Effects of fire on spatial heterogeneity of insects and plants

Lead by: Colin Bergeron

Theme: Arthropod Diversity

Status: Continuing

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Participants

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Background

On the boreal landscape, natural disturbances like fires and insect outbreaks maintain a mosaic of stand ages and types (Heinselman 1981, Johnson 1992, Bergeron 2000) that provide habitat heterogeneity for wildlife and help maintain biodiversity (Danks and Foottit 1989). Succession of boreal vegetation after fire has been well documented (Heinselman 1981). Succession in arthropod communities, however, has received much less attention save that of Holliday (1991) and Buddle et al (2000) that describe some trend in the succession of ground-beetles and spiders. Nonetheless, terrestrial arthropods are highly relevant to the issue of how habitat changes affect biodiversity because they are very sensitive to their environment and important contributors to the diversity (Danks 1996). Few studies, however, have documented the long-term succession of arthropods after fire or the extent to which present-day arthropod communities reflect the fire history. The boreal fire regime (size and frequency) varies both spatially and temporally. As a consequence, a mosaic of stand ages and types is maintained in the forest at both larger and smaller scales (Heinselman 1973, Wein and MacLean 1983, Dansereau and Bergeron 1993, Niklasson and Grandstrom 2000). Part of this variability is due to the fact that boreal trees are adapted to fire in different ways. Some species are able to resist burning, while others are able to quickly colonize burned areas from long distances (Rowe 1983). In their review of insects of boreal ecosystem, Danks and Foottit (1989) propose that insects are similarly influenced by fire and suggest that spatial variation in vegetation induced by fire would be reflected in spatial insect composition as well. Although the short and long-term effects of fire on vegetation succession are well documented (Heinselman 1981, Bergeron and Dubuc 1989, Morneau and Payette 1989, Johnson 1992, Bergeron 2000), parallels in insect community succession remain unclear.

Objectives

1) To reconstruct the fire history at the EMEND site (120 km NW of Peace River, Alberta). 2) To correlate spatial composition of insect and vegetation with fire history. 3) To determine if actual occurrence of macrolepidopteran and beetle species in a given cover-type is correlated with time since the last fire. 4) To determine if occurrence of insect outbreaks varies consistently with fire history.

Key Results

Abstract: I examined the response of invertebrate assemblages to the forest mosaic established by past fire events, and tested the performance of trees as biodiversity surrogates in accurately reflecting relationships between fire history and invertebrate assemblages. Over 80 % of the studied landscape originated from three fire events; 35 % from 1895 (107 years before sampling), 20% from 1877 (125 years before sampling), and 30% from 1837 (165 years before sampling). Less than 8% of the forest originated before the earliest fire detected in 1837. It was clear that even in the absence of fire for over a hundred years, sites with different fire history exhibited major differences in beetle composition and diversity. Oldest sites supported the highest richness followed by sites originating from the most recent fire event. Sites originating from the intermediate fire events had the lowest species richness. Furthermore, the relation between ground beetle assemblages and fire history corresponded to the directional succession shift from harwoods to conifers described for the mixedwood boreal forest. I found that canopy tree composition was a good indicator of the relationship between fire history and carabid assemblage. However, comparison of biodiversity surrogacy models built from either ground survey of trees or data derived from aerial photography reveals that both confusion among tree species, and inaccurate detection and estimation of less common trees species reduced the effectiveness of forest inventories as biodiversity surrogates. Ecosystem classification maps generated from multiple geo-referenced forest attributes performed better as biodiversity surrogates, especially in the detection of crucial old growth habitat. Composition and diversity of three invertebrate taxa (ground beetle, rove beetle, and spiders) were closely correlated to the ecosystem classification map. The use of many taxa improved the sensitivity of the biodiversity indicator to habitat parameters. Pitfall trapping biases were constant among forest types enabling a proper comparison of ground-dwelling invertebrate assemblages between different forests. However, consistent and proper installation of traps is required because catches of some taxa were drastically influenced by placement of the pitfall trap. Considering landscape history in the elaboration of conservation strategies for the extensively managed portion of the boreal forest will foster preservation of biodiversity.