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Boreal trees can grow on saline sites – implications for reclamation success on saline soils

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The Challenge

Soils from oil sands mining can be affected by salts leached from tailings or overburden materials – resulting in saline soil conditions. As a result, re-establishment of forests on saline sites is an important goal on reclaimed oil sands mines. Forest vegetation is typically thought to be intolerant of salinity, but there are rare examples of natural boreal forests growing on saline sites. By looking at these naturally saline sites we can help inform reclamation of sites with challenging saline soil conditions.

The Approach

The researchers looked at a series of six naturally saline sites, dominated by either white spruce or aspen, in northern Alberta to better understand how soil salinity affects tree growth and nutrition. They sampled low, medium, and high salinity plots at each site. In each of these plots they sampled: a variety of soil metrics, tree basal area, yearly tree growth, foliage nutrient and salt concentrations, and root distributions. In general, salinity occurred at depths of 20-100 cm at the sites.

The Results

Surprisingly, both aspen and spruce grew on sites with very high salinity and pH deeper in the soil profile (i.e., 40-100cm), so long as surface soils were not highly saline and had adequate moisture and nutrients.

However, aspen growth was reduced by 50% in highly saline stands compared to non-saline sites and growth rate slowed substantially in all stands once trees were over 15 years old. This suggests that salinity impacted aspen growth more strongly over time. The researchers also found that the majority of roots were distributed in the forest floor organic layer (lfh) and top 20cm of mineral soil with minimal root biomass found in the deeper highly saline soils (i.e., depths of 40-100cm). Thus, it seemed that once aspen roots outgrew their 'favorable' rooting zone, growth rates slowed considerably.

White spruce seemed to be unaffected by the salinity gradient and had steady growth rates over time. However, these growth rates were still lower than non-saline sites and would not be considered commercially viable. The tendency for white spruce to have a shallow rooting system and slow growth rates resulted in it being more tolerant to salinity than aspen.

Fig. 1 White spruce forest growing on saline site in Wood Buffalo National Park. Note the white salt crust on the surface of the soil.

Management Implications

- Increasing the depth of capping material on reclaimed saline sites will increase the rooting depth available for trees – potentially reducing the impact of soil salinity on long-term tree growth.
- Where trees are growing over reclaimed saline soils, stands should be monitored over time. Growth limitations associated with soil salinity may not be evident in juvenile trees, but will become apparent as the trees age.

Further Reading

Lilles, E.B., B.G. Purdy, S.E. Macdonald, and S.X. Chang. 2012. Growth of aspen and white spruce on naturally saline sites in northern Alberta: Implications for development of boreal forest vegetation on reclaimed saline soils. Canadian Journal of Soil Science 92: 213-227.

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