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Past and present outbreaks of the balsam fir sawfly in western Newfoundland: An analytical review

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Abstract

Historical data of defoliation and population density were examined to determine whether a sustained outbreak of balsam fir sawfly (*Neodiprion abietis* Harris) in western Newfoundland, Canada is unprecedented in severity and duration. Results indicate that the current outbreak departs substantially from historical trends, covering a surface area twice the sum of all infestations occurring in the preceding 50 years. The current outbreak is also of longer duration due to a northward expansion of the range usually subjected to severe defoliation by this insect. Time-series analysis indicates that balsam fir sawfly dynamics have a strong second-order component, providing testable hypotheses for future studies investigating the factors responsible for population fluctuations.

Keywords: Defoliation; *Neodiprion abietis*; Population fluctuations; Thinning

The balsam fir sawfly (*Neodiprion abietis* Harris) (Hymenoptera: Diprionidae) is an eruptive defoliator indigenous to North America. The species has a transcontinental distribution (Ross, 1955; Wallace and Cunningham, 1995) and infestations have been recorded on many hosts. In Canada, larvae feed principally on balsam fir (*Abies balsamea* [L.] Mill) and occasionally on white (*Picea glauca* [Moench.] Voss) and black spruce (*Picea mariana* [Mill.] B.S.P) (Martineau, 1985). Periodic outbreaks, usually 3–4 years in duration, have commonly been observed from central to Atlantic Canada (Cunningham, 1984).

Recently, a number of balsam fir sawfly outbreaks have occurred in young, managed stands of Atlantic Canada (Moreau, 2004; Piene et al., 2001). The extent of the defoliation attributed to this insect was such that significant efforts were involved in developing a biocontrol strategy for the management of this species (Moreau et al., 2005). Historically, balsam fir sawfly defoliation has been more conspicuous in Atlantic Canada than elsewhere in North America (Martineau, 1985) but the current outbreak on the west coast of the island of Newfoundland (Fig. 1) is apparently unprecedented in severity (Piene et al., 2001). As an integral part of studies on balsam fir sawfly ecology, a review of available time-series data from historical records was undertaken to examine and compare past outbreaks of this species with the current one. Through the use of a number of diagnostic techniques, certain time-series attributes were also examined to detect whether density-dependent processes (Royama, 1992) are responsible for balsam fir sawfly fluctuations, thus permitting inferences about the population dynamics of the species.

Balsam fir sawfly historical records for area defoliated, host-plant defoliation and population density for the west coast of Newfoundland were recovered from the annual reports of the Newfoundland Forest Protection Association (Anonymous, 1943–1996), from the Forest Insect and Disease Information Survey (Anonymous, 1943–1950; Anonymous, 1951–1995), from interim reports of the Forest Entomology and Pathology Laboratory of Corner Brook, Newfoundland, from district reports of the Forest Insect and Disease Survey (Clarke et al., 1968; Parrott et al., 1966) and from the Newfoundland Department of Natural Resources (Crummey, personal communication). A 65-year series of areas severely defoliated was extracted from these data for a zone of ~15,000 km^2 roughly delineated by Barachois Park in the south, Cormack in the north, Deer Lake in the east and Port-au-Port Bay in the west (Fig. 1). Yearly estimates of the area severely defoliated were based on a combination of aerial surveys and ground samples. Because forest stands in the study area are in the immediate vicinity of the mill in Corner Brook, they have been intensively

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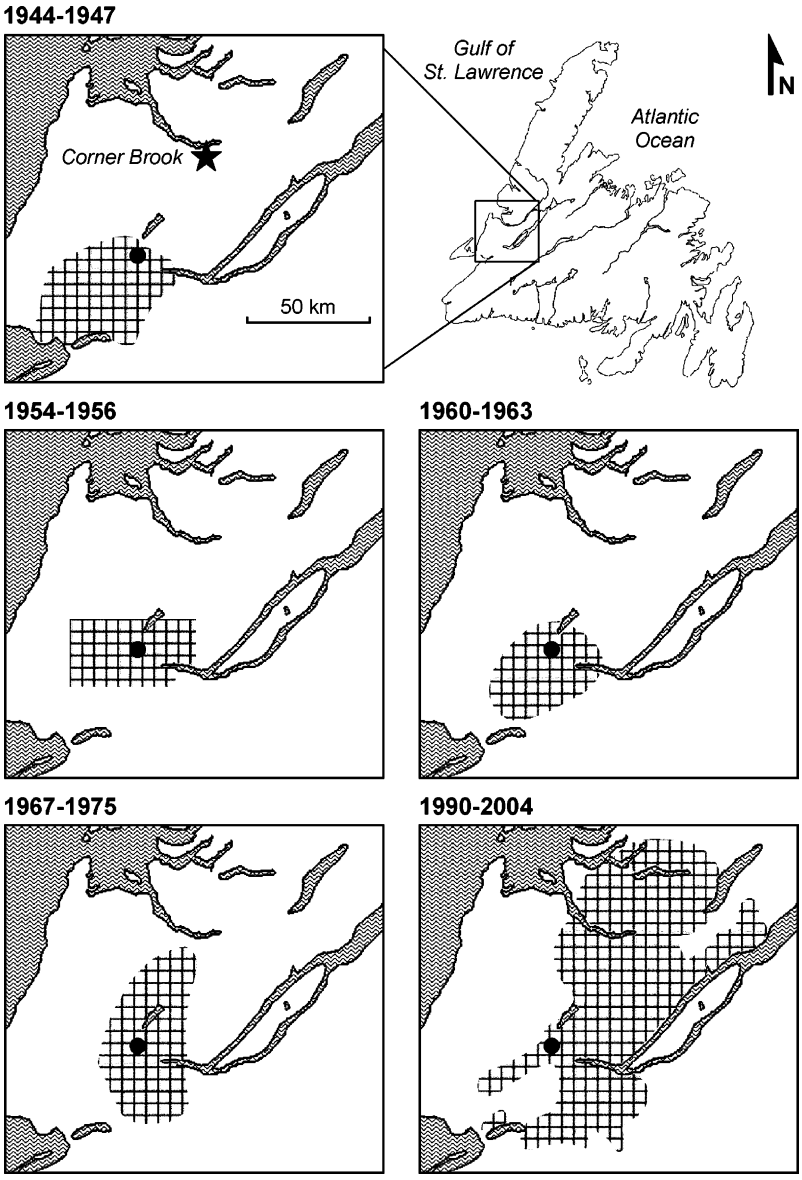

Fig. 1. Map of Newfoundland, Canada identifying the limits of the study area (square) and the limits of the area severely defoliated during the five largest outbreaks described in historical records for this area (crosswise pattern). The Gallants–George's Lake area is identified with a black dot.

surveyed for defoliation throughout the period of time covered by this review. Light (as opposed to severe) defoliation due to balsam fir sawfly feeding, or damage due to other insects, has been reported during the same period for most locations in the study area, suggesting that sampling intensity cannot explain the differences presented here. A complete 31-year continuous data series of host-plant defoliation (i.e., percent loss of old foliage) and an incomplete series of population density (i.e., larvae per standardized collection using the tree-beating method described in Harris et al., 1972) were also recovered for the Gallants–George's Lake area (Fig. 1) where historical records are more extensive. Estimates of population density and host-plant defoliation in historical records were gathered using ground samples. All recovered data are presented in Figs. 1–3.

On an arithmetic scale, the 65-year record of areas severely defoliated by the balsam fir sawfly in western Newfoundland indicates that several outbreaks occurred throughout this period (Fig. 2). The three first outbreaks of the time-series (1944–1947, 1954–1956, 1960–1963) lasted 3–4 years and were relatively localized. In contrast, the subsequent outbreaks were extremely variable in duration and surface area. The last outbreak of the series is especially different from previous ones. Firstly, it covers a surface area twice the sum of all areas defoliated from 1940 to 1989, which is considerably outside the 95% confidence interval of the average size of the four previous largest outbreaks (one-sample t-test: $t_3 = -21.65$; $P < 0.01$) (Fig. 2). Secondly, at the time this manuscript was written, this outbreak was in its 15th year, making it the longest outbreak ever reported. These differences may be due either to a larger area that is severely defoliated, or to longer periods during which individual stands are severely defoliated. Maps of the limits of severe defoliation during the five largest outbreaks described in historical records (Fig. 1) and evidence that balsam fir sawfly populations remain at high densities for only 2–4