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FRONTLINE EXPRESS

Canadian Forest Service – Great Lakes Forestry Centre

Ensuring long-term productivity of forest ecosystems

INTRODUCTION

One of the goals of forest management is to sustain site productivity so that repeated harvests can be undertaken without loss in growth potential. Canada promotes the development of sustainable forest management practices and aims to demonstrate to the public and its international trading partners that Canadian forest practices will maintain and enhance ecosystem conditions and productivity over the long term. These goals are supported by the Canadian Council of Forest Ministers' (CCFM) Criteria and Indicators of Sustainable Forest Management.

Currently there is renewed concern about the long-term effects of harvesting woody materials that have traditionally not been removed from the site for use as a source of bioenergy. All forest harvesting systems leave tree tops and branches distributed across the logged area. In general, stem-only logging leaves greater amounts than full-tree logging, where materials are concentrated in piles at the roadside. This woody material, or slash, is either burned or left to decompose, returning nutrients for to the soil. In the case of full-tree logging however, there is concern that roadside slash piles do not return the nutrients across the site, possibly leading to long-term site degradation. Similarly, if woody material is moved off site to be used for bioenergy, it is important to evaluate whether the resulting loss of nutrients will have long-term consequences on site productivity. These issues are being examined by scientists with the aid of long-term soil productivity studies that have been established throughout the boreal regions of Ontario.

GREAT LAKES FORESTRY CENTRE (GLFC) ROLE

GLFC researchers began studying nutrient cycling (movement) in jack pine ecosystems in 1968. Studies of other ecosystems including black spruce, boreal mixedwood and tolerant hardwoods were added in the late 1970s. Then in 1993, a comprehensive study was initiated to investigate the impacts of various harvesting and forest practices on nine jack pine sites in north-central Ontario. The sites were representative of the range of productivity for jack pine, which typically grows on nutrient-poor soils that may be vulnerable to site degradation. At that time, scientists were responding to the Ontario Environmental Assessment Board's requirements that the effects of full-tree logging on long-term site productivity be examined. In a parallel and complementary fashion, the Ontario Ministry of Natural Resources (OMNR) began conducting similar studies on black spruce ecosystem productivity at nine sites in north-western Ontario.

In 1996, the Canadian Forest Service (CFS) and the OMNR joined a similar United States effort that had been underway since 1989 and the 18 Ontario sites became part of a network, known as the Long-Term Soil Productivity Research (LTSP) study. There is a total of more than 100 sites in the LTSP study, the rest of which are in British Columbia and throughout the United States (Figure 1). Together they constitute the largest network of research sites in the world that examines forest management practices and their impacts on site productivity. GLFC scientists are co-leading the joint Canada-United States and CFS-OMNR studies as well as monitoring and managing the Ontario jack pine sites. They are also involved in new national initiatives directly addressing biomass harvesting. In addition, CFS and OMNR have formed a joint technical working group to address issues surrounding the bioeconomy, such as identifying research needed on the ecological impacts of increased biomass removal to ensure the sustainable use of forest biofibre in Ontario.

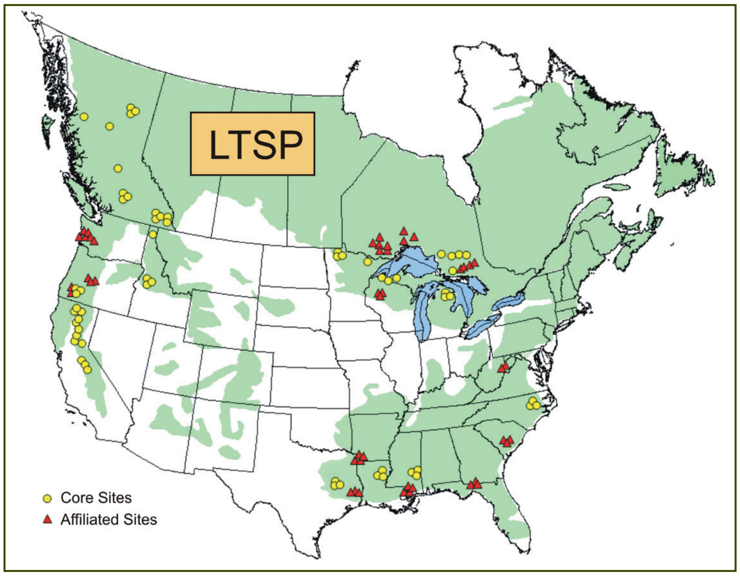

Figure 1. Long-term Soil Productivity (LTSP) network.

GLFC scientists Rob Fleming, Paul Hazlett, Kara Webster and Isabelle Aubin are coordinating a series of studies that look at the impact of forest management practices on various factors affecting site productivity. They are measuring fine root production, biomass allocation, net primary production, nutrient use, soil nutrient content and availability, soil respiration and understory species interactions. By quantifying the effects of removing biomass and forest floor materials, soil compaction resulting from heavy equipment, and vegetation control they will have a better understanding of the interaction between soil physical and chemical properties, overstory and understory vegetation response and forest productivity.

The focus of the studies is on how to mitigate the possible effects of harvesting on long-term site sustainability by moderating operating procedures, particularly those affecting soil porosity and organic matter content. These two properties affect soil temperature, water and gas exchange, soil microbial activity, soil pH (acidity) and nutrient supply, as well as rooting patterns and plant species composition. These studies may lead to recommendations involving harvesting and silviculture procedures that reduce negative impacts and retain soil carbon and nutrients on-site, either through modifications to operating procedures or subsequent site amelioration. Soil carbon both enhances site productivity by improving soil structure, water retention and floral and faunal diversity, and sequesters this element, reducing atmospheric CO_2 concentrations.

The jack pine field experiments are now over 15 years old and approaching a stage of rapid tree growth and high resource demand, when harvest impacts on site productivity are most likely to become evident. Thus results over the next decade will be invaluable in terms of defining treatment effects, suggesting guidelines and standards, and developing site amelioration procedures.

WHAT IS KNOWN SO FAR

To this point results have shown some variation across the range of site conditions, but general trends can be seen. Soil compaction has had little effect on soil bulk density or tree growth, likely due to frost action, root growth and high stone content in these coarse, sandy soils. Initially, growth was often greater with blading (forest floor removal) because of improved microclimates, but after 15 years, trees on these sites show a decrease in productivity (Figure 2). On the more productive sites, jack pine biomass increased where herbicide treatments were combined with site preparation. Although at this point neither soil carbon reserves nor tree growth have been significantly affected by full-tree logging, there is a positive relationship between stand productivity and the total amount of carbon on site after harvest (Figure 3).

The relative importance of various physical, chemical and biological processes varies with time, which supports the importance of long-term monitoring. For example, soil microclimate (temperature and moisture) is most important at the time of seedling establishment, whereas at the onset of rapid growth, soil nutrient demands increase. Once the canopy closes, nutrient demands peak and carbon and nutrient reserves may be at their lowest levels.

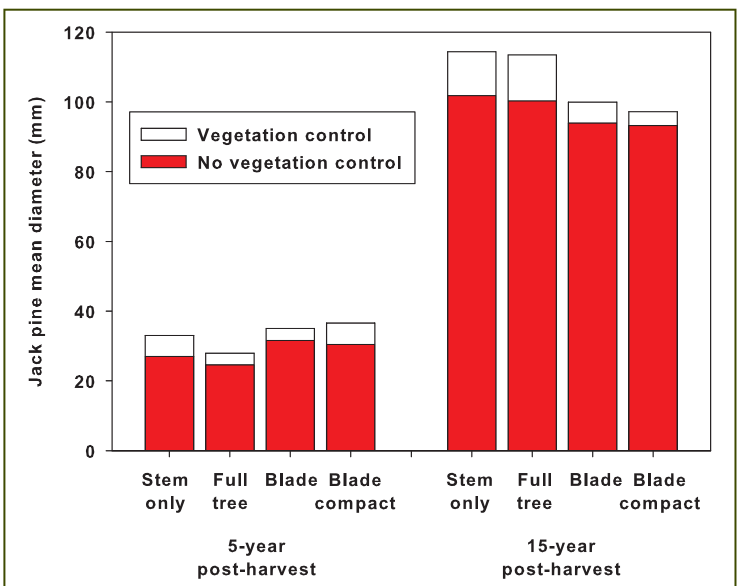

Figure 2. Impact of harvesting treatment on jack pine growth.

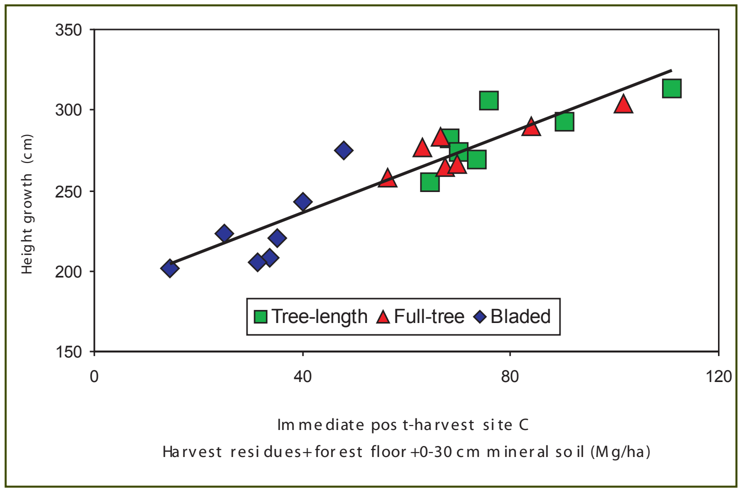

Figure 3. Impact of site carbon on 10-15 year height growth.

Ongoing studies are intended to increase our understanding of the effects of the different treatments on plant growth processes and site productivity. Future studies being considered include: 1) the importance of coarse woody debris and individual plant species to nutrient retention and availability; 2) short-rotation harvests; and 3) amelioration using fertilizer applications.

Collaboration between resource managers and researchers is being facilitated by access to the network of biomass harvest sites across Canada and to LTSP sites throughout North America. Syntheses of information and results from across these studies greatly increases our knowledge base and explanatory power, and broadens our ability to forecast results in given locations.

PRINCIPAL COLLABORATORS

- Centre for Northern Forest Ecosystem Research, OMNR
- Ontario Ministry of Natural Resources and Forestry
- Laurentian Forestry Centre (CFS)
- Pacific Forestry Centre (CFS)
- British Columbia Ministry of Forests and Range
- USDA Forest Service

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