USE OF LOCALLY SOURCED MOSS, LICHEN AND VASCULAR PLANT PROPAGULES FOR THE REVEGETATION OF MINERAL DISTURBANCES IN A BOREAL CLIMATE

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ABSTRACT

Mosses, lichens and low ericaceous shrubs are the dominant component of the barrens vegetation around Mary's Harbour, Labrador. In 2004, an experiment was undertaken near this town where propagules (fragments, seeds, spores, etc.) of mosses, lichens and vascular plants, obtained from nearby donor sites, were spread thinly onto experimental plots that were set up on four disturbed, bare mineral soil areas. The plots were covered with grass mulch, and low doses of bone meal fertilizer were applied. Reintroduction plots were compared to control plots in order to see if reintroducing local plants propagules accelerates the recovery of vegetation.

Data collected after one, two and five years showed that vegetation establishment was better on plots where propagules were introduced than on control plots. Five years after the onset of the experiment, mosses (mainly Polytrichaceae), fruticose and foliose lichens and seedlings of ericaceous shrubs and other woody species were well established on the plots where plant material had been spread. Control plots, in contrast, had a lower moss cover, fewer shrubs and seedlings, and generally lacked lichens.

Key Words: Bryophytes; *Polytrichum*; *Cladina;* pioneer plants; plant establishment**.**

INTRODUCTION

The revegetation of mineral substrate disturbances in northern climates presents special challenges. It is not known how long it would take for these substrates, consisting primarily of rocks and mineral soil, to be colonized by native plants without assistance. Standard revegetation techniques that use hydroseeded grasses may not be as successful there as in more southern locations, due to the harsher climate and poor soils.

While there is a growing interest in the propagation and use of native species of grass and forbs in revegetation (Burton and Burton, 2003), native mosses and lichens, on the other hand, have not received much attention in term of their use in ecological restoration. Yet, mosses are an important vegetation component in many boreal and northern areas. These plants are adapted to poor soils and harsh climates and play significant roles in boreal ecosystems. Some moss species, *Polytrichum* sp. in particular, are known colonists and surface stabilizers in disturbed areas on poor soils, either north or south. Moss colonies can act as seedbeds for the germination of vascular plant species (Delach and Kimmerer, 2002). A stabilizing, insulating layer of mosses will also help reduce the freeze-thaw cycles in surface soil layers, hence protecting seedlings against the risk of being uprooted by frost heaving (Groeneveld and Rochefort, 2005).

The use of pioneer mosses could be an attractive alternative for the revegetation of disturbed land in northern areas (Campeau and Quinty, 2006). The idea is to favour the establishment of species of mosses that appear to be good primary colonizers in order to create a green stabilizing carpet that in turn would facilitate the development of native herbs, forbs and shrubs. The need for added topsoil and fertilizer could also be reduced, since pioneer mosses can establish on very poor, gravelly substrates.

Mosses, lichens and low ericaceous shrubs are the dominant component of the barrens vegetation around Mary's Harbour, Labrador. In July 2004, an experiment was initiated near Mary's Harbour with the objective of of accelerating the colonization of bare mineral soil disturbances by native plants through the application of methods similar to those used on mined peatlands (Rochefort et al., 2003; Quinty and Rochefort, 2003). We hypothesized that, as in peatland restoration, the reintroduction of locally sourced plant propagules, combined with the use of mulch and low dose of fertilizer would favor the development of a stabilizing moss layer, which in turn would facilitate the establishment and development of native vascular plants.

METHODS

The experiment took place at four sites located on the embankments of the newly built Trans-Labrador highway northeast of the town of Mary's Harbour, near the southeastern tip of Labrador (latitude: 52^o 18' N, longitude 55^o 49' W). Climate normals, based on data from 1971 to 2000, were unavailable for Mary's Harbour, but were obtained for Cartwright, Labrador (to the Northwest, latitude 53^o 42' N, longitude 57^o 2' W) and Blanc-Sablon, Québec (to the Southwest, latitude 51^o 27' N, longitude 57^o 10' W). The daily mean temperature in Cartwright was –0.5^o C. Rainfall and snowfall were 573.0 mm and 487.6 cm. For Blanc-Sablon, the daily mean temperature was 0.2^o C. Rainfall and snowfall were 654.1 mm and 412.4 cm.

Plant propagules (fragments, seeds, spores, etc.) of mosses, lichens and vascular plants, obtained from donor sites, were spread thinly onto bare soil experimental plots 50 m^2 each. The plots were mulched with a thin layer of freshly harvested green *Calamagrostis canadensis* stems and leaves. Bone meal fertilizer was hand-spread on the surface at a rate of 20 g/m^2 (i.e. 1 kg per 50 m^2 plot). Reintroduction plots are compared to a control to see if, and by how much, actively reintroducing local plants accelerates the recovery of vegetation. Also tested is the effect of roughening the surface by creating very shallow depressions and ridges on one of the plots. The experiment therefore consisted of three treatments (Control, Propagules added, Propagules added + Surface altered), repeated at four sites.

The plants used for reintroduction were obtained from a barren donor site found at the edge of the quarry at the entrance of Mary's Harbour. The site was characterized by a cover of lichens, mosses and low shrubs on a very shallow peat soil. Low *Sphagnum* hummocks were sparsely distributed within the site. The targeted density ratio for plant reintroduction was a 1:10 ratio of surface collected from the barrens to the surface being revegetated. Mosses and lichens were collected from the donor site to a depth of approximately 10 cm. Additional *Polytrichum* moss fragments were also collected from three other locations, to be reintroduced along with the donor site material. Finally, patches (diameter 15-20 cm) of *Cornus canadensis*, Crowberry (*Empetrum nigrum*) and cinquefoil (*Potentilla tridentata*) were collected with their roots to be transplanted as clumps at the experimental site.

Plant cover data were collected after one (September 2005), two (July 2006) and five years (September 2009). In 2005 and 2009, percentage cover of Polytrichaceae, of other mosses, lichens, shrubs, graminoïds and forbs, and total plant cover were estimated visually on a series 25 x 25 cm quadrats within each plot. Quadrats were distributed systematically along transects that ran at intervals across the plot. Quadrats were regularly spaced at 1 m intervals along each transect. A total of 40 and 50 quadrats per plot were measured in 2005 and 2009 respectively. Due to time constraints, the 2006 visit was very brief and only allowed to visually estimate plant cover of the different categories over each plot.

Early after plant introduction, wind displaced the reintroduced plant material and mulch from almost half of one plot of site 4 and spread it over the adjacent, control plot. This site is excluded from data analyses.

RESULTS

<u>Plant introduction</u>

After one and a half growing seasons (September 2005 data), moss cover in our reintroduction plots was still fairly low, i.e. in the order of 5% to 6%. This was however significantly higher than on control plots, where average moss cover was only 1%. Among reintroduction plots, moss cover did not differ significantly between plots with a modified surface and unaltered plots. No noticeable differences in vascular plant cover could be observed between treatments, but vascular plant cover was still very low, i.e. less than 1%. Lichen cover was difficult to estimate due to the difficulty in determining if the pieces of lichens observed were alive or not. Nevertheless, the percentage cover of live lichens was estimated at lower than 1%.

Difference in moss cover between reintroduction plots and control plots continued to widen the next year (July 2006 data). That year, total moss cover was in the range of 10% to 15% for plots where propagules were added, in comparison to only 1% to 5% for controls. Changes in moss cover composition were also observed. In 2005, moss cover on introduction plots was mainly composed of small ground-hugging, cushion-forming acrocarpous mosses. Most of the increase observed between 2005 and 2006 was however attributable to the development of members of the Polytrichaceae. After two growing seasons, vascular plant cover on the plots was still only in the order of 1% to 3%. Although lichen cover was still very low, our observations suggested that a number of reintroduced lichen fragments were alive and growing. In addition to the introduced fruticose lichens of the genus *Cladina* and *Stereocaulon*, we noted at several sites the presence of *Peltigera* sp. (foliose lichen) on the soil surface.

Five years after the onset of the experiment, mosses (mainly Polytrichaceae), fruticose lichens, ericaceous shrub and other woody species seedlings were well established on the plots where plant material had been spread. Control plots, in contrast, had a lower – although quickly expanding - moss cover, had fewer shrubs and seedlings, generally lacked lichens and showed an overall lower plant diversity. The dominant moss species on our plots after 5 years was *Polytrichum juniperinum*. *Polytrichum piliferum* and *Pogonatum urnigerum* was also often found. Together, moss and lichen cover reached the 50% threshold on some of the plots – including on one of the controls – and was highly variable from site to site.

Transplants

Transplant survival rate was evaluated in September 2005, one and a half growing seasons after transplantation. The global survival rate of transplants was 72%, but varied among species. *Cornus canadensis* had the worse survival rate of all three species, with only 8 out of 17 transplants surviving (47%). *Empetrum nigrum* and *Potentilla tridentata* had good survival rates at 80% and 84% respectively (20 and 21 out of 25 transplants surviving). *Potentilla tridentata* transplants were particularly healthy, many showing the presence of seed heads and new shoots arising around the transplanted clump itself.

Many transplants were still alive in 2009. Several *Empetrum nigrum* transplants had grown noticeably in size, and started to expand outside of the original transplanted area, as did the *Potentilla tridentata* and some of the remnant *Cornus canadensis*.

CONCLUSIONS

Mosses and lichens are an important vegetation component of boreal and northern areas. These groups of plants thus cannot be ignored in revegetation and restoration projects taking place at higher latitudes or altitudes.

The approach used here allowed for the establishment of native mosses, lichens and shrubs on bare mineral soil on experimental plots using locally sourced plant propagules. Early moss establishment on the reintroduction plots was slow, but slightly better to what was recorded in another moss reintroduction experiments previously conducted in Québec (Campeau and Quinty, 2006).

After five years, vascular plant cover was still low and sparse on our plots, but a significant moss and lichens cover had developed and a number of shrub and tree seedlings were recorded. Clearly, the approach tested here has potential, although it needs to be improved and tested in a variety of soil and climate conditions. The feasibility and practicality of using this approach on a larger scale also remains to be evaluated, especially with regards to obtaining local source material.

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REFERENCES

Burton, C.M. and P.J. Burton. 2003. A Manual for Growing and Using Seed from Herbaceous Plants Native to the Interior of Northern British Columbia. Symbios Research & Restoration, Smithers, B.C. 168 pp.

Campeau, S. and F. Quinty. 2006. Use of pioneer mosses for the revegetation of bare mineral sites. Proceedings of the CLRA 2006 Conference, Ottawa, Ontario, pp 57-63.

Delach, A. and R.W. Kimmerer. 2002. The effet of *Polytrichum piliferum* on seed germination and establishment on iron mine tailings in New York. The Bryologist 105: 249-255.

Groeneveld, E.V.G. and L. Rochefort. 2005. *Polytrichum strictum* as a solution to frost heaving in disturbed ecosystems: a case study with milled peatlands. Restoration Ecology 13: 74-82.

Quinty, F. and L. Rochefort. 2003. Peatland Restoration Guide, 2nd ed. Canadian Sphagnum Peat Moss Association and New Brunswick Department of Natural Resources and Energy. Québec, Québec, 106 pp.

Rochefort, L., F. Quinty, S. Campeau, K.W. Johnson and Malterer, T.J. 2003. North American approach to the restoration of Sphagnum dominated peatlands. Wetlands Ecology and Management 11 (1-2): 3-20.