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Understanding patterns in forest tent caterpillar outbreaks: Developing effective pest management strategies

INTRODUCTION

Forest tent caterpillar (*Malacosoma disstria*) is an insect pest native to North America that has historically caused extensive defoliation of trembling aspen, as well as oak, ash, maple and white birch. Over the past decade, the area defoliated by forest tent caterpillar has ranged from 14.3 million ha in 2001 to 150,000 ha in 2009. Widespread outbreaks have occurred in much of the boreal forest at intervals of 10-12 years and typically last three years or less at the stand level and up to six years at the landscape level, depending on natural control factors such as weather, host-parasitoid interactions and forest structure.

Two or more years of heavy defoliation can cause a severe reduction in the radial growth of trees and may cause considerable branch and twig mortality. Trees are weakened by repeated defoliation, which makes them more susceptible to stresses such as drought or other pests. Forest tent caterpillar is one of the causes of aspen decline reported in Alberta and Ontario, and tree mortality has been shown to increase with the duration of sustained defoliation. Population outbreaks of this insect have not been as widely studied as other cyclic insects, such as the spruce budworm and gypsy moth, but the subject warrants more attention as a model system of forest insect disturbance ecology.

GREAT LAKES FORESTRY CENTRE ROLE

The damage caused by this insect has important financial implications for the forest sector, particularly in terms of lost future forest productivity. To help address this impact, Natural Resources Canada, Canadian Forest Service has been working with collaborators to improve our understanding of the disturbance ecology of the pest by examining historical records of forest tent caterpillar outbreaks. Such knowledge helps resource managers develop effective pest management strategies. This information will be further used in predicting the influence of climate change on outbreaks and effects on carbon budget estimates.

Patterns of outbreaks

Records of forest insect defoliation in Ontario and Quebec have been maintained since the 1930s. Scientist Chris MacQuarrie and colleagues used Natural Resources Canada defoliation maps from 1938 to 2002 to study patterns of forest tent caterpillar outbreaks at a broad scale with the goal of improving the understanding of the processes driving these outbreaks. The researchers were interested in the frequency, severity and return interval of outbreaks. The maps showed that six major outbreaks occurred, with the largest average intensity of defoliation during the 1951-54 period. The infestations lasted 2-5 years and recurred every 7-11 years. A summary of these cycles is shown in the table below.

Years	Length of outbreak	Interval since preceding outbreak
1943-44	2 years	
1951-54	4 years	7 years
1962-66	5 years	8 years
1975-78	4 years	9 years
1989-92	4 years	11 years
2000-02	3 years	8 years

Degree of synchronization between outbreaks

In this analysis, scientists wanted to determine to what degree outbreaks were synchronized among the various regions and determine the patterns and processes governing synchronization among populations.

The outbreaks recurred periodically and somewhat synchronously among regions of the two provinces. As can be seen in Figure 1, three regions, namely northwestern Ontario, eastern Ontario/western

Figure 1. Study area (green) showing 3 areas with the strongest synchronization of outbreaks (purple). Broken green lines indicate the boundaries of the other populations.

Quebec and southeastern Quebec showed the strongest, large-scale, synchronized fluctuations. Defoliation in the vast surrounding hinterlands however, tended to be infrequent and sporadic. In addition, there was one area in northeastern Ontario that stood out as having experienced persistent defoliation between 1992 and 1999.

Factors that influence outbreaks

Previous studies that analyzed data from Ontario found that outbreak cycles of forest tent caterpillar were sensitive to local climate, which can influence temporal processes governing population growth and host-parasitoid interactions. In this analysis, researchers were interested in determining whether topography or climatic factors had a greater influence on the synchronization of outbreaks. They hypothesized that the ability of insects to disperse in the landscape was more important, with the relatively flat topography of Ontario and Quebec allowing for greater dispersal than the mountainous regions of the west, where there has been less synchronization. Understanding this effect is important in management efforts, because it could help determine the survey range required around new infestations to accurately detect their extent.

Effects on overall health of aspen

Repeated defoliation by forest tent caterpillar may not allow trees to recover to a normal state of health, which can lead to decline. This appeared to be the case in northeastern Ontario, where an area that experienced eight consecutive years of defoliation starting in 1992 was subsequently mapped as in decline in the early 2000s. The researchers were interested to know if this pattern of outbreak was consistent with the other populations in the insect's range and if there was an increasing trend in outbreak severity over the entire northeastern region. They concluded that this particular population occupied a region of marginal habitat for forest tent caterpillar and that the population fluctuations followed those of the other populations only if weather and tree health at the time of the outbreak were conducive.

Implications for forest management

From a timber supply perspective, the decline caused by forest tent caterpillar defoliation could have important implications for management planning. If climatic factors can contribute to imperfect synchronization of forest insect population cycles and result in large-scale forest disturbances, then climate change may alter the pattern of future outbreaks. There could be significant implications for the overall health of the boreal forest in Canada, which would have serious economic and environmental impacts.

Aerial view of forest tent caterpillar damage

CONCLUSION

Insect population studies will improve our understanding of patterns of outbreaks and factors leading to their decline. This insect should be studied as a model system of forest insect disturbance ecology and to determine potential impacts of climate change on its future distribution and potential risks to Canada's forest resources.

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