducing seeds of vascular plant associated with pools. Shrubs should not get too dense and therefore reduce light intensity or increase evapotranspiration to a certain threshold level which could be detrimental to seed germination. Introducing seeds right after *Sphagnum* fragments were spread seems an optimal option, probably due to an increased contact with bare peat and therefore higher availability in germination microsites. Artificial structures such as phytoplankton net fencing should be installed to trap seeds at the appropriate distance from the water's edge. Targeting environmental conditions favouring the establishment of species typical of pool edges is particularly important as we can not rely on natural recolonization for restoring plant diversity of created pools in restored peatlands (Fontaine *et al.*, 2007). As pools are susceptible to invasion by *Typha latifolia* and as mosses have been shown to be efficient way of controlling the germination of this undesirable species (Bourgeois *et al.*, accepted), establishing rapidly a diversity of plants typical of peatlands is important.

ACKNOWLEDGMENTS

Financial support was provided by the Natural Sciences and Engineering Research Council of Canada, the Ministry of Natural Resources and Energy of New Brunswick, the Canadian Sphagnum Peat Moss Association and its members.

REFERENCES

Bourgeois, B., S. Hugron and Poulin, M. *Accepted*. Establishing a moss cover in restored peatlands inhibits the germination of the invasive species *Typha latifolia*. *Aquatic Botany*, 1st November 2011, AQBOT-S-11-00364.

Fontaine, N., M. Poulin and Rochefort, L. (2007). Plant diversity associated with pools in natural and restored peatlands. *Mires and Peat* Vol. 2, Article 06: 1-17 (on line:http://www.mires-and-peat.net/).

Poulin, M., R. Andersen and Rochefort, L. *Submitted*. A new approach for tracking vegetation change after restoration: a case study with peatlands. Submitted to *Restoration Ecology*, 19 October 2011, REC-11-346.R1.

Poulin, M., N. Fontaine and Rochefort,L. (2011). Restoration of pool margin communities in cutover peatlands. *Aquatic Botany* 94: 107-111.

Pouliot, R., L. Rochefort and Karofeld, E. (2011). Initiation of microtopography in revegetated cutover peatlands. *Applied Vegetation Science* **14**:158-171.

Rochefort L, Quinty F, Campeau S, Johnson K, and Malterer T. (2003). North American approach to the restoration of *Sphagnum* dominated peatlands. *Wetlands Ecology and Management* 11: 3-20.