



Bark-scratching of storm-felled trees preserves biodiversity at lower economic costs compared to debarking



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ABSTRACT

The simultaneous control of insect pests and compliance of conservation targets in conifer-dominated forests has intensified public debate about adequate post-disturbance management, particularly in protected areas. Hence, mechanical bark treatments, such as debarking, of disturbance-affected trees have been widely promoted as an on-site method of pest control that accounts for conservation targets because woody biomass is retained. However, the effects of debarking on non-target biodiversity remain unclear. We analyzed data from a two-and-a-half-year field survey of wood-inhabiting fungi, saproxylic beetles and parasitoid wasps in twelve artificial windthrows, created by pulling down mature Norway spruce trees (*Picea abies*) with winches. Each experimental windthrow comprising one control tree, one completely debarked tree and one bark-scratched tree. Insects were sampled using stem emergence traps. Fruiting bodies of wood-inhabiting fungi, number of wood wasp emergence holes, and number of holes made by foraging woodpeckers were assessed by visual counts. We recorded the amount of time needed to complete debarking by machine, bark-scratching by machine and bark-scratching by chainsaw each on 15 separate trees to estimate the economic costs of mechanical bark treatments.

Our results revealed that both debarking and bark-scratching significantly decreased numbers of the emerging target pest *Ips typographus* to in median 4% (debarked) and 11% (scratched bark) of the number of individuals emerging from untreated control trees. Compared to control trees, debarking significantly reduced the species density of wood-inhabiting fungi, saproxylic beetles, and parasitoid wasps. By contrast, bark-scratching did not reduce the overall species density of wood-inhabiting fungi, saproxylic beetles or parasitoid wasps. The time needed for bark-scratching by machine was significantly lower than debarking, whereas bark-scratching by chainsaw needed a similar amount of time as conventional debarking. However, bark-scratching did have some negative effects in common with debarking, such as the significant reduction of wood wasps emergence holes and the reduction of holes made by foraging woodpeckers. Hence, bark-scratching of downed trees, like debarking, might affect higher trophic levels of biodiversity and should be applied only if pest management is urgently needed. We urge policy makers and natural resource managers to rapidly shift current pest management toward new techniques of bark-scratching, particularly in protected areas. Such a shift in post-disturbance pest-control will foster ecosystem integrity at lower economic cost compared to debarking.

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1. Introduction

Coniferous forest account for more than 25% of the global forested area, contain more than 35% of terrestrial carbon, and harbor significant forest biodiversity (Moen et al., 2014). Hence, management of coniferous forests should integrate both, the

socioeconomic needs of human communities and biodiversity conservation (Moen et al., 2014). Coniferous forests are naturally prone to large-scale stand-replacing disturbances, such as high-severity wildfires, insect outbreaks, and windstorms (Kurz et al., 2008; Seidl et al., 2014). In Eurasia, the major insect pest is the spruce bark beetle *Ips typographus* (Linnaeus, 1758). Between

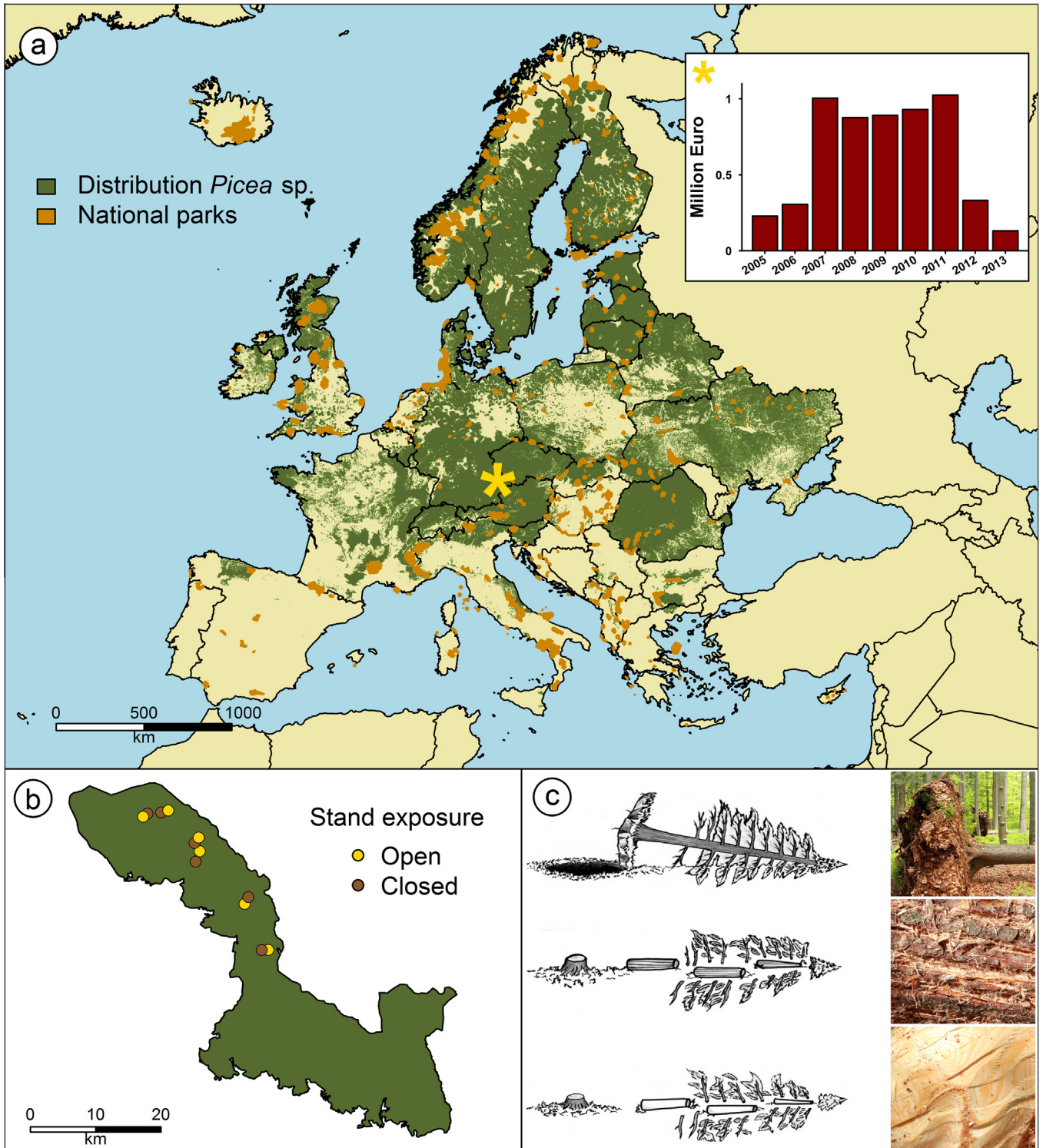


Fig. 1. (a) Recent distribution of spruce (*Picea* spp.) in Europe (based on Brus et al. (2011)). Asterisk: location of the study area, the Bavarian Forest National Park. Inset: economic costs of debarking in the Bavarian Forest National Park. (b) Location of 12 artificial windthrows within the study area; on each plot, three mature spruce trees were felled. (c) Three felled mature spruces on each plot: top row, uprooted and uncut tree (control), middle row, cut tree with scratched bark, and bottom row, cut tree completely debarked.

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