

IMPACT OF MINING ACTIVITY ON LAKE DUPARQUET SHORELINE FOREST DYNAMICS

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Objectives

Mining is a very important economic activity in the Abitibi region of northwestern Québec, Canada. The region was colonized less than 100 years ago and mining has played a predominant role in the rise and fall of many "boomtowns". One such town is Duparquet, located ca. 35 km northwest of Rouyn-Noranda. Duparquet was built around a gold mine and smelter that started its activities in 1932 (Côté, 1975). After the mine and smelter closed in 1955, the town managed to survive by turning to wilderness tourism (camping, hunting and fishing).

There are two ways in which the activities of the gold mine could have affected the local environment. First, the smoke coming out of the pipe must have contained large amounts of heavy metals, SO_x, NO_x, etc., causing significant air pollution. Second, mining wastes were dumped in the nearby Lake Duparquet, filling a large bay with sediments.

Our objectives were to determine (1) if air pollution had an impact on white spruce (*Picea glauca*) and trembling aspen (*Populus tremuloides*) growth; (2) if the effect on aspen was different than that on spruce; and (3) what species colonized the mine waste beach and when.

Material and methods

1. Effect of air pollution on growth of white spruce and trembling aspen

Two sampling sites were selected less than 2 km away from the smelter, one upwind and the other downwind from the mine (dominant winds are from the west). At each site, all white spruce trees > 18 cm were sampled (increment cores taken at breast height) and measured (diameter at breast height, DBH) inside a 15 m radius plot. In addition, three large trembling aspen were sampled in the same way in or near the spruce sampling areas.

The surface of the samples was finely sanded or prepared with razor blades. The tree rings were counted and the samples were crossdated using pointer years (narrow ring width, frost rings, light rings, and traumatic resin ducts for white spruce; narrow and wide rings for trembling aspen). Crossdating was statistically verified using COFECHA (Holmes 1983) and chronologies were built for each site and for the two species using ARSTAN (Cook 1985).

2. Colonization of the mine waste beach

A transect was set up on the mine waste beach, starting at the forest border (the former shoreline) and going towards the lake. Total vegetation cover was estimated in 4.5 m radius circular plots located every 100 m along the transect (7 plots, total). The number of individuals of all tree and shrub species was counted but only the largest individuals were sampled by sawing a disc at ground level. The discs were finely sanded and the trees were aged by counting the number of annual growth rings.

Results

1. Effect of air pollution on growth of white spruce and trembling aspen

The upwind and downwind residual white spruce chronologies start in 1914 and 1947, respectively. The upwind chronology shows an important growth reduction in the 1920s, followed by an increase and another decrease in the late 1930s and early 1940s. Growth increased again in the late 1940s and early 1950s to reach present levels. Growth was very similar at both sites during the period 1954-today. Prior to 1954, however, white spruce growth downwind the smelter was slower than upwind.

The standard trembling aspen chronologies start in 1912 (upwind) and 1948 (downwind), respectively. These dates are similar to those for white spruce, indicating that both species established at the same time, probably after stand-replacing disturbances (fire or logging). No particular growth trend is detectable in the aspen chronologies, except a decrease in growth in the 1950s at the upwind site.

2. Colonization of the mine waste beach

The mine waste beach is largely dominated by sedges and grasses with scattered and mostly small individuals of several tree and shrub species. Willows (*Salix* spp.), cottonwood (*Populus balsamifera*) and paper birch (*Betula papyrifera*) were the most important tree and shrub species on the mine waste beach. A few individuals of balsam fir (*Abies balsamea*) and dogwood (*Cornus stolonifera*) were found less than 300 m from the forest edge. White spruce is also more abundant close to the edge but can be found all the way down to the lakeshore, 700 m away. Finally, some small individuals of eastern white cedar (*Thuja occidentalis*) and trembling aspen were also observed.

The vegetation cover varied between 40 and 90% within the first 300 m from the forest edge, but was less than 10% further down the transect. Using the ages of the oldest individuals sampled, we determined that the first 200 m of the transect were colonized by white spruce and paper birch between 1977 and 1983. The next 100 m were first occupied by paper birch and cottonwood between 1986 and 1989. The latter species also colonized the following 100 m in 1993. Finally, paper birch colonized another 100 m in 1996. The last 200 m are covered by sedges, grasses, and very young (< 5 year-old) trees and shrubs.

Conclusion

With such a small sample, it is hard to untangle the complex disturbance dynamics that white spruce and trembling aspen have experienced over the last 100 years. These disturbances must have been of natural causes, such as insect outbreaks (spruce budworm, forest tent caterpillar) and forest fires, or human-driven, such as logging and mining activities. Nevertheless, a clear difference in growth pattern between the upwind and downwind white spruce chronologies (with the latter showing a slower growth compared to the former) between 1947 and 1954 tends to indicate that mining activity (which stopped in 1955) had an impact on the growth of white spruce (possibly by emission of airborne pollutants). Trembling aspen seems to have been affected in a lesser extent (if at all) by the activities of the Duparquet gold mine. One possible explanation for this would be that, while trembling aspen sheds its leaves every autumn, needles can stay on a white spruce tree for a few years. Thus, clogging of stomata and other porous tissues by pollutants would have a more pronounced effect on white spruce. A higher number of sampling sites as well as larger samples would better facilitate our ability to distinguish the pollution signal from other disturbances such as insect outbreaks, forest fires, and logging activities.

Colonization of the mining residuals area started lately but proceeded quickly. The oldest trees and shrubs established in 1977, more than 20 years after the mine was closed and the smelter had shut down. However, the date of establishment of the analyzed trees and shrubs could have been underestimated because we might have missed some tree rings by sampling at ground level and not at the level of the root collar (DesRochers and Gagnon, 1997). The area is presently dominated by sedge and grass species with few, mostly stunted trees and shrubs. White spruce show desiccation of stem and branch tips. This might be due to high levels of salt or to freezing in early spring. Finally, a strong edge effect is clearly visible as percent vegetation cover is at least 4 times higher near the edge (< 300 m) than further away. Species like balsam fir, white spruce and dogwood seem to take advantage of this edge effect.

References

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