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Canadian Forest Service – Great Lakes Forestry Centre

Impacts of biomass harvesting on forest sustainability: The Island Lake study

INTRODUCTION

There has been a growing interest in harvesting biomass for energy and non-timber forest products. This has evolved due to efforts to stimulate the bioeconomy to offset the decline in markets for traditional wood products and to mitigate climate change. In Ontario, for example, the annual area of forest harvested declined from 210,000 hectares (ha) in 2005 to 100,000 ha in 2010, and this has had a serious economic impact on many forest-dependent communities.

While development of the bioeconomy has potential for many economic, environmental and social benefits, there remains concern about the impacts of biomass harvesting on the long-term sustainability of the forest. A federal-provincial Bioeconomy Technical Working Group was established in 2009 with the goal of developing collaborative science and knowledge transfer opportunities. Subsequently, the Island Lake Biomass Harvest Research and Demonstration Area was established near Chapleau, Ontario, as an important component in developing a comprehensive assessment of the ecological sustainability of biomass harvesting.

The project is a collaborative initiative that includes the Canadian Forest Service (NRCan-CFS) and the Ontario Ministry of Natural Resources and Forestry (OMNRF), as well as industry (Tembec, Ontario Power Generation), First Nations (Northeast Superior Chiefs Forum) and local forest-based communities (Northeast Superior Forest Community).

GREAT LAKES FORESTRY CENTRE ROLE

Researchers from the Great Lakes Forestry Centre and OMNR have collaborated for more than 20 years on research studies that examine the effects of biomass harvesting on soil processes and long-term site productivity in northern Ontario. These studies have focused on stand growth and soil nutrients and are part of the international Long Term Site Productivity Network that includes sites in British Columbia and throughout the United States.

The new Island Lake study explores the issue of sustainability further by examining a more complete range of biomass removals and including forest biodiversity assessments. Of particular note is the wide group of taxa under study, from microbes to insects and vegetation. Researchers are hoping to determine if those groups respond in a similar way to biomass removal and to identify interactions among them as well as with soil processes. The aim is to develop a more comprehensive knowledge of biodiversity response and develop integrative indicators that could be used to conserve biodiversity and sustain site productivity over the long term.

Study site and experimental treatments

The study site is a 40-year-old, second-growth jack pine stand originally clear-cut harvested in 1959. For this study, harvesting took place between December 2010 and January 2011; a total of 49.2 ha was harvested and an uncut area of 8 ha was kept as a control block.

Four experimental biomass removal treatments representing a gradient of intensity were installed. These included (from least tree biomass removed to most) 1) stem-only harvest; 2) full-tree biomass harvest, which included removal of traditionally non-merchantable trees; 3) full-tree biomass harvest with stump removal; and 4) removal of all biomass, including downed woody debris (DWD) and the forest floor by blading.

After logging, the area was site prepared using disc trenching. Plots measuring 70 metres (m) by 70 m in size were established in each of the treatments in a randomized block design, with five replicates of each of the treatments (see Figure 1). Half of the plots (split plots) were then treated with herbicide and were planted with jack pine or black spruce.

In addition, the stem-only and full-tree biomass removal treatments were replicated on old landing sites from the 1959 harvest to investigate the cumulative impact of soil disturbance. These old landing plots are expected to fast forward potential impacts of

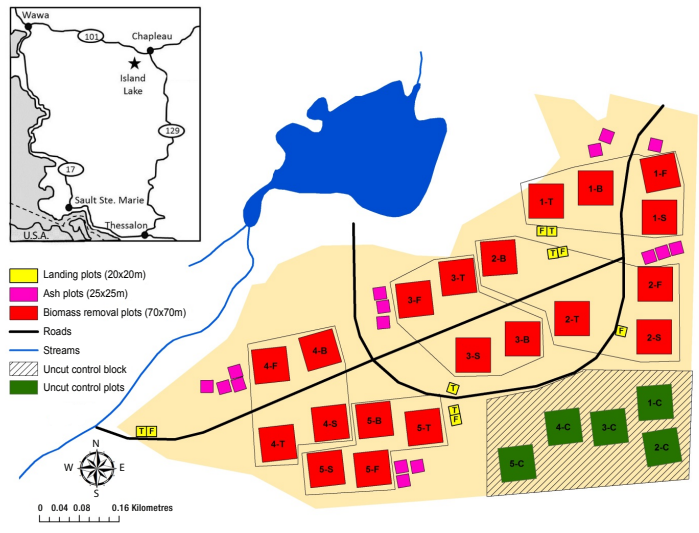

Figure 1. Plot layout at the Island Lake Biomass Harvest Research and Demonstration Area. T refers to stem only harvest, F to full-tree harvest, S to full-tree harvest with stumps removed, B to full-tree harvest with blading, and C for control area.

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biomass removal on sustainability, as the forest floor and some upper mineral soil were removed at that time by blading.

Wood ash application plots were also established in buffer areas adjacent to biomass removal treatment areas, using ash from Tembec's Chapleau co-generation facility. This treatment is intended to increase calcium content of the soil, which is an element of interest due to its high content in woody materials removed during harvest and its depletion in forest soils due to acid deposition.

Assessments

Before harvesting, stand attributes such as tree diameter, height and species were recorded to establish a baseline for comparison with the post-harvest treatments. Vegetation sampling was also carried out to record the presence of species and the vertical structure of the understory. A select number of trees were felled for component chemical analysis. The distribution of biomass by tree components (stemwood, bark, branches and foliage) was calculated using equations derived from previous studies. Trees were also removed and discs cut at 1-m intervals to generate height-age relationships and calculate a site index (an index of site productivity that can be used to compare site quality).

The amount of DWD by species, size and degree of decay was measured, and this information, combined with data on carbon and nutrient concentrations, was used to calculate nutrient loading of the DWD.

Soil pits were dug to characterize soils in each experimental plot and collect samples for chemical analysis.

Microclimate, including air temperature, relative humidity, precipitation, solar radiation and wind, as well as soil temperature and moisture will be monitored to assist in interpreting differences in ecosystem processes.

Stand assessments will include seedling survival, natural regeneration, plantation growth and soil and soil solution properties (acidity, carbon and nutrients) following harvesting.

Studies are underway to investigate how understory vegetation, soil microbial communities (fungi and bacteria) and soil microfauna (nematodes) and macrofauna (invertebrates) are impacted by and recover from biomass harvesting. All of these "non-tree" taxa play an important role in providing ecosystem services in the regenerating forest.

Preliminary results

Measurements of the volume of DWD biomass showed a retention gradient across the treatments: 84.2 m^3/ha for stem-only removal, 28.8 m^3/ha for full-tree biomass removal, 24.0 m^3/ha for stumped areas and 0 m^3/ha for bladed plots. Likewise, an assessment of total ecosystem carbon pools showed that a gradient of removal and retention was achieved. Figure 2 shows the carbon retention by each ecosystem component measured (soil layers, DWD, slash and standing wood) for each of the four treatments and the uncut control area.

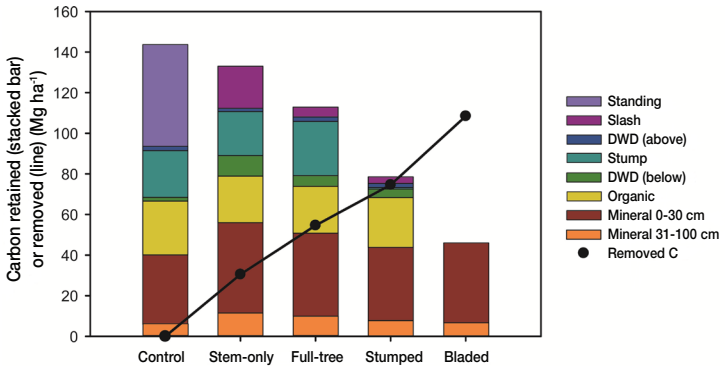

Figure 2. Carbon removal and retention

CONCLUSION

Studies that look at many aspects of the ecosystem over the long term are important to develop a fuller understanding of impacts of biomass removal and biomass retention on forest sustainability. The comprehensive monitoring that is being carried out will contribute to the development of appropriate guidelines for biomass removal.

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POLICY PERSPECTIVE

Natural Resources Canada has a mandate to conduct research relating to the protection of Canada's forest resources under the *Forestry Act* and long-term sustainability of the forest is a goal supported by the Canadian Council of Forest Ministers. It is important to Canadians and our international trading partners that we conduct environmentally responsible forest management, which includes the maintenance of site productivity, healthy soil and water, and conservation of biodiversity.

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