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BLACK SPRUCE IN ONTARIO: AN OVERVIEW

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OCCURRENCE AND IMPORTANCE

Black spruce (*Picea mariana* [Mill.] B.S.P.), native only to North America, is found in all of Canada's provinces and territories. It has a wide ecological amplitude and grows on sites ranging from dry sands, gravels, and shallow soils over bedrock, through deep, nutrient-rich mineral soils on uplands, to waterlogged, nutrient-deficient *Sphagnum* peats on lowlands.

In Ontario, there are approximately 17.5 million ha of black spruce dominated forests. This represents about 41% of the province's total productive forest land (Ketcheson and Jeglum 1972). Of this, 54% grows on upland mineral soil sites and 46% occurs on peatlands. The highest proportions occur in the Clay Belt of northeastern Ontario, where 81% of the productive forest land is black spruce dominated. The extent and distribution of the black spruce dominated forest is shown in Figure 1.

Black spruce is not only the most abundant tree species in Ontario, it is also the most economically important. It has been estimated that the spruce working group (90% black spruce) accounts for 64% (2.0 billion m³) of the coniferous growing stock, and 40% of the total growing stock in Ontario (Ghebremichael 1993). The average annual black spruce harvest has remained relatively constant, and for 1987 was about 7.5 million m³, or 80% of the annual allowable cut.

SITES, ATTRIBUTES, AND SILVICS

On moist, upland mineral soils, black spruce generally occurs in various admixtures with jack pine (*Pinus banksiana* Lamb.), balsam fir (*Abies balsamea* Mill.), white birch (*Betula papyrifera* Marsh.), and trembling aspen (*Populus tremuloides* Michx.). On some sandy outwash soils, it can be found in pure or nearly pure stands. On peatlands, black spruce occurs

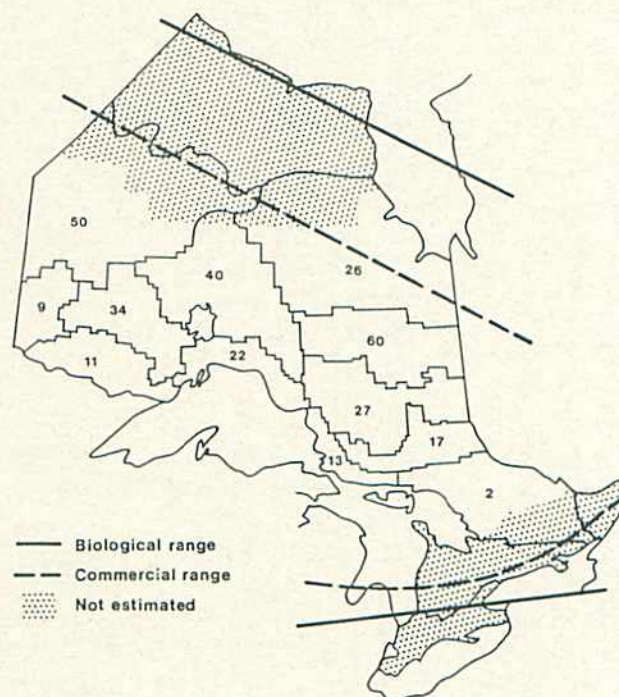


Figure 1. The extent and distribution (% of total land area by ecological section) of black spruce in Ontario (from Ketcheson and Jeglum 1972).



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in pure stands or with minor components of tamarack (*Larix laricina* [Du Roi] K. Koch.) or eastern white cedar (*Thuja occidentalis* L.).

Depending on site conditions, mature black spruce can range from 7 to 30 m in height, but the more productive growth occurs on richer, upland sites. A good example of the latter is the Lydia Lake Seed Production Area near Longlac, Ontario.¹ This 70-year-old stand, growing on a well drained mineral soil with an adequate supply of nutrients, is 30 m high, has a basal area of 40 m²/ha, and a gross merchantable volume approaching 300 m³/ha (Site Class 1 to Site Class 1a). Conversely, typical 100- to 200-year-old stands growing on peatland sites often have three times the stem density, but have only one-half the basal area and one-third the merchantable volume per hectare as compared with average upland stands.

The root system of black spruce is shallow, plate-like, and has no tap root. For this reason it is highly prone to windthrow. Windthrow becomes increasingly prevalent as the stand height increases, stand density decreases, and biological maturity is surpassed (Fleming and Crossfield 1983). Openings created by cutting are often a locale of extensive windthrow.

Black spruce can readily develop adventitious roots in humid peatland conditions. As such, layering is an important method of propagation, and in many stands the abundant advance growth is predominantly of layer origin (Groot 1984). Furthermore, the species is classified as tolerant, which gives it the capacity to grow under moderate shade, even if very slowly. Its ability to respond to increased light after lengthy periods of suppression is critical to the protection of advance growth, and consequently the success of careful logging.

Black spruce regenerates readily from seed. Seedlings usually grow very slowly for a number of years after germination, and on upland sites may attain average heights of only 12–15 cm after 5 years, and 1 m by the age of 10 or 12 (Fleming and Mossa 1995). Heights in excess of 2 m at 10 years have been reported (G.T. Atkinson, pers. comm.). On peatlands, growth rates are usually much slower (Groot and Adams 1994).

On average, good cone crops are produced by black spruce once every 4 years, with some cone production every year (Haavisto 1979). The cones are semiserotinous and release seeds over a period of years. Average annual seedfall is approximately 500,000 viable seeds/ha in fully-stocked mature stands. Most seed is dispersed onto the snow surface during the period from late February to early April the year following cone production. Winged black spruce seeds travel a relatively short distance in the air, the effective distance being about 50–80 m. This information is important for the planning of modified harvesting operations, or where natural regeneration is desired from a seed source.

Very few diseases or insects have a commercially detrimental impact on black spruce. The most serious diseases are the root rots, *Armillaria* spp. and *Inotus tomentosus* (Fr.) Teng reportedly cause losses of 25% to the province's current annual increment (CAI) of this tree species (Gross 1985). Stem decays, especially red ring rot (*Phellinus pini* [Brot.:Fr.] A. Ames), are responsible for up to a 5% loss in merchantable stem volume (Basham 1994). Even though eastern spruce budworm (*Choristoneura fumiferana* Clem.) causes minimal growth loss, it can effectively destroy the cone and seed producing capabilities (Prévost et al. 1988).

REGENERATING BLACK SPRUCE

Because of specific silvical characteristics, black spruce management can be tailored to meet the requirements of a range of sites. To assure adequate regeneration of this cover type, Fraser et al. (1976) determined that of the average area harvested annually in Ontario, 55% required regeneration assistance. Most assistance was needed on upland mineral soil sites, where 70% of the cutovers were inadequately stocked to black spruce seedlings. On peatlands, 38% of the area was poorly stocked. Black spruce research and operational efforts since that time have been directed at improving these statistics; however, Hearnden et al. (1992) reported that the black spruce cover type is still not being adequately regenerated.

Where stands are overmature, especially on peatland sites, considerable numbers of well established advance growth stems may occur (Groot 1984). It is essential to ensure that these are not destroyed during harvesting. Initially, efforts were made to preserve advance growth and reduce damage to fragile sites by adopting the use of wide, low ground pressure tires on logging machinery. This later led to the development of careful logging methods. These methods (e.g., single-grip harvesters) seek to emulate the premechanization era of horse logging. Little site damage was done at that time; trees were felled, topped, and delimbed at the stump and skidded by horse to roadside for bucking into 4- or 8-foot bolts (Fig. 2). This logging method resulted in the well-stocked, midrotation stands that are now prevalent in the Clay Belt of northeastern Ontario.

Modified harvesting techniques, such as strip clear-cutting, which leave a standing natural seed source, have been shown to be very effective on both upland and peatland sites. On upland mineral soils, appropriate site preparation is essential to remove the duff and produce receptive seedbeds (Jeglum and Kennington 1993). Mechanical site preparation may also be necessary to remove excessive amounts of logging slash. On peatlands, most *Sphagnum* moss species form highly receptive seedbeds if they are slash free. If site preparation is required to remove logging slash or competing vegetation, both winter shearblading and prescribed fire are effective, but will destroy any advance growth present.

¹Payandeh, B.; Haavisto, V.F.; Papadopol, P. Lydia Lake black spruce: A benchmark stand. Proc. Wetlands Symposium. 28–31 Aug. 1994, Traverse City, Michigan. (In prep.)



Figure 2. Stacked 4-foot bolts of black spruce harvested using horse logging, circa 1964. Well developed advance growth and unmerchantable-sized stems are visible in the background.

Direct seeding has been successfully used on some upland sites and can be applied to peatlands where advance growth is lacking or natural regeneration is unlikely to occur (Haavisto 1979). On rich upland sites, black spruce seed germination, early seedling development, and growth performance may be inhibited by competing vegetation, because black spruce seedlings tend to grow very slowly for a number of years following germination. For satisfactory development of regeneration, herbicides may need to be used to assure that trees attain "free-to-grow" status. Manual cleaning is a more costly alternative. Considerable planting has also been done on upland and peatland sites, but associated costs must be carefully considered. Because they grow so slowly during the first few years, black spruce germinants and young seedlings are at a disadvantage when competing with other species on fertile sites. For this reason black spruce dominated stands are not common on the richest upland areas, but are the norm on infertile ones.

A common approach taken on many black spruce sites is clear-cutting and unplanned natural regeneration, where no regeneration efforts are made after harvesting, and regeneration of the site is left to nature.

Planned silvicultural systems that are used to regenerate black spruce include:

- *Clear-cutting and planting:* A commonly used approach that is simple to administer and adaptable to many harvesting practices. With appropriate site preparation, this method usually assures that the stocking of black spruce on the site is high enough to satisfy future harvest levels. This system, however, is the most costly (\$1,000 or more per ha) (Jeglum 1990).
- *Direct seeding:* This method can be successful on Very Fresh to Moist upland sites, and on seedbeds prepared to expose the organic/mineral soil interface. On lowlands, pruned (e.g., shearbladed) *Sphagnum* moss seedbeds are optimal. Decomposed peat (black muck) is a very poor seedbed because of its susceptibility to frost heaving.

- *Strip clear-cutting:* This method utilizes standing adjacent seed sources to disperse seed onto receptive seedbeds on both upland and peatland sites. A suggested leave period between cuts is 3–5 years. This system can be most effective, both biologically and economically, when harvesting and regeneration costs are considered.
- *Careful logging to preserve advance growth:* This system can be used on sites where stand conditions have resulted in an abundance of advance growth or where numerous stems of unmerchantable size occur. The technique maximizes the spacing and use of skid trails. Winter harvesting further minimizes environmental impact on sensitive sites (Groot 1987).

STAND MANAGEMENT

On waterlogged peatland sites, excessive moisture in the substrate can limit growth. Black spruce has been shown to respond favorably to drainage (Payandeh 1991); however, this treatment is not currently an operational practice in Ontario. Fertilization to correct nutrient imbalances has resulted in significant growth increases on uplands (Morrison et al. 1976), but on undrained peatlands was not considered to be cost-effective (Payandeh 1991).

Specific silvical characteristics of black spruce offer the silviculturist a range of regeneration options. By matching the season of harvest and harvesting method to site, the black spruce cover type can be successfully regenerated.

REFERENCES AND FURTHER READING

- Basham, J.T. 1994. Reducing stem rot in living black spruce in Ontario. Nat. Resour. Can., Canadian Forest Service – Ontario, Sault Ste. Marie, ON. Frontline Tech. Note. No. 83. 4 p.
- Fleming, R.L.; Crossfield, R.M. 1983. Strip cutting in shallow-soil upland black spruce near Nipigon, Ontario. III. Windfall and mortality in the leave strips: Preliminary results. Dep. Environ., Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O-X-354. 27 p. + appendix.
- Fleming, R.L.; Mossa, D. 1995. Establishment and growth of seeded upland black spruce: 7–12 year response. Nat. Resour. Can., Canadian Forest Service – Ontario, Sault Ste. Marie, ON. NODA/NFP Tech. Rep. TR-8. 13 p. + appendix.
- Fraser, J.W.; Haavisto, V.F.; Jeglum, J.K.; Dai, T.S.; Smith, D.W. 1976. Black spruce regeneration on strip cuts and clearcuts in the Nipigon and Cochrane areas of Ontario. Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O-X-246. 33 p.
- Ghebremichael, A. 1993. Selected forest sector statistics and general economic indicators for Ontario, 1992. For. Can., Ont. Reg., Sault Ste. Marie, ON. Inf. Rep. O-X-426. 121 p.

Groot, A. 1984. Stand and site conditions associated with abundance of black spruce advance growth in the Northern Clay Section of Ontario. Dep. Environ., Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O-X-358. 15 p.

Groot, A. 1987. Silvicultural consequences of forest harvesting on peatlands: Site damage and slash conditions. Gov't of Can., Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O-X-384. 20 p.

Groot, A.; Adams, M.J. 1994. Direct seeding black spruce on peatlands: Fifth-year results. For. Chron. 70 (5):585-592.

Gross, H.L. 1985. The impact of insects and diseases on the forests of Ontario. Dep. Environ., Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O-X-366. 96 p.

Haavisto, V.F. 1979. Some considerations for regenerating black spruce on peatlands in the Northern Clay Forest Section, Ontario. Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O-X-295. 32 p.

Hearnden, K.W.; Millson, S.V.; Wilson, W.C. 1992. A report on the status of forest regeneration. Ont. Min. Nat. Resour., Ont. Independent Audit Comm., Sault Ste. Marie, ON. 80 p. + appendices.

Jeglum, J.K. 1990. Low cost regeneration in Ontario: What are the needs? p.13-28 in P.K. Bidwell, ed. Proc. Low Cost Regeneration Workshop. 10-11 October 1990, Hearst, Ontario. Ont. Min. Nat. Resour., Timmins, ON. 49 p.

Jeglum, J.K.; Kennington, D.J. 1993. Strip clearcutting in black spruce: A guide for the practicing forester. For. Can., Ont. Reg., Sault Ste. Marie, ON. 102 p.

Ketcheson, D.E.; Jeglum, J.K. 1972. Estimates of black spruce and peatland areas in Ontario. Dep. Environ., Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O-X-172. 29 p.

Morrison, I.K.; Swan, H.S.D.; Foster, N.W.; Winston, D.A. 1976. Ten-year growth response to fertilizer of a 90-year-old black spruce stand in northwestern Ontario. For. Chron. 52(2):233-236.

Payandeh, B. 1991. Cost-effectiveness of forest drainage and fertilization in northern Ontario peatlands. p. 197-207 in J.K. Jeglum and R.P. Overend, eds. Proc. Symp. '89. Peat and Peatland - Diversification and Innovation. Vol. 1. Peatland Forestry. 6-10 Aug. 1989, Quebec, QC. Can. Soc. Peat and Peatlands, Dartmouth, NS. 27 p.

Prévost, Y.H.; Laing, J.E.; Haavisto, V.F. 1988. Seasonal damage by insects and squirrels to female reproductive structures of black spruce, *Picea mariana* (Mill.) B.S.P. Can. Ent. 120:1113-1121.



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