Jamie Simpson

Forest and woods-road at Windhorse Farm

Sawdust from the sawmill and shavings from the wood shop are also put in the woodlot in the form of roads. To date, the Windhorse woodlot contains some 20 km of sawdust roads. "Not only does the sawdust make effective roads, but surprisingly, these roads have become incredible tree nurseries," says Drescher. "We sell native tree seedlings, and all we have to do is go to the sawdust roads and dig up the seedlings."

Dollar to Biomass Ratio

Beyond restoring deadwood to the woodlot, the Dreschers strive to get as much monetary return as possible from the trees cut on their woodlot. "We all have to make some money," explains Drescher, "but we'd like to give up as little biomass as possible to make that money." Drescher does this by capitalizing on the highest value markets he can find to sell products from his woodlot. The best of these has proven to be wood for musical instruments, which is milled, dressed and dried on the property before being marketed. "By increasing the dollar-to-biomass ratio of the wood products we sell, we're making more money by cutting a third of the wood we were in the early 1990s," offers Drescher.

Can this approach be taken elsewhere, on woodlots that do not start with as much economic value as the Windhorse woodlot? "Perhaps not right away," answers Drescher, "but we have to start somewhere. You have to look at each situation and try to maximize the dollar-to-biomass ratio. Hopefully, everyone can do better than selling pulp at the ridiculously low prices offered today."

Natural Wealth and Timber Growth

The standing volume of timber on the Drescher propery is high compared to most other Maritime woodlots (over 35 cords of trees over 25cm (10in) diameter per acre / 200m3 / ha). Drescher attributes this impressive condition to the tall and multi-age structure of the woodlot. "We have reasonably fertile ground, but not exceptionally so," says Drescher. "We're not an anomaly – it's not magic – it's just the natural Acadian Forest working like it should: a multiple-aged forest with multiple canopy layers – a condition that maximizes the surface area of chlorophyll in the forest and thus makes best use of the solar energy available."

The Windhorse woodlot has likely produced some 50% more volume of wood over the past 168 years than it would have if it had been clearcut four times over the same time period. Furthermore, the land is left with an intact, economically valuable forest at the end of the 168 years.

"In the short run, is it better, economically, to rob the bank today or to let the interest build up over time? Clearly, it's better to rob the bank. And this is how we often think about the forest. We don't rob the bank because there are laws against it, and because it goes against our common cultural understanding of what's right. Unfortunately, we don't have laws against robbing the forest, and we don't have a well developed, common cultural notion that robbing the forest is worse than robbing a bank."

Tamara Heikalo

Gary Schneider and the Macphail Woods Ecological Forestry Project:

Restoring Acadian Forest on Prince Edward Island

"Good forestry depends on people's connection with the land, the connection that happens when people get excited seeing an owl or holding a salamander, and knowing that these animals need healthy forests. When we make these connections, we learn to value the land, and that influences how we treat the land. If you love seeing owls, and know they need big trees, you'll think twice about clearcutting your land."

Gary Schneider

Macphail Woods

Gary Schneider

Kindling people's connection with the land is Gary Schneider's passion. That is why he created the Macphail Woods Ecological Forestry Project in 1991 to involve others in restoring the Acadian Forest. A joint effort of the Environmental Coalition of Prince Edward Island and the Sir Andrew Macphail Foundation, the Project operates a native plant nursery, offers nature tours, and carries out forest restoration on the Macphail homestead (located near the small community of Orwell), and at a variety of other sites around PEI.

His dedication to restoring the Acadian Forest and encouraging a connection to the land has earned provincial and national awards for him and his project. It has also resulted in a landmark agreement with the provincial government. In a move that shocked both the forest industry and the conservation movement, the Government of PEI offered Schneider and the Macphail Project a chance to extend their forest restoration strategies to include public lands. "Minister Jamie Ballem asked me how much Crown land we would like to manage. I said 2,000 acres and he said 'fine'," Schneider reports with amazement. "It's one of the great things about living in a small place like PEI. Where else would the Forestry Minister come and meet with someone like me, sit down and hash over a deal like this?"

CROWN LAND AGREEMENT

The Macphail Woods Ecological Forestry Project is responsible for managing 800 hectares (2000 acres) of Crown land spread over 17 separate parcels on the south-eastern end of the province. In what many consider a radical move, the agreement is a high profile chance to demonstrate what Schneider calls "sensible forestry." For him, the government support is an indication that public perception of the forest is changing, that people are showing a desire for a healthy Acadian Forest. Schneider also notes that the lack of financial return from Crown land is encouraging the government to try new approaches to forest management.

Schneider and the Province signed a legally binding, ten-year agreement and, as long as the terms of the agreement are upheld, it will be renewed indefinitely every ten years. During the announcement of the agreement, Minister Ballem commented that "… if public lands are to truly reflect local community values, we have to invite communities to help manage these lands. This lease agreement is one way to do that. The Macphail Woods Ecological Forestry Project has earned national and international recognition, and widespread community support for its work. Building on that strong foundation, the lessons learned from this project will benefit other public lands throughout the province."

New Management for Crown Land

Schneider employs a small crew to carry out under-plantings and careful harvesting on the Crown land properties he manages. All work is designed to restore diversity to the properties and improve their economic and ecological value. For example, a fuel wood harvest might be done to shift the species mix of a hardwood stand from poplar and white birch to yellow birch and sugar maple.

Many of the Crown land properties contain plantations, established at considerable cost to the government, and some of which are over 50 years

old. "Ironically," says Schneider, "I'd rather not have to deal with all these plantations. They're mostly an economic loss for us; they require a lot of work in order to restore the natural forest, and many of the products coming out of them, such as Scots pine and poor quality red pine, are worth very little."

On one Crown land property Schneider points out a red pine stand, planted in 1953, which he is now in charge of managing. Almost all of the trees are in decline with thin crowns and little growth potential, and all have large knots that diminish their lumber quality potential. The trees were supposed to self-prune, but instead produced thick dead branches. "The live crown is maybe a quarter of the tree, but the leaf area – the total amount of photosynthesizing potential for these trees – is very low," he points out. "Who would want wood like this?"

Schneider and his crew will cut openings in the plantations, favouring any natural diversity present, and plant high-value tree species and a mix of suitable shrubs. He also plans to involve neighbouring landowners to increase Macphail's impact beyond the 800 hectares of Crown land. If large enough blocks of land can be managed, Schneider points out, there is even the potential to re-introduce animals such as marten, fisher and river otters, all of which have been extirpated from PEI.

FORESTRY LESSONS

Years of forest experience have taught Schneider a lot about what works and what doesn't in forest management. The use of monoculture plantations tops his list of bad forest practices. "They're a real headache," he says. "Plantations tie up land for 50 or 60 years, acidifying the soil and displacing natural forest. And they're often full of a product nobody seems to want."

Having walked through hundreds of plantations on the Island, Schneider finds that they far too often offer little of value in return for a huge investment of taxpayers' money. Many trees are poorly formed with heavily tapered trunks or forked tops, and most have heavy dead branches that reduce the potential for good quality lumber. Plantations with trees as young as 30 to 40 years are already in decline with trees too small to be thinned or harvested for anything but chips and, as he notes, "nobody wants to thin these stands because it doesn't pay."

> *"If Irving, or if a woodlot owner wants to plant Norway spruce – well, that's ok if they do it on their own land. But why on earth should government pay 90% of the bill? Why should government be encouraging it?"*
>
> *Gary Schneider*

Schneider questions the financial wisdom of using public land and funds to establish these plantations. He estimates that the government spends from $500-$900 per acre to establish and maintain the plantations, including administration costs. "Our government puts a lot of money and effort into plantations – site preparation, planting, cleaning, thinning – with little prospect of getting a return on that investment," he says. "Once you factor in the compound interest that could be earned on that money, it's difficult to believe that plantations are a worth-while investment of government money."

As an example, Schneider indicates a young spruce plantation that was left untended and in which the competing hardwood trees now tower above the planted seedlings. "Ironically, the poplar and white birch will be a lot more valuable than the surviving planted trees," says Schneider. "And they're growing here without wasting any taxpayers' money. It's more than slightly bizarre."

RESTORATION PLANTINGS

As he walks through a stand of white spruce on abandoned farmland, Schneider points to a hemlock seedling, one of thousands he and the staff at Macphail have planted to re-introduce once-common trees and shrubs in Island forests. "I just love seeing young hemlock," says Schneider with a smile. "If there are no nearby seed sources, old field stands like this one take a long time to return to natural forest composition. The seedlings we plant will be the future seed sources."

Schneider believes that establishing seed trees is an excellent use of limited time and resources,

making it a practical goal for restoration plantings. At Macphail, they try to plant a good future seed tree every 25 to 30 feet. This is considerably fewer trees per acre than they used to plant since seedling success rate has been much higher than anticipated. What is their secret? "Well, we don't have deer on PEI," says a pragmatic Schneider. "That's a big plus for seedling survival."

While a lot of the Macphail planting takes place in even-aged white spruce stands on abandoned farmland, Schneider also plants in hardwood stands that lack a conifer component. "Pure hardwood stands are hard on wildlife – there's no winter protection for them. So we add in some hemlock, red spruce and white pine," he explains.

Letting the Light in – Patch Cutting

Schneider plants seedlings either in natural canopy gaps or in gaps created through cutting small patches of trees in existing stands. The gaps need to be large enough to allow sufficient light for the species being planted, but small enough to discourage growth of shade-intolerant competition. The patches range from a few trees to a maximum 16m (50ft) in diameter. Very shade-tolerant species such as hemlock, red spruce and sugar maple do well in the smaller openings, while less shade-tolerant species such as yellow birch, red oak and white ash need larger gaps.

Success with patch cutting and under-planting is well demonstrated at the Macphail Project property. Starting in 1991, Schneider and the Project staff began cutting a couple of small patches per acre in a stand of old field white spruce and planting the openings with yellow birch, hemlock, cedar, red spruce, white ash, red oak and a variety of shrubs. By 2006, some of the planted trees were over 6m (20ft) high with some starting to produce seed. "That's the real proof that what we're doing is working," says Schneider. "We are seeing our grown seedlings putting down seed for the next generation. It really shows the potential that's possible with these plantings."

Ironically, a 1989 forest management plan for the Macphail site stated that the white spruce stands on the property were on the verge of falling down because of their age. "It's a common scenario," says Schneider, "for a forestry contractor to tell woodlot owners that their trees are about to fall down, which can scare the owner into clearcutting. What happens with these stands is that they do break-up, but it is a slow process. There's usually plenty of time to work with the stand – to cut it slowly and get shade-tolerant trees established." Over 17 years later, many of the white spruce at the Macphail property were still standing. These remaining spruce will be harvested over the next ten years or left as wildlife habitat. Meanwhile, they continue to provide protection for the plantings.

Planning Patch Cuts

When planning a patch cut, Schneider assesses the stand and generally cuts the least healthy trees. Sizes of openings are based on the requirement of the seedlings to be planted: hemlock can do well with just one or a couple of trees removed, while yellow birch and red oak need larger patches, up to 50 feet in diameter. Patches are smaller if the site is windy or already partially open. "Some people talk about 10 acre patch cuts. But those aren't really patch cuts – they're clearcuts. Ours are very different, maybe a 1/16th of an acre," explains Schneider.

Any hardwoods or other species that add diversity to the stand are maintained in the stand after harvest. Schneider also ensures that standing dead trees are left or he creates new ones by girdling live trees. He emphasizes the importance of cutting no more than a few patches per acre because opening up a stand too much can promote undesirable growth, such as a flush of balsam fir regeneration. "There's so much to learn; every patch cut we do is an educated guess. You have to try and see what works," he advises. "There's a lot of art in restoration forestry."

A Favourite Seedling Source

"Collecting seedlings along woods roads is a good use of time; we gather a lot of seedlings in a short time with no outlay of cash – it's a great activity," enthuses Schneider. "You get out for a walk, get some exercise, get connected with your woodlot, and collect seedlings for planting."

Minister of Shrubbery

Schneider reasons that shrubs are a vital component of the forest ecosystem and should be included in any restoration work. Not only do they add diversity, they also serve as food sources for wildlife and are key soil builders. At Macphail they plant witch hazel, hobblebush, beaked hazelnut and other shrubs solely to add diversity. "It's very important to plant shrubs – they don't make money of course, but we do it for the love of wildlife. A friend once called me the Minister of Shrubbery - I like that!" Schneider says with a chuckle.

JUDGING SUCCESS

The popularity of the Macphail Project with local people is a testimony to its success. "I always reason that if people don't come out to our events – our talks and nature tours – then we're not giving the right message," explains Schneider. That is a problem he does not have. People show up in droves for Project events, sometimes as many as 80 or 90 attending.

Schneider believes the positive restoration message of the Project resonates with people. In the words of long-time Macphail staff member Eric Edward, "We don't try to hammer people with all the evils of bad forestry. Instead, we help people make a connection with the forest. We teach people about wildflowers, and people naturally tend to love plants, so we make the connection between the plants, the forest and the practices that sustain a natural forest. We show kids an eagle nest and they see why we need big trees."

The Macphail Project is also popular because it offers concrete examples of Acadian forest restoration work. "People come to our project sites," says Schneider, "and we can say, 'Here, look, this is what we do – here are yellow birch we planted in an old field white spruce stand that are now up to 18 feet high.' We show people working solutions that they can take and apply to their own woodlots."

Macphail Woods

Nursery beds at Macphail

A Community Resource

The Macphail Project is careful to keep the environmental message positive. Schneider points out that it is easy to be negative about the forest industry, but harping on the negative only makes people depressed. Instead the Project focuses on showing the changes that restoration can make, and helping establish connections with the land through community events. "Our 'Owl Prowls', for example, really make an impression on people," Schneider says. "When they see an owl fly in, they understand why we want to restore the forests."

Working with schoolchildren is a major source of motivation for the Project. Local children become excited when they see positive changes, like a vacant field returning to a viable forest. "The students treat us like rock stars – sometimes they cheer when we walk into the school. It's kind of weird, but it shows that children get excited about this stuff."

Another community connection is developing local markets for wood produced from the Crown land Macphail manages. Schneider is particularly interested in making partnerships with local craftspeople that, in turn, can help spread the concept of restoration forestry. Harvesting ground hemlock – a plant used in cancer research – is another option, and he is keen to show people how to harvest the plant without destroying it.

Schneider also plans to take further advantage of the educational opportunities the Crown land properties offer, perhaps in the form of a learning centre that could teach everything from forest ecology to safe chainsaw usage. Above all, he hopes that the Crown land restoration properties will become meeting places for people to exchange ideas about forests and how they use them. Schneider hopes this will be a chance to not only share ideas about the Acadian Forest, but also to validate the restoration work that people are doing on their own woodlots.

6

Trees of the Acadian Forest

Andrea Sulzer

CHAPTER 6:

TREES OF THE ACADIAN FOREST

The following compendium contains descriptions of 32 species of trees found in the Acadian Forest. Of these, 22 are found throughout most of the region, and 10 are notably less abundant or widespread. Common trees are described first, and are grouped according to their ability to tolerate shade; the less common trees are grouped together.

Common Acadian Forest Trees	**High shade tolerance:** red spruce • eastern hemlock • balsam fir • American beech • sugar maple • striped maple • eastern white cedar
	Moderate shade tolerance: black spruce • red maple • white pine • yellow birch • red oak • white spruce • white ash
	Low shade tolerance: red pine • jack pine • white birch • tamarack • grey birch • trembling aspen • largetooth aspen • balsam poplar
Uncommon Acadian Forest Trees	basswood • butternut • bur oak • silver maple • white elm • black cherry • ironwood • red ash • black ash • service-berry

Tamera Heikalo

A tolerance for shade

Different species of plants require different amounts of sunlight to survive. Species common in open areas – choke cherry, poplar and grey birch, for example – require close to full sunlight, whereas species common in mature forest – such as red spruce, hemlock and beech – require much lower amounts of light to stay alive.

Except where otherwise noted, all images in this section are credited to Natural Resources Canada, Canadian Forest Service – Atlantic Forestry Centre; as appeared in Trees of Knowledge: A Handbook of Maritime Trees *by Geoffrey A. Ritchie; tree silhouettes by Ian Smith Originals.*

Trees with High Shade Tolerance

RED SPRUCE

(Picea rubens)

Red spruce is known as the Acadian Forest's signature tree. Although it is found scattered through New England and in parts of Ontario, red spruce is abundant and dominant only in the Acadian Forest. A shade-tolerant and long-lived tree, red spruce is often a major component of old growth Acadian Forest.

Red spruce grows in a wide variety of soils, but does best in moderately fertile, sandy, acidic soils that are moist yet well drained. A wide-spreading and shallow root system allows red spruce to grow in soils as thin as 33cm (13in), giving it an important role in soils that are too thin to support many other species.

Red spruce usually grows among sugar maple, yellow birch, balsam fir, beech, hemlock and white pine on well-drained sites, and with balsam fir, tamarack and red maple on poorly drained sites; it also grows occasionally in pure stands. All species of spruce are valuable food sources for wildlife, and provide nesting sites and winter protection. Red spruce is often the only conifer present in hardwood stands, so it is particularly important for wildlife.

Regeneration

Like most Acadian Forest softwoods (except for black spruce and cedar), red spruce reproduces by seed only, with no sprouting from roots or stumps. Seed production begins as early as 20 years of age, with full production after age 45; heavy crops occur every 3 to 8 years and seeds remain viable for one year only. Seed germination is best under partial shade on either a moist mix of humus and mineral soil or on decaying wood. Germination tends to be poor on soils with heavy litter layers, and does not occur on sod. Seeds can germinate in light levels as low as 10% of full sun, but seedling growth rate improves as light increases to at least 70% of full sun. Seeds can be dispersed 60 to 90m (200 to 300ft) from parent trees.

Restoration Notes

Forestry practices – particularly intensive high-grading in the 1800s and clear cutting more recently – have reduced red spruce to an estimated 15 to 20% of its former abundance. High-grading eliminates quality seed sources, and clear cutting creates an environment that favours competitors of red spruce, such as balsam fir and shade-intolerant hardwoods. The tree is now considered rare in Ontario, and in New Brunswick the Canadian Forest Service classifies it as a 'species of concern', meaning that precautions need to be taken to ensure its continued presence in the forest. For these reasons, red spruce should be promoted wherever it is found and reintroduced where it has been diminished or lost.

The tree's high tolerance for shade allows it to remain for many years in the forest understory, awaiting a gap in the canopy. Although saplings may appear young because of their small size, understory red spruce trees are often 30 to 50 years of age, and have

As a general rule, white spruce grows in old fields and along the Atlantic coast; black spruce grows in poorly drained sites, especially near bogs; and red spruce grows in mixed-wood, upland forests with moderate to rich soil and along the Bay of Fundy coast.

Red spruce is absent from some areas of the Acadian Forest, notably northern parts of New Brunswick and Nova Scotia, and areas with elevations greater than 600m (2,000ft). Also, red spruce and other species may be rare in some areas, such as Cape Breton Island, because of a slow colonization rate following the retreat of the glaciers some 10,000 years ago.

been found up to 145 years old in this condition. Red spruce trees growing in the understory tend to maintain their vitality while remaining small, and have an exceptional ability to resume faster growth once a canopy gap opens and light levels increase. For these reasons, woodlot owners should protect understory red spruce from damage during harvesting and encourage them to grow by creating canopy gaps during selection harvesting.

Because red spruce seeds do not germinate well on thick layers of leaf litter, natural germination sites include decaying wood, areas with thin duff layers and soil exposed by uprooted trees. Germination can be improved by light ground disturbance, such as that caused by low-intensity harvesting during late summer or fall, timed with heavy seed crop years. Red spruce also tends not to thrive in clear-cuts because moisture levels are often too low for good seedling growth; it cannot tolerate intense heat or exposure to drying winds.

Red spruce seedlings are well suited to planting in stands harvested by strip, patch or selection cutting. Preliminary research at the Canadian Forest Service in Fredericton suggests that the light levels found in the middle of 10m to 20m (33 to 66ft) strip-cuts works well for red spruce seedling growth. The presence of wood sorrel (*Oxalis* spp.) and bunchberry (*Cornus canadensis)* often suggest good sites for planting red spruce.

"Forest harvesting by clear-felling and a long history of selective removal, particularly during the 1800s, have clearly eroded [red spruce] population sizes and numbers.... In absence of advanced regeneration and (or) a viable seed source, red spruce can be largely eliminated following the clearing of upland forests, particularly as one moves inland away from the high atmospheric moisture conditions of coastal areas."

Alex Mosseler *et al.*, 2000[1]

"The presence of natural red spruce regeneration in many younger, mixed-wood stands that still contain scattered remnants of older red spruce trees can be used as an indicator of the potential to increase this old-growth forest component that once dominated much of the pre-settlement forest of eastern Canada."

Alex Mosseler and Ian Thompson, 2000[2]

Consequences of Tree Loss

Researchers have found that certain small, isolated populations of red spruce in Ontario have reduced reproduction ability and their seedlings have reduced growth rates. A loss of genetic diversity is a probable cause of these effects, and this loss could occur elsewhere if red spruce numbers continue to decline. Old red spruce trees are important reservoirs of genetic information, much more so than young trees, and preserving them in a woodlot as seed trees can help to maintain the genetic diversity and fitness of the species.

Red and black spruce hybridization

Under natural conditions, red and black spruce tend to be separated by ecological constraints; red spruce is more shade-tolerant and grows in upland areas, whereas black spruce is less shade-tolerant and tends to grow in wet soils. Forestry practices, however, have favoured the growth of black spruce on sites traditionally occupied by red spruce, so the two species now often grow in close proximity. This is detrimental to red spruce, not only because of loss of habitat to black spruce, but also because the two species can cross (hybridize), which results in erosion of the genetic diversity of the red spruce. Red and black spruce crosses also make species identification difficult, creating problems for those who wish to promote red spruce.

Red spruce

EASTERN HEMLOCK

(Tsuga canadensis)

Hemlock is a common sight in old Acadian Forest, often forming part of old-growth areas. It is one of the most shade-tolerant and longest-lived trees (300 to 500 years) in the Acadian Forest, and tends to grow in cool, moist environments, often on north-facing slopes and along water edges. Within these parameters, hemlock can tolerate a wide variety of soils, but it grows best on rich, well-drained land with high moisture availability.

Hemlock

Hemlock can be confused with balsam fir because both have flat needles. Differences, however, include the white undersides of the smaller hemlock needles and the drooping tips of hemlock branches. Hemlock can be confused easily with other conifers and cut by mistake, especially when thinning young stands of trees. An occasional hemlock will blend easily with other conifer trees. Old hemlock trees are an important source of genetic diversity for the species, and should be preserved wherever they are found.

Hemlock grows at a slow to moderate rate; it can attain a height of 22m (70ft) and a diameter of 60 to 120cm (2 to 4ft). It grows in association with white pine, red spruce, yellow birch, sugar maple, but also occasionally in pure stands. Hemlock is generally wind-firm, and the seed is an important food source for a number of forest birds, including American goldfinch, boreal chickadee, ruffed grouse, pine siskin and red-winged and white-winged crossbills.

Regeneration

Hemlock reproduces exclusively by seed. Seed production begins as early as age 20 years, with full production after age 50 and large seed crops every 2 to 3 years. The best germination occurs in cool, shaded sites with good moisture availability.

Restoration Notes

Once extensively harvested for its bark for use in the tanning industry, and for its wood for making railway ties, hemlock is generally less common than it once was in the Acadian Forest. Therefore, it should be encouraged wherever it is found in order to restore its contribution to the biodiversity of the Acadian Forest. Hemlock is a good candidate for restoration plantings, especially to diversify existing stands of old-field white spruce or intolerant hardwoods. Hemlock seedlings transplant well and are easily grown from seeds.

Hemlock

> Seedling Source Hint:
>
> Lightly used forest roads that pass close to healthy hemlock trees often contain an abundance of hemlock seedlings available for easy transplanting.

BALSAM FIR

(Abies balsamea)

Balsam fir occurs throughout the Acadian Forest, and its abundance has increased substantially over the past several hundred years. This change in abundance seems to be a result of commercial forestry practices, particularly high-grading and clearcutting, both of which tend to promote a proliferation of balsam fir. High-grade harvesting removes species that would normally suppress balsam fir in a mature forest, and clearcutting creates growing conditions that are favourable to balsam

Balsam fir

fir seedlings, which are resistant to damage from exposure to low moisture levels and drying winds. Large-scale insecticide spraying to kill spruce budworm, whose favourite food is balsam fir (not spruce), has kept budworm populations artificially low, thus may also have led to an increase in balsam fir abundance.

Balsam fir ranges from Newfoundland to Alberta, and is common in Canada's eastern Boreal Forest and parts of New England's mixed-wood forests, although due to its short life span and susceptibility to spruce budworm and other disturbances, it is only a minor component in old-growth forest. Balsam fir is an aggressive competitor in the high light conditions found in recently disturbed sites. It can tolerate a wide variety of climatic conditions and grows in almost any soil type, from poorly drained organic soils to gravely sands; it is, however, more nutrient demanding than red spruce. It is highly shade-tolerant, so can reproduce under a partial canopy.

Balsam fir has traits that tend to keep it from establishing dominance on sites with at least moderately fertile soils. First, its relatively short life span of 80 to 110 years means it dies well before the shade-tolerant trees among which it tends to grow. Second, its average mature height of 21m (70ft) on good growing sites means other shade-tolerant trees eventually grow taller and compete more successfully for sunlight. Finally, balsam fir is prone to blowdown in windstorms and is susceptible to a diversity of ailments including spruce budworm, balsam woolly adelgid, and a variety of root and butt rots. As a result, pure stands of balsam fir are unstable and seldom long-lived.

Reproduction

Balsam fir reproduces by seed, which it starts producing as early as 15 years of age, entering full production after age 30 with large seed crops every 2 to 4 years. The trees can establish and grow in partial shade, and only 10% of full sunlight is required for seed germination. Balsam fir seeds germinate on a wide variety of seedbeds, so long as the moisture level is adequate. Balsam fir does not tolerate very low nutrient levels, but it can grow on moderately fertile soils. Peak seed fall occurs in late summer through fall, and seeds are dispersed approximately 15 to 30m (50 to 100ft) downwind from parent trees. Young seedlings (from recently germinated seeds) have been found in the millions per hectare under closed canopies; however, without adequate light, most of these die after one season.

Balsam fir grows in conjunction with almost all other Acadian Forest tree species, but is especially associated with yellow birch, red maple, black spruce and red spruce. Balsam fir generally forms natural pure stands only on rich, moderately drained sites; in most parts of the Acadian forest, it is a lesser component of mixed hardwood and softwood forest.

Restoration Notes

Balsam fir is more abundant and more dominant on the Acadian Forest landscape today than in pre-settlement times due to intensive harvesting and other land use practices that create conditions favourable to its growth. Outside of certain environmentally extreme sites, such as poorly drained and low nutrient soils, balsam fir's place in the pre-settlement forest was as a minor but ubiquitous, short-lived, understory tree and a pioneer species in areas subject to catastrophic disturbance by windstorms. Usually, long-lived, shade-tolerant trees would tend to limit the abundance of balsam fir.

Moderately to highly fertile sites with pure or nearly pure balsam fir stands can be managed during forestry activities to increase the presence of other species. Woodlot owners can accomplish this during pre-commercial and commercial thinning by cutting balsam fir and favouring species that are more desirable. Trees such as red spruce, hemlock, yellow birch, white pine, white ash and sugar maple respond well to release from balsam fir competition.

Balsam fir trees growing in thick stands that are over 35 years old, especially on sites with poor growing conditions, tend to suffer from root and butt rot fungi, and are susceptible to damage from a variety of insects, including spruce budworm. They also tend to have poorly developed root systems and are

thus vulnerable to high winds. Such stands tend to be unstable and thus short-lived.

From a silviculture and restoration point of view, pure or near-pure stands of balsam fir present a challenge because they are unstable and often have low economic value. One management approach is simply to leave such stands and let them 'break up' naturally. If seedlings or seed sources of other shade-tolerant species are present, the breaking up of the stand allows these species to establish as the balsam fir die and light enters the stand. Another option is to harvest in such stands using a combination of strip cuts, selection cutting, and crop tree release in order to favour species other than balsam fir. Planting the narrow harvest openings with species that are at least moderately tolerant of shade can also help to increase tree diversity.

Balsam fir

Unlike other shade-tolerant species, balsam fir trees growing in the understory often do not respond well to increased light from canopy openings. In spite of their small size, such trees can already be chronologically mature, and their short life span and susceptibility to rots generally prevent such trees from being desirable crop trees.

AMERICAN BEECH

(Fagus grandifolia)

Early European explorers describe beech as one of the most common hardwoods in the pre-settlement Acadian Forest (see Chapter 1 for examples). This is not surprising given the species' high shade-tolerance and affinity for a wide variety of soil conditions. Beech trees can be found in almost all moderately fertile soils, except in excessively wet areas. They have a slow to moderate growth rate over a 100- to 200-year life span, but can achieve a mature height of 24m (80ft).

Beech

Beech often grows with red maple, sugar maple, yellow birch, red spruce and hemlock. Beech nuts, the tree's seeds, are an important food source for many species of wildlife. In fact, research indicates that black bear reproduction is synchronized with years of heavy beech nut production.

Unfortunately, beech trees in the Acadian Forest suffer from a disfiguring and often lethal condition. Beech bark disease was introduced to Canada from England in 1890, in a shipment of European beech sent to Halifax, Nova Scotia, as a gift from Queen Victoria to the city of Halifax. An insect and a fungus comprise the disease, which is continuing to spread and wreak havoc on beech throughout the Acadian Forest. Initially, the disease kills the most susceptible beech trees, while the surviving, less susceptible trees are weakened, stunted and disfigured with cankered bark. Beech trees still occur in the Acadian Forest, but most are in a severely degraded state. Fortunately, roughly 5% of beech trees share a genetic resistance to the disease. The smooth grey bark of these 'clear beech' can be easily seen within stands of the diseased trees; however, the number of disease-resistant beech tends to be very small in areas where indiscriminate cutting occurs.

Regeneration

Beech can reproduce by seed, root sprouts and stump sprouts. Stressed trees tend to produce abundant root sprouts, sometimes resulting in dense undergrowth of beech stems. It is largely due to this vegetative reproduction that beech still occurs in the Acadian Forest. Healthy beech trees produce seeds after 40 years of age and full production usually starts after age 60, with heavy seed crops every 2 to 3 years; however, diseased trees expend much of their energy fighting the disease, leaving little for seed production, so seed on heavily diseased trees is often empty. Beechnuts do not germinate well in wet sites, and beech root systems do not tolerate flooding.

Restoration Notes

The most important action that woodlot owners can take to help restore healthy beech is to identify and protect disease-free trees, and to protect any root sprouts they produce since these share the disease resistance. Removing competing trees can help to promote the healthy beech and their associated root sprouts. Unfortunately, the seedlings from resistant trees have only a very small chance of sharing the disease-resistant quality because the pollinating parent has a good chance of being susceptible to the disease.

Because the numbers of resistant beech trees are low, each one is extremely valuable for its genetic properties. Most beech in the Acadian Forest have been exposed to the bark disease, and smooth-barked beech trees larger than 10cm (4in) in diameter can be assumed to be resistant, especially if nearby beech trees show signs of the disease. Some beech trees show a partial resistance to the disease and these should be protected along with perfectly clear beech. It appears that cold winter temperatures have slowed the spread of the disease in limited areas of the Acadian Forest, such as high elevation areas in west-central New Brunswick. Therefore, some trees that are disease free in these regions may not be genetically resistant.

The Canadian Forest Service, Atlantic Region, is conducting research on methods to propagate disease-resistant beech. Propagation of these trees could result in a supply of healthy beech available to plant throughout the Acadian Forest.

Beech leaf

SUGAR MAPLE

(Acer saccharum) (Rock maple, Hard maple)

Sugar maple is a common Acadian Forest tree in areas with moderately to very rich soil and is often a dominant species in climax forests. Also known as rock maple or hard maple, it is very shade-tolerant and long-lived, from 150 to 300 years. It is a nutrient-demanding species that requires deep, fertile, cool, moist and well-drained soils for good growth. Therefore, it generally does not grow on excessively dry or wet soils. Sugar maple is a moderate to fast growing tree on fertile sites, reaching 28m (92ft) in height. This maple tends to grow in conjunction with beech, yellow birch, white pine, red spruce, balsam fir and hemlock.

Sugar maple

Regeneration

Sugar maple reproduces by seed, stump sprouts and occasionally root sprouts. Seed production begins at approximately 40 years, with full production after 70 years, and seed remains viable (able to germinate) for only one year. Unlike many other tree species, sugar maple seed can germinate and grow in undisturbed forest floor litter and it does not require soil disturbance to germinate. A carpet of young sugar maple is often present on the forest floor under closed sugar maple canopies even when there is only enough sunlight to allow them to survive for a few seasons. Although they die if more sunlight does not become available by some opening in the canopy, an on-going rain of seeds ensures they are quickly replaced. Saplings grow well with exposure to 15 to 45% of full sunlight, and under such light conditions tend to grow straight with little side branching. Sugar maple has reduced height growth and extensive side branch growth under full sun conditions.

Restoration Notes

A key species in mature Acadian Forest, sugar maple should be encouraged wherever the soil is suitable for its growth. Large, mature sugar maples help regulate soil moisture content during dry periods by taking water from deep in the ground and releasing it close to the surface. Nearby plants benefit from this process (known as night-time hydraulic lift) because of the moist soil conditions it provides. Only large maples have this ability, though, giving them a particular importance in the forest ecosystem.

Woodlot owners can plant sugar maple in thinnings or patch-cut openings, especially in young even-aged growth where the surrounding forest contains sugar maple. Planted seedlings may require protection from browsing damage by deer and hare. Small sugar maple can survive many years under heavy shade, yet will still respond well if openings are made in the canopy. As a result, these trees can be conserved and encouraged no matter what their position is with relation to canopy, so long as they are reasonably healthy.

Sugar maple trees are sometimes confused with the non-native Norway maple, which occasionally grow near urban areas. Norway maple leaves usually have seven lobes, whereas sugar maple leaves have five.

Sugar maple leaf

STRIPED MAPLE

(Acer pensylvanicum) (Moose maple)

Identified by vertical light and dark stripes on its bark, striped maple is a common sight throughout the Acadian Forest. It is an upland species, preferring moist, well-drained soils, and tends to grow with yellow birch, sugar and red maple, hemlock and red spruce. Although sometimes cut for firewood, it seldom grows more than 0.3m (1ft) in diameter and so is generally not a harvested species.

Because striped maple is a relatively small and shade-tolerant tree, it 'fills out' a forest's vertical diversity by growing under the shade of taller trees, and thus provides forest birds with feeding, nesting and perching sites. Its twigs are a favoured food source of moose, deer and snowshoe hare; red squirrels, chipmunks, and ruffed grouse eat its seeds.

Striped maple is a good candidate for restoration plantings. It grows quickly and can be planted under an existing canopy to diversify a stand or in open areas to provide a shaded micro-climate for seedlings of shade-tolerant species.

EASTERN WHITE CEDAR

(Thuja occidentalis)

Cedar typically grows either in moderately rich, wet soils or in upland sites with calcareous (calcium-rich) soils. It grows throughout most of New Brunswick, but only in the western half of Prince Edward Island and in isolated locations of southwestern Nova Scotia. Within its range, cedar is commonly a dominant tree in swampy areas that have fertile, alkaline to neutral soil and moving water. It is shade tolerant, but less so than balsam fir or sugar maple. It is a long-lived tree, reaching 350 years of age in the Maritimes and occasionally more than 700 years at some sites in Ontario.

Cedar

Cedar has a slow to moderate growth rate, reaching heights up to 15m (50ft). It grows best in moderately well-drained soils, where it can grow up to three times faster than in wet soils. Where it occurs in swamps, the flow and level of the ground water are important conditions for its survival: cedar will not grow well in swamps with stagnant water, and high water levels can kill an entire stand. Trees growing in wet soils also tend to develop heart rot. In forest conditions, cedar tends to grow a straight trunk and a narrow crown; however, in open conditions, it develops a very bushy crown, as is seen in cedar hedges.

Cedar grows with balsam fir, all spruce species, tamarack, hemlock, white pine, white and yellow birch, red maple and aspens. Cedar will out-compete shorter-lived and less shade-tolerant species such as tamarack, balsam popular and black spruce, and will often become a dominant tree in forested swamps. One advantage is a long-reaching root system capable of tolerating extreme sites, such as cliff faces. A variety of forest birds and other wildlife eat its seed, and find cover and wintertime protection in its dense foliage.

Reproduction

Cedar reproduces both by seed and, in swampy locations, by layering. Layering is common in swamps where ground-touching branches and stems of tipped-over trees easily develop roots and establish new stems. Seed production can begin as early as 20 years, with best production after age 75, and high seed crops occur every 3 to 5 years. Seeds are spread by the wind and germinate best on decayed forest floor litter or on peat and moss.

Cedar seedlings cannot survive heavy shade for more than a few years; they must receive partial sunlight to continue growing. Shoots produced through layering, however, are more shade tolerant and can develop under a forest canopy.

Restoration Notes

Largely due to over-harvesting and high-grading, cedar is declining throughout its range in the Acadian Forest. Large, straight cedar trees are valued for their lumber and are often removed from cedar stands; such sites tend not to regenerate well with cedar following heavy cutting. Because of its declining numbers, the Canadian Forest Service considers cedar a tree of special concern in New Brunswick.

Light selective cutting near cone-producing trees can encourage cedar regeneration on upland sites and light shade provides a good microclimate. Ground disturbance is not necessary to encourage the seed growth and seed trees should be preserved wherever possible. Cedar responds well to release from competition at almost any age, as long as it is healthy. Cedar trees are shallow-rooted and, therefore, susceptible to blowdown, especially those growing in wet soils.

Cedar can be planted wherever conditions are favourable – either in rich wet areas, or in uplands with neutral or slightly alkaline soil. Cedar trees transplant easily; seedlings, however, are often eaten by deer and may require protection from browse damage.

Cedar

Trees with Moderate Shade Tolerance

BLACK SPRUCE

(Picea mariana)

Black spruce grows throughout the Acadian Forest and beyond through much of Canada's Boreal Forest. Since black spruce has a tolerance for wet, acidic, low-nutrient soils, it is most often found in bogs and other low-lying, poorly drained areas. It is also an early successional species in recently disturbed areas and, in general, in moist soils with high organic content.

Black spruce

It can attain a height of 17m (55ft), and has a life span of up to 250 years in the Boreal Forest, but generally lives for only 80 years or so in the Acadian Forest region. On good sites, it grows with white spruce and balsam fir, while on poor sites it grows with tamarack or in pure stands. It is a characteristic tree on poorly drained soils, and often forms pure stands around bog edges.

Regeneration

Black spruce reproduces by seed and, in wet areas, by layering. It begins seed production as early as 15 years and produces seeds yearly with heavy crops every 2 to 4 years. Black spruce normally forms single-age-class stands only. It has a moderate tolerance for shade, and sprouts produced through layering in wet sites are inclined to have greater shade tolerance.

Restoration Notes

Before the advent of extensive clearcutting, black spruce was much more restricted in its distribution in the Acadian Forest. Harvesting practices have

opened new land to black spruce, whose early growth is faster than the early growth of red spruce. As well, forestry companies have used black spruce extensively in monoculture plantations throughout the Maritimes. Therefore, it is much more common outside its natural niches than it normally would have been. For this reason, black spruce should generally not be encouraged on upland sites, and black spruce plantations can be converted to a natural species mix. Areas where red spruce does not naturally occur (parts of Cape Breton, for example) are an exception.

Black spruce is an excellent candidate for restoration plantings near bogs and on other acidic, poorly drained sites as it is resistant to flooding. Because it is shallow-rooted, black spruce is extremely susceptible to windthrow, especially where it occurs in wet soils. As a result, woodlot owners should use caution when harvesting in black spruce stands; less than 20% tree removal will help to avoid wind damage by limiting canopy openings and avoiding increases in the height of the water table (water table rises when trees are removed from an area).

Black spruce

RED MAPLE

(Acer rubrum)

Red maple is an abundant and widespread tree throughout the Acadian Forest. It can tolerate a wide variety of sites, including swampy areas, flood plains, and excessively dry conditions.

On poorly drained sites, red maple grows with black spruce, cedar and balsam fir, and it grows with balsam fir, red spruce and yellow birch on better drained sites.

Red maple

It tends to be most common on moist, well-drained and moderately fertile soils. It is a moderate to fast growing tree, reaching a height of 22m (70ft) and living for upwards of 150 years.

Reproduction

Red maple reproduces by seeds and it also sprouts prolifically from stumps. Seed production begins at age 30 years with full crops after 40 years. Mature trees produce a good seed crop almost every year. Red maple is moderately shade-tolerant, and grows well both in full sunlight and in the shade of a partial canopy.

Restoration Notes

Red maple is a strong competitor, especially when it regenerates by means of sprouts. It is probably more abundant in today's cut-over Acadian Forest than it would have been in the absence of frequent clearcut harvesting because of its aggressive regeneration and short life span, which helps it respond well to frequent harvests. Therefore, red maple generally should be selected against, particularly on good growing sites, in order to favour longer-lived species that are now less abundant such as sugar maple, white ash, hemlock, cedar, white pine and red spruce. However, red maple should be maintained in areas where it is one of few hardwoods present; in such cases red maple is important to forest biodiversity and soil health.

Red maple leaf

WHITE PINE

(Pinus strobus)

White pine grows throughout the Acadian Forest. It has an aesthetic appeal for many, and has been described as the stateliest tree in Acadian Forest for its great height and distinctive profile. White pine can reach a diameter of over 1.2m (4ft) and heights of 35m (115ft) or more. As the Acadian Forest's tallest tree, it often rises above the canopy as a 'super dominant' tree, and is easily seen silhouetted against the sky.

White pine tolerates a variety of growing conditions and soil types, from dry rocky outcrops to wet

swales. It is a moderate to fast-growing tree, but achieves its best growth in the well-drained, moist, sandy soils found in riparian areas. With a lifespan of 400 to 500 years, it is one of the longest-lived species in the Acadian Forest. On well-drained sites, white pine grows with hemlock, red spruce, yellow birch and sugar maple; on dry sites, with jack pine and red pine; and, on poorly drained sites, with black spruce and tamarack. It also occasionally occurs in pure stands.

White pine

Regeneration

Seed production begins at 20 years, with full production after 50 years and good crop years every 3 to 5 years. Its seeds germinate best on moist, sandy soils with some mineral soil exposed, and germination can be poor on heavy litter layers. Seeds can travel at least 60m (195ft) within the forest and even greater distances in the open.

Restoration Notes

In the 1700s, eastern North America was known for its massive white pine, many of which grew in the Acadian Forest. England went to great lengths to reserve many of the best white pine for the exclusive use of its Royal Navy (especially during the Napoleonic Wars when access to Baltic pine was cut off). Large, straight white pine trees were much sought-after for use as masts in shipbuilding; in fact, white pine was often the main resource of interest for early settlers. Settlers harvested white pine to the point of over-exploitation and, by the mid 1800s, it was no longer the mainstay of the lumbering industry. It is less common than it would be in absence of over-exploitation, so should be encouraged wherever it is found.

White pine is an excellent candidate for restoration plantings. Seedlings are moderately shade-tolerant and require approximately 55% full sunlight for good growth. It is important to note that seedlings can tolerate up to 80% shade, but require additional light after a few years to continue growing. Clearing patches near white pine seed trees can encourage natural regeneration during good seed-crop years. Light ground disturbance, such as low-impact harvesting during late summer or fall, can also encourage seed germination by creating a favourable seedbed. Old white pine trees are usually highly genetically fit, so are particularly valuable sources of both seeds and genetic diversity.

White pine needle bundle and cone

"Greed and ignorance, a precious pair ... never did more execution on a small scale than they wrought in the beautiful pineries of Nova Scotia."

R.R. McLeod, 1903[3]

"Harvesting pressures have reduced eastern white pine to small, isolated groups of trees over large portions of its former geographic range."

Rajora *et al.* 2002[4]

White Pine Weevil

White pine weevils attack and kill the 'leader' or top shoots on young white pine. This causes one or more side shoots to replace the leader, resulting in crooked and often forked trees. Weevil damage is common in white pine growing in the open, but rare in those growing under a partial canopy, where they tend to have thin top shoots. Therefore, keeping a partial canopy over or near the trees until they are at least 6m (20ft) tall can help prevent weevil damage.

"It is a curious circumstance that only pines in full sunlight are bitten by weevils; shaded pines are ignored. Such are the hidden uses of adversity."

Aldo Leopold, 1949

YELLOW BIRCH

(Betula alleghaniensis)

Yellow birch

Yellow birch is a common hardwood tree throughout the Acadian Forest. It grows in a range of soil conditions, but its best growth is on moderately drained, moist, fertile soils. Yellow birch can live up to 300 years, and attain a height of 25m (80ft). Perhaps because it is only moderately shade-tolerant – less than most other long-lived species – it rarely forms a dominant canopy.

On better-drained soils, yellow birch grows with a wide range of other species, including sugar maple, red maple, white ash, ironwood, beech, red spruce, white pine, cedar, hemlock and balsam fir. On poorly drained sites, it tends to grow with black spruce and red maple.

Reproduction

Yellow birch reproduces primarily by seed and occasionally by stump sprouts. Seed production begins at 40 years, with full production after age 70. Good crops of seeds occur every 1 or 2 years, and the small seeds germinate best on moist mineral soil. Germination tends to be poor in thick, undisturbed forest litter, but fallen deadwood and old stumps provide suitable, raised germination sites, which are often blown clear of hardwood leaves that otherwise tend to smother yellow birch seeds. This explains why yellow birch trees are occasionally seen supported by stilt-like 'legs' – roots that grew around a stump or rotten log that subsequently decomposed and disappeared.

Restoration Notes

Large amounts of yellow birch lumber were shipped to Europe during the 1800s, and good quality yellow birch continues to be harvested for its valuable lumber and veneer logs. Because it was a significant component of mature Acadian Forest and has been reduced in quality, if not necessarily quantity, yellow birch should be encouraged.

In the absence of suitable germination sites provided by deadwood, light disturbance of the soil such as by low-impact harvesting during late summer or fall will encourage yellow birch regeneration. Yellow birch is a good tree to include in restoration plantings, but it is a favourite food source for deer so protection from browsing may be necessary.

Yellow birch is moderately shade-tolerant, requiring 45% to 50% full sunlight to grow well. Especially when young, growth of new side (epicormic) branches can occur when yellow birch receives a sudden increase in light. It will respond well to release from competition up to at least 65 years of age. However, yellow birch trees are very sensitive to rapid exposure to sunlight following harvesting, so cutting around yellow birch should be light to prevent damage.

Yellow birch leaf

Yellow birch trees lose their characteristic smooth yellow papery bark as they age, and develop instead a rough, platy, thick bark. Those not familiar with old growth yellow birch may mistake it for another species, and they are likely the species that was historically referred to as "black birch" by early European explorers and settlers.

RED OAK

(Quercus rubra)

Red oak generally grows throughout eastern North America, south of the Boreal Forest. It grows throughout most of the Acadian Forest, except for parts of Cape Breton and eastern and northern New Brunswick. Red oak seedlings often grow in unexpected places, at times great distances from parent trees, thanks to active acorn dispersal by blue jays and small mammals. Red oak trees prefer

deep, moist, well-drained soil, but can tolerate a wide variety of sites. It is a moderate to fast growing tree, reaching a height of 24m (80ft) and living for upwards of 250 years.

Red oak

On good sites, red oak can be found growing with sugar maple, beech, yellow birch, white ash, red spruce, red pine and white pine; on poorer sites, it grows with aspen, white birch and red maple. Red oak acorns are an important food source for many wildlife species, particularly red squirrels, blue jays, grackles, woodpeckers and ruffed grouse.

Regeneration

Red oak reproduces by seed (acorns) and stump sprouts. Acorn production begins at age 25 years with full production after 50 years and good crops produced every 2 to 5 years after maturity. Best acorn germination occurs on leaf litter-covered soil, and acorns germinate poorly on dry or exposed soil.

Restoration Notes

Red oak is likely less abundant in the Acadian Forest than it would be naturally, so is an excellent addition to restoration plantings. Red oak has a moderate to low tolerance to shade, so seedlings need partial to full sun. The seedlings do not grow well in wet soils, and protection from browsing may be necessary. Red oak trees response well to release from competition until age 30. However, growth of new side (epicormic) branches can occur when a red oak receives a sudden increase in light.

Red oak leaf

WHITE SPRUCE

(Picea glauca) (Pasture spruce, Field spruce, Cat spruce)

White spruce

White spruce is found throughout the Acadian Forest today, but this typically Boreal species is naturally characteristic in the Maritimes only along Nova Scotia's exposed Atlantic coast and in a few other similarly harsh environments. While white spruce tolerates certain harsh conditions, such as wind-swept ocean shores, it generally does not grow in wet soils or attains only a stunted growth on such sites. However, it is a widely occurring and opportunistic species on disturbed sites, particularly old farmland where it can compete with the abundant grasses found there. As a result, a common name for white spruce in the Maritimes is 'pasture' or 'field' spruce. White spruce grows across Canada, with the exception of the Pacific coast, and is common in the Boreal Forest. It can tolerate a wide variety of soil types and climatic conditions but achieves its best growth in moderately fertile, deep, sandy soils that are moderately to well drained.

On poorly drained sites, white spruce grows with black spruce and balsam fir and on better-drained sites with white birch and trembling aspen. White spruce often forms pure stands on abandoned farmland. It is a moderate to fast growing tree, reaching heights up to 24m (80ft) and a longevity up to 200 years. However, its lifespan may be less on formerly ploughed land; along the Northumberland Strait in both Prince Edward Island and Nova Scotia, it has been observed to grow rapidly until age 50 years or so and then quickly deteriorate, leading to a collapse of the stand. A variety of wildlife eats its seeds, and it

is second only to balsam fir in its susceptibility to feeding by spruce budworm.

Regeneration

White spruce begins seed production by 30 years, and produces large crops every 6 to 12 years. Seeds are viable for 1 or 2 years, and most seeds fall within 90m (295ft) of a parent tree. Best germination is on moderately to well-drained soil. White spruce trees are more shade-tolerant than black spruce and can survive for several years in a partially shaded understory. White spruce does not regenerate well under itself.

Restoration Notes

White spruce is vastly more abundant outside of its narrow natural ecological niche today than it would have been under natural conditions. Its ability to colonize old farmland has given it a remarkable presence in the Acadian Forest region. Because much farmland formerly used for active pasturing and cultivation was abandoned after the Second World War, many white spruce stands date from the 1950s.

From a restoration perspective, woodlot owners can use white spruce growing on old farmland as a nurse crop in the transition to a more diverse forest. White spruce stands can be patch cut, strip cut or selection harvested in order to break up the age structure of the stand, offer a cool, moist environment for regeneration similar to that found in natural Acadian Forest gaps, and encourage increased species diversity. Because desirable tree species can be rare in old-fields that are dominated by white spruce, planting desired species in such stands may be necessary. Young to immature white spruce stands often have little if any deadwood; snags can be created for wildlife by girdling a few of the larger white spruce on each acre.

White spruce has shallow roots and can be prone to blowdown, so harvesting in white spruce stands should be done with caution. Strip-cut harvest openings should be orientated perpendicular to the strongest winds (which are usually from the west and north-west). White spruce tends not to respond well to release from competition.

White spruce

WHITE ASH

(Fraxinus americana)

White ash grows throughout much of the Acadian Forest especially in nutrient-rich, moist, moderately to well-drained soils. It often grows on riverbanks and lower slopes, and can survive temporary flooding. White ash is moderate to fast growing, with a lifespan up to 200 years and heights averaging 23m (75ft).

White ash

White ash requires abundant nitrogen and calcium for best growth. It tends to grow with beech, white birch, yellow birch, sugar maple, hemlock and balsam fir. White ash seeds are an important food source for a variety of birds.

Regeneration

White ash regenerates by seed and by stump sprouts. Seed production can begin at 20 years with full production after 40 years and good seed crops most subsequent years. The seeds can be dispersed by wind a distance of 135m (450ft) and require a winter dormancy period before they can germinate. Germination is best in moist soil with partial to full sunlight. Seedlings initially gain height quickly, with best growth at 45% full sunlight, but they require more light after several years in order to continue growing.

Restoration

Valued for its high-quality lumber, white ash appears to be reduced from its natural abundance in the Acadian Forest. Therefore, it is an excellent candidate for restoration plantings, especially

on rich soils near waterways. It can be easily transplanted, but protection from browse damage may be necessary. Woodlot owners can encourage white ash by conserving seed trees and by creating partial canopy openings for seedlings.

Emerald Ash Borer

White ash in the Acadian Forest may come under serious threat from an introduced insect known as the emerald ash borer. This beetle is lethal to white ash, and has the potential to devastate the Acadian Forest white ash if it reaches the Maritimes. The beetle is currently found in parts of Ontario. Contact the Canadian Forest Service in Fredericton, New Brunswick, for the most current information on the status of this threat.

White ash leaf

Trees with Low Shade Tolerance

RED PINE

(Pinus resinosa)

Red pine is a wide-ranging species throughout North America, but is generally restricted to areas south of the Boreal Forest. It grows throughout most of the Acadian Forest except for eastern Nova Scotia and the east coast of New Brunswick, and is most often found growing on sandy plains and in other well-drained, fine soils. It does not have a high nutrient demand (although more so than jack pine), and often grows in soils too poor to support white pine. Red pine seedlings do not compete well on fertile soils, so its niche tends to be in less fertile soils with minimal competition.

Red pine

Since red pine is fast growing, it is occasionally grown in commercial plantations. Red pine trees can attain a height of 26m (85ft), and live for up to 200 years. Red pine usually grows with white and jack pine, but it occasionally grows in mixed forests or as a pure stand. Red pine is shade-intolerant and will not reproduce under a full canopy.

Regeneration

Red pine reproduces solely by seed with production beginning at 20 years and full seed crops after 50 years. Large seed crops occur every 3 to 7 years. Germination is best in a moist mix of humus and mineral soil, and is poor on heavy forest floor litter. Average seed dispersal is 12m (40ft).

Restoration Notes

Compared with most other pioneer-type species, red pine is less of a concern from a restoration perspective. It is generally an uncommon species and probably was the same in the original Acadian Forest mix. Therefore, woodlot owners can maintain it wherever it grows naturally to promote species diversity.

Red pine plantations, however, can be managed to restore natural diversity. Red pine stands can be cut with selection, strip or patch methods, and under-planted with shade-tolerant species. Red pine has moderately deep, wide-spreading roots and is generally windfirm. Because red pine has a very low level of genetic diversity, individuals within a stand tend to have a very similar growing ability, leading to poor self-thinning. If not actively thinned, red pine trees growing in a plantation will crowd each other and none will take a dominant position in the canopy, leading to a general loss of vigour in the stand.

Red pine cone and needle bundle

JACK PINE

(Pinus banksiana)

Jack pine is one of the most widely distributed tree species in Canada. It is a common component of the Boreal Forest, and tends to grow in areas with warm to cool summers, cold winters and low rainfall. It grows well with a wide variety of soil moisture and fertility levels, but its niche tends to be nutrient-poor and sandy soils, and is a common post-fire pioneer species.

Jack pine

Jack pine grows mainly in the eastern half of New Brunswick and central Nova Scotia, and in other scattered pockets. It grows best on well-drained, sandy soils, can attain a height of 19m (60ft), and lives for up to 130 years; it tends to be somewhat shorter lived in the Acadian Forest. It grows with black spruce, white birch and aspen, but often forms pure stands, especially on recently burned ground. Unlike most Acadian Forest species, jack pine can tolerate the high levels of aluminium found in post-fire soils.

Regeneration

Jack pine reproduces by seed, which it begins producing at 10 years of age, with full production after age 40. Good seed crops occur every 3 to 4 years and germination is best in moist mineral soil. Heat from either the direct summer sun or a low-intensity forest fire is required for jack pine cones to release their seed. The trees are very intolerant of shade and will not regenerate under a canopy.

Restoration Notes

Jack pine seedlings are tolerant of harsh growing conditions so it is a common pioneer species in recently disturbed areas, especially following forest fires in the wake of European colonization. Its abundance in the Acadian Forest has in all likelihood increased because of harvesting practices that favour its growth and because of an increased incidence of forest fires. In the Kouchibouguac Park area of eastern New Brunswick, for example, there is little evidence of its existence prior to European settlement, even though it is common there now. Jack pine was once widely planted in commercial plantations, but its use in this manner has declined in recent years.

Outside of its natural niche habitat, jack pine should generally be discouraged. Plantations of existing jack pine present excellent opportunities to restore Acadian Forest; they can be cut with strip and patch methods to create a cool, moist environment amenable for under-planted late successional species. Jack pine trees are generally windfirm thanks to their moderately deep and wide-spreading roots.

Researchers with the Canadian Forest Service in Fredericton, NB, have noted that plantations of jack pine can lead to the acidification of soil, potentially resulting in a site that is no longer able to support hardwood or mixed wood forest.

Jack pine

> *"The near absence of jack pine in the historical record was in striking contrast to its current abundances in modern forests in the area [of Kouchibouguac National Park and adjacent landscapes in eastern New Brunswick]. So limited was its former distribution, that it was confirmed from only one historical description of the study area."*
>
> Donna Crossland, 2006[5]

WHITE BIRCH

(Betula papyrifera)

White birch grows on a wide variety of soils and in many climatic conditions, so it is widespread throughout the Acadian Forest. Indeed, it is common all across Canada as a component of the Boreal and other forest types. White birch is a pioneer species; it regenerates rapidly in cutover areas and

commonly forms almost pure stands. It can tolerate harsh conditions, often growing in soils too poor to support other species. It achieves its best growth, however, on deep, moist, fertile soils, where it is a moderate to fast growing tree. It can reach a height of 24m (80ft), and has an upper lifespan of 130 years on the best sites.


White birch

White birch grows with many other tree species, but is often associated with aspen, pin cherry, grey birch and balsam fir. Unfortunately, it can be affected by birch dieback, a phenomenon common in coastal areas, identified by the progressive dying of its canopy. The causes of this problem are not entirely known, but it probably results from a combination of factors that include prolonged winter warm spells followed by deep freezing, as well as drought, pollution and acid precipitation.

Regeneration

White birch regenerates largely by seed. It produces seeds as early as age 15 years, with full production after 40 years and good seed crops every other year. The seeds germinate well on moist mineral soil and poorly on a duff or layer of leaf litter. They are easily transported by wind and moving water, and can also be blown over the surface of snow or ice. Seeds are dispersed mainly during the fall and early winter.

White birch seedlings usually have rapid initial growth, reaching their best height growth with 45% full sunlight. However, because white birch has a low tolerance to shade once past the seedling stage, trees must receive nearly full sun to continue growing.

Restoration Notes

On highly disturbed sites, caused by clear-cuts or forest fires, for example, white birch is a very strong competitor. A short-lived and fast growing tree, it plays an important role by re-vegetating the land, capturing nutrients and stabilizing the soil. Once dead, its quickly decaying wood provides an early source of deadwood habitat for wildlife. However, harvesting and other land use practices over the years have created conditions that favour white birch beyond its natural abundance before European settlement.

Because of this over-abundance, stands of white birch and other shade-intolerant hardwoods should be managed to encourage longer-lived, shade-tolerant species. Such stands can be thinned or selection, patch or strip cut, then under-planted with species such as red spruce, sugar maple, yellow birch, white ash, hemlock and others as appropriate to the site. White birch does not do well when left exposed after heavy harvesting because it is prone to blowdown and ice damage.

Where occasional white birch trees occur within balsam fir stands, they provide an important source of hardwood leaf litter, as well as prime snags for cavity-nesting wildlife. Woodlot owners can maintain white birch in such stands to provide these ecosystem benefits.


White birch leaf

TAMARAK

(Larix laricina) (Eastern larch, Hackmatack)

Tamarack is one of the most widespread of all North American conifers; in Canada it grows from Newfoundland to the Yukon, and is a common component of the Boreal Forest. In the Acadian Forest, tamarack occurs on a wide range of soil conditions and is particularly common in bogs and other poorly drained sites.


Tamarack

Tamarack can tolerate a wide variety of temperature, soil, moisture and nutrient conditions, including wet, organic and acidic soils. On poorly drained sites, such as the edges of bogs, and in disturbed sites, notably nutrient-poor old farmland, tamarack grows with black spruce and red maple or forms pure stands. On better sites, it grows with trembling aspen, white birch and balsam fir. On good growing sites with well-drained, light, fertile soils, tamarack is the Acadian Forest's fastest growing conifer tree. Tamarack trees can grow as tall as 23m (75ft) and live for up to 180 years, although these maximums are usually not achieved on former agricultural land.

Regeneration

Tamarack reproduces primarily by seed, but occasionally by root sprouts or, in wet areas, by layering. Seed production begins as early as 12 years, with full crops after age 40 and large crops every 3 to 6 years. Seed germination is best in moist mineral or organic soil with light duff or litter cover. Seed dispersal tends to be less than 30m (100ft). Tamarack has a very low tolerance for shade, so will not reproduce under the shade of its own canopy.

Restoration Notes

Tamarack fills an ecological niche within the Acadian Forest by growing on wet and generally nutrient-poor sites. Forest harvesting and other land use practices, however, have increased its abundance outside of this niche. Because it is shade-intolerant and short-lived, tamarack growing on upland sites lasts for only one generation before it is replaced by later successional species. Harvesting stands of tamarack using selection, strip or patch cuts, as well as under-planting with shade-tolerant species, can encourage this process.

Although it is shallow rooted, tamarack is generally windfirm when growing in well-drained soils. Given its fast growth on upland sites, tamarack can be a useful source of large-diameter deadwood in young forest stands. Tamarack is well suited to restoration plantings on old fields and wet and acidic sites, but the seedlings must have continuous full sun or they will not survive long.

Tamarack

Tamarack is the only conifer that completely sheds its needles on an annual basis. Tamarack trees are particularly beautiful in the fall when the needles turn, in Aldo Leopold's words, "smoky golden," before being shed for the winter.

GREY BIRCH

(Betula populifolia)

Grey birch is found throughout the Acadian Forest, but its range is restricted to eastern North America. Like white birch, it is a pioneer species that is very common on recently disturbed land. It grows on a wide variety of soils, from dry to poorly drained, and often regenerates well on nutrient-depleted soils where other trees do not grow well. However, it is the shortest-lived tree in the Acadian Forest, with an upper lifespan of 50 years. With mature height of 11m (35ft), it is also the shortest tree in the Acadian Forest.

Grey birch grows with alders and tamarack on poorly drained sites, and with white birch, pin cherry and aspen on better-drained sites. It occasionally forms pure stands, particularly in nutrient-poor soils.

Regeneration

Grey birch reproduces by both seeds and stump sprouts. Seed production starts at age 15 years, with full production after 30. Seed production is prolific and occurs annually.

Restoration Notes

Because grey birch grows almost exclusively on recently disturbed ground, sometimes where other trees cannot survive, it plays an important role in re-vegetating sites, capturing nutrients and stabilizing soil. Being short in height and longevity and very intolerant

Grey birch leaf

of shade, grey birch is quickly succeeded by other species; stands can be thinned and under-planted with shade-tolerant species.

TREMBLING ASPEN

(Populus tremuloides) (Quaking aspen, Poplar)


Trembling aspen

Trembling aspen is a pioneer species common on disturbed sites throughout the Acadian Forest. It is one of the most widely distributed species in North America and an important component of Canada's Boreal Forest. Trembling aspen grows on a wide variety of sites, from dry outcrops to bogs, but its best growth is on well-drained soils. On good sites, trembling aspen is the fastest growing tree in the Acadian Forest. It can attain a height of 18m (60ft), and live for up to 100 years. There are three species of aspen native to the Acadian Forest, and they are sometimes referred to collectively as poplar or 'popple' trees.

Regeneration

Trembling aspen can regenerate from seed and stump sprouts, but root sprouting is its most common reproduction method. Root sprouts can form dense growth around a parent tree, and one parent tree is often the source of an entire stand of trembling aspen. Although they may appear to be separate trees, each stem is attached to the parent tree when young and is therefore genetically identical. Groups of such clones have been recorded containing thousands of stems and occupying up to 80 hectares (200 acres). Seeds can be produced by age 20 years, with full crops after age 30 and high crop production every 4 to 5 years. Seeds remain viable for only 2 to 4 weeks, and germination is poor on leaf litter.

Restoration Notes

As with other pioneer species, trembling aspen is much more abundant today than it would be under natural conditions because of clearcut forest harvesting and other land-use practices. Stands of trembling aspen do not endure long in the Acadian Forest. Since they are very shade-intolerant and cannot reproduce under a canopy, they are succeeded by more shade-tolerant species unless the canopy is quickly opened by harvesting, fire, insect attack or blowdown. Selection harvesting as well as patch and strip cuts can be used to thin stands of trembling aspen, and the thinned stands can be under-planted with long-lived and shade- tolerant species. Harvested openings should be small (single tree opening) to prevent prolific root sprouting. Cutting trembling aspen in summer, or girdling them, may help to reduce root sprout growth the following year. Trembling aspen are generally not susceptible to blowdown.

Given their fast growth and short lifespan, trembling aspen often become the first available source of standing and fallen deadwood in young forest stands, and large diameter trees make excellent snags for cavity-nesting wildlife. Because trembling aspen tolerates a wide variety of soil conditions, it is a good candidate for restoration plantings on degraded sites. It is also good for establishing quick forest cover: root sprouts can grow up to 2m (6ft) in their first year.


Trembling aspen leaf

LARGETOOTH ASPEN and BALSAM POPLAR

(Populus grandidentata and Populus balsamifera)


Largetooth aspen

Largetooth aspen and balsam poplar are similar in a silvicultural sense to trembling aspen. They are both shade-intolerant pioneer species with wide ranges, often establishing quickly on recently disturbed land. Largetooth aspen tends to prefer slightly warmer climates than the other two poplar species, and generally

grows in sandier soils. Balsam poplar, on the other hand, tends to grow in wetter and less acidic soils.

Restoration Notes

Both largetooth aspen and balsam poplar have the same restoration characteristics as trembling aspen.

Largetooth aspen leaf

Balsam poplar has large, sticky buds with a distinctive scent that gives rise to its other common name, Balm of Gilead. Those who know the strong scent seem to either love or detest it.

Balsam poplar leaf

Uncommon Trees

Although not widespread in the Acadian Forest, the following species are important components of the forest ecosystem where they do grow. These species are generally at the northern edge of their ranges in the Acadian Forest, so should be conserved and promoted for the diversity they add to the forest region, especially in the light of the predicted impacts of climate change.

BASSWOOD

(Tilia americana) (American linden)

In the Maritimes, basswood is found only in southwestern New Brunswick, and mainly in the St. John River valley area. It is a component of the Appalachian Hardwood Forest, the majority of which was lost in New Brunswick to agricultural development during the 1800s, so is now rare in the province. Basswood grows on moist, rich soils that are alkaline to lightly acidic. It has a high shade-tolerance and moderate growth rate. It can attain a height of 22m (70ft), and live for up to 200 years.

Basswood

Basswood leaf

BUTTERNUT

(Juglans cinerea)

Butternut grows in the rich floodplains of the St. John River valley region of New Brunswick and, occasionally, along New Brunswick's Miramichi River. It prefers fertile, moist, well-drained soils. Butternut can attain a height of 21m (70ft) and lives for up to 80 years. It is a fast-growing tree, and requires almost full sunlight for best growth, though light shade will help promote tall and straight seedling growth.

Butternut

Unfortunately, a lethal disease (butternut canker) is spreading throughout the butternut's range, and may cause the demise of the species within the Acadian Forest. Although little can be done to prevent the spread of the disease, it is important to conserve butternut, especially those isolated from main populations. Of particular importance are any trees that might show resistance to the disease; unfortunately, however, researchers have yet to document resistance to the disease.

Butternut leaf

BUR OAK

(Quercus macrocarpa)

Bur oak

In the Acadian Forest, bur oak is found growing in a narrow band along New Brunswick's St. John River. Bur oak prefers deep, rich, moist soils that have an alkaline to neutral acidity, but it is tolerant of a wide range of soil conditions. It grows at a slow to moderate rate, and has a low to moderate shade-tolerance. Due to its rarity, bur oak should be conserved wherever it is found. It is important to note that bur oak can be confused with the introduced English oak, which is an occasionally invasive species. Defining characteristics of bur oak include irregular leaf lobes, unlike the leaves of English oak, and acorns with distinctive fringed caps.

Bur oak leaf

SILVER MAPLE

(Acer saccharinum)

Silver maple

In the Acadian Forest, silver maple grows along the rich floodplains of rivers in various parts of southern New Brunswick, such as the banks of the St. John River. Silver maple occasionally forms almost pure stands in floodplains with significant seasonal flooding. It is moderately shade-tolerant and is a fast-growing tree. It can reach a height of 27m (90ft) and has a lifespan of 130 years. Silver maple can be planted and promoted in areas with wet and seasonally flooded soils.

Silver maple leaf

WHITE ELM

(Ulmus americana)

Elm

White elm was once widely spread throughout most rich hardwood and mixed-wood areas in the Acadian Forest, and was a particularly common component of floodplain forests. Today, however, its numbers are few because of an introduced fungus known as the Dutch elm disease, which has largely eliminated the species from the Acadian Forest. The disease tends to affect mature trees, so young trees often escape the disease for long enough to reach seed bearing age. For this reason, young white elm can still occasionally be seen, especially along rivers.

Elm leaf

White elm grows well in moist, fertile, deep soils, and is moderately shade-tolerant. It is a moderate to fast-growing tree, reaching a mature height of 30m (100ft) and living for up to 200 years.

BLACK CHERRY

(Prunus serotina)

Black cherry is found scattered in rich hardwood and mixed-wood areas throughout most of southern New Brunswick and western Nova Scotia. It is shade-intolerant and fast growing, reaching a height of 23m (75ft) and living for up to 200 years. It attains its best growth in moist, fertile soils. Black cherry is sought after for its valuable wood, and was probably more abundant in the past than it is today, so should be promoted wherever it occurs. It can be included in restoration plantings on rich soils in full sun.

Black cherry

Black cherry leaf

IRONWOOD

(Ostrya virginiana) (Hop hornbeam)

Ironwood grows in rich hardwood and mixed-wood forests throughout southern New Brunswick, most of Nova Scotia, and parts of Prince Edward Island, where it tends to grow on well-drained hillsides and ridges. Ironwood is often an understory tree, owing to its short height, approximately 12m (40ft) when mature, and its high tolerance for shade. It has a slow to moderate growth rate, and lives for up to 100 years. Its wood is among the hardest of all trees in North America.

Ironwood

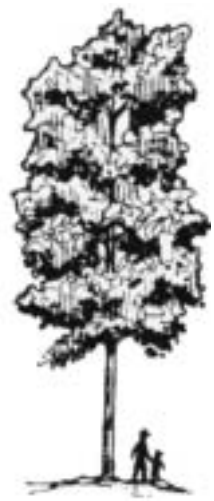
Ironwood was once more common in the Acadian Forest than it is today, so should be encouraged wherever it is found. It transplants easily, and is an excellent addition to restoration plantings on rich, well-drained soils with partial shade. Because of its relatively short height at maturity, ironwood adds vertical diversity to forest stands.

Ironwood leaf

RED ASH

(Fraxinus pennsylvanica)

Red ash grows throughout much of western New Brunswick and in isolated regions of Nova Scotia. Where it occurs it can be found scattered throughout mixed-wood forests. Although red ash tolerates a wide range of soil conditions, its main habitat is wet soils with neutral acidity, near rivers and lakes. It is a fast growing tree and has a moderate to low shade tolerance. Red ash can reach a height of 18m (60ft), and its upper lifespan is 200 years. Red ash is a good tree to include in restoration plantings of riparian areas with wet soils.



Red ash

Red ash leaf

BLACK ASH

(Fraxinus nigra)

Black ash grows in scattered locations throughout much of the Acadian Forest in wet soils adjacent to water bodies. It has a slow to moderate growth rate and a low to moderate shade tolerance. Black ash reaches heights of up to 18m (60ft) and can live for up to 130 years. It is a good tree to include in restoration plantings of areas along the edges of rivers and streams. Basket makers prize black ash because its wood can be split easily into pliable strips for use in basket making; it has particular significance to First Nations people for this reason.

Black ash

Black ash leaf

SERVICEBERRY

(Amelanchier) (numerous common names)

The Amelanchier genus is comprised of several dozen species of serviceberry; the exact number is difficult to know because species of serviceberry readily crossbreed, making species counting and identification tricky. The serviceberry genus is found throughout North America and at least 10 species grow in the Acadian Forest. They tend to grow on moist, well-drained soils, and are especially noticeable in the spring when they put forth a profusion of white flowers. Serviceberry is moderately shade-tolerant.

Serviceberry

Although often growing in shrub or small tree form, serviceberry occasionally reaches 12m (40ft) in height, and can form part of the forest canopy. Serviceberry is often mistaken for other species during forest harvesting, and cut indiscriminately. However, it should be conserved when found in woodlots because it is an uncommon forest component and its berries are an important food source for wildlife (and they're not bad eating for humans as well).

Serviceberry

Serviceberry has a long list of common names, including wild pear, Indian pear, shadbush, shadblow, saskatoon berry, mayberry, juneberry, and bilberry. According to folk legend, many of its common names refer to the timing of its flowering, whether it be in May, or June, or when rivers are full with shad, or when the ground is thawed enough to hold a burial service.

SHRUBS IN THE ACADIAN FOREST

In addition to the species described in this section, the Acadian Forest is home to a wide variety of other shrubs and small trees. All of these plants are an important source of diversity in the Acadian Forest. Many help capture and cycle nutrients, protect soil, and provide cover and food to birds and other wildlife. Woodlot owners can help maintain these species by including them in restoration plantings and by not cutting them during forest harvesting or thinning. Many such plants are lost needlessly during pre-commercial thinnings. Check the resource list at the end of this section for reference information about planting shrubs and the many benefits they provide.

Alder *(Alnus species)*

Found throughout the Acadian Forest, many consider alder shrubs as a scourge for the speed and tenacity with which they occupy abandoned farmland. Nonetheless, alders actually have considerable ecological value for healthy soil and habitat:

• Alder roots are host to bacteria that take nitrogen from the air and turn it into a nutrient for plants in a process known as nitrogen fixation. The bacteria grow in nodules attached to the roots of alder shrubs. Studies have shown that this alder-bacteria team can add 160 kg of nitrogen per hectare per year to the soil (140 lbs/acre/year). This is a valuable service because nitrogen is an important nutrient for plant growth and is sometimes depleted in land that was farmed for a long time.

• Alder roots stabilize soil and thus help prevent erosion; this attribute is especially valuable in riparian environments.

• Alders provide shade that can kill sod and other plants common on old fields that can be a barrier to the establishment of trees.

• Alders provide habitat and food for numerous birds, including grouse, siskins, goldfinches and redpolls, just to name a few. As well, American woodcock nest under the cover of alder thickets and feast on the abundant earthworms found there.

For these reasons, alders make an excellent nursery cover for Acadian Forest restoration plantings. Woodlot owners can cut openings within alder thickets and plant them with species appropriate to the site. Although the planted trees may need tending to ensure alder sprouts do not smother them, the taller trees will eventually over-top and shade-out the alders. This is the natural process of succession with alders, and will happen eventually even without intervention.

"[Shrubs] prevent soil erosion and provide the conditions needed for the seedlings of the larger tree species to get established. They provide food and shelter for wildlife. Some species take nitrogen from the air and fertilize the soil. And all of them produce oxygen which is just as fresh and breathable as that of the noblest oak."

Glen Blouin,
Weeds of the Woods, *1992*

Trees and Shrubs of Concern

The Canadian Forest Service, Atlantic Region, identifies the following trees and shrubs as species of concern because they are either naturally rare or have declined in numbers because of diseases or over-harvesting. The Canadian Forest Service, Atlantic Region, provides information on each of these species on its website.

Trees

Sugar maple (*Acer saccharum*)
American beech (*Fagus grandifolia*)
White ash (*Fraxinus americana*)
Black ash (*Fraxinus nigra*)
Red ash (*Fraxinus pennsylvanica*)
Butternut (*Juglans cinerea*)
Ironwood (*Ostrya virginiana*)
Red spruce (*Picea rubens*)
Red pine (*Pinus resinosa*)
Black cherry (*Prunus serotina*)
Bur oak (*Quercus macrocarpa*)
Eastern white-cedar (*Thuya occidentalis*)
American basswood (*Tilia americana*)
Eastern hemlock (*Tsuga canadensis*)
American elm (*Ulmus americana*)

Shrubs and Small Trees

Hazel alder (*Alnus serrulata*)
Mountain paper birch (*Betula cordifolia*)
Dwarf birch (*Betula glandulosa*)
Button bush (*Cephalanthus occidentalis*)
Alternate-leaf dogwood (*Cornus alternifolia*)
Witch-hazel (*Hamamelis virginiana*)
Canada plum (*Prunus nigra*)
Black willow (*Salix nigra*)
Canada yew (*Taxus canadensis*)
Squashberry (*Viburnum edule*)

APPENDIX A:

FOREST MEASUREMENTS AND CONVERSIONS REFERENCE

CORDS AND CUBIC METRES

A cord is a measure of stacked wood in the round that fills a volume of 128 cubic feet, and often described as a pile of wood that is 4ft by 4ft by 8ft. Importantly, a cord of stacked wood contains both wood and air space. The amount of air space in a cord depends on type of trees in the pile; softwood trees, for instance, are generally straighter than hardwood trees, so they stack more tightly with less air space.

The amount of wood in a cord of firewood depends on whether the wood is sold as cut and split or in long lengths. A cord of cut, split and stacked firewood contains less air space than a cord of stacked 8ft wood, for example.

Converting English measures of volume to metric measures of volume has to be done with care because a cord always refers to a measure of stacked wood in the round, including both wood and air space. A cubic metre, however, can be either a measure of solid wood or a measure of stacked wood in the round. If 'stacked' or 'solid' is not specified, a cubic metre usually refers to solid wood. The following conversions are given with this in mind:

One cubic metre (m3)

= 0.45 cords of 8ft softwood
= 0.44 cords of 8ft poplar
= 0.52 cords of 8ft hardwood (other than poplar)

One cord of 8ft softwood = 2.2m3
One cord of 8ft poplar = 2.27m3
One cord of 8ft hardwood = 1.92m3

One cubic metre of stacked wood
= 0.28 cords (any species)

One cord (any species)
= 3.62m3 (stacked wood)

MEASURING LUMBER

A board foot is a measure of lumber that equals 144 cubic inches, often referred to as a measure of solid wood that is 1 inch by 12 inches by 12 inches. 'Mfbm' refers to 1,000 board feet of lumber. 1,000 board feet (1Mfbm) of lumber equals 2.36 cubic metres of solid wood.

The number of board feet in a cord of wood depends on the diameter of the logs that make up the cord. A cord of larger logs produces more board feet of lumber than a cord of smaller logs because the milling of smaller logs produces more scrap wood (waste) per unit of lumber produced than the milling of larger logs. For example, a 16-foot log with a small end diameter of 20 inches contains 11 times more volume of wood than a 16-foot log with a small end diameter of 6 inches. However, the larger log produces 15 times more lumber than the small log (300 board feet from the larger log; 20 board feet from the smaller log).[1]

Weights
Different species of trees have different densities of wood, so weight per volume of wood depends on the species of tree. The following, therefore, is an approximate measure of weight per unit of wood:

1 cord (softwood) = 4500 lbs = 2045 kg
1 cord (hardwood) = 4800 lbs = 2180 kg
1 MT (metric tonne) = 1000 kg = 2204.6 lbs
1 T (English ton) = 2000 lbs = 909 kg

[1] Based on the New Brunswick Log Rule for determining board feet of lumber output from a log by length and small-end diameter. NB Log Rule is based on a saw kerf of 0.25 inches; values would be different for bandsaw mill (saw kerf of 1/8 inch).

IMPERIAL / METRIC CONVERSIONS[1]

Factors for Converting Imperial to Metric

Length
inches x 2.54 = cm
feet x 0.3048 = m
yards x 0.9144 = m
chains x 20.1168 = m
miles x 1.60934 = km

Area
square inches x 6.4516 = cm2
square feet x 0.092903 = m2
square yards x 0.836127 = m2
acres x 0.404686 = ha
square miles x 2.58999 = km2

Volume
cubic feet x 0.0283168 = m3
gallons x 4.54609 = L
cubic yards x 0.764555 = m3
cords x 3.62456 = m3 (stacked)
cords (8ft swd) x 2.208712 = m3 (solid)
cords (4ft swd) x 2.40637 = m3 (solid)
cords (8ft hwd) x 1.982177 = m3 (solid)
board feet x 0.00564972 = m3 (logs)

Ratios
cords/acre x 8.95647 = m3 (stacked)/ha
cords/acre (8ft swd) x 5.457838 = m3/ha
cords/acre (4ft swd) x 5.947672 = m3/ha
cords/acre (8ft hwd) x 4.898058 = m3/ha
cords/acre (mixed) x 5.317892 = m3/ha
fbm/acre x 0.0139607 = m3/ha (logs)
fbm/acre x 0.0058309 = m3/ha (lumber)
square feet/acre x 0.229568 = m2/ha
cubic feet/acre x 0.069972 = m3/ha

Factors for Converting Metric to Imperial

Length
cm x 0.393701 = inches
m x 3.28084 = feet
m x 1.09361 = yards
m x 0.0497097 = chains
km x 1.09361 = miles

Area
cm2 x 0.155 = square inches
m2 x 10.7639 = square feet
m2 x 1.19599 = square yards
ha x 2.47105 = acres
km2 x 0.386102 = square miles

Volume
m3 x 35.3147 = cubic feet
m3 x 1.30795 = cubic yards
m3 (stacked) x 0.275896 = cords
m3 (solid) x 0.452753 = cords (8ft swd)
m3 (solid) x 0.415460 = cords (4ft swd)
m3 (solid) x 0.504496 = cords (8ft hwd)
m3 (solid) x 0.464667 = cords (mixed)
m3 (logs) x 177 = board feet

Ratios
m3 (stacked)/ha x 0.111651 = cords/acre
m3/ha (2.44m swd) x 0.183223 = cords/acre
m3/ha (1.22m swd) x 0.168133 = cords/acre
m3/ha (2.44m hwd) x 0.204163 = cords/acre
m3/ha (mixed) x 0.188044 = cords/acre
m3/ha (logs) x 71.6295 = fbm/acre
m3/ha (lumber) x 171.5 = fbm/acre
m2/ha x 4.356 = square feet/acre
m3/ha x 14.2913 = cubic feet/acre

[1] Adapted from the Nova Scotia Department of Natural Resource's Forestry Field Handbook, 1993

APPENDIX B:

NEST BOX SIZE AND PLACEMENT PARAMETERS

Bird	Entrance Hole Size	Inside floor area	Height of wall panels	Min. height above ground	Location	Max. No. of pairs per acre	Additional Comments
Chickadee, Downy Woodpecker	1 1/4"	3 1/4"x 3 1/4"	8"	6'	On pole or a tree near shrubs, in woods	1-2	Like to nest near bushes and shrubs
Nuthatch	1 1/4"	3 1/4"x 3 1/4"	8"	6'	On pole or a tree near shrubs, in woods	1-2	
Bluebird, House Sparrow	1 1/2"	4"x 4"	10"	7'	On post or tree in open area	1, 4	
Tree Swallow	1"x2 1/2"	4"x 4"	10"	7'	On post or tree in open area	8	Prefer open areas within sight of water
Hairy Woodpecker, Crested Flycatcher	2"	5"x 5"	12 1/2"	10'	On post or tree in open area	1	
Purple Martin	2"	5"x 5"	6"	8'	On post or tree in open area	50	Difficult to attract unless they already frequent a particular area.
Common Flicker	2 ½"	6"x 6"	15"	10'	On post or tree in open area	2	Prefer boxes placed above surrounding foliage
Saw-whet Owl	2 ½"	6"x 6"	12"	12'	Thick conifer woods	2	
American Kestrel	3"	7 1/2"x 7 1/2"	17"	15'	On a pole or tree in open area	2	
Pileated Woodpecker	3"x4"	8"x 8"	12"-30"	12'	In woods	2	
Wood Duck, Hooded Merganser, Common Goldeneye	3"x4"	10"x 10"	20"	8'	Wooded swamp	2	Prefer nesting in boxes placed near or above water (box is attached to a pole standing in the water)
Barred Owl	6"x6"	12"x 10"	20"	20'	Woodland	2	

RECOMMENDED READINGS AND RESOURCES

RECOMMENDED READINGS

A tree-marking guide for the tolerant hardwoods working group in Ontario
Anderson, H. and J. Rice. 1993. Science and Technology Series, Volume 8. Toronto, Ontario: Ministry of Natural Resources.
This is an in-depth guide to assessing tree vigour and marking trees, and includes informative colour photos. Although written for Ontario, it is applicable to the Acadian Forest.

Atlantic Forestry Review Magazine: www.countrymagazines.com
This magazine is a good source of information about forests, forestry and woodlots in the Atlantic provinces, including editorials on current events and issues, practical information on forest management and notices of events.

***Eastern Woods & Waters* articles by Bob Bancroft**
- Acadian Forest: History, Evolution and Succession. 2002. Vol. 18 (4): 14-16.
- Acadian Forest: 400 years of forest removal. 2003. Vol. 18 (5): 12-14.
- Do you see a woodlot as a living forest, or just trees with dollar signs on them? 2003. Vol. 19 (3): 23-25.

These three articles are a readable and insightful overview of the Acadian Forest and its potential for restoration.

Focus Species Forestry: A Guide to Integrating Timber and Biodiversity Management in Maine
Bryan, Robert. 2004. Maine Audubon: Falmouth, ME.
This practical reference for anyone in the Acadian Forest region contains informative photographs and illustrations, and is available for purchase from Maine Audubon.

Weeds of the Woods
Blouin, Glen. 1992. Goose Lane Editions, Fredericton, NB.
Illustrated with numerous colour photographs, Blouin provides a wealth of information on common Acadian Forest shrubs and small trees, including notes on identification, their use by wildlife, their use as food and medicine by European settlers and First Nations people, and their use as ornamentals.

Silvics of North America: 1. Conifers; 2. Hardwoods
Burns, Russell M., and Barbara H. Honkala, tech. coords. 1990. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC
This is the 'bible' of silvics for the trees of North America. The two volumes (one for hardwoods and one for softwoods) comprise a useful and comprehensive resource on trees and forest management. The entire book is available on the internet at http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm.

The Nature of New Brunswick: A Biodiversity Primer
Clowater, Roberta and David Coon. 1996. Conservation Council of New Brunswick: Fredericton, NB.
Written for the non-scientist, this well illustrated publication presents a comprehensive introduction to biodiversity in New Brunswick and is applicable to the entire Acadian Forest region.

Components of a Backyard Wildlife Habitat
Coverstone, Nancy. (no date) Bulletin #7137. University of Maine Cooperative Extension.
This is a well-written, illustrated and easy-to-understand guide to creating and promoting a variety of wildlife habitats in one's own backyard. It is available on the University of Maine Cooperative Extension website.

Deadwood – Living Forests: The Importance of Veteran Trees and Deadwood to Biodiversity
Dudley, Nigel, and Daniel Vallauri. 2004. World Wildlife Fund, Gland, Switzerland.
This excellent resource highlights the problems caused by extreme cases of deadwood removal, as have occurred in various European forests. It is available on the internet and is richly illustrated with colour photographs.

Biodiversity in the Forests of Maine
Elliott, Catherine (ed.). 1999. University of Maine Cooperative Extension.
This is a comprehensive review of biodiversity in Maine's Acadian Forest and techniques to maintain it during forestry operations. It is available for purchase (hard copy) or for free (electronic copy) from the University of Maine Cooperative Extension website. Following is an excerpt from this website:

"Biodiversity in the Forests of Maine describes characteristics of forest stands and landscapes that are important to biological diversity, and recommends forest management techniques that can help maintain biodiversity in Maine's forests. The manual is intended for use by foresters, biologists, loggers, forestland owners, and forestland managers. Educators, land-use planners, and others interested in forest biodiversity will also find it useful. 176 Pages"

Trees of Canada
Farrar, John Laird. 1995. Fitzhenry Whiteside Ltd. and the Canadian Forest Service: Ottawa.
Farrar's book is an excellent reference on the characteristics of trees growing in Canada, and includes colour photos and helpful notes on differentiating similar species. It does not, however, contain information about tree silvics.

Applied Partial Cutting for Growing a Profitable Woodlot
George, Don. 2002. St. Francis Xavier University, Antigonish, NS.
A practical resource for woodlot owners written by a forester with a long career spent putting selection cutting into practice.

Seeing the Forest Among the Trees
Hammond, Herb. 1991. Polestar Press: Vancouver.
Hammond is a forester and ecologist, and along with his wife Susan is the co-founder of the Silva Forest Foundation. Although this book deals with the forests of British Columbia, Hammond's concept of "wholistic forestry" (a term coined by Hammond) applies equally to the Acadian Forest. From the Silva Forest Foundation website: "Wholistic forest use puts the forest back on centre stage and moves human beings to a supporting role," Hammond says.

Nature's Way: An Introduction to Forest Ecology
Harrison, Girvan. 2007. Earthwood Editions, Gagetown, NB.
Girvan Harrison is a long-time instructor at the Maritime College of Forest Technology in Fredericton, NB. This publication is a good introduction to forest ecology and human use of the forest.

The Trees in my Forest
Heinrich, Bernd. 1997. Ecco, HarperCollins, New York.
Heinrich is an ecologist based in Maine and Vermont, and has authored a number of popular books that explore concepts of nature and ecology. This inspiring and insightful book is based on Heinrich's experiences in owning, exploring and managing a woodlot in Maine.

Beyond the Beauty Strip: Saving What's Left of Our Forests
Lansky, Mitch. 1992. Tilbury House, Gardiner, Maine.
Lansky's book is a well-researched and comprehensive critique of ecological, economic, social and political issues of forest management in Maine.

Low Impact Forestry: Forestry as if the Future Mattered
Lansky, Mitch (editor). 2002. Maine Environmental Policy Institute. Hallowell, Maine.
This publication is a compendium of practical information on implementing low-impact forest harvesting, including reviews of harvesting equipment, options for paying loggers and discussion of the economics of low impact forestry.

"Mitch Lansky has compiled a valuable collection of the latest knowledge available on the subject. If the future really matters, this book may be even more successful than his last." - Wade Prest, Atlantic Forestry Review

A Sand County Almanac
Leopold, Aldo. 1949. Oxford University Press. New York, NY.
Leopold is a grandfather of the conservation movement, and wrote elegantly and effectively on the need to cultivate an ethical relationship with the land in order to guide society's use of natural resources. Leopold builds his case for a land ethic while reliving early-morning bird-watching moments, fishing and hunting trips, cutting firewood, and his actions to restore natural diversity on his property. A good read for any woodlot owner.

Trees of Knowledge: A Handbook of Maritime Trees
Ritchie, Geoffrey. 1996. Canadian Forest Service, Natural Resources Canada, Fredericton, NB.
Ritchie's publication is a handy quick reference for most of the trees in the Acadian Forest, with good illustrations and cultural notes.

Selection Management of Private Woodlands in Nova Scotia: A Steward's Guide
Schneider, Aaron. 1998. Centre for International Studies, University College of Cape Breton and Enterprise Cape Breton Corporation, Sydney, NS.
Schneider explores the ecological and economic case for selection management in this publication, providing case studies from Nova Scotia and across North America.

Conservation Guidelines for ecologically sensitive forested sites on private woodlots within the Fundy Model Forest
Singleton, Julie, Judy Loo and John Foley. (no date) (Information Report M-X-207E). Canadian Forest Service - Atlantic Forestry Centre: Fredericton, NB.
Although written specifically for New Brunswick's Fundy Model Forest, this well-researched guide is applicable to most of the Acadian Forest region.

Small Woodland Owner's Handbook
Small Woodland Owners Association of Maine. 2005. Augusta, Maine.
This publication includes information useful for all woodlot owners in the Acadian Forest region, including a review of planning, silviculture methods and selling wood.

Native Trees and Shrubs: A collection of publications from the Macphail Woods Ecological Forestry Project
Schneider, Gary, Ruth Richman, Liz Dacombe, Kevin MacLean, Susan Shaw, and Susan MacDonald. (no date) Orwell, PEI.
A comprehensive and well-researched how-to guide to propagating and planting Acadian Forest trees and shrubs, this publication includes information on attracting wildlife, creating windbreaks and hedgerows and naturalizing school grounds. Much of this information is also available on the Macphail website.

Units of Measure and Conversion Factors for Forest Products
Philp, Jim. (no date) Bulletin #7103. University of Maine Cooperative Extension.
This is a useful and easy-to-understand overview of measuring the volume of trees and wood products. Quoting from the publication: "When you measure the volume of a standing tree, you are in fact only estimating." It is available for free on the University of Maine Cooperative Extension website.

The Maine Woods
Thoreau, Henry David. 1864. Penguin Books (1988): New York.
This book provides insightful observations of the forest of Maine in the mid-1800s, and is a good read for anyone interested in the Acadian Forest.

Reading the Forested Landscape: A Natural History of New England
Wessels, Tom. 1997. The Countryman Press: Woodstock, VT.
With the eye of an ecological detective, Wessels reveals the subtle clues that illuminate a woodlot's past: the storms, fires, disease and human actions that shape the forest's present condition.

ORGANIZATIONS

Falls Brook Centre: www.fallsbrookcentre.ca
This site contains a forest stewardship section with information on forest certification and non-timber forest products.

Low Impact Forestry (Conservation Council of New Brunswick): www.lowimpactforestry.com
This site contains an introduction to low impact forestry, and profiles a number of woodlot owners and contractors who are implementing low impact forestry. It includes a photo gallery and links to other websites.

Low Impact Forestry (Maine Environmental Policy Institute): www.lowimpactforestry.org
This site contains a number of essays by Mitch Lansky, an author of two books on forestry in Maine.

Macphail Woods Ecological Forestry Project: www.macphailwoods.org
This organization's website is one of the most comprehensive sources of practical information on woodlot management. It includes information on growing trees and shrubs, enhancing wildlife habitat, and implementing low-impact harvesting.

Silva Forest Foundation: www.silvafor.org
Although this organization is based in British Columbia, the concepts of forest management presented are applicable to the Acadian Forest. Its founders, Herb and Susan Hammond, are well-regarded proponents of ecosystem-based forest management.

Windhorse Farm: www.windhorsefarm.org
This site contains educational material about ecological forestry and forest certification, as well as advertisement for FSC-certified wood products.

University of Maine Cooperative Extension: www.umext.maine.edu
This site contains a wealth of practical information for woodlot owners. This information is accessed by scrolling to their Natural Resources section, and then clicking on the topic of interest.

Fundy Model Forest: www.fundymodelforest.net
The Fundy Model Forest is one of eleven forest research organizations funded by the federal government across Canada. The FMF is located in New Brunswick, and its website provides numerous publications of interest to woodlot owners.

Nova Forest Alliance: www.novaforestalliance.com
Another of Canada's model forests, the NFA is located in Nova Scotia and its website contains much useful information. Of particular note is the searchable database of information on the Acadian Forest.

New Brunswick Federation of Woodlot Owners: www.nbwoodlotowners.ca
The Federation offers information that is useful throughout the Maritimes, and acts as a directory of New Brunswick's woodlot marketing boards.

INFOR: www.infor.ca
INFOR is a New Brunswick-based clearing house of information on woodlot management, including maple syrup and Christmas tree production. INFOR has a number of low-priced publications available for sale, including the following titles:
Stand Volume and Growth: Getting the Numbers; Pruning to Enhance Tree and Stand Value; Merchantable Thinning Manual – Softwoods; Forestry Techniques for the Clearing Saw.

Canadian Forest Service: http://cfs.nrcan.gc.ca
The Canadian Forest Service offers a wealth of information on forest ecology and forest management. Among many useful items is a user-friendly guide to insects and diseases that adversely affect trees in eastern Canada.

Association for Sustainable Forestry: www.asforestry.com
The ASF administers funding for silviculture treatments on woodlots in Nova Scotia.

Conservation Council of New Brunswick: www.conservationcouncil.ca
The Conservation Council of NB website provides information about the Acadian Forest, Low Impact Forestry and old growth forests in New Brunswick.

Ecology Action Centre: www.ecologyaction.ca
The Ecology Action Centre website provides information about forestry and land conservation issues in Nova Scotia.

Nova Scotia Woodlot Owners and Operators Association: http://nswooa.blogspot.com
In addition to being the home of the NSWOOA, the oldest independent woodlot owner association in Nova Scotia, this site provides information on sound woodlot management useful for all woodlot owners in the Acadian Forest region.

ADDITIONAL INFORMATION SOURCES

The following articles and other sources of information were used in the preparation of this book.

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Betts, M.G, A.W. Diamond, G.J. Forbes, K. Frego, J.A. Loo, B. Matson, M.R. Roberts, M. Villard, R. Wissink and L. Wuest. 2005. Plantations and biodiversity: A comment on the debate in New Brunswick. The Forestry Chronicle 81(2): 265-296.

Betts, M.G. and G.J. Forbes (eds.) 2005. Forest Management Guidelines to Protect Native Biodiversity in the Greater Fundy Ecosystem. New Brunswick Co-operative Fish and Wildlife Research Unit, University of New Brunswick: Fredericton, NB.

Betts, M.G., S.E. Franklin, and R.G. Taylor. 2003. Interpretation of landscape pattern and habitat change for local indicator species using satellite imagery and geographic information system data in New Brunswick, Canada. Can. J. For. Res. 33: 1821-1831.

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Betts, M.G., D. Mitchell, A.W. Diamond, and J. Bêty. 2007. Uneven rates of landscape change as a source of bias in roadside wildlife surveys. J. of Wildlife Management 71 (7): 2266 – 2273.

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Crossland, D.R. 2006. Defining a forest reference condition for Kouchibouguac National Park and adjacent landscape in eastern New Brunswick using four reconstructive approaches. Master of Science in Forestry thesis, Faculty of Forestry and Environmental Management, University of New Brunswick, Fredericton.

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