Response of Advanced White Pine to Release

Project Number: 160-103

Literature review

The shelterwood silvicultural system has been recommended for the regeneration of white pine in central Ontario for 25 years or more. This system consists of a series of partial harvests (preparatory, regeneration, first removal) followed by a final removal cut (OMNR 1998). The partial harvests are aimed at creating a residual overstory with 40-50% crown closure and understory light levels near 50% of full sunlight. Operationally, the timing of sequential harvests is determined by the size, condition, and abundance of regeneration. Traditionally, a period of 20 years between harvests has been recommended. Application of silvicultural treatments matched to site and stand conditions that enhance the growth of established white pine regeneration will probably greatly reduce the period between harvests. Unfortunately, the response of young pine to silvicultural treatments under the shelterwood system is poorly understood (Hibbs and Bentley 1987). In addition, the intensity of harvesting that optimizes seedling growth and quality and minimizes the degree of logging damage to residuals and regeneration, needs to be identified. A thorough search of the scientific literature that included theses from the University of Toronto, Harvard University, and Yale University, indicated that there is currently a critical lack of research information on the timing and intensity of shelterwood harvests.

The shelterwood system is used to emulate the natural disturbance regime of white pine dominated stands in the GLSL forest region (OMNR 1998). Recurrent, low intensity surface fire (20-30 years), and less frequent stand replacing fire (100-150 years) enhanced the regeneration of white pine by reducing the overstory canopy and preparing seed bed (Van Wagner and Methven 1978, Heinselman 1981). Survival of scattered overstory trees provided a source of seed and sheltered the forest floor, improving the potential for natural regeneration of this moderately shade-tolerant species (Hannah 1988, Smidt and Puettmann 1998). Partial shading also reduces damage from pine weevil and blister rust (Sullivan 1961, Lancaster and Leak 1978, Szuba and Pinto 1991, Katovich and Morse 1992), and decreasing the abundance and vigour of shade-intolerant competitors (Hannah 1988, Smidt and Puettmann 1998).

Many white pine stands managed under the shelterwood system in eastern and central Ontario are scheduled to receive a first removal cut within the next few years to stimulate the growth and development of advance reproduction. Regeneration surveys (performed before prescribing a first removal cut) indicate that the density and stocking of white pine advance reproduction beneath these shelterwoods is variable (Pinto, unpublished data), and concentrated beneath larger, initial canopy openings. Much of the pine regeneration is overtopped by understory hardwoods such as red maple, white birch, and poplar, and is in a suppressed condition. Average understory light intensities are ~5-6% of full sunlight (Parker and Morneault, unpublished data), far below levels needed for competitive height and diameter growth of this species (Logan 1966, Messier et al. 1999). Because this regeneration has developed under moderate to heavy shade, its morphology and physiology are adapted for photosynthesis, growth, and survival under low light conditions. This regeneration is typically small in stature with small, sparsely foliated crowns.

Vegetation management to release this reproduction from understory competition is being considered to enhance its canopy recruitment. However, the release response of severely suppressed stems is a serious management concern in shelterwood systems where partial overstories are retained. If this regeneration is incapable of responding adequately to release or suffers prolonged growth inhibition or high mortality after exposure to more extreme microclimatic (e.g., higher light and temperature, lower humidity) conditions, costly, unnecessary tending treatments can be avoided. Instead, a second suite of silvicultural treatments could be applied to establish a new cohort of abundant, vigorous pine regeneration.

The potential for successful acclimation and growth of advance regeneration after release treatments is dependent on many factors, including shade tolerance, age, vigour, and size of regeneration, and the degree and rate of change in post-release microenvironment (Tucker and Emmingham 1977, Ferguson and Adams 1980, Tesch et al. 1993, Ruel et al. 2000). In conifer species, growth and survival of advance regeneration have been strongly related to morphological features such as pre-release annual height increment, live crown ratio, stem height, and the number of lateral branches (Ferguson and Adams 1980, Seidel 1980, Helms and Standifor 1985, McCaughey and Ferguson 1988, Tesch et al. 1993, Murphy et al. 1999, Ruel et al. 2000). These traits provide integrated measures of the degree of suppression and/or tree vigour, and therefore may serve as valuable indicators of release response. Provincial standards for acceptability of advance regeneration of conifer species based on live crown ratio, height, and/or overall condition (e.g., presence of wounds, insects) are currently in use in British Columbia and Quebec (Ruel et al. 2000).

It is commonly stated that suppressed white pine regeneration has the capacity to respond well to release (Horton 1962, Wendel and Smith 1990). The scientific literature on the growth response of white pine released from hardwood, conifer, and mixedwood overstories generally supports this view (Spaeth 1922, Schantz Hansen 1937, Young and Eyre 1937, Downs 1943, Logan 1950, Geernick et al. 1954, Buckman and Lindgren 1962, Goebel and Cool 1968, Berry 1982, Stiell 1984, Kelty and Entcheva 1993, Puettmann and Saunders 2000). Badly suppressed individuals and trees $\geq$30 years old with live crowns less than one-third of stem height are said to exhibit a lesser growth response to release, particularly sudden exposure to full sunlight (Young and Eyre 1937, Horton 1962, Wendel and Smith 1990). However, little quantitative information exists to support operational observations on the release response of white pine advance regeneration in various states of suppression. Further, the effects of release from understory hardwoods in white pine shelterwoods have not been studied in Ontario or elsewhere.

White pine exhibits considerable morphological plasticity to light availability (Bormann 1965, O'Connell and Kelty 1994, Messier et al. 1999, Puettmann and Saunders 2000), allowing for visual characterization of current growth performance. Morphological indicators of release response for eastern white pine have not been established although trees of greater pre-release height exhibit a larger growth response following partial or total removal of shade (Goebel and Cool 1968, Puettmann and Saunders 2000). Accordingly, practical, morphological indicators of pre-release growth performance may be useful tools for predicting post-release growth potential.

Aerial spraying with herbicides such as glyphosate has been used to treat clearcut plantations for many years and the science behind this approach is fairly well understood. Operational application of this method in shelterwood stands has occurred on a very limited scale during the last 5 years, but the results of the treatments have not been monitored and quantified and little is known of the efficacy or crop tree tolerance to herbicides where partial canopies are retained. Although white pine has shown tolerance to glyphosate (Downs et al. 1984), and white pine is listed as resistant to both glyphosate and triclopyr (McLaughlan et al. 1996), there is some concern over herbicide injury to crop trees when used in shelterwood systems.

The proposed research will provide scientifically sound information on the establishment, cultivation, and management of advanced white pine regeneration in white pine shelterwood systems. More specifically, this project is aimed at quantifying (1) the effect of timing and intensity of removal cuts, and (2) the release response of white pine from a variety of age classes, vigor classes, and ecosites. These data will be used to identify morphological indicators of release response for operational use in the field. This project will also improve our understanding of the best silvicultural practices for shelterwood management and use an adaptive management process to convey results to practitioners. Finally, it will contribute data for building growth and yield curves for managed shelterwood stands urgently needed by forest management planners as input to the Strategic Forest Management Model for calculation of allowable cuts from these stand types.

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