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The impact of ungulate game on natural regeneration in a fir-beech national nature reserve, Western Carpathians

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Abstract

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The objective of this work was to assess the impact of ungulates on the natural regeneration of woods in a model area within the National Nature Reserve (NNR) of Mláčik – by comparing marked specimens within a pair of research areas. Damage to the naturally regenerating woods was analyzed, the impact of damage to height growth, the impact of game species on the development of the number of trees and their species represented within the growth. The measurements began in the autumn 2007, then they were repeated twice a year (spring, when damage caused by ungulates during the winter was surveyed, and in the autumn – for the damage caused during the summer). The saplings found in the NNR Mláčik are: ash, beech, sycamore, elm, fir, and Wild Service Tree. Scattered are aspen, birch and willow. Ash, fir, maple and elm suffer the most damage due to gnawing. As the regeneration of fir saplings occurs only sporadically, this species may be considered the most endangered tree within the reservation. After two years of protection, significant differences were found in the number of fir trees between the open areas in comparison to the enclosed areas. From the degree of damage and significantly reduced numbers one, can ascertain its high attractiveness to the game. Overall, beech is the least damaged species by game, with only a marginal difference recorded between the plots (fenced and unfenced).

Key words

beech-fir mountains, game damages, natural regeneration, nature reserve, ungulate game

Introduction

A natural part of forest ecosystems is wild game, which consume not only herbal components of the ecosystem, but also tree species. The degree of their damage depends on the frequency of game, which is regulated by predators in the wild, or by man in commercial forests. In natural conditions of a balanced and normally functioning ecosystem, in general, the proportion of vegetable games' food does not exceed 5% of the annual biomass production (Müller, 1992).

Among the numerous influences that determine endangerment to forest species by game, the most significant are the growing stage, the development stage and predisposition of individual tree species to damage by game in accordance with the forest altitudinal vegetation zones (Konôpka and Hell, 2004). The consequences of damage to tree species by game depend on several factors. The most important among them are: the tree species, its age, position in the forest and the season. The main causes of damage are: high frequency of game, food supply and disturbance to games' biorhythm – which causes increased activity (Blaško, 2009). Damage caused by game can be controlled and influenced by phytotechnical preventative measures – mechanical, chemical or biotechnological (Hlaváč, 2002). Long-term and stable regulation of game frequency requires the most up to date knowledge on

wild game, which is not in evidence in many cases. Regulation of game frequency and the concept of game management is often determined only by shooting large numbers for sought after trophies (Trisl, 1998).

An intense browsing of tree species by game leads in many areas to substantial interference with the artificial and natural forest regeneration. Regeneration is delayed, tree species decline in increment and quality, which ultimately increases their mortality. As a result of selective browsing by game, there are visible changes in species composition. Actually, tree species with a higher nutritional attraction are often excluded from full regeneration. The consequences of this impact are visible both at the economic and environmental level – restriction of natural adaptation processes, predisposition to other damage (e.g. drought) and reduction of species diversity (Čermák and Mrkva, 2007).

Material and methods

The Mláčik National Nature Reserve (NNR) lies in the southern part of Kremnické vrchy Mts, 6 km north of the village of Železná Breznica (district of Zvolen). The protected area is located within the range of altitude 690 to 960 m a.s.l., mainly on south-westerly exposed slopes with an inclination of 10–20% (in the centre of the area), 40–45% (in the eastern part), 50–65% (in the western part). The surface of the Reserve is 147.20 hectares. According to the current organisation of forest management, a part of the NNR territory belongs to the district of Forests of the Slovak Republic, State Enterprise; OLZ (Forest Enterprise) Žarnovica, LS (Forest District) Ihráč. Another part of the territory belongs to the district of VšLP TU vo Zvolene (University Forest Enterprise of the Technical University in Zvolen), LS (Forest District) Budča.

According to Professor Zlatník, the forests of the NNR Mláčik are classified into two forest altitudinal vegetation zones: fir-beech and beech. Overall, 6 forest type groups are represented (fir-beech – AF, beech – Fp, typical beech – Ft, lime-beech – Ftil, maple-beech – Fac, ash-maple – FrAc).

Mainly the European beech (*Fagus sylvatica* L.) and the silver fir (*Abies alba* Mill.), occasionally found with the Norway spruce (*Picea abies* L. Karst.), the wych elm (*Ulmus glabra* Huds.) and the sycamore maple (*Acer pseudoplatanus* L.) occur in the tree layer. The shrub layer has not been usually developed.

The impact of ungulate game on natural regeneration in the NNR Mláčik was observed through a network of permanent monitoring plots. Ten paired plots (10 fenced and 10 unfenced) have been constructed in the reserve's territory. Research is carried out on a surface of the reserve within the area of the VšLP district, which is approximately half the total surface of the reserve. The demarked plots are square-shaped; the fences are made of wooden panels, 2 metres high. The size of the fence is 6 × 6 m, while inside the fenced plot only the surface of 5 × 5 m is evaluated. From the inside of the fenced plot, a 0.5 m wide strip was omitted, in order to avoid edge effects – the potential impact of game through the lath inhibitions. The unfenced plots were established near the fenced ones, with an area of 5 × 5 m, they are demarked with wooden pins. Additional information by Šuleková and Kodrík (2009).

The research began in autumn of 2007, when an entry inventory was made. The tree species not exceeding the height of 200 cm were identified in the plots. The species composition and frequency was registered, their height was measured and damage evaluated. The measurements were taken twice a year.

Results

The measurements in the NNR Mláčik were carried out from autumn 2007 until spring 2010. During this three-year period, information on the state of regeneration in the reserve area, namely the species composition and their frequency, was obtained. It was found which tree species are the most attractive and least attractive to game. Further examination dealt with the effects of damage relating to height growth of trees species and their overall development.

Species composition

There were 12 tree species overall in regeneration in the paired plots in the NNR Mláčik during the first measurement in autumn 2007. An inventory of the species, including their abbreviations can be found in the following summary:

Trees – European ash – EA (*Fraxinus excelsior* L.), European beech – EB (*Fagus sylvatica* L.), sycamore maple – SM (*Acer pseudoplatanus* L.), Norway maple – NM (*Acer platanoides* L.), wych elm – WE (*Ulmus glabra* Huds.), silver fir – SF (*Abies alba* Mill.), European mountain ash – EM (*Sorbus aucuparia* L.), common aspen – CA (*Populus tremula* L.), European birch – EB (*Betula pendula* Roth.)**; shrubs** – goat willow – GW (*Salix caprea* L.), common hazel – CH (*Corylus avellana* L.), rose – RO (*Rosa sp.*).

The most represented tree species in the plots was the European ash. It was followed by the European beech and sycamore maple. These three species together accounted for almost 90% of all the individual trees under examination. The Norwegian maple, the silver fir, the wych elm and the European mountain ash were less represented. The common aspen and the European birch occurred sporadically. Among shrubs, the goat willow, the common hazel and rose were found in the plots but

their presence was minimal. In the next evaluation only the tree component was taken into account.

The most represented species in the fenced plots are the European ash (49%), the European beech (26%) and the sycamore maple (13%). They are followed by the Norwegian maple (5%), the wych elm (2%), the European mountain ash (2%) and the silver fir (2%). The common aspen and the European birch are found here with a representation of less than 1%. In the unfenced part, the most represented species were the European ash (50%), the European beech (27%) and the sycamore maple (14%). They were followed by the Norwegian maple (4%), the silver fir (2%) and the wych elm (2%). The European mountain ash and the European birch were represented by less than one percent.

Changes in frequency of tree species

During the research, a gradual reduction in the frequency of the European ash was discovered. This tree species regenerates abundantly in the reserve area, but during growth it is severely injured and gradually dies. The mortality occurs fairly equally in both the unfenced and fenced plots. In the fenced plots, this condition is mainly caused due to damage from the period prior to the establishment of research plots. The European beech, as the main basic tree species in the forest, is the least injured of all species in the reserve. The decline in the frequency of the European beech in the fenced and unfenced plots is comparable. The fact that this species was not significantly damaged even in previous periods suggests that reduction of the European beech also in unprotected areas was caused by natural mortality rather than the influence of game. The maples, which are commonly found with the European ash are damaged comparably to the European ash and they also gradually die. If they are found in combination with other tree species, mainly with the European beech, they are damaged to a lesser extent. The silver fir, despite its relatively rich regeneration in the reserve, occurred rarely in the research plots. Although the number of marked specimens was too small for an objective evaluation of the frequency change, from the given state one can ascertain its attractiveness for the game in this area. As well as the silver fir, the wych elm was found in the plots only sporadically. Therefore, its evaluation will be only informative. Despite intense damage, the frequency of this species was not reduced.

Several specimens, especially among the species of the European ash and sycamore maple, despite still being registered, gradually die due to intense damage. This means that the decline in the frequency of these species will be subsequently higher than reported in Figs 1, 2.

Tree species injuries

The most injured tree species in the NNR Mláčik are the silver fir and valuable broadleaves – the sycamore maple, the Norwegian maple, the European ash and the wych elm.

Most of the European ash has been totally destroyed, by repetitive multiannual browsing of all shoots, leaving only a small trunk with a number of dwarf shoots. Throughout the whole reserve, quite numerous and heavily browsed areas are created. The specimens have thickened trunks with multiple branches at the top, with almost no height growth. They gradually die. When testing the degree of damage with reference to the height, statistically a very significant difference

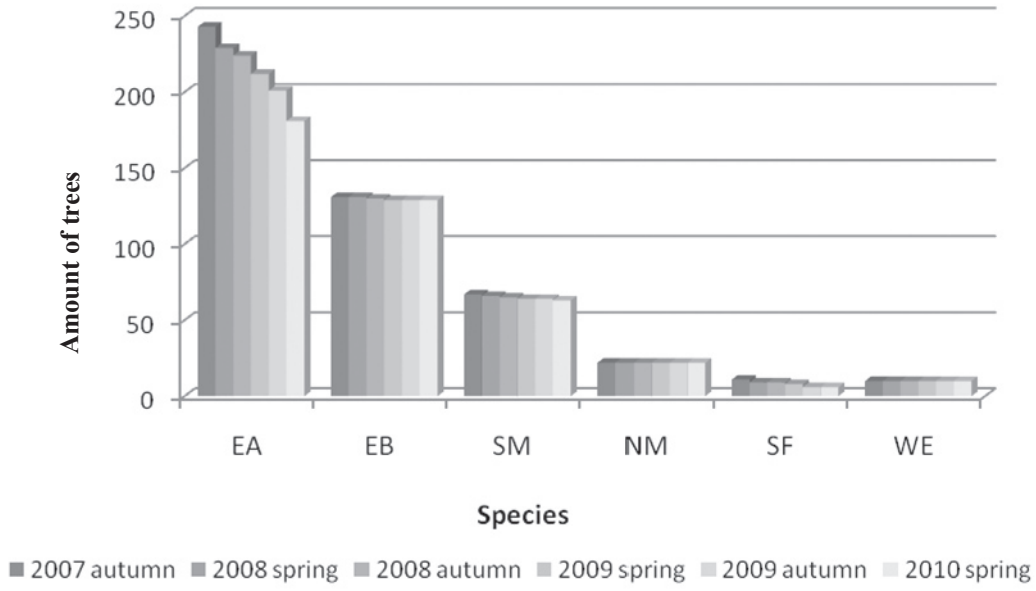

Fig 1. Trend of absolute frequencies of unfenced plots for the period 2007–2010.

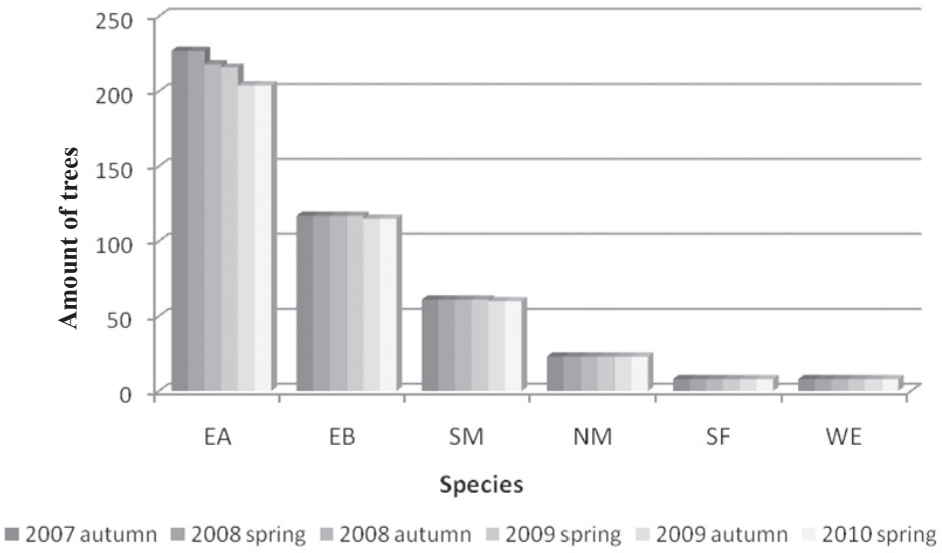

Fig 2. Trend of absolute frequencies of fenced plots for the period 2007–2010.

between the damage in different height classes was confirmed. It was proved that the higher the specimens were, the more damaged they were.

The European beech is the least damaged of all the evaluated species. In the years 2007 and 2008, only very slight damage was discovered: 95% of specimens had a maintained top shoot. In the spring of 2009, damage to even this species increased. We noted browsing of the terminal shoot in the case of 25% of specimens. Despite the fact that several specimens of this species were injured during the winter, it can be concluded that the European beech regenerates in this area without problems.

When comparing the degree of damage between the sycamore maple and the Norwegian maple, a significant difference was confirmed. In a summary evaluation of the damage degree, more damage to the sycamore maple was recorded. The reason is the height of the assessed species. The Norwegian maple occurred only in the 1st and 2nd height class (up to 50 cm), the sycamore maple in the 1st–5th height class (over 130 cm). In the case of the sycamore maple, testing the degree of damage with relation to the height class, confirmed a statistically significant difference. Similarly, damage to the European ash grew with increasing height. When damage to both species in the individual height classes was compared, it was very similar.

There is a noticeable decline in the silver fir, raising concerns about the quality of forests in the future. From evaluating the degree of its damage, even though only a small group of specimens was assessed, a high preference for the silver fir in game was obvious. The damage occurs mainly during the winter months. In spring 2009, only 9% of specimens did not have damaged terminal shoots.

The wych elm belongs among the most intensely injured tree species in the area. Although only a small group was evaluated, it was observed that the wych elm is one of the species with a very good regenerative capacity. After only a one-year isolation period from the impact of game, all the observed specimens replaced their terminal shoots.

Mean height of tree species

The evaluation included the average increment in the height of the European beech, the sycamore maple, the Norwegian maple, the European ash, the silver fir and the wych elm. The average height increments of the individual species over a three-year period, and the difference in the mean height increment between the fenced and unfenced plots are shown in Fig. 3. At the beginning of the research, the species in both the protected and unprotected areas displayed a comparable height. Gradually, a more significant growth of the tree species is visible in the fenced plots.

After a two year observation period, the mean heights were differentiated with reference to the fencing and tree species. The sycamore maple, the Norwegian maple and the silver fir in areas freely accessible to the game achieved no height growth over the evaluated period. Compared to the baseline state, a height reduction was even reported, despite the fact that in the case of the Norwegian maple and the silver fir, the mean height was less than 30 cm, i.e. outside the zone of games' greatest impact. In the fenced plots there was an increase of 21.0% in the Norwegian maple, 27.2% in the sycamore maple and 36.6% in the silver fir.

A big difference between the fenced and unfenced plots was found in the case of the wych elm. Its height

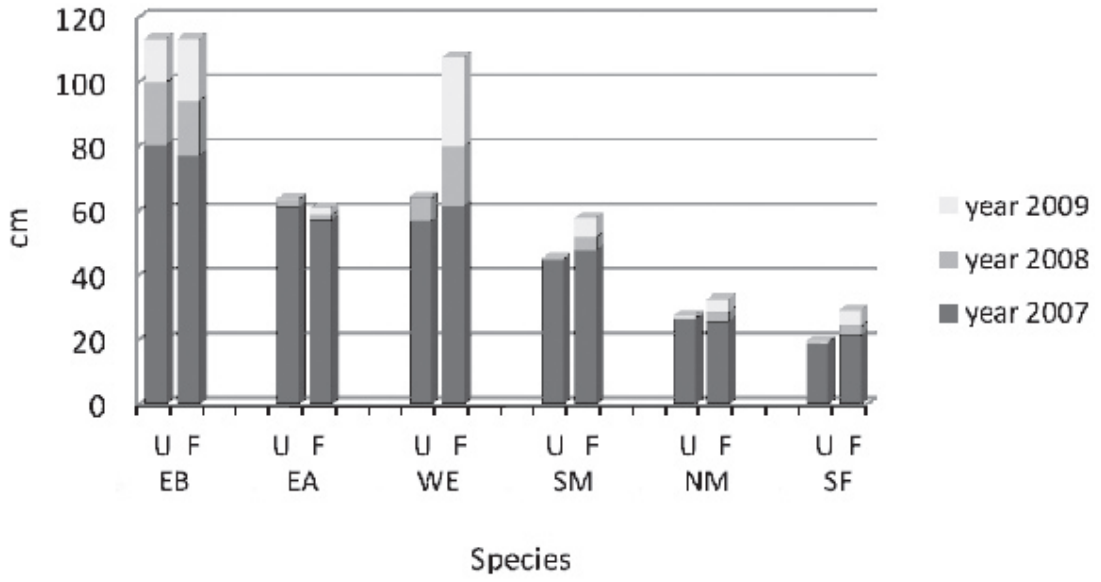

Fig. 3. Changes in the average height of individual tree species over three years (U, unfenced plots; F, fenced plots).

increment was 6-times higher on the protected plots. In the unfenced plots, the height increment was 13.2% over a two-year period, in the fenced plots up to 74.8% of the original height.

In contrast, the growth of the European beech in the paired plots is balanced. Because of a lesser attractiveness in the given area, game influences its development very little. In the fenced plots, the increase in the mean height was 47.1%, on the unfenced ones 41.3%.

The European ash also grows equally in the plots, but for an opposite reason – even protected specimens were in previous periods, damaged to such an extent that their development has significantly reduced. The unprotected specimens are less harmed, because on heavily damaged specimens there is nothing for game to eat. The height increment of the European ash over the two year period was 4.1% in the unfenced plots, 6.5% on the fenced ones.

In all species on the unfenced plots, a lower height increment was found during the second year of evaluation. The reason is a higher degree of damage during the winter of 2008/2009. Even the referred species sycamore maple, the Norwegian maple, the silver fir and the European ash, which in the final evaluation showed no (or minimal) height increment, during the first year gained in height, however, during the second year their height decreased. In the fenced plots, the development was to the contrary.

Discussion and conclusions

The objective of this research was to assess the impact of game on the natural regeneration within the National Nature Reserve Mláčik. By comparing the status of natural regeneration in areas where game has free access with plots where its access was excluded, the impact of game was reliably distinguished from other influences.

According to Finďo (1985a), the growth of tree species accessible to game largely depends on the attractiveness of the given species to game. According to the author, valuable broadleaves can be considered as having grown out of the reach of game at a height of between 2.0 to 2.3 m. In the constructed plots, trees of over 2.0 m did not occur at all. All the specimens had a height accessible to game. From these findings it can be concluded that in the case of species very attractive to game, the damage increases with height, as game 'does not allow' the trees to grow out of its reach. In the case of the highest specimens, the damage accumulates over years.

According to our research, the findings of some authors (Paulenka, 1986; Ammer 1996; Čermák, 1998) believing that damage of tree species decreases intensely with their increasing representation, were not confirmed. In the NNR Mláčik, the European ash is the most harmed species despite having the highest representation in the regeneration. Abundant regeneration of this species was observed in the reserve during an inspection, focusing particularly on the forest type group Abieto-Fagetum, where its damage is the greatest. When testing the degree of damage with reference to the height, statistically a very significant difference between the damage in different height classes was confirmed.

Pfeffer (1961) states that if a tree repeatedly loses its terminal shoot, it grows in width and often dies. Finďo and Žilinec (1993) also describe the same process. They affirm that when tree species are damaged, various morphological changes occur, such as deformations of the

trunk, or the formation of branched axes. The research confirmed this claim in the European ash. Heavily injured European ashes had a thickened trunk with multiple branches in the highest areas. These damaged tree species, even in the fenced plots, were merely surviving and had no height increment. Ultimately, many of them have died, or in the near future will dry out. In some cases, an affected specimen replaced the terminal shoot in the bottom part of the trunk (usually amounting to about 20 cm from the ground). The replaced terminal was characterized by very intense growth. The reason was a well developed root system. The upper parts of such injured specimens do not put forth shoots, but gradually die. Časnocha (1968) in his work describes various consequences of damage to different species. For example, lime, according to his claims, after intense damage enters into a bush form. In contrast, the sycamore maple, the Norwegian maple or the European ash put forth the terminal shoot from a lower bud after browsing, and for a few years the initial severe injury to the tree cannot be located. According to our research, we can only confirm his claim that the European ash replaces its terminal shoot. Conversely, the development of lime and maple was different. Lime, even after severe damage, regenerated very well, as confirmed by Kessl (1957). He included it among the species with the easiest regeneration. The observation of the specimens has only been over a three year period so far, therefore, subsequent development may differ slightly. A high degree of damage was also recorded on the wych elm, the sycamore maple and the Norwegian maple. The wych elm turned out to be a species with a very good regenerative capacity, even though the research on this species was conducted only on a small group. Similarly, Kessl (1957) ranked the wych elm among the species with the easiest regeneration. According to our research, it belongs among the intensely damaged species. However, after one-year period of isolation from the influence of game, all the observed specimens replaced their terminal shoot. At the end of the observation period, the value of the degree of damage to this species was 1, despite the fact that the wych elm is the second most damaged tree species after the European ash.

Finďo et al. (1993), from their research in Poľana indicate that a statistically significant loss of height occurred in unfenced areas in the sycamore maple, the European ash, the goat willow and the wych elm. He did not record a statistically significant impact in the height of the silver fir, which he explains by its low mean height. According to our results, height growth was most influenced in the sycamore maple, the Norwegian maple and the silver fir. In the unfenced plots, these species achieved no increment over a two-year period. The height even decreased compared to the baseline state. The silver fir is highly damaged even though all the specimens are small. Their mean height is even lower than Finďo (1993) stated in his work. Inside the fenced plots, they grow very gradually. A big difference between the fenced and unfenced plots is also found in the wych elm. In the fenced plots, the height increment was 6 times bigger than in the unfenced plots. The growth of the European beech in the paired plots is balanced. Its development in this area is affected very little by game. The European ash had also a balanced height increment in the plots. However, as protected specimens were also previously significantly injured, their development was reduced. In all the species in the unfenced areas, a lower height increment was found in the second evaluated period. The reason is a higher degree of damage during the winter of 2008/2009. In the fenced plots, the height increment was bigger during the second evaluated year.

The least damaged of all species was the European beech. Despite the fact that several specimens of this species were injured during the winter, it can be concluded that the European beech regenerates in this area without problems. Similarly, the European beech is also reported as the least damaged tree species by Finďo (1985b), Finďo and Žilinec (1993); Gašparík (2001); Kaštier (2002); Čermák and Mrkva (2003).

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Vplyv raticovej zveri na prirodzenú obnovu jedľovo-bukových porastov v národnej prírodnej rezervácii, Západné Karpaty

Súhrn

Cieľom práce bolo na modelovom území v národnej prírodnej rezervácii Mláčik zistiť vplyv raticovej zveri na stav prirodzenej obnovy porovnávaním označených jedincov na párových výskumných plochách. Analyzovalo sa

poškodenie prirodzene sa obnovujúcich drevín, vplyv poškodenia na výškový rast, vplyv zveri na vývoj početnosti drevín a ich druhové zastúpenie v poraste.

S meraním sa začalo na jeseň roku 2007, následne sa vykonávalo dvakrát do roka (na jar, kedy sa zisťovali škody zverou spôsobené v zimnom období a na jeseň, škody spôsobené v lete). V NPR Mláčik sa v zmladení nachádzajú jaseň, buk, javor horský, brest, jedľa, jarabina. Ojedinele osika, breza, vŕba. Odhryzom sú najviac poškodzované jaseň, jedľa, brest a javory. Za najviac ohrozenú drevinu v rezervácii možno považovať jedľu, ktorá sa v zmladení vyskytuje len sporadicky. Pri porovnaní zmladenia po dvoch rokoch ochrany sa zistil významný rozdiel v početnosti jedle v oplôtkoch a na voľnej ploche. Zo stupňa poškodenia a značnej miery redukcie vidieť jej vysokú obľúbenosť pre zver. Buk je v danej lokalite zverou poškodzovaný najmenej zo všetkých drevín.

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