Spruce it Up!

effects of the oil sands on trembling aspen and white spruce

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Introduction:

The oil sands of northern Alberta have continuously been a large source of Canada's income[1] at the cost of the country's environmental well-being[6]. Canada contains 1.7 trillion barrels of oil in the Athabasca Oil Sands Region (AOSR); there are environmental concerns in the ecosystems[4]. Environmental issues like acid rain, fog, and mist from acute pollutants; spills, leaks, malfunctions and explosions[5] from ongoing pollutants; tailings ponds releasing pollutants through flare stacks into the atmosphere[7]. Marleau studied in the AOSR area and it was found that the Manganese (Mn) has been negatively effected in the trees downwind, decreasing radial growth in white spruce (*Picea glauca*) trees[3]. Trembling aspen (*Populus tremuloides*) has not yet shown any adverse effects downwind from the AOSR[5].

Mn is suspected to be a large factor in the adverse effects in *P. glauca*. Figure 1 shows the sites and samples downwind from the AOSR and upstream on the Clearwater River will show increasing amounts of toxic Mn in *P. glauca* from the time the oil sands first started producing in 1967[3] to present day. There will be no negative signs of toxic Mn in *P. tremuloides*[5]. It is also assumed that the Mn will be in the same toxic forms as seen by Marleau, which was Mn (II) in all *P. glauca* material except leaf litter which was identified as Mn-oxides[5].

With the use of the IDEAS Beamline at the Canadian Light Source (CLS) along with *P. glauca* and *P. tremuloides* sample cores from a previous experiment done by Kershaw along the Clearwater River upstream, starting north of La Loche, SK to Tar Island, AB, we will determine how the AOSR is affecting trees downwind, in respect to Mn levels. The experiments performed will determine exactly what elements are seen in high dosage or toxic amounts in *P. glauca* and *P. tremuloides* and what speciation these toxic elements are found in.

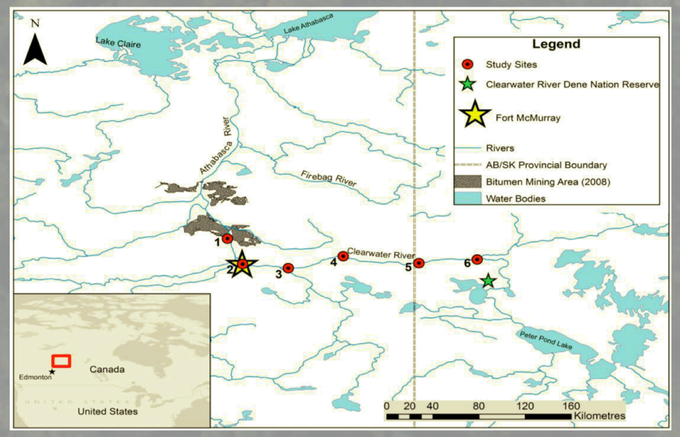

Figure 1. Kershaw's map from 2013 of the sites where *P. glauca* and *P. tremuloides* core samples were taken. Sites of interest are 1, 4, and 6, with site one being upstream from the AOSR, but downwind[3].

AOSR and Manganese:

- Bitumen mining produces both acute, and ongoing pollutants from its by-products that are harmful to the environment[5].
- The projected growth, in a trend similar to Figure 2, will continue to release unpredictable airborne-contaminants[5].
- Airborne pollutants can be carried large distances from wind and water, which allows them to settle into different atmospheric cycles, like soils, air, and rain or snow[5].
- Mn is released into the atmosphere from many anthropogenic processes, including fossil fuel combustion[2].
- Typically, Mn settles close to its source but fine particles can be carried far away and are transported from previously mentioned methods[2].
- Mn levels are found to be very high in mines, and ore-processing plants[2].
- Mn is not found in nature in the native Mn form[2,] but is mostly found as pyrolusite (MnO_2); it is less commonly found as Mn in the form of oxides, silicates and carbon[2].

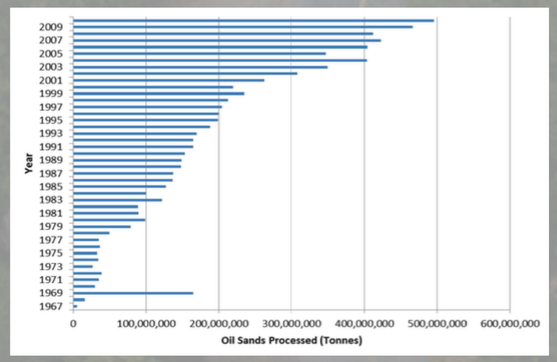

Figure 2. Amount (tonnes) of oil sands processed in the AOSR from 1967 to 2010[3].

Materials and Methods:

- Samples of both species from sites 1, 4, and 6 which are upstream, but downwind from the AOSR were prepared by Kershaw[3].
- *P. glauca* tree cores from the control site, southwest of Fort McMurray, were prepared by Marleau[5].
- All the samples were in the form of tree cores approximately 25-30 cm long.
- Using the Velmex program connected to a 63X microscope, we counted the tree rings and located the years 1960 (before the AOLS started producing), 1970 (after the AOLS started producing), and 2006 (after production at the AOLS doubled).
- We planned to scan the tree cores on the IDEAS beamline using XRF, XANES, and elemental mapping.
- XRF (X-ray fluorescence spectroscopy) is used to determine the elemental composition. XANES (X-ray absorption near edge structures) is used to find levels of specific elements of interest. Elemental mapping is used to do full scans of objects and create a 'map' of a specific element.

Results from a Previous Study Near the AOSR:

- The radial growth for *P. glauca* showed to be declining downwind from 2004 onwards[5] when production was doubled, as shown in Figure 2.
- 8 out of 18 elements identified through the IDEAS beamline were consistent throughout all the samples taken, Mn was the only of these elements to have a distinct pattern[5].
- All of the *P. glauca* samples downwind showed higher levels of Mn compared to the control, with the farther downwind having greater levels and causing adverse effects[5].
- All of the *P. tremuloides* samples showed higher levels of Mn and potassium (K), however, the amounts were not significant enough to cause adverse effects[5].

Similarly to Figure 3, we expect results throughout our samples to increase in Mn levels further away from the AOSR due to increasing oil sands production since 1967.

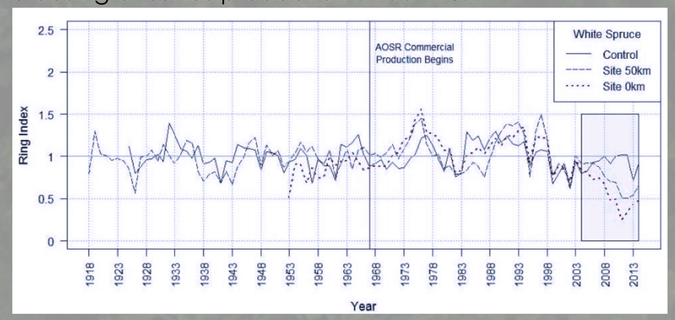

Figure 3. Radial growth in *P. glauca* downwind from the AOSR, declines are shown in the box starting at 2004[5].

References:

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FYRE on the beamlines

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