Silviculture for Sugar maple

Beloved species presents challenges, but it's worth the effort

by Gaetan Pelletier

At this time of the year, it is easy to appreciate the importance of Sugar maple in Eastern North America. The tradition of tapping trees for sap, to produce syrup and other sweets, has evolved to become a significant industry – and New Brunswick, in particular, is now gaining global market share. But Sugar maple is also much sought after by the wood products industry. The species is important for high-end products such as flooring, cabinet components, and furniture, and it is also coveted for typically low-grade commodity derivatives such as tissue, textiles, and pellets. Sugar maple is a highly desired tree, and there isn't enough growing stock to satisfy the demand.

In the last 10 years, the Northern Hardwoods Research Institute has surveyed tens of thousands of acres of tolerant hardwood stands that contained a high proportion of Sugar maple. Overall, only half of the Sugar maples in New Brunswick and Nova Scotia were categorized as "acceptable growing stock," meaning they are in reasonable health and of good form. (Of these two criteria, only form can slightly improve over time; some defects, such as sweep, can become less prominent as a tree gets larger.)

The fact of the matter is that Sugar maple is one of the most demanding species, in terms of growing conditions. Regardless of utilization, it is in trouble, and needs immediate attention. Throughout the Maritime provinces, Sugar maple is dropping in proportion, tree size, and overall health. The species is facing a number of challenges, including climate, soil degradation, disease and pests, forest fragmentation, and air pollution. Forest landowners and managers must pay attention to the trees that are already established, but they must also ensure that future trees are recruited. Our changing climate is bringing cycles of sustained drought, more frequent icy precipitation, more extreme wind events, and more freeze-thaw cycles in the deep of winter. In the future, Sugar maple will sustain greater climate-induced stress. (Figure 1)

This stand is well regenerated with Sugar maple seedlings, but the overstory is in poor shape. A moderate to heavy partial harvest would be advisable, to allow the seedlings to grow adequately. (NHRI photo)

GROWING CONDITIONS

Sugar maple prefers well-drained, loamy soils that are rich in organic matter, as it requires a range of essential nutrients, including nitrogen, phosphorus, potassium, and calcium. In addition to providing nutrients, leaf litter and humus help to improve soil structure and retain moisture. Overly dry soils can stress

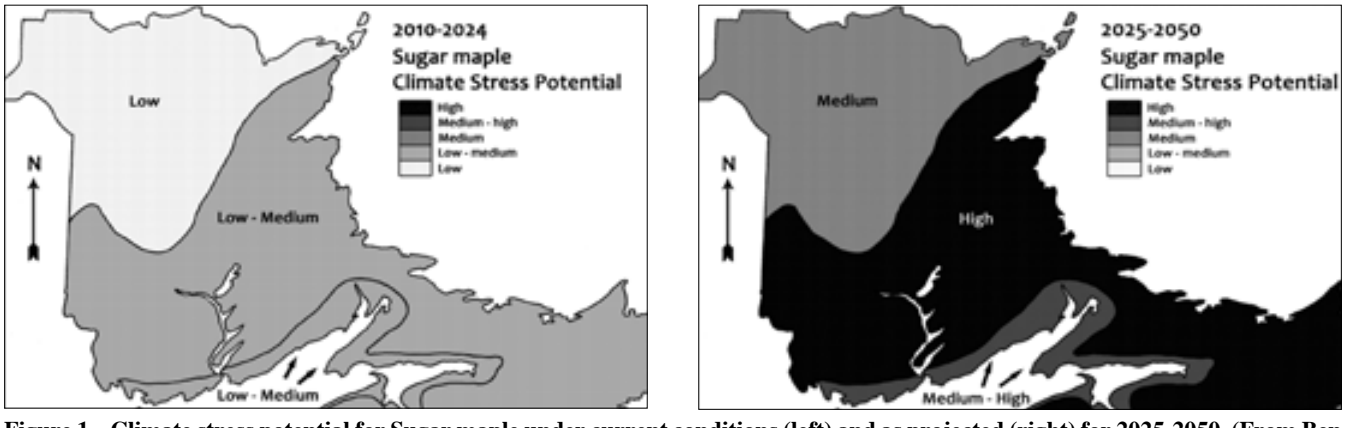


Figure 1 – Climate stress potential for Sugar maple under current conditions (left) and as projected (right) for 2025-2050. (From Ben E. Phillips and Colin P. Laroque MAD Lab Report 2009, Mount Allison Dendrochronology Laboratory)

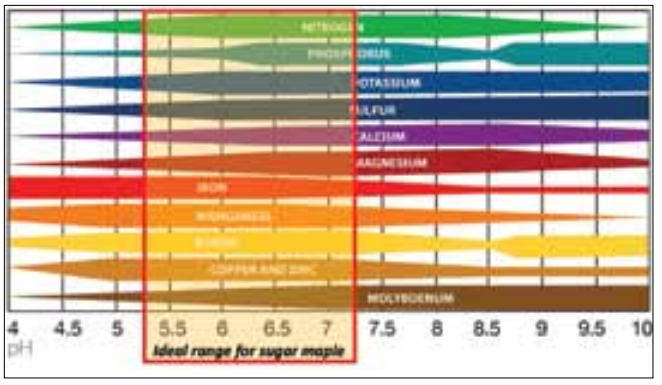


Figure 2 – Availability of nutrients for plants as a function of pH.

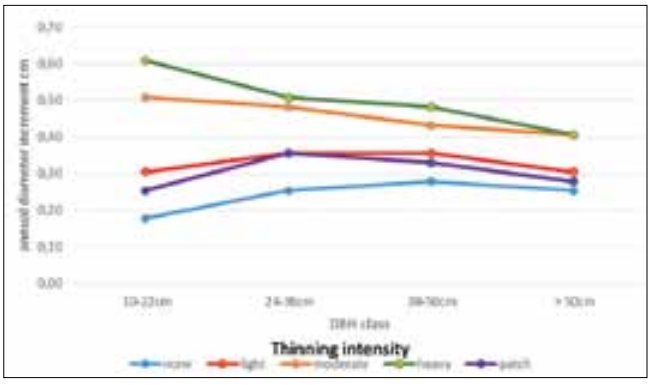


Figure 3 – Individual tree diameter growth rate as impacted by diameter and the intensity of thinning treatment.

the tree, while poorly drained soils can lead to root rot. Sugar maple does well on soils with a neutral pH between 6 and 7. Soils that are too acidic or too alkaline can reduce the tree's ability to absorb essential nutrients. (Figure 2)

It has been demonstrated that keeping companion species in the stand increases site productivity and improves the overall health of Sugar maple. To this end, the Québec Ministère des Ressources naturelles et des forêts recommends maintaining at least a quarter of the stand in species other than Sugar maple.

Sugar maple trees are particularly sensitive to temperature changes, so the range of suitable habitats for the species may be shrinking. As the warming trend continues, with extreme temperatures becoming more common, Sugar maples are subjected to increased stress, making them more susceptible to diseases such as tar spot, verticillium wilt, and maple anthracnose. They are also becoming more vulnerable to damage from insects such as Forest tent caterpillar moth, Sugar maple borer, and Spongy moth – and exotics such as the Asian longhorned beetle now also pose a threat.

Individual Sugar maples benefit from reduced competition by other trees. It has been clearly demonstrated throughout Eastern North America that maintaining the stand at a relatively low basal area, and ensuring that the crowns of crop trees are released on at least three sides, will keep Sugar maples growing at optimal rates. Tree health and vigour also impact their rate of growth. (Figures 3 and 4)

Finally, natural regeneration of Sugar maple can be challenging, due to factors that include climate change, soil degradation, forest fragmentation, competition with invasive species, pests and diseases, and land use changes.

REMEDIES

Fortunately, we can improve how and when we conduct forestry treatments, to favour Sugar maple. The first step is to characterize forest stands and trees, so that a diagnostic can be done. The essential elements to consider are species composition, density (basal area), diameter distribution, and tree vigour. (Figures 5 and 6 are examples of modern precision digital forest inventories now available to assist practitioners.) Keep in mind that very acidic soils may have little potential to sustain Sugar maple in the long run.

With this species, it is very important to pay attention to regeneration. If it is established, it must be released; if it is not established, openings must be created. Sugar maple regenerates best with removal intensities of 40-60 percent of the canopy cover, or at residual basal areas of 16-22 square metres per hectare. (Figure 7)

For mature trees that are already established, a silviculturist or forest landowner should consider these key concepts for harvest-based silviculture:

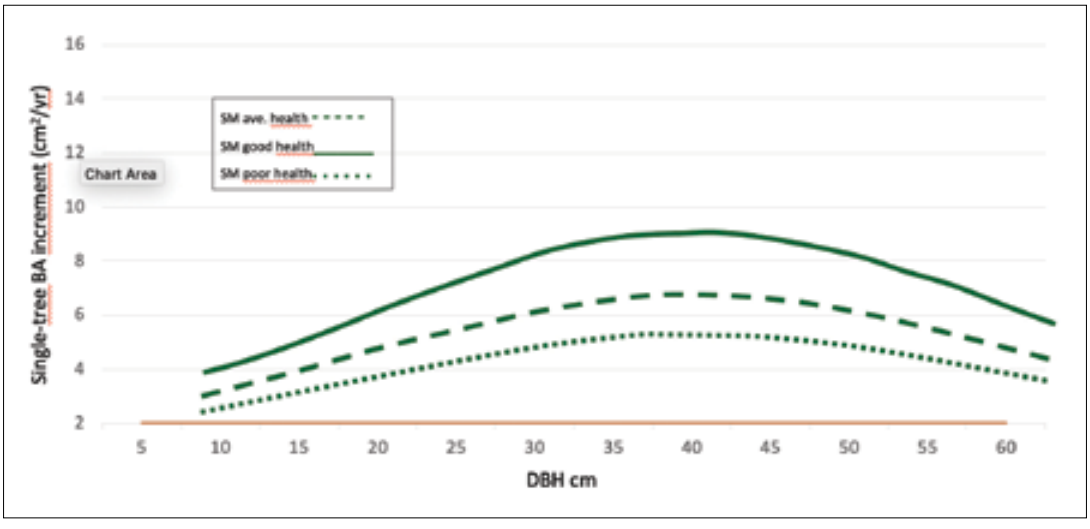


Figure 4 – Sugar maple growth rates in relation to tree diameter and vigour.

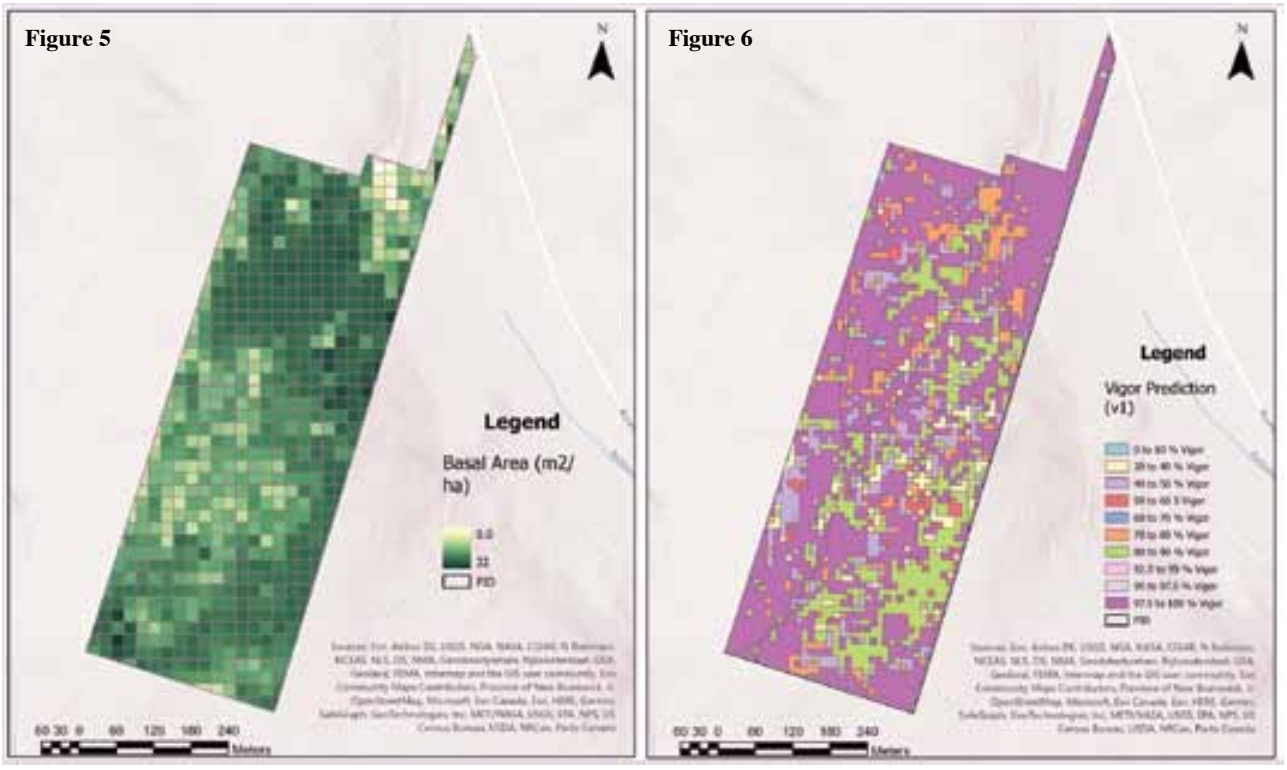


Figure 5 – LiDAR-derived basal area at a resolution of 20 metres by 20 metres, with areas of excessive density shown in dark green. Figure 6 – NHRI mapping of tree vigour using satellite imagery at 10 metres by 10 metres resolution, where changes can be detected on a weekly basis.

• If the stand has low proportions of acceptable growing stock (less than eight square metres per hectare or less than 40 percent of merchantable volume), consider an even-aged regime that will initiate a new stand of one or two age classes.

• When there is enough acceptable growing stock, regulate density and maintain basal area at 18-22 square metres per hectare by scheduling entries 15-25 years apart. Sugar maple is very vulnerable to competition from other trees.

• Harvest large trees and those of poor vigour first, as they have the slowest growth rates.

• Try to maintain at least 25 percent of the stand in other species. This will improve overall yield, and minimize risk.

• Pay attention to severe weather events, insect infestation, and diseases, as the species is highly sensitive to stressors.

Addressing these challenges to ensure our Sugar maple thrives requires a multi-faceted approach that includes improved forest management practices, mitigating stress on trees, and maintaining several age classes, paying particular attention to the recruitment of new cohorts. In extreme situations where harvest-based silviculture has failed to promote natural regeneration of Sugar maple, and where the site holds great potential, artificial regeneration may be an alternative, albeit a very intensive and expensive one.

(Gaetan Pelletier is executive director of the Northern Hardwoods Research Institute, in Edmundston, N.B.)

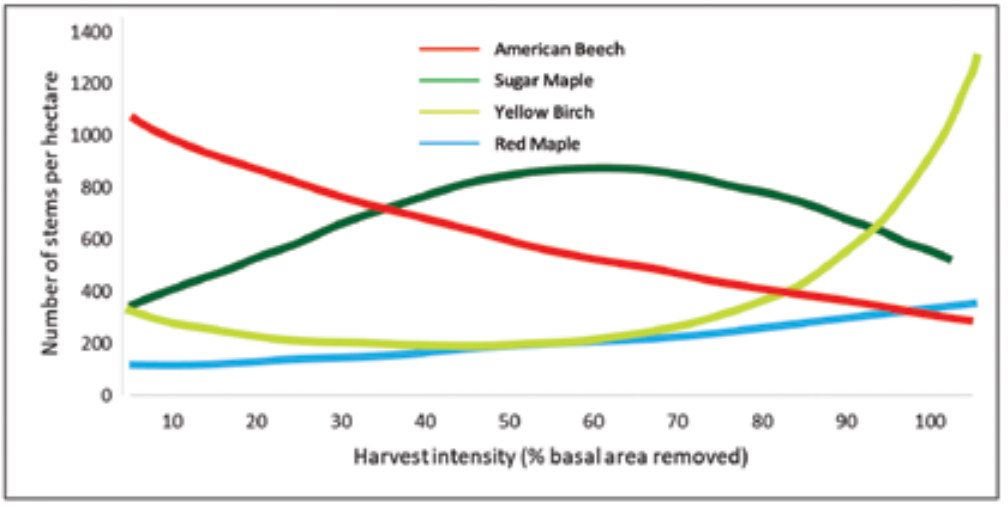


Figure 7 - Natural regeneration of hardwoods in relation to harvest intensity.

UPHILL BATTLE

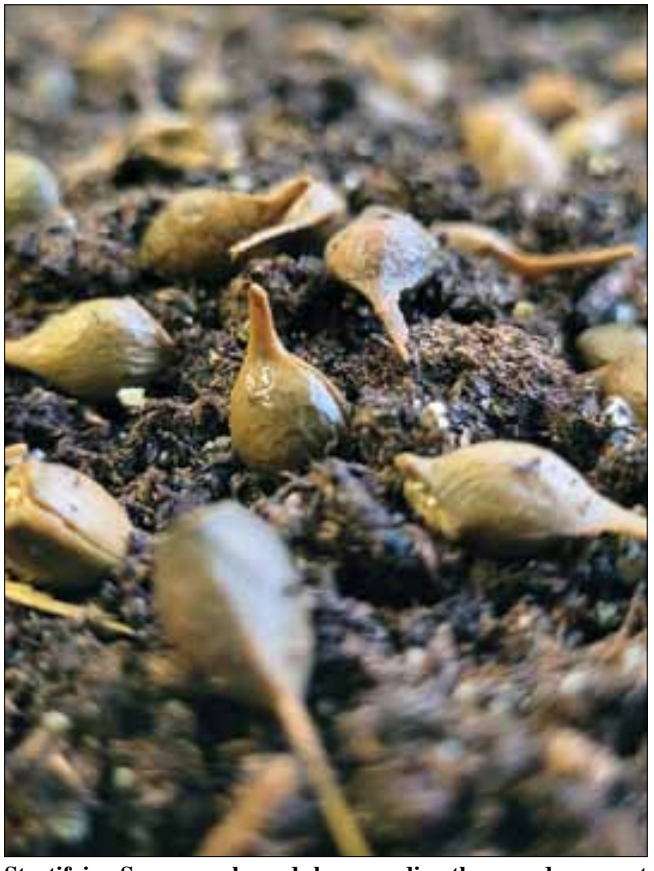
Hard truths about artificial regeneration of Sugar maple

by Storm Robinson

Time and again, researchers, foresters, and landowners have tried and failed to grow a Sugar maple plantation anywhere except where this species had recently thrived. Establishing Sugar maple has always presented problems – due to predator browsing, herbaceous competition, forest cover removal, and issues with frost pockets. Now, with climate change bringing increased disturbance regimes, rising temperatures, and inconsistent snow cover, we question whether our Sugar maple will have time to adapt. There are even issues with natural regeneration, due to beech bark disease suckering and sprouting in maple-beech stands, causing increased competition.

Here lies the problem: what can we do if both natural regeneration and artificial regeneration have failed to re-establish and grow Sugar maple stands where the species was once quite successful? And is there a way to restore maple stands where clearcutting or agriculture has reduced the site quality? And finally, is it worth the cost and effort to try? The short answer is maybe.

Natural regeneration, with carefully planned silviculture, is the recommended practice for growing Sugar maple, as it provides the light and moisture regimes required for this specialist species. Natural regen can be encouraged through harvesting techniques such as single-tree selection of hardwoods growing in the overstory. The Northern Hardwoods Research Institute recommends following our Silviculture Prescription System (SPS 2.0) for natural regeneration targets. Though artificial regeneration generally gives the grower more control over the environment, it can be tedious and costly for hardwoods.



Stratifying Sugar maple seeds by spreading them on damp peat moss and chilling them for 90 days at 1-4 degrees C.
(Storm Robinson photos)

Producing maple seedlings requires considerably more nursery resources than growing softwood planting stock.

One major challenge to growing maple, especially for nurseries that are used to housing softwoods, is the space required. With their large leaves, the seedlings need more growing space that must be fumigated, tilled, bedded, maintained, and harvested. Hardwoods also consume more water and fertilizer than many softwood species.

There are also seed supply issues in Atlantic Canada, especially for Sugar maple, which is at the fringe of its range. There are only a few commercial producers of high-quality hardwood seed, and much of the stored seed is reserved for conservation, or in high demand for research projects. In this region, Sugar maple only produces heavy seed crops every five to seven years. The seed supply shortage is confounded

NHRI decision key for maple plantations. These recommendations represent a bare minimum; to ensure success, intense site preparation and tending should be considered in all cases, if cost-benefit ratio will allow it. (Storm Robinson, 2023)

by the low germination rates of Sugar maple, relative to Red and Silver maple.

With so many challenges, why do we bother growing maple? Under extensive forest management practices, softwood may produce higher returns – but under intensive management, maple grown on suitable sites (and properly cared for) can produce the highest returns, while meeting many more sustainability objectives. Sugar maple is sought after for its beautiful colours, hard wood, and sweet sap – and the diminishing supply of high-quality maple makes artificial regeneration more attractive to industry. Planting is also the only means to grow maple stock on an abandoned field or clearcut. Researchers must understand the factors affecting the trees' growth to predict future impacts of climate change.

THE RIGHT STOCK

To germinate, Sugar maple seeds require moist stratification at temperatures slightly above freezing for 90 days. You can do this outdoors by direct seeding in the fall, or indoors in a fridge. The recommended practice is to soak dry seed for 72 hours before stratifying indoors in peat moss. The optimum temperature for germination is about 1 degree Celsius, the lowest of any forest species.

Early germination can cause breakage and difficulties when the seeds are sown, so keep checking them every 30 days. Early root development has been deemed one of the most important phases in growing Sugar maple. If the seeds have started to establish roots early, it is best to keep them in the peat moss until they develop their first leaves, so as not to interrupt root development.

Once they germinate, they must be transplanted to your container of choice. The use of artificial growing media gives container nurseries more control over the growing environment, which is extremely important when growing maple. The type of container you select will impact the early success of the maples. For example, containers with high density can cause overcrowding, and containers with too large a hole can lead to erosion of the growing media. In containers without inner grooves to guide the roots downward, root spiraling may occur, leading to problems when the seedlings are planting out.

It is important to manage competition for light and resources. One must also consider every aspect of nursery practices, including shading, temperature, soil properties, moisture, and pests. We recommend consulting the experts before beginning to grow your own maple seedlings.

Of course, an alternative is to purchase seedlings from a reliable nursery. We recommend planting seedlings that have grown for two years in a greenhouse plus one year outdoors. However, seedling size is generally more important than age. A stem height of 20-30 centimetres and minimum root collar diameter of 5.0-6.5 millimetres is sufficient. Although the size of the seedling matters, transplanting larger trees into a site that has had insufficient site preparation has been found to be less effective than planting smaller seedlings into a prepared site. If cost is an issue, it is best to spend the money on site preparation.

SITE AND TIME

Even the best Sugar maple planting stock may fail if ideal site selection and site preparation criteria are not met. This species grows best in highly fertile, moist soils with a pH range of 5.5-7.5. Much of New Brunswick has more acidic soils, which must be amended with lime.

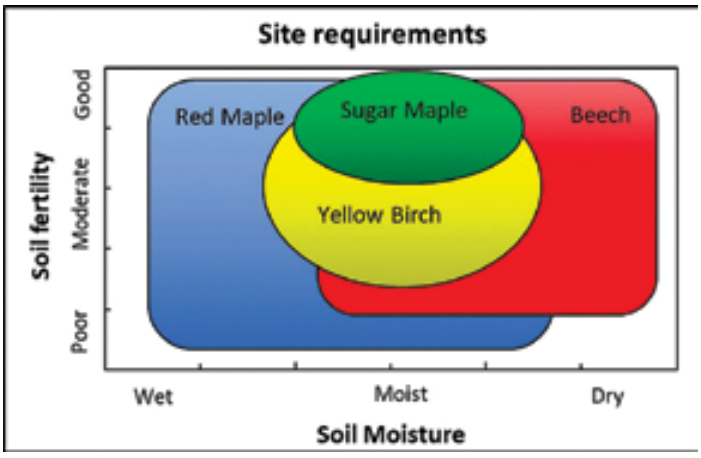
Planting timing is also very crucial to Sugar maple. If your intention is to plant in the spring, treating the buds with

growth inhibitors such as abscisic acid may delay shoot emergence long enough to give the roots time to establish. However, since maple plantations are so rare (and so rarely successful, for a multitude of reasons), there is a lack of evidence that such treatments are worth the cost and effort.

The alternative would be early spring planting – which requires plowing roads continuously through the winter to ensure access, and preparing the seedlings for potential frosts by cold-storing them throughout the winter. Fall planting of maple has its own set of challenges, including poor root regeneration, frost heaving, and heavy browsing.

Site preparation may involve plowing, discing, or other means of removing vegetative competition. The method chosen will depend on the soil, topography, density, accessibility, and operational capacity. Cost may also be a consideration, but investing in site preparation is generally economical in the long run. If possible, plan on four to five years of tending and monitoring.

Depending on the size of seedlings, successful establishment may be limited due to browsing by large herbivores such as deer and moose, or damage from voles, mice, rabbits, birds, and insects. One recommended strategy is habitat manipulation – such as fencing, or growing preferred browse species around or outside the plantation. Another is to install tree guards for mice and voles. Regardless of the method, the height of the saplings should exceed the height of your predator of concern before they are left without tending.



Site requirements for northern hardwood species.
(Adapted from Lee Allen, 2013)

In summary, Sugar maple seedling survival depends upon management for light regimes, weed control, and wildlife. If these requirements are not met – especially in areas with high American beech regeneration, large deer populations, or compacted or acidic soils – there is very little chance of plantation success.

(Storm Robinson is a research and development forester with the Northern Hardwoods Research Institute. This article is inspired by the applied knowledge and research of NHRI, the National Tree Seed Centre, and Kingsclear Provincial Tree Nursery.)