Clear Cutting Causing Long-term Declines in Forest Productivity?

Implications of the Forestry Strategy

Dale Prest
Sackville
dale@forestsinternational.org

Dale Prest, Ecosystem Services Specialist with Community Forests International, holds a Masters in Earth Science and is a small woodlot owner.

Soils have long been treated as an inanimate substrate from which good things arise; that is, treated like dirt. However, many farmers, gardeners and woodlot owners have long known that this is not the case. Now, science has been catching up in recent decades, confirming that soils are complex systems, where biology, geology and chemistry come together to form the basis of productivity and of much of our economy. In particular, forest soil researchers are now showing the folly of the professional foresters neglect of forest soils, as it is these soils that ensure a sustainable and productive yield of timber into the future.

My own research[1] was undertaken in a region of Nova Scotia with soils and forests very similar to parts of New Brunswick. Walking in the Red Spruce dominated forests of the Eastern Shore of Nova Scotia, one would be forgiven for thinking one were in the Fundy forest: Red Spruce, Yellow Birch, and maples. My work compared two sites that were managed identically until the 1970s. In 1976 one of the sites was clear-cut, while the other one remains intact to this day. Today the clear cut site is a stand of 35 year old Red Spruce and Balsam Fir, while the second site is a stand of 120 year old Red Spruce. Both sites share the same climate and forest cover, with only minor differences between the two in terms of soil.

What I found was that the 35-year-old site now has 27% less organic matter in the top 50 cm of soil, and 26% less nitrogen. That these two soil components have shown a parallel decline compared with the 120 year old site is not a surprise; in our coarse soils just about the only thing that retains nutrients like nitrogen, potassium and calcium, is organic matter. If you lose organic matter in your soil, the nutrients will also be lost.

Indeed, any farmer will tell you that two of the most important things to have in your soil if you wish to grow healthy, abundant crops is organic matter (for example green manure) and nitrogen. Without large additions of the two at the right times of the year, farmers would be out of business. The implications of losing soil organic matter and nitrogen on timber yields and forestry are just as severe (albeit over a longer rotation).

Other researchers have also encountered this trend. Dr. Amanda Diochon, doing research for her PhD[2] at St. Francis Xavier University, found that organic matter loss from soils continues for 40 years following clear cut harvesting. It takes 70-80 years for the organic matter to rebuild to the levels present prior to clear cutting.

Inputs of organic matter into the soil are crucial to sustaining soil organic matter, thereby sustaining soil nutrients. Inputs come in the form of deadwood from above and through roots in the form of root growth and sugars injected into the soil. Clearcutting dramatically reduces both of these inputs.
Photo by D. Prest

This suggests that harvest rotations less of than 80 years will inevitably result in a sustained loss of organic matter – and as previously stated, lead to a continued loss of nutrients from our forest soils.

Researchers from Dartmouth University[3] determined that hardwood forests in New Hampshire subject to the greater soil disturbances that occur during clear cutting, suffered greater losses of organic matter than during other forest harvesting practices. These losses of organic matter are still detectable for at least 50 years after harvesting. New Brunswick shares many of the same hardwood tree species with New Hampshire.

These recent insights prompted leading forest scientists,[4] on December 6th, 2013, to urge the scientific community to rethink and re-examine the accepted paradigm that clear cut harvesting has little effect on soil organic matter.

Nitrogen is one of the most important nutrients that sustain productivity on land, and is the nutrient most often in short supply. When added, it most often yields the greatest benefit. Scientists have long known that clear cutting greatly increases nitrogen loss from forests.[5] In particular, when herbicide treatments are used scientists have found nitrogen in groundwater may increase up to 56 times over the two years following harvest as compared to prior levels.[6, 7]

This loss of nitrogen following clear cutting is now being detected in soils, and apparently lasts for decades. Research now underway in the Maritimes suggests that nitrogen levels in forest soils continue to decrease for up to 70 years following cutting. It takes up to 120 years for the nitrogen to recover to pre-harvest levels. This work suggests that any clear-cut rotation of less than 120 years is likely to be unsustainable.

These are important points to consider for anyone concerned about sustaining jobs in rural New Brunswick.

Could it be that we are already experiencing the effects of forest productivity loss as a result of clear cutting? And how would we recognize such a loss?

A forest is a very complex system. However, there are things that we can look at anecdotally that may suggest such a trend of decreasing productivity in forest soils.

I would look for signs that our forests are not growing as quickly as we think they should. Plantations that were expected to be ready for harvest by a specific date may need additional time to produce the desired wood volumes. I would look for signs that some tree species, such as Balsam Fir, which require higher quality soils, may not grow as vigourously as they did in the past. I would look for signs of an increase in the occurrence of species that thrive on low quality, mineral soils, particularly if these species are dominant in the early years following clear cutting. Ecologists call these species pioneer species, because they are the first tree species to colonise area following a disturbance, such as a clear-cut. In forested habitats, Pin Cherry, poplars and White Birch are examples of these early successional stage species.

Could other factors account for such observations? Undoubtedly. Nonetheless, these are the very things one would expect to observe if our forest soils are suffering from a loss of organic matter and nutrients. In the absence

When forestry operations avoid opening the tree canopy too much – less than 10 m some researchers suggest – soil nutrient dynamics aren't necessarily altered, suggesting that soil organic matter is conserved and will continue to sustain healthy timber yields long into the future. Photo by D. Prest

of long-term studies over several decades and rotations, and in a funding climate often hostile to such investigations, these may be the "canaries in the coal mine" for our soils.

Currently, predictions of forest growth form the basis of how much we think we can sustainably cut. These predictions are based on models that I do not believe realistically incorporate new scientific findings. These findings suggest that short rotation clear cut harvesting results in an unsustainable loss of nutrients from our soils, and likely reduces the productivity of our forests. In modeling science there is a saying: "Garbage in; garbage out." If models are not using the best data from the best science to perform their analysis, then the outputs will be close to worthless. It follows that the policies built upon these outputs will be worth even less.

Clear cutting exposes forest soils to increased temperatures, which is known to increase rates of decomposition. In particular, when forest operations tear into the mineral soil losses of organic matter from the soil have been shown to be even worse.
Photo by J. Simpson

References

1 D. Prest, L. Hellman and M.B. Lavigne. 2014. Mineral soil carbon and nitrogen still low three decades following clearcut harvesting in a typical Acadian Forest stand. Geoderma, 214-215, pp. 62-69.

2 A. Diochon, L. Kellman, and H. Beltrami. 2009. Looking deeper: An investigation of soil carbon losses following harvesting from a managed northeastern red spruce (*Picea rubens* Sarg.) forest chronosequence, *Forest Ecology and Management*, 257, pp. 413-420.

3 L. Zummo and A. Friedland. 2011. Soil carbon release along a gradient of physical disturbance in a harvested northern hardwood forest, *Forest Ecology and Management,* 261, pp. 1016-1026.

4 T. Buchholz, A. Friedland, C. Hornig, W. Keeton, G. Zanchi and J. Nunery. 2013. Mineral soil carbon fluxes in forests and implications for carbon balance assessments, *Global Change Biology and Bioenergy,* doi: 10.1111/gcbb.12044.

5 F. Bormann, G. Likens, D. Fisher, R. Pierce, 1968. Nutrient loss accelerated by clear-cutting of a forest ecosystem. *American Association for the Advancement of Science*, 159 (3817), pp. 882-884.

6 G. Likens, H. Bormann, N. Johnson, D. Fisher and R. Pierce. 1970. Effects of forest cutting and herbicide treatment on nutrient budgets in the Hubbard Brook Watershed Ecosystem. *Ecological Society of America*, 41 (1), pp. 23-47.

7 P. Vitousek and P. Matson, 1985. Disturbance, nitrogen availability and nitrogen losses in an intensively managed loblolly pine plantation. *Ecological Society of America*, 66 (4), pp. 1360-1376.