MONOCHAMUS SPP. (COLEOPTERA: CERAMBYCIDAE) AS PRIMARY COLONIZERS OF LIVE JACK PINES (*PINUS BANKSIANA*)

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INTRODUCTION

The July 4th 1999 catastrophic windstorm in the Superior National Forest resulted in wind-throw of 477,000 acres of forest land with wind damage to over 1.7 million trees (1).

Bark (Scolytidae), and wood-boring (Cerambycidae, Buprestidae) beetles are prime candidates expected to invade wind-disturbed forests (2, 3). This severe wind-disturbance event provides a unique opportunity to study beetle colonization patterns on damaged and undamaged residual trees in the general area of disturbance, and to determine whether bark and wood-boring beetles could contribute to decline and mortality of undamaged residual trees.

PROJECT OBJECTIVES

1. To compare the presence and extent of colonization by bark and wood-boring beetles that may cause decline and mortality of trees within undisturbed and wind-disturbed stands.

2. To correlate beetle activity and species composition with attributes of jack pine trees such as DBH and height.

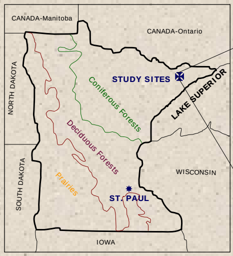


Figure 1A - Map of Minnesota showing study sites.

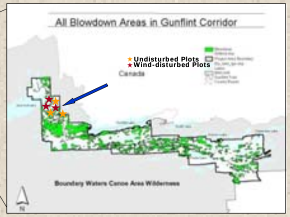


Figure 1B - Stars indicate plot locations.

METHODS

FIELD SITES: We sampled beetles during the summers of 2001 and 2002 along the Gunflint Corridor in the Superior National Forest in northeastern Minnesota (Fig. 1 A,B).

TREE SELECTION: Six plots (~2 ha in size) were established in 2001 within jack pine sites (three replicates in each of the undisturbed and wind-disturbed conditions) (Figs. 1, 2). Within each plot, trees were selected and assigned to temporal-spatial classes as follows: 20 standing and 10 each of standing dead, leaning (dead or alive), and fallen dead jack pine trees (total of 300 trees for the study) (Fig. 2A). The trees were selected for these temporal-spatial classes with the assumption that they might advance from one class to another with time. Tree DBH and height were recorded.

BEETLE SAMPLING: In July of 2001, each tree was assessed initially for external signs of beetle colonization (boring dust, entrance/exit holes, etc.). If beetle activity was observed, then we determined the type of beetle involved and if possible, the species involved, by establishing 500 cm^2 rectangular sample areas at DBH from randomly selected cardinal sections of each tree. For example, diamond-shaped oviposition scars and large (1 to 1.5 cm diameter) round exit holes indicated the presence of cerambycids, whereas small (1 to 3 mm diameter) round exit/entrance holes indicated the presence of bark beetles. Further, on dead or dying trees a 100 cm^2 square bark/phloem sample was removed at DBH from randomly selected cardinal section to count the number and determine the species of larvae or adults present beneath the bark, and to count the number of galleries present. On live trees, only external signs of beetle activity were recorded. Live, standing trees with external signs of cerambycid activity at the base were climbed as high as possible (generally 10-20 m) to check for further signs of colonization, especially by bark beetles.

In July of 2002, the evaluation was repeated. In this case, we recorded beetle activity only on newly attacked trees and on trees that had advanced to a new temporal-spatial class (e.g., leaning to a fallen dead tree or standing live to a standing dead tree) since 2001. Results are provided primarily for the summer of 2002 because during this season greater beetle activity was observed on standing live trees.

(A) A Wind-Disturbed Stand

(B) An Undisturbed Stand

Figure 2 – A wind-disturbed (with spatial classes of trees) (A) and an undisturbed (B) jack pine stand (three replicates each).

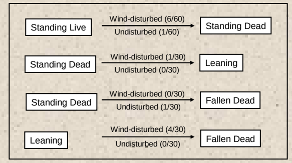


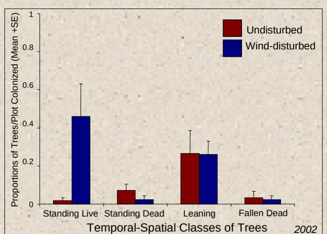
Figure 3 – Changes in representation in temporal-spatial classes of jack pine trees between 2001 and 2002. Numbers in parentheses refer to the number of trees changing classes out of the total number of trees previously present in that class within wind-disturbed and undisturbed plots.

Figure 4 - (C)

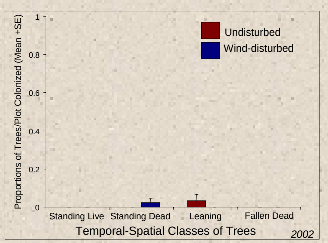
(A)

(B)

Figure 4 – (A) Standing live jack pines colonized by cerambycids; (B) Oviposition scars of cerambycids (arrows); (C) Maturation feeding by adult cerambycids (arrows).

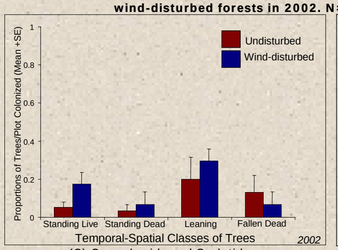


(A) Cerambycid Beetles (*Monochamus* spp.)



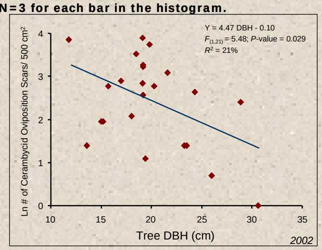
(B) Scolytid Beetles (*Ips* spp.)

Figure 5 – Proportions of jack pine trees (Mean + SE) colonized only by cerambycids (A) or only by scolytids (B) by temporal-spatial classes of damaged trees in undisturbed and wind-disturbed forests in 2002. N=3 for each bar in the histogram.



(C) Cerambycids and Scolytids (*Monochamus* spp. and *Ips* spp.)

Figure 5 (C)– Proportions of jack pine trees (Mean + SE) colonized by cerambycids and scolytids in temporal-spatial classes of damaged trees in undisturbed and wind-disturbed forests in 2002.



Cerambycid Colonization and Tree DBH

Figure 6 – Relationship between log numbers of cerambycid oviposition scars on standing live jack pine trees and tree DBH in wind-disturbed forests in 2002.

PRELIMINARY RESULTS

Between 2001 and 2002, 12 of the 300 trees changed temporal-spatial classes and 10 of these were in wind-disturbed plots (Fig. 3). Furthermore, although the leaning class contained trees that were both alive and dead when the trees were selected in 2001, between 2001 and 2002, 15 of 30 leaning trees died in wind-disturbed plots and 14 of 30 leaning trees died in undisturbed plots.

In 2001, we had observed initial signs (female oviposition scars) of only cerambycid beetles (primarily *Monochamus* spp.) colonizing five standing live jack pine trees in wind-disturbed (3 cases) and undisturbed (2 cases) plots.

In 2002, seven standing live jack pine trees had already died (Fig. 3, 4A), and *Monochamus* spp. activity increased on the remaining standing live jack pines in the plots as we observed oviposition scars (in the absence of bark beetles, primarily *Ips* spp.) on ~24% (27/114) of trees, and *Ips* spp. alone not colonizing any trees, and both *Monochamus* spp. and *Ips* spp. co-colonizing ~11% (12/114) of trees (Fig. 4A, B). We also observed cerambycid adults during extensive maturation feeding on young jack pines (Fig. 4C).

A two-way ANOVA from 2002 with disturbance categories and temporal-spatial classes as factors indicated that was no significant difference in the proportions of trees colonized by *Monochamus* spp. alone in wind-disturbed and undisturbed plots (p = 0.09) however, greater proportions of standing live trees were colonized than each of the remaining classes (p = 0.01) (Fig. 5A). No such differences were observed for *Ips* spp. alone (p > 0.05) (Fig. 5B). There was no significant difference in the number of trees colonized by both *Monochamus* spp. and *Ips* spp. between the two disturbance categories (p = 0.22) but there were significant differences within the four temporal-spatial classes (p = 0.007) (Fig. 5C).

Densities of oviposition scars created by female cerambycids (in exclusion of scolytids) on all standing live trees were significantly and negatively correlated with tree DBH (p = 0.03) (Fig. 6) whereas no significant relationship was found with tree height (p = 0.40).

PRELIMINARY CONCLUSIONS

We have found that, through female choice of oviposition sites, cerambycids can become primary colonizers of live jack pine trees following a wind-disturbance event. This appears to have occurred during the third growing season after the event, and this should be borne out by a significant movement of trees from the standing live class into the standing dead and other classes in 2003. Also, sampling beneath the bark of these newly classified trees in 2003 will allow us to more accurately determine the relative abundance and success of cerambycids and scolytids colonization.

Furthermore, the density of cerambycid oviposition scars was higher on smaller-sized trees and lower on larger-sized trees indicating that smaller trees may be more susceptible to colonization by beetles.

Preliminary results challenge the current hypothesis that scolytids are always the initial colonizers among subcortical insects on coniferous trees. Also, since cerambycids (and scolytids) utilize fallen and damaged trees to increase their populations following a wind-disturbance, our observations of increased colonization of standing live trees in wind-disturbed plots support the hypothesis that removal of wind-damaged trees via salvage-harvesting or prescribed burning may protect residual trees in jack pine forest stands.

ACKNOWLEDGEMENTS

Research funding has been provided by the Departments of Entomology and Forest Resources, UMN; Carolyn M. Crosby Fellowship & the Dayton-Wilkie Fellowship, UMN to KJKG; Minnesota Agricultural Experiment Station Project #MN-17-070; a Sigma Xi-Grant-in-Aid to KJKG; a USDA-FHM-Fire Evaluation Grant #01-GD-11244225-196; and the USDA-FS-North Central Experimental Station.

We especially thank Manfred Mielke, USFS for facilitating financial support for the project, and for providing equipment/field safety and training sessions. Numerous personnel from the Minnesota DNR, USDA-Gunflint Ranger Station, and University of Minnesota provided logistical and field assistance.

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