

The Lord OF the Rings

What do tree rings reveal about pollution in Saint John, New Brunswick?

Prequel:

In 1960 the Irving Oil Company opened the Irving Oil Refinery in Saint John, New Brunswick (Irving Oil Inc., 2016). When Irving Oil Refinery upgraded in 1998 they incorporated modern wet scrubbers which remove sulfate and nitrate pollutants. These became operational in 2000, but particulate matter containing heavier metals can be missed by this process. It is predicted that the particulate matter generated by the refinery will bio-accumulate and adversely affect red spruce (*Picea rubens*) and white birch (*Betula papyrifera*) which are found in the Acadian forest surrounding Saint John, New Brunswick. The objective is to investigate the presence of copper and nickel in these trees and determine if the wet scrubbers used in the refinery are effectively eliminating these heavy metals. The presence of these elements will be examined by the beamline at the Canadian Light Source.

An Unexpected Correlation:

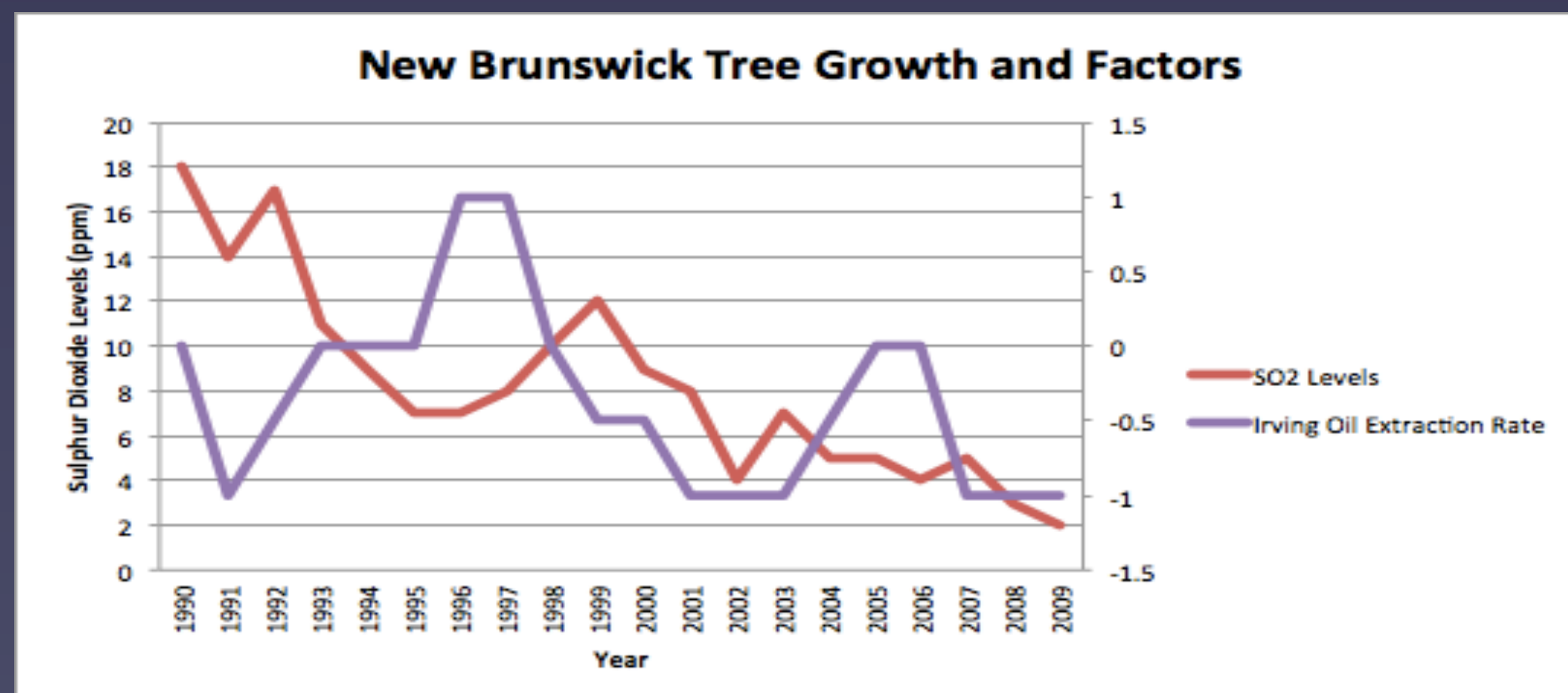


Figure 1.1 Sulfur dioxide levels in New Brunswick compared to the amount of oil extracted from the Irving Oil Refinery. Air quality tends to decrease as the production levels of Irving Oil Refinery increase (New Brunswick Department of Environment, 2013).

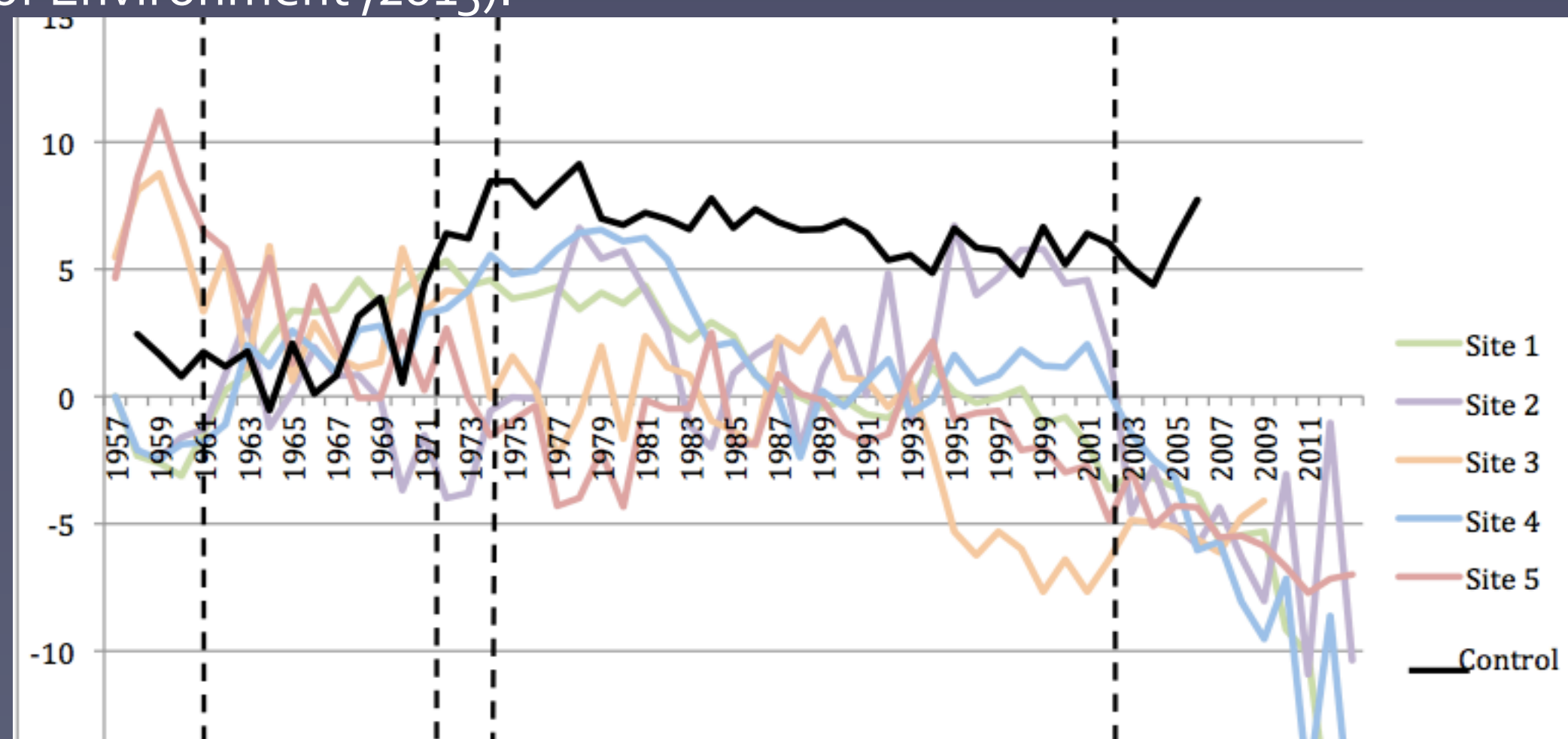


Figure 1.2 Tree growth downwind of the Refinery is declining while the control group possesses steady growth (Murray 2013).

Tree growth should correlate inversely with pollution and extraction rates, but it seems independent of either of these factors. We hypothesize that the decline in tree growth is a result of pollution from heavy metals and not from sulphur dioxide.

Desolation of Copper:



Tree growth does not correlate to SO₂ levels, however one of the major pollutants from Irving Oil Refinery is particulate matter. Particulate matter is composed mostly of copper and nickel which are heavy metals (Murray, 2013).

A study indicated that red spruce at higher elevations will uptake heavy metals in the atmosphere, which reduces its biomass (Taylor & Norby et al., 1986).



Figure 2. Two white birch trees that were both exposed to heavy concentrations of copper (1600 mg), but one exhibits a resistant genotype (Nkongolo & Theriault, 2016).

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Credits

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What to Expect in the Sequel:

To confirm whether or not copper is becoming bioavailable to red spruce as a result of pollution from the Irving Oil Refinery *The Fellowship* will use the Canadian Light Source (CLS). *The Fellowship* plan to use XRF's on the IDEAS beamline to scan for the presence and relative concentration of elements. We are looking at three primary factors of the pollution.

Presence:

To test for the presence of copper in red spruce trees we will scan sample chopped cores from Irving site locations. We will compare a control site upwind of the refinery (which should not be affected by the refinery pollution) with several locations downwind of the refinery to see if air pollution causes copper to become bioavailable.

Spread of Pollution:

Comparing the presence of copper between a control site and locations with distances of 0 km, 3 km, 5 km, and 7 km will tell us if and how far the pollutants are spreading and how far, the pollutants are spreading. We will also compare the relative concentrations between the locations. We expect the highest copper concentrations to be found 0 km away from the refinery.

Timeline:

By counting the years on the tree rings and comparing the concentrations of copper year by year to the history of Irving's upgrades (below) we will determine if the amount of oil produced by Irving has an effect on the amount of pollution. We will also determine if the implementation of scrubbers in 2000 reduced copper pollution.

