Frontline

Forestry Research Applications

Canadian Forest Service–Sault Ste. Marie

Technical Note No. 87

IMPACT OF THE JACK PINE BUDWORM IN ONTARIO

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INTRODUCTION

The jack pine (*Pinus banksiana* Lamb.) component of northern Ontario's forest comprises only 15 percent of the total wood volume. However, this tree species is considered second only to black spruce (*Picea mariana* [Mill.] B.S.P.) in commercial value to this region of the province. While 25 insect pests can cause serious damage to jack pine in Ontario, the jack pine budworm (*Choristoneura pinus pinus* Free) is the most serious. Outbreaks of this pest occur at roughly 10-year intervals, with each episode lasting from 2 to 4 years (Howse 1986). Damage to the jack pine resource resulting from the 1982–1986 infestation in northeastern Ontario has been the subject of several studies (Gross [1992], Gross and Meating [1994], and Gross et al.[1]). In addition to characterizing and quantifying damage, these studies were designed to produce growth–loss estimators applicable to stands defoliated by the jack pine budworm.

This paper describes damage to jack pine stands caused by the budworm and presents impact estimators as a useful tool for pest managers.

DEFOLIATION

Jack pine budworm prefers to feed on the male flowers and current needles; however, back-feeding on older needles is common, especially when the level of defoliation on current needles is moderate (26–75 percent) or severe (>75 percent). Light defoliation (1–25 percent) causes little noticeable damage. During a major jack pine budworm outbreak, back-feeding can be extensive. In fact, complete defoliation of the upper crown is common in many stands that have been subjected to severe defoliation (Fig. 1). This aspect of budworm management is important as the amount of damage

Figure 1. Crown character of jack pine in stands that have been defoliated by the jack pine budworm.

[1] Gross, H.L.; Brooks, G.R.; Irwin, R.N. 1995. Aftermath of a jack pine budworm infestation. Nat. Resour. Can., Canadian Forest Service–Sault Ste. Marie, Sault Ste. Marie, ON. NODA/NFP Technical Report. (In review.)

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that occurs at this severity of defoliation can cause significant growth loss and whole-tree mortality.

Studies conducted in Ontario have found that the amount of defoliation and subsequent impact that occurred between and within stands were highly variable. Estimates of growth loss and mortality (*see* Table 1) are average values based on studies of a number of stands. Damage in any given stand, having a specific defoliation history (e.g., 1 year moderate, M; 1 year moderate/1 year severe, MS) frequently varies from the average values. This makes risk prediction for a specific stand difficult, and readers are cautioned that estimates in Table 1 are only average stand responses.

Table 1. Estimates of average stand level growth loss and mortality derived from the 1982–1986 jack pine budworm infestation in northeastern Ontario. Values represent cumulative losses for the period of the infestation and recovery.

Defoliation[1] history	Growth loss[2] (%)	Mortality[3] (%)
M	40	1.0
S	90	2.5
MM	90	4.0
M_M	100	3.0
M_S	110	3.0
S_M	120	4.0
MS	120	5.0
SM	140	5.5
S_S	170	5.5
SS	200	8.0

[1]Defoliation history (i.e., degree of defoliation in successive years) is coded as follows: S = severe (>75 percent), M = moderate (26–75 percent), and _ = void–light (0–25 percent). For example, M_S = first year moderate, second year void–light, and third year severe.

[2]Growth loss is expressed as a percent of annual volume increment (AVI), and is cumulative for the period of defoliation and recovery.

[3]Mortality is expressed as a percent of gross standing volume (GSV) lost, and is cumulative for the period of defoliation and recovery.

GROWTH LOSS

Growth losses for various defoliation scenarios often show an expected loss equivalent to 1 or more years of annual volume increment (Table 1). This is impressive considering that annual increments of greater than 4 m^3/ha are expected for well stocked jack pine on good sites. Some of the study stands in northeastern Ontario were growing at better than 6 m^3/ha per year prior to the budworm infestation. However, as noted earlier, individual tree or stand reaction is highly variable.

Little impact to growth rate is apparent during the first year of budworm defoliation as damage is most intense after the springwood has been produced. Any reduction in growth rate

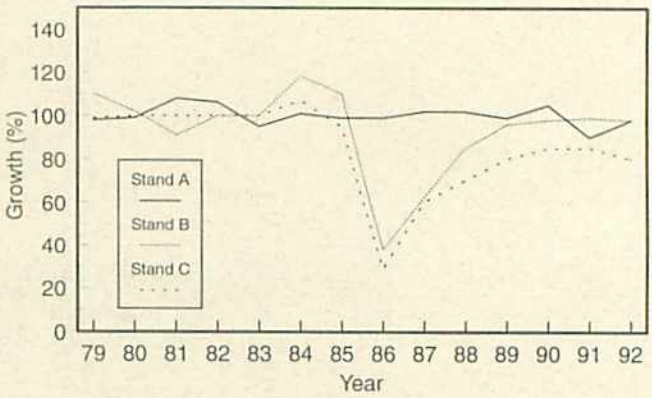

Figure 2. Average annual growth of three jack pine stands (1978–1992) subjected to various levels of defoliation by the jack pine budworm: Stand A (control); Stand B (moderate defoliation 1985–86); Stand C (moderate defoliation 1984–85). Growth is illustrated as a percentage of average annual volume increment for the preinfestation period 1979–1983. Growth above or below 100 percent indicates above or below average growth, respectively.

during the first year is therefore restricted to summerwood. The greatest growth loss occurs in the year following the onset of defoliation. For example, moderate defoliation in 1985 will result in decreased growth in 1986 (Fig. 2). Depending on the severity of the defoliation, growth losses continue for several years after defoliation stops. Growth rates then increase yearly until preinfestation levels are reached. Stem analysis performed by Gross (1992) showed that growth loss along the stem was correlated with the amount of damage and defoliation in associated crown areas. Consequently, growth loss was greatest in the upper crown where defoliation was most intense. The loss apparent at the lower stem can be biased by as much as 70 percent, and therefore the use of tree cores to determine growth loss can result in extreme error.

Most stands will recover their growth rate within 2 years. However, in some of the more severely affected stands recovery of lost volume can take longer because of the lasting influence of mortality and dead-top damage.

MORTALITY

Most of the budworm caused mortality occurred within 2 years of the end of defoliation. The level of mortality was generally related to the severity and duration of the pest outbreak (Table 1). Mortality was low when high or moderate defoliation was limited to 1 year. When infestations remained at a moderate or high level for more than 1 year, budworm caused mortality of dominant and codominant pines usually exceeded 3 percent (Table 1). A few stands that sustained high defoliation of both current and older needles had up to 6 percent mortality. Mortality, however, was most common to trees with a suppressed/intermediate crown position, and not to dominant/codominant trees.

The pattern of mortality appeared well distributed in less severely affected stands. However, as this level exceeds 3 percent, pockets of dead trees become more common.

Mortality causes an immediate loss in standing volume and a long-lasting influence on stand growth. When mortality is scattered, the crowns of neighboring live trees eventually expand into the unoccupied growing space and contribute to stand volume. When pocket mortality occurs, however, the loss in stand volume continues until new trees grow and become productive in those areas.

The effect of *Armillaria* root rot (*Armillaria* spp.) in defoliated stands was also investigated. Jack pine is generally considered to be more resistant to *Armillaria* than is either spruce (*Picea* spp.) or fir (*Abies* spp.). A survey of jack pine budworm defoliated stands in Ontario revealed that *Armillaria* was not common. However, where present, root rot was found to be associated with an increase in mortality and overall growth loss.

DEAD-TOP DAMAGE

Trees with dead tops occur at a ratio of three for every tree that dies because of defoliation. Dead-top damage is difficult to assess during the year of defoliation, however, as many trees have tops that are completely devoid of needles but are not dead. Dead tops are most easily identified in the year following the end of defoliation.

Trees with dead tops less than 3 m in length usually showed good growth recovery. Crown tops in these trees are somewhat rounded rather than conical, and frequently have multiple leaders (Fig. 3). While this does not significantly affect stand volume, top kill can limit the merchantable length achievable by juvenile and semimature trees. The merchantable length of mature trees is less affected by top kill. This loss of merchantable length is important only in terms of lumber production; the loss in volume for purposes of pulping is negligible. A relationship between extensive top kill and whole-tree mortality has not been established. However, it is understood that trees with top kill greater than 3 m frequently do not recover their growth, and continue to grow at a reduced rate for an extended period. Such trees would essentially become suppressed, and are prone to future mortality due to competition from surrounding trees that now occupy the upper canopy.

Figure 3. Multileadering of jack pine crown after severe defoliation by the jack pine budworm.

Besides lost volume and tree mortality, dead tops in jack pine pose other problems. The dead spike is a safety hazard that must be taken into account during logging operations. This can add to harvesting costs. Concerns have also been raised that dead tops would serve as a point of entry for stains and decay. However, the study by Gross et al.[2] showed stem material below the dead portion to be sound and infection by secondary organisms to be minimal.

SUMMARY

Defoliation for more than 1 year at moderate to severe levels will cause a significant impact to stands in terms of growth loss and mortality (Table 1). The patchy nature of mortality, when present above 3 percent, and its concentration in certain stands is an important consideration, as most of the mortality is not simply scattered throughout the resource. Mortality ultimately accounts for two-thirds of the lost volume in a jack pine budworm affected stand. Dead-top damage on mature trees is apparently unimportant with respect to lost volume in the short term. However, trees with dead tops greater than 3 m in length frequently do not recover growth, and are prone to future mortality. In addition, immature and semimature trees with significant dead-top damage will have a reduced merchantable length.

The impact of only 1 year of moderate defoliation is not great (Table 1). However more extensive damage can be expected from increased levels of defoliation, particularly if back-feeding occurs during the first year of significant defoliation. In addition, the possibility of additional years of defoliation is quite high early in an infestation and must also be considered when control or salvage operations are contemplated. A significant reduction in stand volume can be expected from outbreaks lasting more than 1 year.

[2]Ibid.

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The preparation of this note was funded under the Northern Ontario Development Agreement's Northern Forestry Program.

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Catalogue No. Fo 29-29/87E
ISBN 0-662-24339-0
ISSN 1183-2762

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