some ecological effects of shelterwood harvesting and site preparation in white pine forests

Site description, study design, and treatments

Andrée E. Morneault[1]

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Background

Eastern white pine (*Pinus strobus* L.) is an ecologically, socially, and economically important forest tree species of the Great Lakes-St. Lawrence and souther[1]n boreal forest regions (Rowe 1972) of eastern Canada. White pine represents 11% of the coniferous volume and 5% of all species in the Great Lakes-St. Lawrence forest region (Lowe 1994). Almost 80% of all forest-dwelling wildlife species use white pine forests for some aspect of their habitat requirements (Naylor 1994). White pine is the arboreal emblem of Ontario and white pine forests are highly desirable for recreation (Old Growth Policy Advisory Committee 1993). Historically, white pine was the most economically important Great Lakes-St. Lawrence conifer species. In the 19th century, through the sale of timber berths and the collection of timber dues, white pine generated nearly 30% of all revenue collected by the provincial treasury, financing schools, roads, and other necessary services and functions provided by the Government of Ontario (OMNR 1984). Today, the domestic and international demand for timber of medium and high quality is generally strong. Prices for mill-delivered white pine logs are high, largely because the supply of good quality white pine is limited (OMNR 1993).

Unfortunately, the pine resource in eastern North America has been reduced (Horton and Bedell 1960, OMNR 1993, Corbett 1994). Possible reasons for this decline include: (1) removal of seed sources over large areas, (2) logging replacing fire as the major disturbance (3) poor seedbed conditions in second-growth forests (4) ability of hardwoods to revegetate rapidly under short-rotation harvest, and (5) in areas of high deer populations, deer browsing (Maissurow 1935, Hough and Forbes 1943, Cwynar 1977, Foster 1888; all cited in Frelich 1992). The current supply of white pine in the Great Lakes-St. Lawrence falls short of forest industry's demand (OMNR 1998). On operational sites where the shelterwood system was applied in the 1970s and 1980s, surveys in the late 1990s indicate that white pine regeneration has been inconsistent (Pinto, unpublished data). Successes have occurred in areas where scarification was timed with a good seed year or sites were planted following scarification, and where competing vegetation was controlled. Diminished white pine regeneration associated with the competitive effects of woody and herbaceous species has been reported elsewhere (Stoeckeler and Limstrom 1950, Day and Carter 1990, Elliot and Voss 1995, Leak et al. 1995).

In Ontario, the *Crown Forest Sustainability Act* (RSO 1995) requires that silvicultural practices regenerate target tree species, but also maintain ecological sustainability. However, white pine stands managed under the shelterwood system on productive sites cannot be successfully regenerated without seedbed preparation and control of competing vegetation. Early intervention, in the form of mechanical and/or chemical site preparation, helps to provide acceptable growing conditions early in the establishment phase. To be acceptable, these interventions must be both effective and economically justifiable.

Study Objectives

The objectives of the study were to examine the effects of the seeding cut of the shelterwood system and 4 site preparation techniques on white pine ecosystems, including:

- Overstory (health, seed production, growth, genetic diversity)
- White pine regeneration (artificial regeneration, natural regeneration, ecophysiology, response to competition)

Other ecosystem components (plant diversity and succession, carabid beetles, redback salamanders, downed woody debris, nutrient dynamics)

Site Description

The study is located 65 km north of Parry Sound, near Britt in central Ontario (50°80', 54°85') (Figure 1). In 1995, the study plots were located in 90- to 100-year-old stands dominated by white pine with minor components of red pine (*Pinus resinosa* Ait.), trembling aspen (*Populus tremuloides* Michx.), and white spruce (*Picea glauca* (Moench) Voss). These Site Class 2 (Forest Resources Inventory) white pine sites were classified as Ecosite 11 (white pine-red pine, fresh to moist) based on the Central Ontario Forest Ecosystem Classification System (Chambers et al. 1997). Soils vary over short distances but are most commonly medium sandy loams, less than 30 cm deep, dry to moderately fresh, and very rapid to well drained. Pre-

[1] Forest Research and Development Section, Ontario Ministry of Natural Resources, North Bay ON

treatment stand basal areas ranged from 35 to 40 m^2/ha. Understory vegetation was dominated by balsam fir (*Abies balsamea* (L.) Mill.), red maple (*Acer rubrum* L.), trembling aspen, low sweet blueberry (*Vaccinium angustifolium* Ait.), beaked hazel (*Corylus cornuta* Marsh.), bracken fern (*Pteridium aquilinum* (L.) Kuhn), and wild raisin (*Viburnum cassinoides* L.), with very little advance reproduction of white pine.

Study Design

The study was established using a randomized complete block design, with 5 treatments replicated in 3 blocks. The treatments are:

NC: no cut, no site preparation
C: cut (1997) and no site preparation
M: cut (1996) and mechanical site preparation (1997)
H: cut (1996) and chemical site preparation (1997)
MH: cut (1995) and both mechanical (1996) and chemical site preparation (1997)

Blocking was based on site characteristics. Blocks are separated by several km and differ in total pre-harvest basal area of pine and moisture regime. Treatment plots measure 100 m x 50 m and are surrounded by a 30-m buffer. (Figure 1).

Treatments

Before harvest, plots were marked to retain 50% crown closure in dominant and codominant trees, following the OMNR tree marking guidelines (OMNR 1998). Marked trees measuring greater than 10-cm diameter at breast height (DBH) were removed and stand basal areas were reduced from an average of 37.5 m^2/ha to an average of 20 m^2/ha. Experienced operators manually felled and tree-length skidded the marked trees. Designated plots were mechanically site prepared in early fall using a 6-way blade mounted on a D4 bulldozer. This treatment mixed leaf litter, duff, and mineral soil, uprooted some woody competitors, and displaced woody debris into small piles. Mineral soil exposure and mixed duff and soil covered an average of 25% of treated plots, similar to operationally treated areas. Chemical site preparation was applied in late summer by broadcast spraying Vision® herbicide at 2.1 kg a.e. ha^{-1} using a mist blower mounted on a rubber-tired skidder. On the combined mechanical scarification and chemical treatment plots, the herbicide was applied 1year after the mechanical treatment. Based on a survey done in 1998, spray coverage averaged 69% of plots treated with herbicide alone, and 75% of plots treated with the herbicide treatment after scarification. Spray coverage depends on many factors; here the main one appeared to be residual balsam fir, which blocked the spread of herbicide resulting in islands of untreated area behind them. Each treatment plot was planted with 1-year-old white pine Jiffy container stock on May 6-8, 1998 using operational standards (2.7 x 2.7-m spacing).

Interim results for each study component are provided in separate factsheets.

For more information contact:
Andrée Morneault (andree.morneault@mnr.gov.on.ca;
(705-475)-5566

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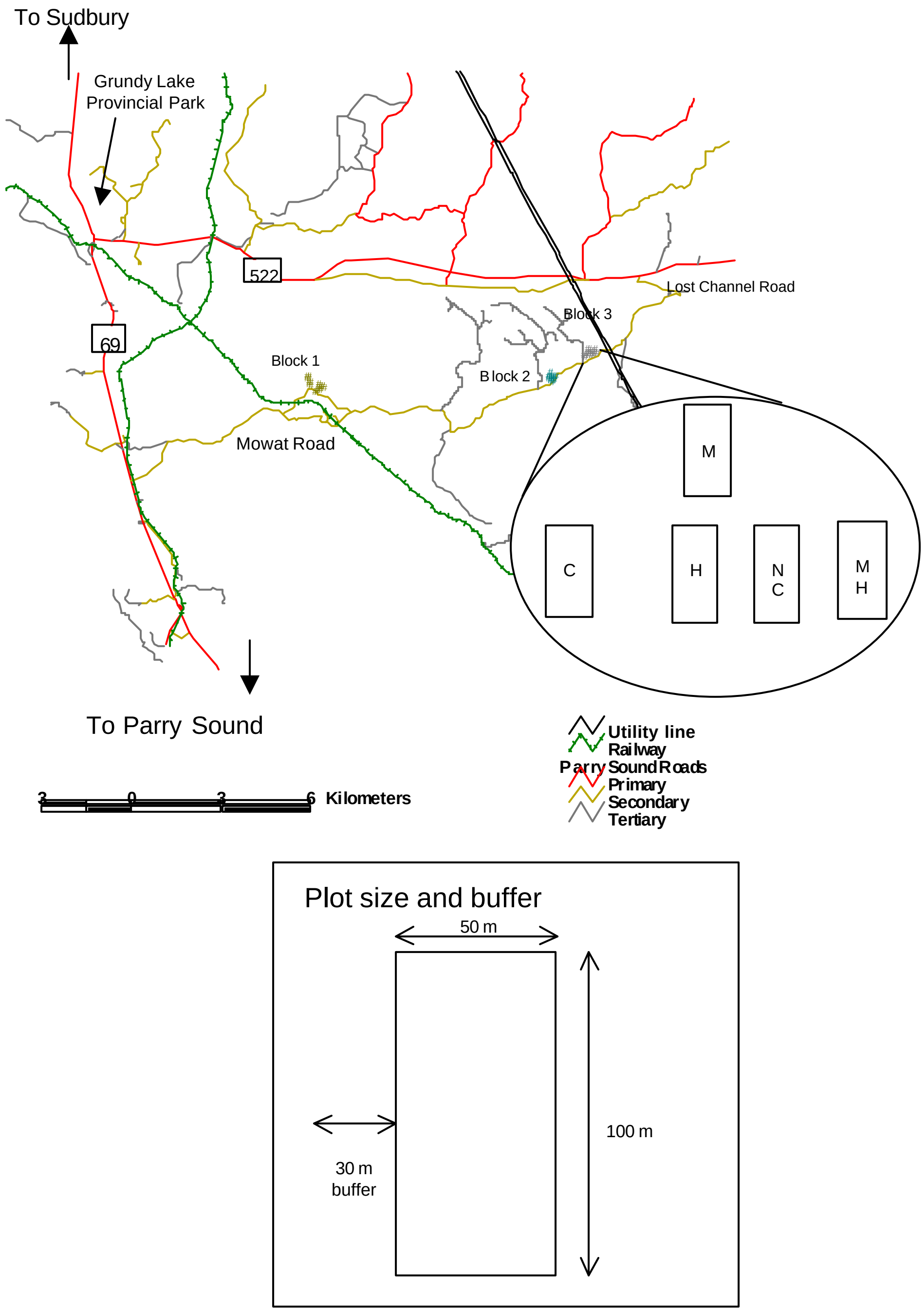

Figure 1. Study location and block layout with an example of the plot arrangement in Block 3 (oval) and plot layout (square).