Silvicultural Research in Québec's Hardwood Forest

Research Note
Tabled at the XII World Forestry Congress – Québec, Canada 2003,
by the *Ministère des Ressources naturelles, de la Faune et des Parcs du Québec*

September 2003

Direction de la recherche forestière (Forest Research Branch)

Ressources naturelles, Faune et Parcs
Québec

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by

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Abstract

The hardwood forest zone in Québec covers 110,000 km^2 in the extreme south of the province, or 15% of the forested area. Sugar maple stands are the most widespread types of stands in the hardwood zone. Softwood stands, such as hemlock, white pine and red pine, typical in this zone, are found in smaller numbers.

The hardwood forest covers the most populated portion of Québec and contains great natural wealth, which bestows it with inestimable value. This hardwood zone plays an important economic role by supplying high-quality timber and producing maple syrup. This vast zone nevertheless underwent the effect of colonization, and cutting practices that were poorly adapted to the natural stand dynamics greatly reduced their timber production potential.

The *Direction de la recherche forestière* (Forest Research Branch) of the *ministère des Ressources naturelles, de la Faune et des Parcs du Québec* (MRNFP)[3] started by undertaking research to work out hardwood forest dynamics. It then conducted studies on partial cuts adapted to the hardwood forest, such as selection cutting. Currently, a range of harvest modalities is being studied to determine the behaviour of treated stands. An experimental network also covers southern Québec. Results of this research will help to orient the types of silvicultural interventions to practise related to characteristics of the forest, and will contribute to ensuring its sustainability for the benefit of all Québecers.

Keywords: Hardwood forest, maple stands, hemlock stands, birch stands, pine stands, silviculture, *ministère des Ressources naturelles, de la Faune et des Parcs du Québec*

[3] On April 29, 2003, the *Ministère des Ressources naturelles du Québec* (MRN) became the *Ministère des Ressources naturelles, de la Faune et des Parcs du Québec* (MRNFP).

A profile of Québec's hardwood forest

The hardwood forest zone covers the extreme southern part of Québec, and occupies the most northerly portion of a wide band that extends from the east-central United States. Deciduous species are predominant in this zone, which covers almost 110,000 km^2, or 7% of Québec and 15% of its forest area.

Sugar maple stands are the most widespread type of stand in the hardwood zone. Though they are dominated by sugar maple (*Acer saccharum* Marsh), these stands are also composed of other species according to the site and the region. Among the accompanying species are bitternut hickory (*Carya cordiformis* (Wangenh) K. Koch), butternut (*Juglans cinerea* L.), white ash (*Fraxinus americana* L.), basswood (*Tilia americana* L.), ironwood (*Ostrya virginiana* (Mill.) K. Koch), black cherry (*Prunus serotina* Ehrh.), red oak (*Quercus rubra* L.), American elm (*Ulmus americana* L.), American beech (*Fagus grandifolia* Ehrh.), yellow birch (*Betula alleghaniensis* Britt.), black ash (*Fraxinus nigra* Marsh.), and a few other rarer species present in the extreme south of Québec. Also found almost exclusively in this hardwood zone are softwood stands, such as hemlock, composed especially of eastern hemlock (*Tsuga canadensis* (L.) Carrière), as well as white pine (*Pinus strobus* L.) and red pine (*P. resinosa* Ait.) stands.

Québec's hardwood zone is divided into three bioclimatic domains: maple/hickory, maple/basswood and maple/yellow birch. The maple/hickory domain is found in the extreme southwest of the province. A little to the north and east, in the St. Lawrence River valley and in the Gatineau River valley, one finds the maple/basswood domain. The sugar maple/yellow birch domain represents the most northerly part of the hardwood forest. It covers the southern portion of the Laurentian Plateau and the Appalachian hills. In these three domains, the hardwood forests occupy various habitats, excluding extreme conditions such as very moist, very dry and extremely rocky soils, which are especially colonized by mixedwood stands and conifers. Very moist soils are generally favourable to stands composed of balsam fir (*Abies balsamea* (L.) Mill.), red maple (*Acer rubrum* L.), red spruce (*Picea rubens* Sarg.), white spruce (*Picea glauca* (Moench) Voss), eastern white cedar (*Thuja occidentalis* L.) and black spruce (*Picea mariana* (Mill.) BSP). The yellow birch/balsam fir stand type is often found in the maple/yellow birch domain on very rocky soils at the base of slopes. Escarpments are often occupied by hemlock, white pine and eastern white cedar.

The hardwood forest covers the most populated parts of Québec. As it is adjacent to inhabited areas, the hardwood forest helps to purify the air in big cities. Easily accessible, and attractive because of its natural beauty and autumn colours, it offers people a wide range of outdoor activities: vacationing, camping, cross-country skiing, hiking, hunting and fishing. The territory where the hardwood forest grows contains great natural wealth, where its many lakes and water courses endow it with indisputable value, as does the diversity of its flora and fauna. Québec's emblem tree, the yellow birch, is a hardwood species that is representative of this rich and diversified forest.

An Important Economic Contribution

The hardwood forest supplies a large volume of timber. 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. It makes a sizable economic contribution to many towns by supplying thousands of jobs in both the forest and the mills. Quality hardwoods are used to manufacture veneer, furniture, flooring and panelling, whereas poor quality trees are used for pulp and firewood.

Among the deciduous communities, maple stands offer, in addition, the possibility of being managed for maple syrup production. There are approximately 10,000 maple syrup producers in Québec. Some support themselves entirely from this activity, but many simply earn a supplementary income. Besides its economic importance, maple syrup production remains an integral part of Québec's culture and tradition.

Historical outline

Colonization left its mark on large areas of the hardwood forest, which had to be cleared for agriculture. These vast agricultural lands are especially concentrated in the St. Lawrence River valley and along its tributaries. Large expanses of forest occur on rolling and mountainous lands, where sand and stone deposits make them unsuitable for farming. Excessive soil moisture associated with organic soils and heavy clays, or sands of low fertility, can also explain the presence of forested zones even within the farmed areas.

In the most southerly part of Québec, where soils are more fertile and the temperature higher, the sugar maple/hickory and sugar maple/basswood domains were the most seriously affected by human activity (clearing, fire, farming, rearing livestock). In this region the forested landscape is composed of broken stands. Toward the north, in the sugar maple/yellow birch and balsam fir/yellow birch domains, large forested tracts are becoming more common. These forests contain stands that have arrived at various stages of restoration following fire or clearcutting, where shade-intolerant species predominate, such as trembling aspen (*Populus tremuloides* Michx.), large-toothed aspen (*Populus grandidentata* Michx.) and white birch (*Betula papyrifera* Marsh.).

The harvesting methods called "diameter limit cutting" were the most commonly practised method in hardwood and pine forests. This cutting method consists in removing trees that are larger than a specified upper diameter, which is established according to the species and the expected end use. 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, had the effect of weakening a stand's potential. It also caused regeneration problems when the cut was too intense. Thus, these cuts created a range of variable quality hardwood stands, from those still in good condition to those depleted from intense diameter-limit cutting.

The end result of these practices was to seriously reduce the allowable cut for lumber. In the early 1980s, government authorities looked for solutions to remedy the situation. Appropriate silvicultural treatments were proposed that would ensure the sustained yield of stands still containing quality trees. Other types of silvicultural treatments were also considered to reconstruct the stands that had been degraded by very intensive cuts.

Silviculture based on natural stand dynamics

Research into natural forest dynamics revealed that most sugar maple stands regenerate uninterruptedly in shade under the canopy or in small openings created by fallen trees. Major disturbances, such as fire and severe insect epidemics, are infrequent in hardwood stands and do not affect large areas, as they do in the boreal forest. Among the most frequent natural disturbances in hardwood forests are wind storms, ice storms, die-back and diseases which cause tree mortality. These disturbances create small gaps in the forest cover.

Light intensity in the understorey is a determining factor for the establishment and development of regeneration. Under a canopy one generally observes an abundance of shade-tolerant species, such as sugar maple and American beech, whereas yellow birch, being less shade-tolerant is found mainly in small openings. Most sugar maple stands are uneven-aged; that is, they are characterised by a mixture of stems of different ages and dimensions. In these stands the number of stems is very high in the small diameter classes and decreases with increasing diameter. Tree age usually ranges from 30 to 50 years for stems that are 10 cm in diameter at breast height, and 150 to 200 years for trees greater than 40 cm in diameter.

Following a major disturbance, such as fire, natural sugar maple sites are usually colonized by a large proportion of shade-intolerant species (trembling aspen, large-toothed aspen, white birch). These species, which grow very rapidly in height, after a few years form an even-aged stand (stand in which most of the trees have almost the same age). A few years after the initial disturbance, sugar maple, being tolerant to shade, gradually develops under the cover of the shade-intolerant species. If no other disturbance occurs, sugar maple and the species associated with sugar maple stands are destined to colonize the site as the shade-intolerant species gradually die.

Based on our knowledge of hardwood forest dynamics and their current condition, various silvicultural treatments are being researched to determine the best ways to put them into practice to optimize stand timber yields or accelerate the return of desired species. Thus, to learn the long-term effects of silvicultural practices, more than fifty research plots have been established in Québec's hardwood zone, and are periodically

monitored. They total more than 200 hectares of forest, where stems are monitored individually over time. This research is being carried out on:

- selection cutting;
- succession cutting;
- commercial thinning;
- regeneration cuts.

Selection cutting

Selection cutting is indicated for uneven-aged stands that contain a sufficient number of crop trees. Correctly carried out, selection cutting ensures a sustained yield, while retaining a permanent forest cover. This cutting method continues the coexistence of species that are found naturally in the ecosystem, and preserves the habitat for all the fauna and flora.

Succession cutting

Succession cutting is practised in stands dominated by mature shade-intolerant species (large-toothed aspen, trembling aspen, white birch) that are accompanied in the understorey by species that are tolerant and semi-tolerant to shade (sugar maple, yellow birch). This type of cutting method consists in removing stems of shade-intolerant species, while retaining the developing stems of shade tolerant species in the understorey. It favours natural succession in the stand by stimulating the growth of suppressed trees and allowing the intolerant species to be recovered before they deteriorate and die.

Commercial thinning

This cut is indicated for dense even-aged stands when the dominant stems have attained commercial size. It improves stand quality and value and shortens the time needed for the stand to attain maturity by accelerating the growth of the best trees in the stand. One or several thinnings may be done prior to the regeneration cut.

Regeneration Cuts

Regeneration cuts being studied are the shelterwood cut, the clearcut with seed trees and strip clearcuts. Regeneration cuts are tested in even-aged stands when trees have reached maturity, and in unbalanced or deteriorated uneven-aged stands. These cuts partly emulate the action of major disturbances on natural stands.

Conclusion

Québec's hardwood zone is very valuable, as much from the point of view of biodiversity and its natural attractions as for the quality of its timber. Located in the most

populated region of Québec, it has been subjected to human disturbances more than any other forest zone. Silvicultural research at the Forest Research Branch is aimed to work out silvicultural practices that support these forests' characteristics and ensure their sustainability for the benefit of all Québecers.

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