Vole impact on tree regeneration: insights into forest management

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Abstract

In Europe, much of the damage to tree seedlings in plantations is caused by rodents, such as common vole (*Microtus arvalis*), field vole (*M. agrestis*) and bank vole (*Myodes glareolus*). To understand the relationships between the environmental variability which may influence the rodent impact in forest plantations we conducted a study in 12 forest regions of the Czech Republic. In total, we recorded cumulative damage in 19,650 young trees of 8 species at 393 plots. Broadleaves were far more affected by gnawing than conifers (mean 10% and 3%, respectively). Of the monitored species, beech was damaged most often (24% of individuals). The intensity of browsing differed between the regions (6-60% of browsed individuals) with the lowest damage at altitudes below 400 m a.s.l. The proportion of the trees damaged increased with age of the plantation up to 6 years. The factors which principally influenced the impact on trees were herb layer plant cover, its height, its species composition, litter size and presence of weedy species.

Keywords: environmental variables, forest regeneration, vole impact

Introduction

Rodents represent an important natural component in forest ecosystems. The typical feature of rodents is high reproduction rate and related fluctuation in their abundance within seasons of the year and within several-year periods (Hansson, 2002a; Stenseth et al., 2002; Tkadlec and Zejda, 1998). This ability is, from the forestry point of view, the most significant problem. Rodents at high population densities at localities with favourable conditions (open areas) cause damage to vegetation especially in artificial regeneration of forest stands (Hansson, 2002b). The biggest problems are caused by species that consume mainly the vegetative parts of plants; i.e. the field vole and the common vole. Bank voles as a forest rodent having a broader feeding niche are less damaging in forest plantations (Hansson, 2002b). At the times of food shortage, these species feed on bark and under certain conditions they are able to destroy young trees at whole planted areas (Gill, 1992). In spite of the damage small mammals cause to woody species, little attention is paid to research of their ecology in relation to the forest environment in central Europe. This is because in the former forestry practice coniferous trees were favored over other broadleaved tree species and forest damage was low and neglected. In the last ten years there was a strong intention to replace spruce monocultures by mixed coniferous-broadleaved stands. These are close to natural composition and suffer much higher impact on the broad leaved plantations (Gill, 1992).

The aim of our study was a survey on the extent of damage caused by rodents to artificial forest plantations within the Czech Republic and to demonstrate possible factors which may influence the intensity of damage. Our results may route to practical applications as to predict and prevent rodent damage and help in tree planting and planting plots management.

Materials and methods

Within the Czech Republic, we selected 12 regions representing forests in various altitudes. In each of these regions, we assessed the extent of rodent-caused bark browsing at 15 to 40 plots. The monitored plantations were 3 to 15 years old and of various tree species. The plots were chosen with respect to the prevailing group of forest types in the region. At each plantation plot we examined 50 individuals of the selected tree species. In each tree, we took record of its height, stem diameter at soil surface and extent of bark damage over the last 4 to 5 years. Damage was estimated on the basis of the debarked area size, distance of the lower margin of the browsed area from soil surface and share of the damaged circumference of the stem. At each tree the microhabitat was checked as to percentage of herb layer, dicotyledonous herbs, grasses and weedy species cover. Special attention was given to the presence of

the litter and its thickness categorized increasingly as 1 to 3 levels. The same factors as in microhabitats were checked in plantation plot surroundings. All considered factors were analysed by fitting a generalized linear model.

Results

In total 19.650 trees of the 8 species at 393 plots were checked for cumulative damage by rodents. Broadleaves were more affected by gnawing than conifers (mean 10% and 3%, respectively). Of the monitored species, beech was damaged most often (24% of individuals). The intensity of browsing differed between the regions (6-60% of browsed individuals) with the lowest damage at altitudes below 400 m a.s.l. The proportion of the trees damaged increased with age of the plantation (χ^2=44.55, p<0.001) (up to 6 years). Regarding tree microhabitat quality the most important factors were herb layer plant cover (χ^2=272.38, p<0.001) and its height (χ^2=380.10, p<0.001). Also important was its species composition. Impact is high if grasses prevail (χ^2=14.28, p<0.001) and lower if dicotyledonous species prevail (χ^2=76.55, p<0.001). Very important was the presence of the litter and its thickness (which is mostly connected with grass invasion) (χ^2=116.16, p<0.001) and invasion of weedy species (χ^2=116.21, p<0.001). Also the surrounding plots parameters were important and correspond to the particular plot parameters. The rate of damage was higher if surrounding plots were invaded by grasses (χ^2=96.41, p<0.001) with thick litter size (χ^2=10.93, p<0.001). Fencing of the plots also increased rodent damage (χ^2=9.27, p<0.01).

Discussion

Our results show the importance of habitat structure on the level of tree damage. Succession of vegetation at forest clearings changes the living conditions (amount of food, shelter) of rodents and their species composition. The share of damaged trees (of the attractive species) increased with age of the felled area and may be due to accumulation of browsing in the first five years after planting. As an example Ferguson et al. (2003) reported nine years old planting of pines with low ground vegetation to be not suitable for herbivorous voles. In our study, local conditions of the trees were of great importance for the degree of the tree bark damage and tree survival. Thick grass litter, higher herb layer cover and its height were clearly related to increased damage of the trees on clearings. Grassy clearings and meadows are suitable biotopes for vole species (Birney et al., 1976). Vegetation removal with herbicides, grazing or cutting are widely recognized control techniques for many rodent species (Gill, 1992). Also the weed control in tree microhabitats is known to decrease vole damage (Davies and Pepper, 1989). All of these negative factors can be considered and directly managed.

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