GfÖ Ecological Society of Germany, Austria and Switzerland

Basic and Applied Ecology 11 (2010) 363–372

Basic and Applied Ecology

www.elsevier.de/baae

How will low-intensity burning after clear-felling affect mid-boreal insect assemblages?

Joakim Hjältén*, Heloise Gibb[1], John P. Ball

Department of Wildlife, Fish, and Environmental Studies, Swedish University of Agricultural Sciences, SE-901 83 Umeå, Sweden

Received 18 March 2009; accepted 16 December 2009

Abstract

Intensive forest management and fire protection programs have dramatically reduced the frequency of fires and this is believed to have negative effects on biodiversity. As a result, fire is used as a restoration tool to improve conditions for fire adapted/favoured species. The aim of our study was to determine how burning of clear-felled areas (i.e. those typical of real-world management in Fennoscandinavia) influenced beetle assemblages, and to identify taxonomic and functional groups and individual species that are favoured by burning as it is currently practiced. We studied five sites, each consisting of one burned and one unburned clear-cut. Beetles were collected in sixteen pitfall traps per site for three consecutive years. Regardless of whether beetles were divided into taxonomic or functional groups, abundance was generally higher on burned clear-cuts, with the exception of Staphylinidae which showed indications of an opposite response. The species assemblages differed significantly between burned and control clear-cuts in all years. The species contributing most to the difference included *Corticaria ferruginea*, *Pterostichus adstrictus*, *Corticaria rubripes*, *Atomaria pulchra* and *Hylobius abietes* (all more common on burned clear-cuts), and *Drusilla canaliculata* and *Atomaria peltata* (more common on controls). We also found a succession of species, i.e. *Otiorhynchus nodosus* and *Anthicus ater* became dominant species on burned clear-cuts the third year after burning whereas *C. ferruginea* and *A. pulchra* became scarce. In conclusion, clear-cut burning clearly changed the assemblage composition of beetles and seems to benefit at least some species associated with natural fires. Thus, although clear-cut burning cannot exactly emulate the effect of natural fires it could be used as a restoration tool for improving the quality of the matrix outside protected areas and in particular to create habitats for disturbance-associated species, including species associated with fire.

Zusammenfassung

Intensive Waldmanagement- und Feuerschutzprogramme haben die Häufigkeit von Waldbränden dramatisch reduziert, und dies könnte negative Auswirkungen auf die Biodiversität haben. Daher wird Feuer als ein Instrument der Restauration eingesetzt, um die Bedingungen für an Feuer angepasste oder durch Feuer geförderte Arten zu verbessern.

Das Ziel unserer Untersuchung war zu bestimmen, wie das Abbrennen von Kahlschlagflächen (d.h., solche, die typisch für die tatsächliche Bewirtschaftung in Fennoskandien sind) die Käfergemeinschaften beeinflusste, und zu ermitteln, welche taxonomischen und funktionellen Gruppen und welche Arten durch das gegenwärtig praktizierte Brennen begünstigt werden.

Wir untersuchten fünf Flächen, jede mit einem abgebrannten und einem nicht abgebrannten Kahlschlag. Die Käfer wurden mit 16 Bodenfallen je Kahlschlagfläche über drei Jahre hinweg gefangen.

*Corresponding author. Tel.: +46 90 7868400; fax: +46 90 7868162.

E-mail addresses: Joakim.Hjalten@vfm.slu.se, joakim.hjalten@szooek.slu.se (J. Hjältén).

[1] Current address: Latrobe University, Melbourne, Australia.

doi:10.1016/j.baae.2009.12.012

Unabhängig davon, ob die Käfer in taxonomische oder funktionelle Gruppen unterteilt wurden, waren die Fangzahlen auf den Brandflächen generell höher. Die einzige Ausnahme bildeten die Staphylinidae, deren Abundanzzahlen entgegengesetzt verteilt schienen.

Die Artengemeinschaften unterschieden sich in allen Jahren deutlich zwischen Brandflächen und Kontroll-Kahlschlägen. Im wesentlichen beruhten die Unterschiede auf den folgenden Arten: *Corticaria ferruginea*, *Pterostichus adstrictus*, *Corticaria rubripes*, *Atomaria pulchra* und *Hylobius abietes* waren auf den Brandflächen häufiger, während *Drusilla canaliculata* and *Atomaria peltata* auf den brandfreien Kontrollflächen höhere Abundanzen erreichten.

Wir stellten außerdem eine Artensukzession fest: *Otiorhynchus nodosus* und *Anthicus ater* wurden im driten Jahr nach dem Brennen dominante Arten, während *C. ferruginea* and *A. pulchra* selten wurden.

Wir schließen daraus: Das Brennen ändert die Zusammensetzung der Käfergemeinschaft deutlich und scheint wenigstens einige mit Feuer assoziierte Arten zu begünstigen.

Auch wenn das Abbrennen von Kahlschlägen nicht alle Effekte eines natürlichen Feuers nachbilden kann, könnte es doch eingesetzt werden als Restaurationsmaßnahme zur Verbesserung der Matrix außerhalb geschützter Gebiete und besonders, um Habitate für mit Störungen assoziierte Arten, einschließlich pyrophiler Arten, zu schaffen.

Keywords: Beetles; Biodiversity; Clear-cuts; Prescribed burning; Saproxylic beetles; Assemblages

Introduction

Natural boreal forest ecosystems are structured by disturbances, such as fires and storms and by gap dynamics (Niklasson & Granström 2000; Brassard & Chen 2006). Fire is thus an integral part of the boreal forest ecosystem and is known to maintain biodiversity through the creation of a mosaic landscape composed of various successional stages (Zackrisson & Östlund 1991). Fire also creates large volumes of dead wood, allows deciduous trees to colonize (Berg et al. 1994; Esseen, Ehnström, Ericson, & Sjöberg 1997) and leads to the formation of certain soil and forest structures (Granström 2001), thus providing suitable habitats and substrates for a vide variety of species. Fire-killed trees provide an important food source for many species of insects and fungi (Muona & Rutanen 1994; Penttilä & Kotiranta 1996; Wikars 2002). Numerous insect species are attracted to burned areas and several insect species breed almost exclusively in burned forest (Wikars 1997; Buddle, Langor, Pohl, & Spence 2006) and are thus dependent on fire for their long-term survival (Wikars 1997 but see also Saint-Germain, Drapeau, & Buddle 2008). Pyrophilous insects often have adaptations that allow them to find suitable burned areas, for example good dispersal capacity and special organs for detecting fire (Evans 1966; Schutz et al. 1999). Fire is also important for a broader range of organisms because it simultaneously creates dead wood in open areas and reduces competition (McCullough, Werner, & Neumann 1998). Furthermore, a burned area contains large amounts of dying and weakened trees that support saproxylic organisms over a longer period of time (Wikars 1997).

However, intensive forest management and fire protection programs have dramatically reduced the frequency of fires in many forest ecosystems (Zackrisson & Östlund 1991; McCullough et al. 1998; Niklasson & Granström 2000). Fire scar analyses show that historically about 1% (200 000 ha) of all Swedish forested land burnt annually as a result of natural fire dynamics (Niklasson & Granström, 2000). Recent estimates indicate a considerable decrease, from only 0.001% to 0.02% (i.e. 300–5000 ha) burning annually in Sweden (Esseen et al. 1997; Granström 2001). The reduction in fire frequency and the high intensity of forest management are considered the main threats to biodiversity in boreal forests (Siitonen 2001; Grove 2002). In Sweden, 382 beetle species are regarded as benefiting from fire (Lundberg 1984) and 1126 of the 4210 red-listed species in Sweden are dependent on dead wood. Of these approximately 38% or 501 species are saproxylic beetles (Dahlberg & Stokland 2004).

Thus, concerns that a large number of these species might become extinct due to reduced fire frequency and modern forest practices have led to changes in Swedish legislation and stricter certification demands by the Swedish Forest Stewardship Council (FSC). For example the Swedish FSC standard (Anonymous 1998) requires large land owners to burn 5% of the regenerating dry and mesic forest area over a 5-year period. Insects provide the bulk of biodiversity in boreal forests and perform a range of important functional roles (Seastedt & Crossley 1984; Dahlberg & Stokland 2004). Thus, given the relatively high costs and practical problems of burning as a conservation measure, it is perhaps somewhat surprising that the value of the burning as actually performed by managers is not very well evaluated for its effect on insect assemblages (but see Wikars & Schimmel 2001; Wikars 2002; Hyvärinen, Kouki, & Martikainen 2009; Gibb & Hjältén 2007; Toivanen & Kotiaho 2007a). Thus, the aim of our study was to determine how burning of clear-felled areas (i.e. typical of real-world management in Fennoscandinavia) influenced beetle assemblages, and to identify taxonomic and functional groups and individual species that are favoured by burning.