

# Use of Prescribed Fire as a Management Tool for Enhancing Pyrophilous Beetle Populations in the Sub-boreal Coniferous Forests of Minnesota

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## INTRODUCTION

The importance of fire in the sub-boreal forests is reflected by the large number of organisms directly or indirectly dependent upon burned areas for food, shelter or reproduction (1). Such fire-dependent or 'pyrophilous' organisms may have been adversely affected by the suppression and exclusion of wildfires in the past century in northern Minnesota (2,3). Pyrophilous species are crucial to the breakdown of coarse-woody debris and post-disturbance nutrient cycling. Thus, they are important within managed forests.



Wildfire causes major alterations to the physical and chemical attributes of soil, and these alterations have implications for litter-dwelling or 'epigeic' organisms (4,5). Amongst epigeic species, ground beetles (Coleoptera: Carabidae) are particularly sensitive to habitat changes especially those ensuing from prescribed burning, and many species are classified as pyrophilous (2,3,6). Furthermore, carabids are important predators in trophic chains, and are easily sampled and taxonomically identified (5). We outline a study that evaluates the use of carabids as bioindicator taxa for determining the efficacy of wildfires and prescribed burning in the retention of pyrophilous species.

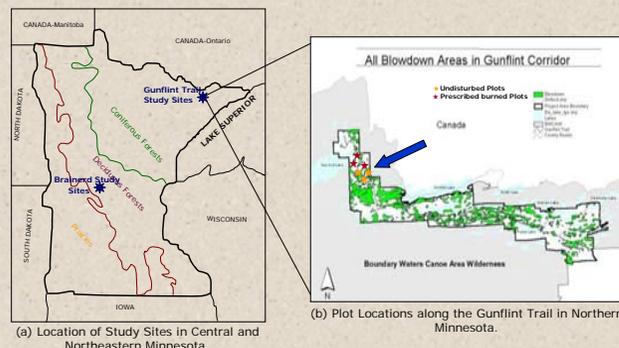


Figure 1 – Study Sites in Minnesota.

## PROJECT OBJECTIVES

1. To determine the immediate responses of pyrophilous carabid species to naturally burned areas and wind-disturbed-prescribed burned areas in Minnesota.
2. To compare pyrophilous carabid species of a northern and shallow-rooted jack pine forest to a more southern, deeper-rooted jack pine forest.
3. To assess if specific structural attributes of a prescribed burned forest such as forest composition (overstory & understorey plant species) and structure (proportion of live and dead trees & soil disturbance) are important for the survival of pyrophilous carabid species in northern forests.



Figure 2 – Undisturbed and Naturally Burned Stands (three replicates each) in the Brainerd Area (a, b), and Undisturbed and Wind-disturbed-prescribed Burned Jack Pine Stands (three replicates each) in the Superior National Forest (c, d).

## METHODS

**Study Sites:** Beetle populations were sampled in 2003 from forests along the Gunflint Corridor in the Superior National Forest (SNF), and from forests ~2 miles south of Brainerd in Minnesota (Figure 1). The overstory of both the forests is jack pine, however, soils are shallower and rockier in the SNF, and are deeper and sandier in the Brainerd area (6). In 2002 and 2003, we monitored beetles in 3 plots each of the (1) undisturbed (control), and (2) naturally burned areas (burned on May 31, 2002) in the Brainerd area (Figures 2 a, b). In 2003, we monitored beetles in 3 plots each of the (1) undisturbed (control), and (2) severely wind-disturbed (>67% tree mortality)-prescribed burned forest stands (burned in late-October 2002) in the SNF (Figures 2 c, d).

**Beetle Sampling:** We sampled carabids using forty-eight pitfall traps consisting of a 1 liter outer and a 500 ml inner plastic container buried level with the ground (7) (Figure 3). Surface-active beetles fell into the inner cup that was filled partially (1/3) with propylene glycol to kill and preserve them. An elevated square plywood roof covered the traps to exclude rain, debris and small animals.



Figure 3 – An Unbaited Pitfall Trap with a Lid.

**Sampling Design:** Four pitfall traps spaced by ~50m were placed on straight-line transects within each plot. Transects were placed at least 50m away from forest edges to reduce edge-effects, and plots were spaced at least 500 m from each other. Sampling was conducted from late-June to mid-September, and traps were emptied every 15 days. All adult carabid beetles are currently being identified to species-level.

**Sampling Forest Attributes:** Data about changes in forest characteristics including forest composition and structure in undisturbed and wind-disturbed-prescribed burned areas will be assessed from the permanent vegetation plots established elsewhere in the SNF as a part of the larger wind-disturbance project (6, 8).

**Statistical Analyses:** We will compare beetle catches and diversity in undisturbed and burned stands and from the two forest types using ANOVAs. Ordination and cluster-analysis will be used to evaluate differences in beetle assemblage composition among treatments. Beetle data will be correlated with forest characteristics to understand specific attributes important for pyrophilous species.

## EXPECTED RESULTS

**Objective 1:** In a preliminary study in the SNF (6), we caught a number of pyrophilous carabid beetles such as *Sericoda obsoletum*, and *S. quadripunctatum*. Thus, we speculate that both wildfire and prescribed burning will increase the abundance of pyrophilous beetle species.

**Objective 2:** We are analyzing data from both the SNF and Brainerd, however, the most commonly trapped beetle within prescribed burned areas in the SNF was *Pterostichus melanarius*, a European carabid beetle. We predict that disturbed areas, especially around the more urban Brainerd areas, may be colonized by invasive and exotic species.

**Objective 3:** *S. quadripunctatum* is known to be associated with burnt stumps and branches in burned areas (9). As the type and amount of coarse-woody debris varied between the unburned and burned sites in the SNF and Brainerd (Fig. 2), we predict that forest structural attributes will likely influence the abundance distribution of pyrophilous carabid species.

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## LITERATURE CITED

1. Speight, M. C. D. 1989. Saprophytic invertebrates and their conservation. Council of Europe Publication, Strasbourg.
2. Wilkars, L.-O., 1992. Skogsbrand och insekter. [Forest fires and insects.] Entomologisk Tidskrift, 113 (4), 1-11.
3. Wilkars, L.-O., 1997. Effects of forest fire and the ecology of fire-adapted insects. Comprehensive Summaries of Uppsala Dissertations from the Faculty of Science and Technology 272. Acta Universitatis Upsalensis, Uppsala, Sweden.
4. Stork, N. E. (Ed.), 1990. The role of ground beetles in ecological and environmental studies. Intercept Andover, U. K.
5. Spence, J. R., Langor, D. W., Hammond, H. E. J., and Pohl, G. R. 1997. Beetle abundance and diversity in a boreal mixed-wood forest. In Forests and insects. Eds. A. D. Watt, N. E. Stork and M. D. Hunter. Chapman and Hall, London. Pp. 285-299.
6. Gilmore D.W., Seybold S.J., Zasada, J.C., Anderson, P.J., Kastendick, D.N., Gandhi, K.J.K., and Johnson, H.P. 2002. Cumulative effects of a severe windstorm and subsequent silvicultural treatments on plant and arthropod diversity in the Gunflint Corridor of the Superior National Forest in northern Minnesota: project design. In Forestry at the Great Divide, Proceedings: Society of American Foresters 2001 National Convention, Colorado. Pp. 364-379.
7. Spence, J. R. and Niemelä, J. K. 1994. Sampling carabid assemblages with pitfall traps: the method and the madness. Canadian Entomologist 126, 881-894.
8. Gilmore, D. W., Kastendick, D. N., Zasada, J. C., and Anderson, P. J. 2003. Alternative fuel reduction treatments in the Gunflint Corridor of the Superior National Forest: second year results and sampling recommendations. US Department of Agriculture, Forest Service, North Central Research Station, Research Note NC-381.
9. Lindroth, C. H. 1961-69. The ground beetles of Canada and Alaska – Opuscula Entomologica (Suppl.), 20, 24, 33 & 34.