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Long-term Silviculture Research on Northern Hardwoods in Québec (Canada)

Steve Bédard and Michel Huot

Direction de la recherche forestière, Ministère des Ressources naturelles et de la Faune, Sainte-Foy, Québec

General

The hardwood forest subzone in Québec covers 110,000 km^2 in the extreme south of the province, or 15% of the forested area. It contains a wide range of species but is dominated by northern hardwoods. Sugar maple stands are the most widespread forest type. Softwood stands, such as hemlock, white pine and red pine, are found infrequently. Easily accessible, this forest offers people a wide range of outdoor activities. This hardwood subzone plays an important economic role by supplying high-quality timber and maple syrup. The merchantable volume of high-density hardwoods is estimated at one billion cubic metres and the annual allowable cut is estimated at nearly 7.8 million m^3. These hardwoods are processed by many veneer mills, sawmills, and pulp and paper mills distributed throughout the area

The hardwood forest covers the most populated portion of Québec and contains great natural wealth, which bestows it with inestimable value. This vast zone nevertheless underwent the effect of colonization. Cutting practices that were not always adapted to the natural stand dynamics greatly reduced their timber production potential.

The harvesting method called "diameter limit cutting" was the most commonly used method in hardwood and pine forests. At that time the forest was seen as an inexhaustible resource. Because of its proximity to inhabited areas, the hardwood forest was often subject to consecutive partial cuts, where the most valuable species (red oak, yellow birch, sugar maple) were systematically harvested. This practice, which in many cases left poor quality trees standing (Robitaille and Boivin 1987), had the effect of lowering the potential of a stand. It also caused regeneration problems when the cut was too heavy. Thus, these cuts created a range of residual hardwood stands, from those still in good condition to those depleted from intense diameter-limit cutting. The end result of these traditional practices seriously reduced the annual allowable cut of high quality logs. In the early 1980s, government authorities looked for solutions to remedy the situation. More appropriate silvicultural treatments were proposed that would ensure a sustainable harvest.

Research Network

During the past two decades, interest in hardwoods led to many studies by the various organizations devoted to forestry research. The Direction de la recherche forestière (Forest Research Branch) of the Ministère des Ressources naturelles et de la Faune du Québec (MRNF) first undertook studies on the forest dynamics of hardwood forests, which in the early 1980s resulted in the first proposals for their management. Since 1983, studies on selection cutting were undertaken in several types of hardwood forests. A range of harvest intensities is being studied to determine the response of treated stands. A plot network covers southern Quebec, from the Temiscamingue region to the Gaspé (see triangles in figure 1). More than 15 research locations have been established across the hardwood subzone and are remeasured every 5 years. Also, two experimental forests described below have been used to support provincial research efforts. Some papers have been published on the response of selection cutting on growth and regeneration in sugar maple and hemlock stands (Majcen and Richard 1992, 1995, Majcen 1995, 1996, 1997, Majcen and Bédard 2000, Bédard and Majcen 2000, 2001, 2003, Majcen et al. 2005) . In concluding, these results show that a 15-20 year cutting cycle could be expected depending on site.

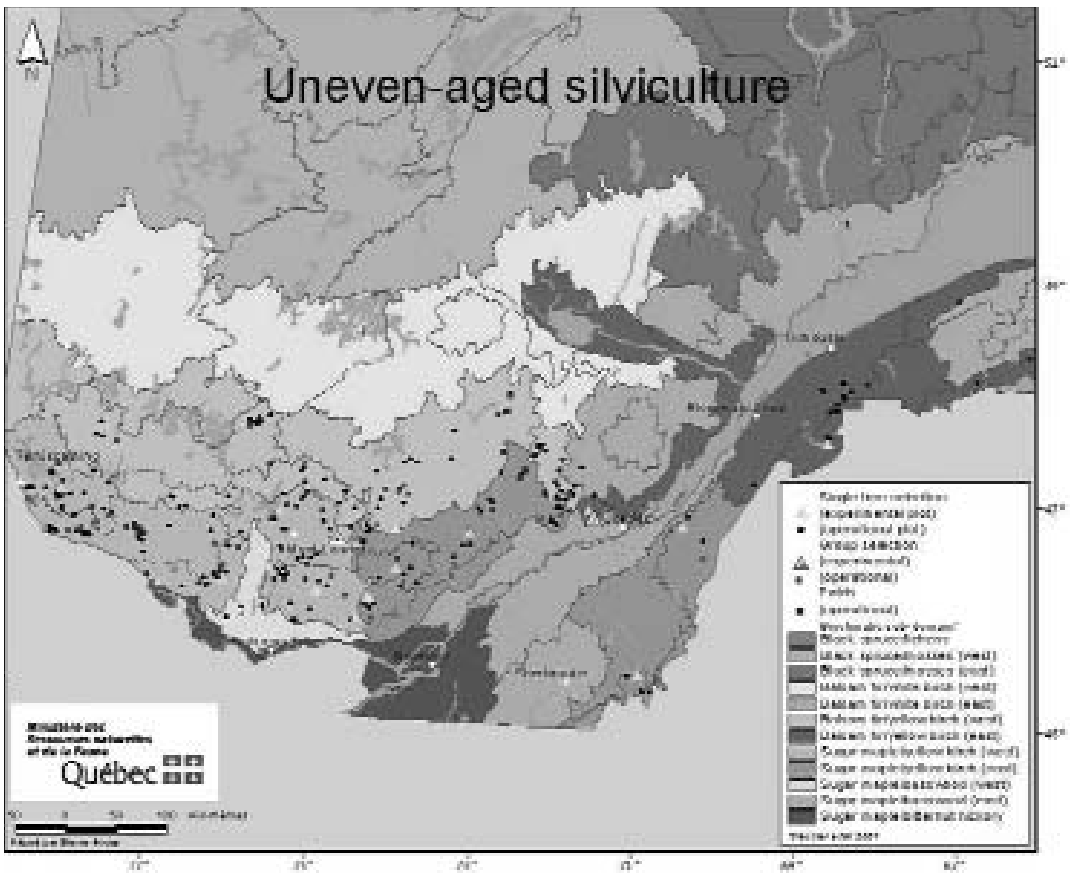

Figure 1. Long-term research plot network (triangles) and a new long-term monitoring program (dots) developed in current forestry operations.

In addition to MRNF background studies about uneven-aged management in hardwood forests, it was decided to set up a provincial monitoring program on Crown lands specific to single-tree selection (see black dots in Figure 1), group selection and patch cuttings. The main objective is to collect growth and yield data on current industrial operations across the province. Data is collected by MRNF regional staff, based on methods developed by its Forest Research Branch. However, tree marking and harvesting are the responsibility of each forest licensee. The work about single-tree selection alone includes 977 (1/25 ha) sample plots located in 223 forest stands scattered in the southern part of Québec. These plots have been established over a 5 year period from 1995-1999 and a 5-yr measurement cycle is planned for the future (Bédard and Brassard 2002, Bédard et al. 2004). The two other treatments, i.e. group selection and patch cutting, have been initiated in year 2000. New plots will be established until 2006. The main focus is on natural regeneration. Site preparation evaluation is made shortly after cut, and stocking and density data is also collected after 2, 5 and 8 years. The new regeneration study also includes free-to-grow assessments.

The Mousseau Research and Teaching Forest

The Mousseau research and teaching forest is part of the research network (Figure 2). This forest, with an area of more than 3,600 hectares, is located in the heart of the sugar maple-yellow birch domain (MRNFP 2003). Because of its diversity and disturbance history it provides a representative sample of this important bioclimatic domain.

The first research done at the Mousseau Forest began in 1981, and basic forest ecology and growth and yield studies were initiated by Zoran Majcen. This work provided a better understanding of the composition,

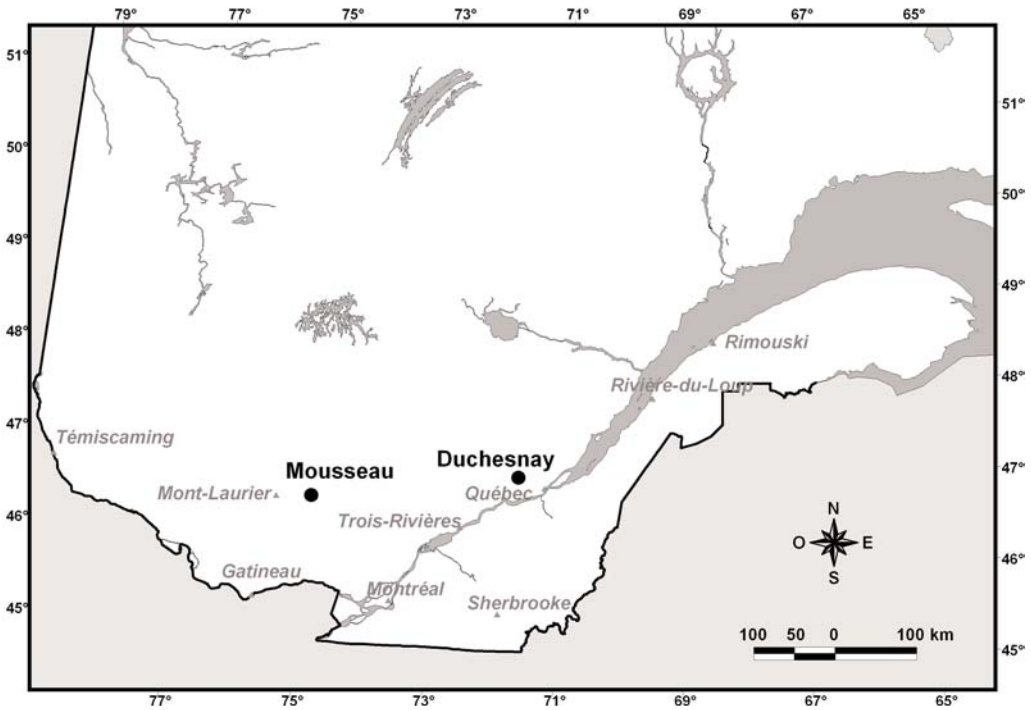

Figure 2. Location of Mousseau and Duchesnay long-term hardwood research forests in Québec.

habitat characteristics and structure of the hardwood forest. Majcen used these background studies to develop an applied research project on selection cutting with the collaboration of La Lièvre forest management unit (Forêt Québec). The first tree marking guide and technical guide on selection cutting in maple stands was published in 1990 based mostly on the experiments carried out in the Mousseau Forest.

The increasing interest in learning how to manage hardwood forests encouraged the Quebec government to grant this area a research and teaching vocation. Since its establishment in 1990, the Mousseau Forest has been visited by several groups of college and university students. Today, there are 20 experimental blocks treated by single tree selection. The results of the research done at the Mousseau Forest are also being used to test management hypotheses concerning growth, mortality and regeneration in uneven aged hardwood forests following a first 15-year cutting cycle

Today, those interested in forestry, especially regional representatives, technicians, foresters and maple syrup producers can familiarize themselves with various types of cutting, such as single tree selection, group selection, shelterwood, succession cutting and strip clearcuts.

Duchesnay Station

The Forest covers a total area of 8900 ha, as of 1969 and is also representative of the sugar maple-yellow birch domain (Figure 2). Duchesnay has been the site of various studies since 1944. A sawmill school has been used to train sawmill operators, scalers and also forest rangers. Up to 3450 students have graduated between 1935 and 1970. Today, Cégep de Sainte-Foy is still using Duchesnay as an area for training forest technicians. Université Laval also uses Duchesnay to train new professionals. A forest education Centre was created at Duchesnay in the early 70's.

In 1970, much information was needed about tree and stand response to thinning, regeneration methods and how to tend young hardwood forests. Lise Robitaille spent her research career in hardwood silviculture. She initiated basic studies between 1970 and 1980 and reported on these studies in 1977. She first reviewed all existing silvicultural trials and studies in Québec (Robitaille and Roberge 1976). She wrote papers on yellow birch (Robitaille and Roberge 1981; Robitaille and Majcen 1991) and sugar maple (Robitaille and Pardé 1979) silviculture. She also gave a conference about the effects of site preparation on planted and natural yellow birch (Robitaille 1978).

Research carried out in immature stands helped in developing provincial standards of tending. Precommercial thinning in 30-yrs-old stands and a release study in a 10-yrs-old stand have shown interesting results for diameter growth. The release study is still being followed up (Robitaille et al. 1990; Huot and Savard 2000).

In a joint effort with the Québec Ministry of Agriculture, the Canadian Forest Service and Université Laval, Lise Robitaille established a long-term study in 1973 on sugarbush management. At that time, people were concerned about the long-term effects of a new vacuum pumping method on tree health. Three thinning treatments and fertilization were applied to 58 sample plots. Guidelines specific to tree marking for sap production were developed (Robitaille et al. 1977) from several observations made in the 60-yrs-old sugarbush. Long-term results have been published by Pothier (1995, 1996). Although researchers were careful about testing the new vacuum system, no detrimental effect of tapping could be detected on tree diameter growth

over a 20-yr period. This study is considered unique in the literature, but the experimental sugarbush is relatively unknown to others since the publications are in French only.

In 1981, the first visual symptoms of hardwood decline were observed in the 23 ha sugarbush. For reasons other than tapping, tree crowns began to show signs of dieback, which prompted investigations into other regions like the Appalachians (Robitaille et al. 1985; Roy et al. 2004). Thereafter, the whole Lake Clair watershed, which includes the experimental sugarbush, has been the site of new studies such as precipitation chemistry and soil fertility (Houle et al. 1997). Liming has also been tested at Duchesnay to improve sugar maple health in declining stands (Moore et al. 2000).

While strip-cutting has been used extensively at Duchesnay from 1981 to 1987, no results have been published. The public usually reacts against the use of clearcutting. In some of these strips, red and Norway spruce, and eastern white pine have been planted at a low density e.g. 500 stems per hectare, in an attempt to improve stand productivity. There are examples of large clearcuts at Duchesnay, operated in the 1940's for charcoal production and also in 1972. These regenerating areas still provide opportunities to study even-aged management, and how hardwood species develop after clearcutting

A recent gap regeneration study e.g. 1-2 ha in size, initiated by Huot in 1996 will provide for regeneration results. One surprise is the presence of wildlife mostly deer and moose which visited the 20 openings regularly and browsed on the regeneration.

A new management method dealing with uneven-aged stands, was tested for the first time in 1988. This method was implemented in order to better adapt silvicultural practices to the characteristics of uneven-aged forests, as well as to improve their quality and promote natural regeneration. This new method developed by Zoran Majcen was later applied over the whole public education forest Centre, located upfront of the Duchesnay Station. In total, 10 experimental blocks have been established since 1989.

Other Research

New research pertaining to light profiles in both control and managed uneven-aged stands have been recently published (Beaudet et al. 2004) from both Duchesnay and Mousseau Forests. This example shows that existing MRNF long-term projects can provide good opportunities for academic studies. An unexpected ice storm hit large areas of hardwood forests on January 1998. Evaluating risk of tree mortality and salvage options in ice damaged stands has been published by Boulet et al. 2000. Again, in the most recent years, forest pathology was used to develop a new tree classification system called MSCR, in a field guide designed to assist tree markers in stand improvement decisions (Boulet 2005).

Conclusion

Long-term research undertaken at Mousseau, Duchesnay and other locations have shown uneven-aged management to be a reliable method in hardwood forests. Majcen (1994) has published on the historical aspects of uneven-aged management in Québec's hardwood forests. Stand quality may be improved when using appropriate silviculture. Research results obtained to date are very encouraging. We still have to find a balance between economics and good forestry. Therefore, if our goal is to have sustained yields, with logging

operations every twenty years, it is essential that the next cuts be limited as much as possible to low-vigour trees. A change in current practices is therefore required in order to ensure the sustainable management of this resource.

Other treatments can also be used in our silviculture. For instance, tending may be used in young stands and reproduction methods like uniform and irregular shelterwood can play an important role in the future. Pursuing MRNF tree improvement efforts on a few target species like northern red oak, white ash, yellow birch, black cherry and black walnut seems vital to hardwood afforestation in the south. Other areas of research also deserve our attention, like defining treatments for irregular and highgraded forests. We also need to develop more accurate prediction tools for growth and yield in both even-aged and uneven-aged forests.

While it is hard to tell about the future, Québec has already shown a strong interest in long-term silviculture studies. Exchanges with other provinces and adjacent states in the US are helpful since long-term studies are relatively rare in the Great-Lakes and St-Lawrence forest region.

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