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INTRODUCTION

Climate-induced range shifts in boreal forest pests: ecological, economic, and social consequences[1]

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Climate change is causing northward shifts in species ranges. For mobile species such as insects, this will increase their access to forest ecosystems where in the past their presence and impact was limited. Range expansion and increases in outbreak severity of forest pests have been documented in Europe and North America (Jepsen et al. 2008; Bentz et al. 2010). Temperature-mediated phenological changes and trophic interactions among host trees, herbivorous insects, and their natural enemies are linked to the long-term effects of range expansion on boreal ecosystems. The degree to which temperate and boreal forest ecosystems are resilient to novel disturbance regimes will have direct consequences on the provisioning of goods and services from these forests and on long-term forest management planning. These concerns were the impetus for the organization of a workshop on climate-induced range shifts in boreal forest pests. Contributions to this special feature are selected papers from the International Union of Forest Research Organizations (IUFRO) workshop held in July 2016 in northeastern Quebec. The workshop was organized around five themes related to the consequences of range shifts of boreal forest insect pests: (1) plant–insect phenology, (2) species range expansions, (3) ecosystem response to changes in disturbance regimes, (4) interactions among disturbances, and (5) forest management and adaptation to change.

Papers on plant–insect phenology explored the impact of potential changes in phenological synchrony between tree hosts and their pests on population growth and insect outbreaks. Insects that feed on foliage in northern forests have a limited growing period, which makes synchrony with budburst of their hosts critical to survival and reproduction. If climate change alters these relationships, there could be several potential outcomes for both insects and their hosts. Increased asynchrony between young emerging larvae and tree hosts could lead to higher dispersal and mortality (Despland 2018). Insects emerging from diapause could alter their behaviour in response to resource availability in the spring and adapt to changes imposed by a warmer climate (Fuentealba et al. 2018). Insect populations might also exhibit sufficient phenotypic plasticity to allow them to switch to new host species, expand their populations into new geographic locations, and adapt to new local environmental conditions (Fält-Nardmann et al. 2018).

The triggers of synchronization on increases in pest populations and the factors that lead to outbreaks have long been topics of speculation. A modeling exercise based on statistical analyses of abundant empirical data suggests that weather and the spread of spruce budworm outbreaks were strongly correlated with the spatial extent of the outbreaks (Nenzén et al. 2018). An abundant production of host tree cones is shown to be strongly correlated with synchronous increases in spruce budworm populations (Bouchard et al. 2018). The production of cones in itself is controlled by meteorological conditions. The authors' suggestion that weather affects the occurrence of a number of bottom-up trophic factors, including cone production, which are linked to synchronous increases in spruce budworm populations, complicates predictions on how climate change could influence future outbreaks. Navarro et al. (2018) present a unique new approach to studying long-term occurrences of outbreaks over thousands of years using wing scales. These scales persist in soil sediments and offer an interesting alternative to paleoecological reconstructions of past outbreaks.

Changes in disturbance regimes associated with climate change will have important consequences on forest productivity (Boulanger et al. 2017). In their concept paper, Ayres and Lombardero (2018) propose tactics to improved pest management in the future. Developing sound theoretical and practical knowledge is key to anticipating and managing forest pests in the future. This will have to be combined with improved monitoring and modelling of possible changes in pest ranges and suppression of pests by the deployment of early intervention strategies. Furthermore, in addition to pest management, a forest management strategy aimed at reducing future forest vulnerability to pests and other disturbances must be developed if we want to adapt to the impacts of climate change.

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[1]Introduction to the special issue "Effect of climate change on boreal pest range shifts and their ecological consequences", a selection of papers from the International Union of Forest Research Organizations (IUFRO) workshop hosted by Working Group 8.01.06 (Boreal and Alpine Forest Ecosystem) and co-sponsored by working groups 7.03.07 (Population Dynamics of Forest Insects) and 7.03.05 (Ecology and Management of Bark and Wood Boring Insects), held in Sept-Îles and Baie Comeau, Quebec, on 11–15 July 2016.

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