JOURNAL OF FOREST SCIENCE, *56*, 2010 (6): 265–270

Rodent-caused damage to forest trees from the viewpoint of forestry practice

J. Kamler[1,2], K. Turek[2], M. Homolka[1], E. Bukor[2]

[1]*Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Brno, Czech Republic*
[2]*Mendel University in Brno, Brno, Czech Republic*

ABSTRACT: Small mammals cause serious damage to forests but there is only little knowledge of their ecology and possibilities of plantation protection. The objective of our study was to collect information on the damage caused by rodents to plantations of forest tree species. Data were obtained from a survey conducted in 2008 that was aimed at damage caused by small mammals. Questionnaires were sent mostly to foresters engaged in the Lesy CR state enterprise. We obtained usable data from 316 foresters. The response rate was 81%. It was confirmed that rodents cause significant damage all over the Czech Republic and that the occurrence of damage cannot be easily predicted with certainty as significant damage may appear perhaps in a small part of the threatened plantations where the key conditions for small mammals have been fulfilled. The main factors which affected probability of damage include: presence of a woody species attractive to rodents; suitable structure of ground vegetation enabling the pest species to breed sufficiently during the vegetation period; and also long-lasting snow cover. The current approach of forestry practice to damage by small mammals is considerably passive and we are missing an alert system of threat to stands and a methodology of dealing with problematic situations. Most of the foresters are uninterested in small mammals and many have only very smattering knowledge of the dangerousness of individual species and their ecological requirements. The use of rodenticides is expensive and the most effective and economic measure to lower damage by small mammals is to support forest management favouring natural regeneration of forest stands.

Keywords: bank vole; bark damage; field vole; forest damage

Small and large mammal species are natural members of forest ecosystems, increasing their biodiversity. At high population densities, the herbivorous species are able to significantly affect the inhabited biotopes and thus cause considerable damage or even exclude normal forest management (Augustine, McNaughton 1998). Therefore, keeping the herbivore-caused damage to trees at an acceptable level is one of the priorities of forest management (Gill 1992). Contrary to the game species, small mammals receive much less care, although they reduce natural forest regeneration by consuming seeds of woody species and injure young trees in forest plantations by bark browsing (Schneider 1996; Niemeyer, Haase 2003). Significant damage to forest regeneration caused by rodents appears mainly in the winter season, typically only at some localities and in some years (Baubet et al. 2005). In spite of the fact that sometimes the activity of rodents leads to total destruction of plantations, Czech foresters do not yet have a reliable system of prediction of threat to stands and so their possibilities to fight this problem are very limited. At the same time, preventive measures, such as specific methods of forest regeneration, are being applied only very little. That is why many foresters anxiously await the end of winter when the

Supported by the Ministry of Agriculture of the Czech Republic, Project No. QH72075.

extent of damage to plantations becomes apparent, being unable to defend against this harmful factor. One of the reasons for this passive approach to dealing with damage caused by small mammals is certain underestimation of its seriousness on the basis of past experiences. At places that had been planted mainly with conifers, small mammals really caused only minor damage as they find conifers (especially spruce) only little attractive (Hjalten, Palo 1992). In recent years, however, the share of broadleaved tree species in plantations has increased and one of the outcomes of this management is severe rodent-caused damage at many localities. It is therefore an important task of this time to find some reliable measures that will allow the successful protection of broadleaved species, not only due to the extent of economic losses, but also in order to ensure a sufficient share of broadleaves in stands, which is a basic prerequisite for the future of healthy forests in our landscape (Augustine, McNaughton 1998).

The severity of damage to forests caused by small mammals and the incompleteness of knowledge of their ecology and feeding behaviour have lead us to initiation of an extensive research focused on monitoring the population dynamics of rodents in forest environment, their feeding behaviour and the damage they cause. At the beginning of the research, we conducted a survey among foresters in the form of a questionnaire with the aim to find out how they perceive the significance of rodent-caused damage, what the main characteristics of the affected stands are like and what methods of plantation protection are used in practice. The objective of our study was to collect information on the damage caused by rodents to plantations of forest tree species, to learn about the practical knowledge of foresters related to this problem and to evaluate their positive and negative experiences on the scale of the whole Czech Republic.

MATERIAL AND METHODS

Data were obtained from a survey conducted in 2008 that was aimed at damage caused by small mammals. Questionnaires were sent mostly to foresters engaged in the Lesy CR state enterprise. Questionnaires were constructed and administered using instructions for a total-design method (Dillman 1978) and followed guides used in similar studies dealing with free living herbivores (Conover 1998; Genghini et al. 2002). 390 questionnaires in total were mailed to 78 forest divisions of the Lesy CR state enterprise. Foresters were asked to complete the questionnaire and to return it to our office. The questionnaire was designed to collect any important information from foresters on the importance of rodents in forests and on factors affecting damage. Twenty-three questions were divided into three sections:

(1) Area description. Information about locality, elevation above sea level and forest composition.
(2) Severity of damage caused by small mammals. In this section we asked for information on the extent of damage in the locality, if the damage caused by small mammals is below, near, or above the damage caused by wind, snow, insects and large herbivores, on endangered tree species, age of the most damaged trees, prevalent type of damage and characteristics of vegetation of severely damaged plots.
(3) Control of damage caused by small mammals. Information gathered in this section regarded methods for a reduction of damage caused by small mammals. Foresters were asked to indicate which species of small mammals were present in their area, if they had experiences in the control of damage and for each control method we asked for its evaluation.

RESULTS AND DISCUSSION

We obtained usable data from 316 foresters. The response rate was 81%. Rodents cause significant damage all over the Czech Republic and almost every forest district reported the occurrence of severe as well as mild damage over the years. For 35% of the addressed foresters, damage caused by small mammals is virtually unknown and the economic loss is insignificant. Other 50% of the respondents find the damage bearable, without a serious impact on their management. Only for 15% of foresters the rodent-caused damage represents a serious problem threatening their management. This corresponds to the comparison of damage caused by rodents and damage due to other harmful factors. Most of the foresters (over 80%) regard the damage by small mammals as less serious than that caused by abiotic factors, bark beetles and herbivorous game. The results show that the occurrence of rodent-caused damage depends on the coincidence of several factors in a specific area at a specific time (Sullivan et al. 1993). The occurrence of damage cannot be predicted with certainty as significant damage may appear perhaps at a small part of the threatened plantations where the key conditions have been fulfilled. Those conditions include: presence of a woody species attractive to rodents (Hjalten, Palo 1992); suitable structure of ground vegetation enabling the

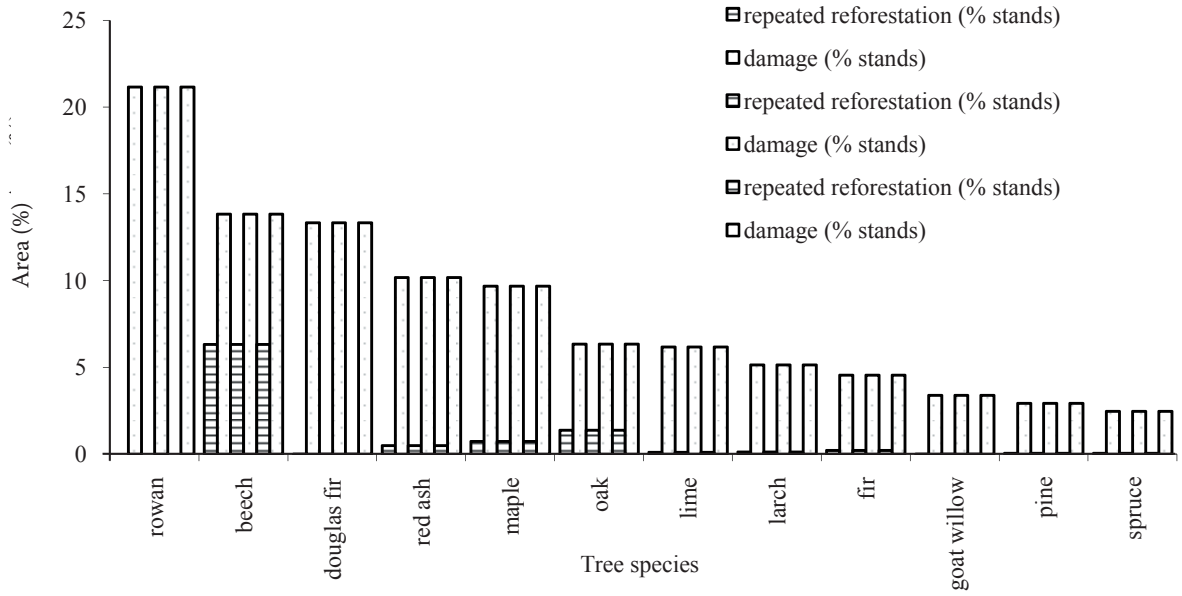

Fig. 1. Extent of damage by small mammals and repeated reforestation (% stands) in relation to individual tree species

pest species to breed sufficiently during the vegetation period (Hansson 2002); and also long-lasting snow cover (Baubet et al. 2005). High abundance of pest species is not the cause of damage at localities not suitable for small mammals (for example due to the lack of herbaceous cover) or at localities where rodents can use alternative attractive food sources (Hansson 2002).

No relationship was found between the intensity of threat to woody species by small mammals and altitude of the locality ($P > 0.05$). Only in the areas at the altitude of 600–700 m a.s.l. the rodent-caused damage was lower than at other localities ($P < 0.05$). A common characteristic of the little threatened localities is a high share of coniferous species both in the parent stands and in plantations. Evidently less threatened are the plantations of coniferous species than those of broadleaves. Significant differences were found between the damage suffered by individual tree species. Rowan, beech and Douglas fir were affected the most; alder, spruce and pine the least (Fig. 1). Only minor damage appears in beech plantations at lower altitudes where the stands are reproduced purely by a shelterwood system with the use of natural regeneration and thus the herbaceous cover does not fully develop here. The intensity of damage to individual tree species corresponds to the need of repair planting in plantations that were totally destroyed by rodents. In the case of beech it was necessary to repeat reforestation in 6% of the planted area on average due to rodents, while in other tree species it was several times less (Fig. 1). Differences in damage between tree species are due to differences in feeding attractiveness (Hjalten, Palo 1992).

Significant differences in the intensity of damage to trees at clearings were found in dependence on the structure of the herbaceous cover. According to foresters, the clearings free of ground vegetation or covered only with dicotyledonous herbs were threatened only little, while the clearings with forest weeds were threatened five times more and those covered with grasses approx. 12 times more. The role of the herb layer is also reflected in the situation on fertile soils where the damage is four times more frequent than on poor soils. These findings are in agreement with results of several studies which documented the importance of the herb layer for small mammal populations (Sullivan, Sullivan 2001; Sullivan et al. 2005).

The foresters were also asked which small mammal species participated in browsing. It turned out that more than a half of them do not pay attention to small mammals or cannot determine the species and so they are unable to specify which of them contribute to the damage. Among the species classified as pests, the most frequent was the bank vole as a typical forest species while the field vole and common vole are much less harmful according to the foresters. However, this opinion concerning the significance of the individual species is in contradiction with the information the foresters provided on the distribution of damage which is the greatest on grass-covered clearings (Fig. 2), i.e. a biotope suitable mainly for field and common voles (Klenner, Sullivan 2003). Both species are able to inhabit the

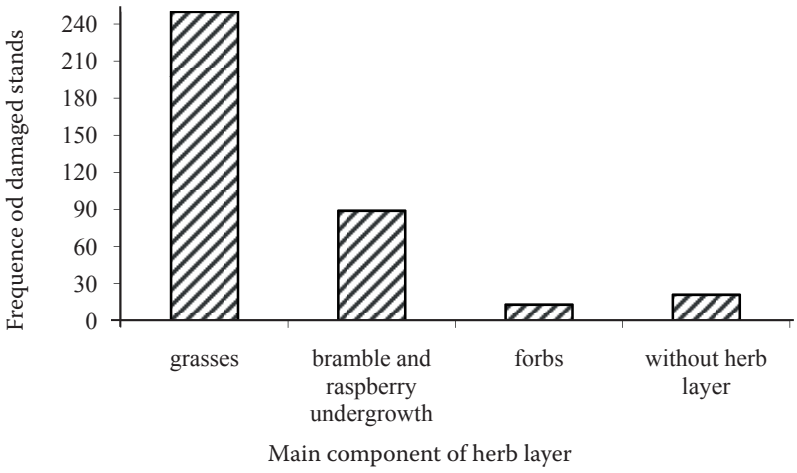

Fig. 2. Distribution of damage according to the composition of the herb layer

grassy clearcut areas very well and to drive the bank vole out of there. The survey revealed underestimation of the significance of rodents' (especially common vole's) impact on forest woody species as well as considerable gaps in the foresters' knowledge of the ecology of small mammals. Another question was which year since 2000 had been the worst as regards the rodent-caused damage (Fig. 3). Yet it turned out that even at close localities, rodent-caused damage may emerge in different years, indicating that the population dynamics of rodents is not synchronized. Forest Protection Service (FPS) reports the most serious damage to plantations caused by small mammals in 2000, 2001 and 2005. We can only speculate why the data from the survey and from FPS differ so fundamentally. One of the possible explanations is a certain delay in damage detection as it is not often clearly visible in spring when the affected trees flush, but only during summer when they gradually die back. Six foresters pointed out snow cover as the most significant environmental factor, markedly increasing the risk of damage.

Possible preventive steps against damage caused by small mammals to plantations

Seven questions in the survey dealt with the protection of plantations against small mammals. Approximately a half of the respondents stated that they were not aware of any effective way of protection while the other half thought that the protection of plantations was possible. The foresters also expressed their opinions concerning the effectiveness of eight suggested methods of protection; surprisingly, the highest number of them (26%) found it effective to install bird boxes for owls and birds of prey and the second place was taken by the treatment of threatened areas with rodenticides (23%) (Fig. 4). As for the most common application of rodenticides, only a small part (12%) of the responding foresters regarded this method as trouble-free and well effective; 65% of them found rodenticides effective, but with limited applicability due to their relation to environment and price. More than a half of the foresters concluded that the existing possibilities of plantation protec-

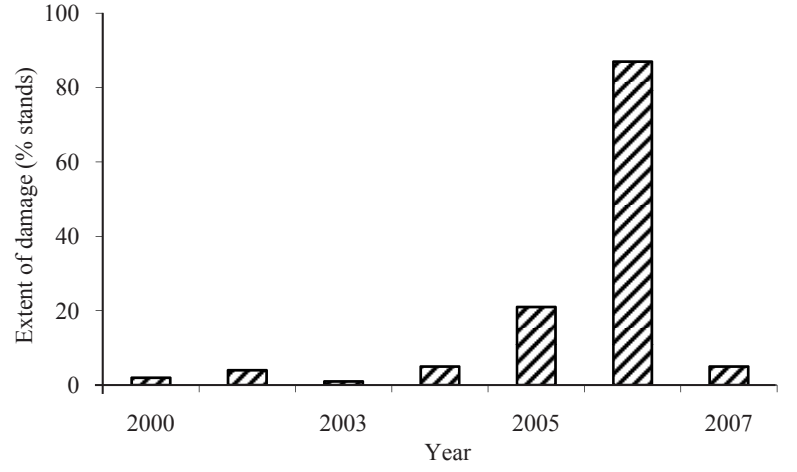

Fig. 3. Extent of damage by small mammals to all tree species in the last four years (% stands)

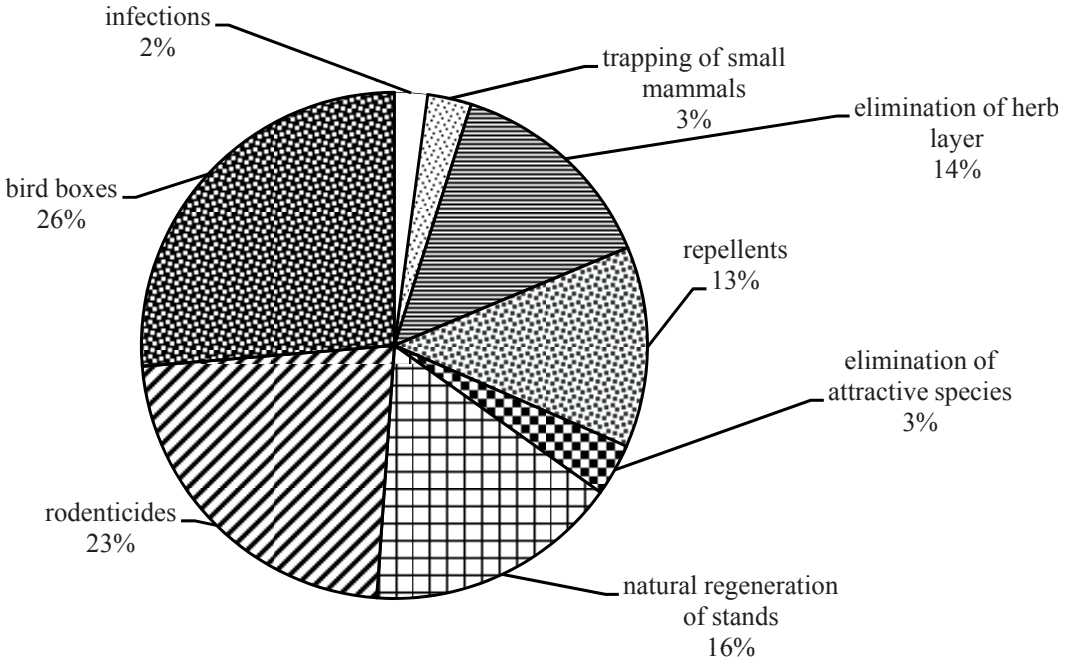

Fig. 4. Methods to lower damage by small mammals according to foresters' opinions

tion against rodent-caused damage did not satisfy the needs of forestry practice. Nevertheless, 58% of the responding foresters used rodenticides at least occasionally and 2.5% of broadleaved and 0.2% of coniferous plantations were treated with rodenticides annually at the monitored localities. Despite the costs of rodenticides, only 7% of the foresters monitored the abundance of small mammals. The rest of them decided on the application of rodenticides or other protective measures on the basis of other signs. As much as 80% of the foresters thought that rodent-caused damage could be reduced by appropriate forest management methods and they provided many examples. The most frequent was a suggestion to support forest management favouring natural regeneration which seems to be the most effective and economic measure to lower damage by small mammals (Sullivan, Sullivan 2001; Heidecke, Pelz 2003; Modzel et al. 2004). A reduction of the herb layer on the clearings is also regarded as a practical tool helping to reduce damage caused by small mammals. Therefore, another possibility is to carry out regeneration cuttings on smaller plots in order to prevent the growth of herbal vegetation, or even to perform total elimination of forest weeds by herbicides. According to the foresters, predators could also play an important role in the control of rodents and should be supported. They recommended clearing away the brushwood so that it would not serve as shelter for small mammals, installing bird nesting boxes and some even suggested a ban on hunting foxes in forests in order to increase the predator pressure on small mammals.

CONCLUSIONS

The survey among foresters has confirmed that at some localities the damage caused by small mammals indeed presents a significant problem for the regeneration of broadleaved tree species. At the same time it is evident that at many places such damage does not appear at all for different reasons. However, the current approach of forestry practice to this damage is considerably passive and we lack an alert system of threat to stands and a methodology of dealing with problematic situations. Most of the foresters are uninterested in small mammals and many have only a very smattering knowledge of the dangerousness of individual species and their ecological requirements. That is why the partial information on the possibilities of damage prevention is only of empirical character and does not allow generalization. Further research in this field is necessary to provide well-founded information on the methods for signalling the threat to stands and possibilities how to defend against the damage caused by small mammals.

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Received for publication June 17, 2009
Accepted after corrections February 19, 2010

Corresponding author:

Doc. Ing. Jiří Kamler, Ph.D., Mendelova univerzita v Brně, Lesnická a dřevařská fakulta, Zemědělská 3, 613 00, Brno, Česká republika
tel.: + 420 545 134 539, fax: + 420 545 134 529, e-mail: kamler@ivb.cz