Forest Ecology and Management 414 (2018) 47–53

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Burning harvested sites enhances polypore diversity on stumps and slash

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ARTICLE INFO

Keywords:
Boreal forest
Timber harvest
Biodiversity
Pine forest
Logging residuals
Wood fungi
Prescribed fire

ABSTRACT

Prescribed burning after clear-cut is a traditional silvicultural method used for promoting regeneration of new tree cohort, but it also affects biodiversity of the harvested sites. We studied, on sites dominated by *Pinus sylvestris* with *Picea abies* admixture, how burning of clear-cuts affects wood-decaying fungi on stumps and slash left on sites. In total, 18 sites, nine of which were burned, were studied in a large-scale field experiment in eastern Finland. Polypore fungi were surveyed 10 years after the burnings. In total, we sampled 13,083 stumps and 12,023 pieces of slash and counted 6,598 polypore records of 54 species.

Burned stumps hosted more polypores than unburned stumps, but burning had no effect on polypores on slash. Both stumps and slash hosted also some red-listed polypore species – more so, if the resource was burned. The results show that stumps and slash can be valuable substrates for wood-decaying fungi, including rare and red-listed species. We recommend avoiding full-scale, intensive stump and slash harvest e.g. for bioenergy, and to apply prescribed burnings on harvested sites, to enhance polypore diversity in managed forests.

1. Introduction

In production forests, logging residuals that are left on clear-cut sites are often the only available resources for wood-inhabiting species during the early succession of forest. Slash (fine woody debris) comprises about 50%, roots 35%, stumps 15% and logs 2% of the total volume of wood left on the clear-cut sites (Dahlberg et al., 2011). Recently, extraction of these resources has increased (Routa et al., 2013; de Jong et al., 2017), to meet the increased demand for bioenergy in energy production. In the EU, the goal is to produce 20% of the energy from renewable sources, including bioenergy, by year 2020, and some EU countries have set their targets much higher. Such intensification of forest biomass extraction may have severe consequences to forest biodiversity and, particularly, to species that can occur on small-diameter dead wood and cut stumps. In fact, several dead-wood-associated species seem to occur at least occasionally on small-diameter pieces of wood, and their significance for fungal diversity may have been underestimated previously (Juutilainen et al., 2014).

Similarly, the importance of cut stumps for polypore species is not known. These logging residuals are likely to be suitable substrate for several species but the occurrence of species on different fractions of logging residuals is unclear. Furthermore, since logging residuals are available only transiently after a harvest, there is no continuum in the input of dead wood after the forest has been clear-cut, which may lower their suitability as a substrate for dead-wood-associated species. Specifically, it is unclear whether red-listed species are able to utilize logging residuals (i.e. slash and stumps; de Jong and Dahlberg, 2017).

Logging residues form a diverse and heterogeneous substrate for dead-wood-associated species (Eräjää et al., 2010). In addition to host tree and size variation, also qualitative variation in wood substrate properties may be important. For example, prescribed burning (or wildfire in natural forests) and consequent charring of wood may significantly modify the properties of dead wood (e.g. Venugopal et al., 2016) and, thus, also affect the assemblages of species (Carlsson et al., 2014; Suominen et al., 2015). If prescribed burning enhances the diversity of dead-wood-associated species, burning the logging residues may prove to be a novel way to maintain forest biodiversity in managed forests.

Prescribed burning after clear-cut has been traditionally used for soil scarification and for promoting tree regeneration. Prescribed burning also promotes biodiversity of harvested sites (Hyvärinen et al., 2006; Toivanen and Kotiaho, 2007; Heikkala et al., 2016). Wildfires create sun-exposed sites where much dead wood is aggregated, providing early successional habitats for dead-wood-dependent species (e.g. Kouki et al., 2001; Swanson et al., 2011). Retaining some unharvested woody biomass on clear-cut sites, in combination with prescribed burning, could mimic natural disturbances and thus provide habitats for dead-wood-dependent species in managed forests.

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https://doi.org/10.1016/j.foreco.2018.02.007
Received 1 November 2017; Received in revised form 30 January 2018; Accepted 6 February 2018
Available online 22 February 2018
0378-1127/

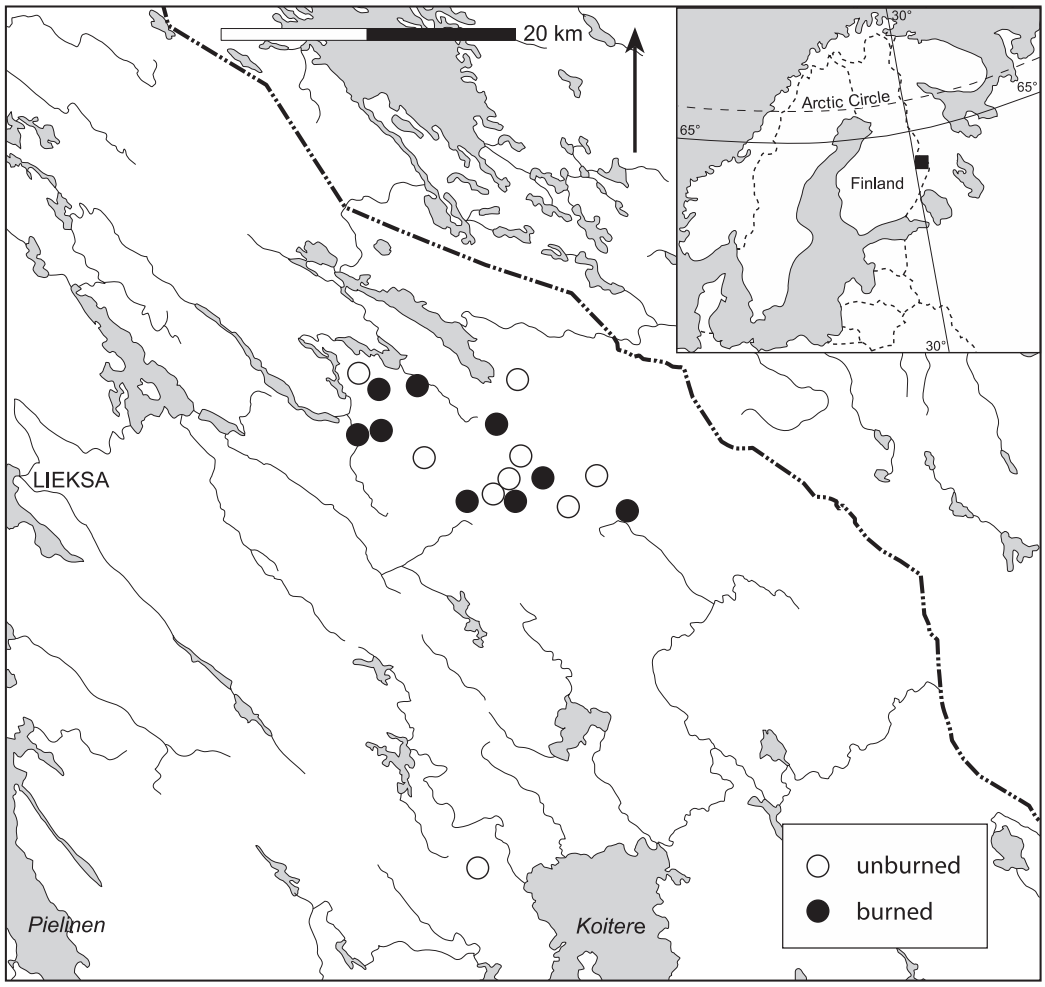

Fig. 1. Map of the study sites.

In this study, we sampled stumps and slash for polypores in a large-scale, replicated experimental study with burned and unburned clear-cut sites 10 years after the treatments. Based on previous knowledge of the habitat and substrate requirements of polypores, we hypothesized that (1) logging residues (cut stumps and slash) are suitable substrates for polypores on harvested sites, (2) polypore communities of cut stumps and slash are different on burned sites compared to unburned sites. If our hypotheses are true, use of fire after final felling could be considered a complementary conservation tool, and both stumps and slash would be recommended to be left on the cut sites.

2. Methods

2.1. Study design and sampling

The study was performed in eastern Finland on the transition zone between the southern and middle boreal zones (Ahti et al., 1968; Fig. 1.). We chose 18 sites (each 3–5 ha in area) where the dominant trees were ca. 150-year-old. The sites were dominated by *Pinus sylvestris* (on average 73% of the growing stock volume), with *Picea abies* (22%), *Betula* spp. (3%) and some other deciduous trees (2%). Before logging, the total volume of living trees was 254 $m^3 ha^{-1}$ (S.D. = 58.9) on the sites to be burned and 302 $m^3 ha^{-1}$ (S.D. = 70.5) on the sites to be left unburned; there was no statistical difference between these two treatment categories.

The study sites were harvested by clear-cutting in the winter 2000–2001, leaving a few retention trees on the sites. All stumps and slash (tops and branches of the harvested trees) were left on the harvested sites. The height of stumps was typically 20 cm and the cutting diameter of the tree tops 7 cm. Most of the branches were less than 5 cm in diameter and thus not sampled for polypores (see below). Nine of the 18 sites were randomly chosen to be burned at the end of June 2001. The burning was mostly surface fire but trees that were left on sites often died or were seriously injured (Heikkala et al., 2014, Čugunovs et al., 2017). Many of the dead wood substrates were burned on the surface and thus most wood remained hard and complete. The complete experimental design is described in more detail in Hyvärinen et al. (2005) and Heikkala et al. (2014).

On each of the 18 sites, one 1-ha study plot was established in the center of the study stand. Two years after the treatments (in 2003) all stumps and slash (tree tops and branches) ≥ 9 cm in diameter were measured for their diameter and their tree species were identified on each plot. For small-diameter (5–9 cm) items, the tree species was documented only if a polypore was found on them. For logging residuals, the diameter was measured in the middle of the stem. Wood pieces smaller than 5 cm were excluded from the inventories.