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BLACK SPRUCE ANNUAL VOLUME LOSSES TO PESTS ESTIMATED AT 30% OF CURRENT ANNUAL INCREMENT IN ONTARIO

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CATEGORY: Pest impacts
KEY WORDS: Black spruce, spruce budworm, root rots, stem decays, current annual increment

INTRODUCTION

The concept of "impact" includes all effects that a pest can exert upon its host species throughout its range. It can be examined from two perspectives: biological and economic. The biological aspect encompasses a range of effects from growth loss to mortality, regardless of size, value, location, or age. The economic aspect assesses effects only on those trees having an economic value. While this may be a more useful perspective, economic values are difficult to calculate in a jurisdiction the size of Ontario. Only the biological impact is discussed in this report because, although it does not provide the forest manager with dollar values, it does indicate the relative impact of pests. Managers must then decide whether some form of intervention is required based on their assessment of the value of the trees affected.

Figure 1. Typical appearance of a dead black spruce stand following a spruce budworm epidemic.

Estimates of biological impact are by no means precise. The expanse and diversity of both the forest resource and pest activity within it preclude accurate estimates of timber loss. Many degrees of impact are possible depending on factors such as the severity and duration of the attack, the size of the outbreak, the virulence of the pest, and the availability and condition of host trees. In this report, estimates of loss are based on the current knowledge of Ontario's forests, on previous pest infestations and impacts (Fig. 1), and on comparisons of past and current losses.

BACKGROUND

Gross et al. (1992) estimated the gross standing volume of black spruce (*Picea mariana* [Mill.]B.S.P.) in Ontario at almost 2 billion m^3. This figure was based on computer analyses of the Ontario Forest Resources Inventory (FRI) conducted in the fall of 1989.

To avoid a possible doubling of impact, attempts were made to exclude or separate losses caused by a particular pest from those estimated for another. In two reports on loss due to pests in the forests of Ontario (Gross 1985, Gross et al. 1992), two pest groups and an individual pest species were deemed to have a significant impact on current black spruce inventory statistics. These were root rots, stem decays, and the eastern spruce budworm (*Choristoneura fumiferana* Clem.). Average annual impacts of these pests on black spruce in Ontario from 1982 to 1987 are summarized in Table 1.

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Table 1. Estimated average annual impacts of major pests of black spruce in Ontario, 1982–1987.

Pest	Growth loss (m^3)	Cull (m^3)	Mortality (m^3)	Total impact (m^3)
Root rot	355,974	–	5,172,802	5,528,776
Spruce budworm	322,000	–	867,800	1,189,800
Stem decay	–	722,487	–	722,487
Total (all pests)	677,974	722,487	6,040,602	7,441,063

In addition to those that have an impact on inventory and Current Annual Increment (CAI) statistics, there are many forest pests that damage seedlings or young stands when tree volumes and CAI are relatively small. Thus, although their ultimate influence on stand productivity can be devastating, the damage has little or no influence on current inventory statistics. These pests can affect growth, stocking, and yield but it is impossible to accurately predict or estimate their eventual impact.

ROOT ROTS

Table 1 illustrates that of all pests or pest groups, root rots have the greatest impact on black spruce in Ontario. An estimated 5.5 million m^3 of black spruce are lost annually because of the action of root rot fungi. This represents an amount equivalent to 25% of the province's estimated current annual increment of 22 million m^3 for this tree species (Gross 1985). These fungi decay tree roots and the bases of stems thereby resulting in growth loss, direct mortality, and indirect mortality due to blowdown (Fig. 2).

Figure 2. Tomentosus root rot in a 90-year-old black spruce stand near Black Sturgeon Lake, Ontario.

Since Ontario's FRI only reports standing volumes for live trees, periodic inventories do not detect standing dead trees that have been killed by root rot infestation. Nevertheless, these losses represent a significant volume. The estimated 5.5 million m^3 of black spruce lost annually to root rot is important when compared with actual and expected yields from inventory data. The estimated annual growth loss of 355,974 m^3 is probably conservative. It contains no provision for growth lost by trees that have already been killed by root rot and therefore do not appear in the inventory.

Mortality usually occurs in patches, and the impact on stand development and tree growth is largely a function of reduced stocking. Data for an analysis of this type of growth loss were unavailable, but considering the magnitude of root rot mortality in black spruce, an estimated additional hidden loss of several hundred thousand cubic metres is reasonable.

SPRUCE BUDWORM

From 1982 to 1987, an estimated 1.2 million m^3 of black spruce were lost annually in Ontario because of spruce budworm activity (Table 1). About 73% of this loss was in the form of mortality; the remainder was growth loss. Both of these were caused by budworm larvae feeding on spruce foliage.

Readers may be more familiar with the effects of spruce budworm on balsam fir (*Abies balsamea* [L.] Mill.) or white spruce (*P. glauca* [Moench] Voss), the host species favored by the insect. Mortality of balsam fir trees begins after approximately 4 years of moderate-to-severe defoliation. For black spruce growing in association with balsam fir, mortality generally begins after 6 or 7 years. On that basis, 10 years after moderate-to-severe defoliation begins, balsam fir stands may lose an average of 82% of their volume compared with a loss of less than 10% volume in black spruce stands (Gross et al. 1992).

Annual losses (1,189,800 m^3) during the 1982–1987 period (Gross et al. 1992) caused by budworm feeding on black spruce are down somewhat from the 1,469,000 m^3 annual losses estimated for the 1977–1981 period (Gross 1985). This reflects the fact that the spruce budworm infestation that began in Ontario around 1967 reached a peak during the 1980 and 1981 growing seasons. Cumulative losses for the entire infestation (1967 to 1987) were estimated at 11,438,000 m^3 for black spruce and 82,265,000 m^3 for balsam fir.

STEM DECAYS

An estimated 722,487 m^3 of black spruce timber is culled annually in Ontario because of stem decay (Table 1, Fig. 3). This reflects the rate at which sound stem wood is deteriorating and represents a reduction in the gross standing volume of black spruce available for harvesting and utilization. This is a substantial annual loss; only trembling aspen (*Populus tremuloides* Michx.) and jack pine (*Pinus banksiana* Lamb.) have greater stem decay losses in Ontario (Gross et al. 1992).

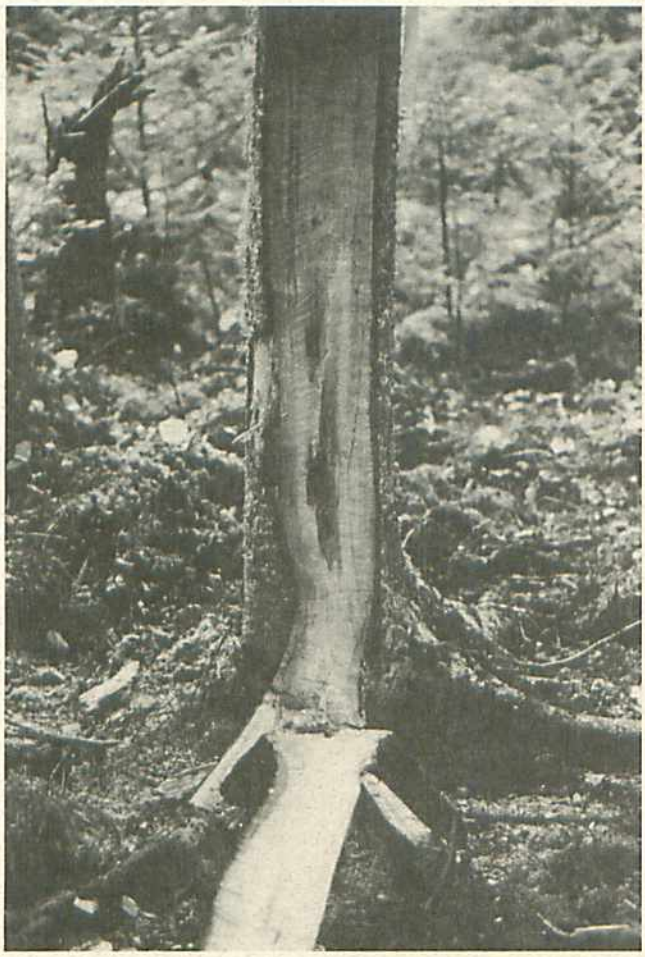

Figure 3. Brown cubical rot in heartwood and sapwood of an approximately 60-year-old black spruce near Geraldton, Ontario.

However, among all of Ontario's major tree species, only red pine (*P. resinosa* Ait.) has a lower percentage of its merchantable stem volume affected by decay than does black spruce (Basham 1991). The relatively large annual cull of black spruce occurs because this species represents about 36% of Ontario's total gross standing forest volume (Gross et al. 1992).

OTHER PESTS OF BLACK SPRUCE

In addition to the three principal agents described above, forest managers will from time to time undoubtedly encounter other pests on black spruce. Pests of seedlings or very young trees may have serious long-term impacts.

Based on present knowledge, impacts caused by other pests are not large enough to be included in the inventory. Davis and Myren (1990) recorded only three diseases "capable of causing serious injury to or death of living trees" and of the three, only eastern dwarf mistletoe (*Arceuthobium pusillum* Peck) was collected with any degree of frequency throughout most of the range of black spruce. Even so, its overall impact is considered insignificant. Other common diseases include needle rusts (*Chrysomyxa* sp.) and needle casts (*Isthmiella* sp.). Their impacts are believed to be negligible except during infrequent epidemic conditions. Under these circumstances there would be some growth loss impact or mortality of seedlings.

In addition to the spruce budworm, many other insects are active on black spruce, but they are believed to have little or no impact on inventory statistics. Most common are the yellowheaded spruce sawfly (*Pikonema alaskensis* Roh.) and the white pine weevil (*Pissodes strobi* Peck). These are important pests of younger trees, but the extent of their impact on the provincial spruce resource is unknown because their damage does not show up in FRI statistics. Also included in this group are the spruce coneworm (*Dioryctria reniculelloides* Mut. & Mun.) and sawyer beetles (*Monochamus* sp.). Although these insects are not included as major pests of black spruce, they certainly influence growth and yield, and must be considered as having an impact on the forest resource.

CONCLUSIONS

Within Ontario, the total average annual loss of black spruce volume caused by root rots, spruce budworm, and stem decays (Table 1) is 7,441,000 m^3, only 0.39% of the estimated gross standing volume of 1,917,545,000 m^3. This may seem insignificant until one considers that it is an annual recurring loss and that it represents roughly 33% of the black spruce CAI. The high relative value of the black spruce resource, especially to the pulp and paper industry, makes this loss of particular importance.

Methods for minimizing black spruce loss due to root rot are presented in other technical notes by Whitney (1994) and Whitney and Dumas (1994), as well as in a comprehensive paper by Whitney (1989). Measures to minimize the impact of stem decays on black spruce have also been described (Basham 1991, Basham 1994). As shown in these notes, both root rots and stem decays are generally of little concern on lowland sites. On well drained upland sites, black spruce rotation ages of 75 to 85 years are recommended to ensure that serious losses caused by root rots and stem decays are minimized (Basham 1994).

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Dr. Jack Basham is a retired forest pathologist who spent most of his career with the Canadian Forest Service conducting research on stem decays of the native trees of Ontario.

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