

Natural Revegetation of a Boreal Gold Mine Tailings Pond

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Abstract

Understanding the natural revegetation of forests disturbed by the dumping of mine wastes is vital for the success of reclamation strategies. The Gunnar gold mine tailings pond in southeast Manitoba has remained largely unvegetated since the mine was closed in 1942, with limited vegetation developed on one side of the pond. We examined the natural *Picea mariana*/*Larix laricina* forest that has developed on the pond to determine how the plant community develops and what changes in the tailings are associated with this development. Vegetation sampled along transects showed a consistent pattern of succession from *Equisetum palustre* to *Salix* spp., and *Populus balsamifera*, to *Larix laricina* and finally to *P. mariana*. *Larix laricina* and *P. mariana* are moving into the site at the rate of 1.5 m per year with *L. laricina* invading 4 years

ahead of *P. mariana*. Both tree species show a similar pattern of annual growth, showing positive correlations with spring precipitation, a pattern also occurring on *L. laricina* growing on a nearby site. The establishment of *E. palustre* was accompanied by initially rapid decreases in compaction and conductivity of the tailings, and an increase in inorganic nitrogen. Surface organic matter depth, coarse organic matter mass, and soil organic carbon increased at a constant rate, whereas subsurface coarse organic matter had an initial rapid increase followed by a gradual increase. As fern allies (and specifically members of the Equisetaceae family) have a number of properties that facilitate succession on mine wastes, their use should be explored further.

Key words: *Equisetum*, mine tailings, revegetation, vegetation succession.

Introduction

The main waste products of ore processing operations are crushed rock material, referred to as tailings. The rate of plant colonization of disturbed land is dependent on the extent of the disturbance, the prevailing edaphic conditions, and the presence of neighboring and residual vegetation persisting since disturbance (Szarek-Łukaszewska 2009). In the case of mine tailing dumps (hereafter referred to as ponds) natural revegetation occurs at a very slow rate because of their low nutrient status, poor aggregation, and low organic carbon (Tordoff et al. 2000; Shu et al. 2005). Additionally, highly acidic tailings ponds produced from sulfide-bearing ores limit or entirely suppress revegetation because of the high bioavailability of heavy metals (Winterhalder 1996).

Understanding the processes that occur during natural colonization and succession on mine wastes is important for guiding restoration programs (Alday et al. 2011a). Colonization typically begins at the margins of tailings ponds from existing vegetation (Shu et al. 2005). Wind-borne or animal-delivered

seeds and vegetative propagules from neighboring vegetation provide pioneer plant species, establishing at pond margins and favorable microsites (Shu et al. 2005). Therefore, the dispersal mode of plants can strongly affect the trajectory of succession (Alday et al. 2011b). Organic matter input to the tailings from early successional plant turnover may help to stabilize the tailings surface and allow for improved wind-borne sediment and seed interception (Bradshaw 2000). The decomposition and mineralization of deposited organic matter can fuel microbial communities, and have a positive feedback on overall plant health due to positive effects on soil structure and nutrient cycling (Shrestha & Lal 2006). The early pioneer plant stage will transition toward a woody community, accompanied generally by an increase in organic matter depth and the associated nutrient pools (Smith et al. 1997).

Throughout the world there are hundreds of thousands of mine sites where operators no longer exist (orphaned mines). In these cases, the responsibility of site remediation of the land, including tailings dumps, either falls to new operators, governments, or of does not occur. The Province of Manitoba (Canada) has approximately 150 abandoned or orphaned mines, a few of which have mine tailings ponds. One of these, the Gunnar gold mine in southeastern Manitoba, was in operation from 1936 to 1942 (Slivitzky 1996). Our previous work (Renault et al. 2007) has shown that the chemical and physical properties of the Gunnar tailings have prevented plant growth on most of the pond. These properties included high bulk

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