2004 ERA Laboratory Testing

What is Toxicity Testing?

Toxicity tests allow us to measure effects of metals in soil on plants and other organisms in our environment in a laboratory under controlled conditions. We set up experiments to grow plants and invertebrates in soil collected from different parts of Sudbury, and measure their responses to different metal levels in the soil.

What do we measure?

- Survival – do plants and invertebrates survive in different soils?
- Growth – are there differences in the growth of plants under different conditions? (example in Figures 1-4)
- Reproduction – are invertebrates able to reproduce in different soils?
- Avoidance – when given a choice, will an earthworm avoid soils with higher metal levels?

What will this tell us?

The overall question that the 2004 Field Study aimed to answer was:

- Do soil metals in Sudbury's natural areas present an unacceptable risk to forest ecosystems?

How can we answer this question?

We must determine:

- Will organisms chosen for the toxicity tests (test species) grow in Sudbury soils?
- Are there differences in effects between sites with high and low metal levels (i.e., is the effect less when metal levels are lower)?
- Are metals in the soil slowing the recovery of forest ecosystems in Sudbury?

Test Species

The first step was to make sure that test species to be used in the toxicity tests would grow in Sudbury soil collected from a site with very low metal levels (reference site). If a species doesn't grow well in any soil from Sudbury, it would make it difficult to see effects from metals.

We tested trees (trembling aspen, black spruce, and white spruce), plants and grasses (red clover, goldenrod and northern wheatgrass), and invertebrates (earthworms and springtails).

Are there differences between effects seen in soils with high and low metal levels?

To test this we conducted all tests in 2 soils; one with high metal levels and another that had very low levels (reference site). By testing the best- and worst-case scenarios, we can see immediately if metals are having any effect at all (see Figures 1 and 2).

Are differences due to metals or to pH of the sites?

Sudbury soils are naturally very acidic (low pH). Many plants and invertebrates do not grow well if pH is low. Also, the impact of metals in the soil on plant development may increase with low soil pH.

To test whether soil pH was causing the effects rather than metal levels, we increase the pH by adding lime to the soil. We then repeated all of the tests to determine if measured effects were from pH, metals, or a combination of both (Figures 3 and 4).

We will be able to answer this question in the next phase of testing. We plan to use soils collected along the lines of high to low metal levels. This will allow us to better understand if effects are due to different levels of metals in Sudbury soils.

Are soil metals slowing the recovery of forest ecosystems in Sudbury?

We will answer this question by combining all information collected for each site during the 2004 Field Program. First, we want to answer:

- Do metals in soil impact more than one of the tested species?
- Do plants decompose at different rates, depending on metal levels?
- Are essential nutrients important to plant growth present in the soil?
- Is the ecological diversity (types and numbers of plants) of the area high or low?
- Can we relate these factors to metal levels, pH or a combination of both?

Preliminary Results

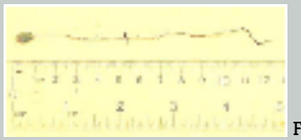

Figure 1

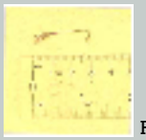

Figure 2

White spruce seedlings grown in soil from the reference site (Figure1) and a site with high metal levels (Figure 2). The difference in the size of the root and shoot between the sites is very clear (12cm versus 3cm). The plants did not grow well in the soil from the site with high metal levels.

Figure 3

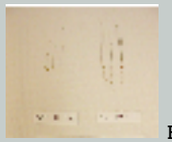

Figure 4

Figure 3 shows northern wheatgrass grown in soil from the reference site before and after adjusting pH.
Figure 4 shows the same grass grown in soil that has high metal levels before and after adjusting pH. Growth is different between the reference site and the high metal site. We can decrease these differences by adjusting pH, but they still exist.

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