Disturbance Effects of Oil Sands Exploration practices on Coarse-textured Soils and *Populus tremuloides* Michx. Regeneration

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Abstract

Oils sands exploration (OSE) sites associated with in situ oil sands development are required to evaluate and delineate oil resources. As many OSE sites are required for development, they are an important disturbance in Alberta's northern boreal forest. Once these sites are cleared and disturbed for exploration, they can result in habitat disturbance and fragmentation, invasion of weed species, changes to surface drainage, and changes to soil properties. Timely regeneration of boreal forest species after reclamation is critical to limit the negative impacts of exploration activities. One of the current challenges for industry is the lack of forest regeneration on coarse-textured OSE sites. This study examined the effects of OSE practices on soil properties that could be associated with the slow regeneration of boreal forest species on coarse-textured soils. We conducted field experiments to investigate the effect of OSE practices on coarse-textured soil properties by comparing disturbed and undisturbed sites. The field experiments examined: 1) the changes in soil properties that may result in poor regeneration; in particular, the changes to particle size distribution to determine if OSE practices were homogenizing the natural heterogeneous bedding of coarse-textured soils; 2) the soil warming patterns of wood mulch used commonly during reclamation; and, 3) the differences in nutrient availability with different wood mulch surface amendments (no mulch, 10 cm of mulch, and mulch incorporated with soil). The results indicated that OSE disturbance decreased very coarse sand content, silt content, sodium adsorption ratio, and available ammonium and increased fine sand content, pH,

electrical conductivity, calcium, potassium, carbon:nitrogen, and available nitrate. OSE practices homogenized the natural bedding of coarse-textured soils, but homogenization did not result in a change to plant available water as both field capacity and wilting point increased. The higher field capacity and wilting point were likely due to the redistribution of finer particles throughout the soil profile as indicated by changes to the D_{10} value. The use of wood mulch on OSE sites resulted in a two week lag for soils with mulch to reach above 1˚C in the spring (delayed soil warming). In this study, mulch use did not result in lower nutrient availability and there were no differences of nutrient availability if mulch was incorporated or used as layer. Of the soil properties evaluated in this study, the field experiments indicated that changes to coarse-textured soil properties most likely to affect regeneration included homogenization, pore size distribution, delayed soil warming, and nutrient availability. A greenhouse experiment was conducted to further investigate the effects of delayed soil warming and commonly used wood mulch on the growth of *Populus tremuloides* and nutrient availability. In the growth chamber experiment, we compared *Populus tremuloides* seedlings flushed at 5 and 10˚C (with or without mulch) and warmed to 20˚C. The results suggest that delayed soil warming, mulch amendment, and their interaction affected *Populus tremuloides* growth performance. Delayed soil warming resulted in lower aboveground and belowground growth. The mulch amendment resulted in lower aboveground growth. The interactive effect between delayed warming and mulch amendment resulted in seedlings flushed at 10˚C without mulch having the better growth performance of all treatment combinations. Though mulch incorporation resulted in changes to measured soil chemical properties and nutrient availability, this did not translate to differences in *Populus tremuloides* growth. Based on this study, lower disturbance construction methods for OSE drilling pads should be considered for coarse-textured sites and mulch use should be used sparingly on sites to be revegetated with cold sensitive species such as *Populus tremuloides*.