

EFFECTS OF BROWSING ON THE CONDITION AND DEVELOPMENT OF REGENERATION OF TREES IN THE REGION OF RÝCHORY (KRNAP)

P. Čermák, P. Grundmann

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Abstract

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In the region of Rýchory (KRNAP – the Krkonoše National Park), effects of roe deer and red deer browsing on the condition and development and natural and artificial regeneration of stands was studied in 2003–2004. Winter and summer browsing were observed in 14 couples of plots (always one with mechanical protection, the second without the protection) and in one control couple in a wintering preserve for red deer. In both years, winter browsing predominated in the region and thus, it is possible to suppose that roe deer was the main browser. As for natural regeneration, silver fir (26% in winter 2003), rowan (36% in winter 2003) and sycamore maple (26% in winter 2004) were the most damaged species. In artificial regeneration, silver fir damage predominated (68% in winter 2003). In the wintering game preserve with the high winter concentration of red deer, damage to all trees exceeded 40% and heavy damage showed also species slightly damaged out of the preserve such as spruce (63%) and beech (75%). Artificial regeneration was damaged more markedly than natural regeneration in all terms of monitoring. The percentage of browsing damage increased with the distance of the additional feeding device.

browsing, red deer, roe deer, natural regeneration, artificial regeneration

Browsing is an important limiting factor of the successful growth of broadleaved and coniferous species. The CR Ministry of Agriculture had the extent of game damage prepared in 2000 on the whole territory of the Czech Republic. The study was the follow-up of monitoring carried out in 1995. Based on the comparison of both studies the marked increase of browsing damage to young forest plantations is evident, above all to tree tops but also lateral shoots. In the category of any damage, on average 39.8% trees were damaged by game in forest plantations. New or repeated damage was found on average in 22.4% trees (ČERNÝ et al., 2002).

The aim of nature conservation in protected regions (particularly in large-area regions where communities are the subject of protection/conservation) is close-to-

-nature or natural forest with marked spatial differentiation, genetically autochthonous or at least valuable stands and the maximum use of natural processes. Natural regeneration is inevitable part of forest dynamics not only on the ground of requirements of natural communities. Adaptation processes occurring in the stage of the highest species, numerical and thus also genetic diversity during natural regeneration are important part of the forest ecosystem resilience.

From the viewpoint of the growth of trees, their number and species structure effects of browsing on the development of natural regeneration was demonstrated on the number of actual areas including especially protected areas (eg ČERMÁK & MRKVA, 2003a). The aim of the presented paper is to document the condition of this effect on the important re-

gion of KRNAP, ie a region one of the protection priorities of which is just the conservation of valuable forest stands. The region of Rýchory was also chosen because it made possible to compare natural regeneration with artificial regeneration (underplanting and additional planting) and also to compare ordinary plots in free hunting grounds with intensive effects of game in a wintering preserve.

MATERIAL AND METHODS

The area under investigation occurs in the easternmost part of the Krkonoše Mts (Giant Mts) forming a separate mountain range between Horní Maršov, Žacelář and Svoboda nad Úpou at an altitude of 450–1033 m. Research plots were situated in central and upper parts of slopes at an altitude of 650–880 m. The area is part of Forest District Svoboda nad Úpou, management-plan area Maršov, superior organization unit the

Krkonoše National Park Direction. The area is included into the MS Babí hunting ground and results of game management are given in Tab. I.

There is a wintering game preserve for red deer as part of the network of the KRNAP game preserves. The major part of red deer population of the Babí hunting ground were in the preserve in winter. Trees were not protected from browsing although this measure is considered to be inevitable for wintering game preserves (PINTÍŘ & TUMA, 2003). Of course, thanks to the measure this game preserve could be used as a control plot to determine impacts of the high concentration of game. In the winter period, game is daily fed in the preserve. In the 2003–2004 winter season, 18 q of hays, 15 q of haylage, 10 q of grain feed and 65 q of other feed were consumed in the wintering game preserve. Additional feeding is also carried out in feed troughs out of the preserve.

I: Results of game management in 2004

2004	roe deer				red deer			
	roe buck	roe-doe	roe kid	total	deer	doe	fawn	total
NJKS	30	30	19	79	7	7	4	18
Enumeration	38	31	22	91	15	10	7	32
Hunting plan	19	12	15	46	5	7	6	18
Hunted down	19	5	11	35	5	3	9	17
% NJKS	115%				178%			

Some 14 representative couples of square plots 5×5 m (12 plots) to 20×20 m (2 plots) were selected in the area in co-operation with a forest manager, another plot 5×5 m was laid out for comparisons in the wintering preserve. Always on one plot of a couple, trees were left without any protection from browsing, the second one was fenced or trees were protected thereby by individual mechanical protection. In all selected plots, natural regeneration occurs (in various stages of development), part of the plots was completed by artificial regeneration in past years.

Research plots rank among the 5th fir/beech and the 6th spruce/beech forest vegetation zone, forest type group 5S – “fresh” fir/beech forest, 6S – “fresh” spruce/beech forest and 6K – acid spruce/beech forest.

Trees were monitored for both years (2003–2004) always in two terms, viz in May (winter browsing) and in September (summer browsing). Trees from 10 to 200 cm in height were the subject of investigation.

In particular trees, the actual occurrence of browsing was studied not distinguishing intensity and the point of damage, ie the actual simple presence of browsing. For each of the monitoring plots, a detailed description of natural conditions was prepared including the determination of a distance to the nearest hunting devices (feed troughs, game food plots, salt licks, wintering game preserves, hunting devices etc).

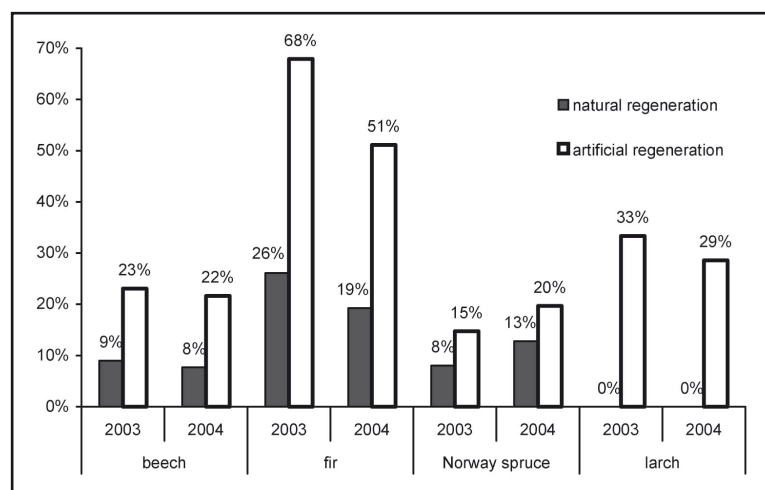
RESULTS

Differences between particular plots were obviously given by a distance from an additional feeding device (will be specified), natural conditions, maturity and number of trees than by differences in the number of game. Results are, therefore, given the overview of all 14 plots (Tab. II). In natural regeneration, silver fir trees were most damaged (26% in winter 2003), rowan (36% in winter 2003) and sycamore maple (26% in winter 2004). In both years, winter browsing mar-

edly predominated, in the aggregate of all species being 13% in winter 2003, 12% in winter 2004, 4% in summer 2003 and 2004. In artificial regeneration, damage to silver fir predominated (68% in winter 2003).

Through winter browsing artificial regeneration was

damaged unambiguously more intensely than natural regeneration (Fig. 1) and the most marked differences were noticed in silver fir. In summer browsing, results are not so definite (Fig. 2), in the majority of cases browsing in artificial regeneration is again more marked the greatest differences being again in silver fir.



1: Comparison of damage to trees in natural and artificial regeneration by winter browsing

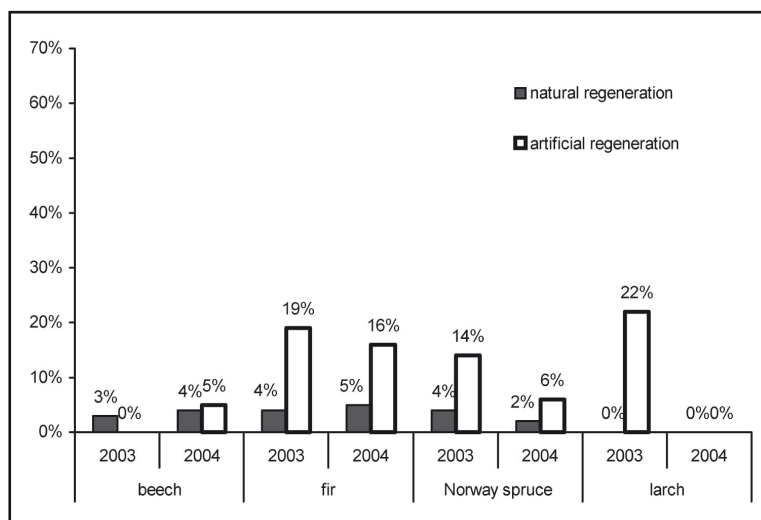
II: Results of the monitoring of browsing in 2003–2004 (the sum of all plots with the exception of wintering game preserves)

2003	winter browsing			summer browsing		
	all trees	damaged	%	all trees	damaged	%
NATURAL REGENERATION						
beech	1221	110	9%	1238	39	3%
rowan	170	61	36%	173	14	8%
Norway spruce	149	12	8%	151	6	4%
fir	111	29	26%	107	4	4%
birch	45	4	9%	51	0	0%
sycamore maple	41	7	17%	40	2	5%
ash	10	4	40%	10	0	0%
goat willow	10	7	70%	9	2	22%
larch	6	0	0%	6	0	0%
pine	1	0	0%	1	0	0%
Total	1764	234	13%	1786	67	4%
ARTIFICIAL REGENERATION						
Norway spruce	122	18	15%	121	17	14%
fir	53	36	68%	52	10	19%
beech	39	9	23%	38	0	0%
larch	9	3	33%	9	2	22%
Total	223	66	30%	220	29	13%

2004	winter browsing			summer browsing		
	all trees	damaged	%	all trees	damaged	%
NATURAL REGENERATION						
beech	1231	95	8%	1258	49	4%
rowan	228	59	26%	231	9	4%
Norway spruce	164	21	13%	170	4	2%
fir	109	21	19%	111	6	5%
birch	74	10	14%	81	1	1%
sycamore maple	42	11	26%	43	4	9%
ash	9	4	44%	12	0	0%
goat willow	9	7	78%	11	3	27%
larch	6	0	0%	5	0	0%
pine	1	0	0%	1	0	0%
Total	1873	228	12%	1923	76	4%
ARTIFICIAL REGENERATION						
Norway spruce	122	24	20%	120	7	6%
fir	45	23	51%	45	7	16%
beech	37	8	22%	40	2	5%
larch	7	2	29%	7	0	0%
Total	211	57	27%	212	16	8%

In the wintering game preserve, damage to trees caused by winter browsing was markedly higher than in a free hunting ground in both years. In spring 2004, the damage reached even 100% (Tab. III), browsing was very extreme and in a number of trees the damage evidently occurred several times during the winter period. In 2003, summer browsing was not detected in the game preserve. In 2004, browsing was only negli-

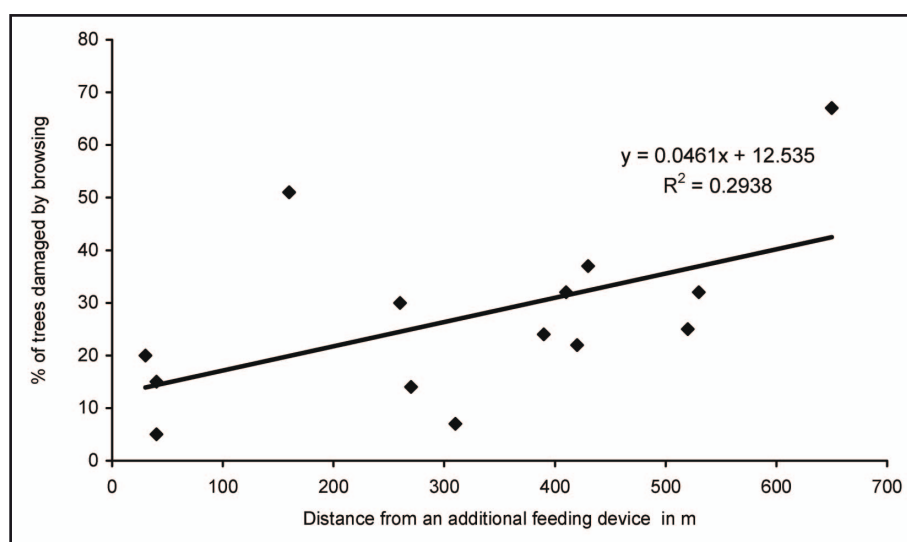
gible, the attendance of the game preserve being very small in summer. Consequences of intensive browsing in the game preserve can be also demonstrated on the noticeable decrease in the number of trees after total winter browsing in 2003/2004 (Tab. III). The decrease in abundance virtually referred to all species and in total, 57 trees died from spring to summer 2004 (16% of the total number).



2: Comparison of damage to trees in natural and artificial regeneration by summer browsing

III: Results of the monitoring of browning in a wintering game preserve in 2003–2004

2003	winter browsing			summer browsing		
	all trees	damaged	%	all trees	damaged	%
NATURAL REGENERATION						
Norway spruce	200	125	63%	200	0	0%
rowan	63	52	83%	60	0	0%
beech	36	27	75%	39	0	0%
birch	27	11	41%	29	0	0%
larch	17	12	71%	16	0	0%
goat willow	9	9	100%	9	0	0%
sycamore maple	6	6	100%	5	0	0%
Celkem	358	242	68%	358	0	0%
2004	winter browsing			summer browsing		
	all trees	damaged	%	all trees	damaged	%
NATURAL REGENERATION						
Norway spruce	200	200	100%	169	0	0%
rowan	59	59	100%	49	0	0%
beech	38	38	100%	29	2	7%
birch	28	28	100%	25	0	0%
larch	13	13	100%	12	0	0%
goat willow	9	9	100%	6	0	0%
sycamore maple	5	5	100%	5	1	20%
Celkem	352	352	100%	295	3	1%



3: Relationships between the percentage of damaged trees and the distance of a plot from an additional feeding device – winter browsing, spring 2004

With the increasing distance of a monitoring plot from an additional feeding device the percentage of trees damaged by browsing increased. Correlati-

on relations are not too strong the most evident being in winter browsing in 2004 – $r = 0.542$, $p < 0.05$ (Fig. 3).

DISCUSSION AND CONCLUSIONS

With respect to the concentration of large part of red game in wintering game preserves, detected damage to trees by winter browsing (particularly silver fir and rowan) is relatively high, even higher than expected. It is possible to suppose that roe deer significantly participates in browsing damage. Based on available data (Tab. I) the game shows higher standing crop in the region as compared with standard (normed) standing crop.

On the other hand, intensity of summer browsing is surprisingly low (with respect to the roe deer standing crop). Roe deer, a typical browser from the viewpoint of food strategy, consumes trees rather intensively even in the growing season. According to various literature sources, woody species occupy in its food 60–80% in summer (FIŠER & LOCHMAN, 1969; HOMOLKA, 1991, 1993; HEROLDOVÁ, 1997). One of possible interpretations of the low summer browsing (as against winter browsing) is the increased winter concentration of roe deer in monitored localities. Roe deer comes down from higher locations with high snow cover and unfavourable weather conditions to medium locations about 700–800 m. While rather intensive winter browsing is caused by numerous roe deer and part of red deer occurring out of the wintering game preserve summer browsing is caused only by less numerous roe deer. In summer, red deer stays particularly in top parts and the proportion of woody species in its summer food is usually markedly lower than in winter when it ranges even about 50% (FIŠER & LOCHMAN, 1969; HOMOLKA, 1993).

The higher damage to silver fir and rowan as compared with other species proves present findings on the high food attractiveness of the species. In an extensive survey carried out in various forest ecosystems of Moravia in 1995–1998, rowan appeared to be the most damaged species (ČERMÁK, 1998) reaching also very high damage in the study of selected small-area especially protected areas in the CR in 2000–2003 (ČERMÁK & MRKVA, 2003a). The preference of rowan and silver fir (together with willow) in browsing in a mountain forest in the Di S. Martino Natural Park was noted by extensive studies carried out in 1994–1995 (MOTTA & FRANZOI, 1997). The preference of rowan was also found in forests predominated by Scots pine in Scotland (MITCHELL et al., 1982; MILLER et al., 1998). In some cases, damage to trees reached extreme values as many as 99% (CUMMINS & MILLER, 1982). The gradual decline of rowan in young forest stands in Slovenia is documented by ADAMIC & KOTAR (1995). In natural regeneration after a fire in Sweden, rowan was the most numerous species among seedlings, nevertheless, thanks to intensive brow-

sing it disappeared from regeneration during several years (LINDER et al., 1997).

Considerable damage to silver fir mostly exceeding other commercial species is documented by a number of authors, eg PAULENKA (1986, 1991), MOTTA & QUAGLINO (1989), EIBERLE & BUCHER (1989), BERNHART & SCHUSTER (1990) or SCHORI (1997). In fir/beech stands, silver fir is appreciably more damaged by browsing as compared with beech (eg MISCICKI & ZUREK, 1995). The detected high browsing damage to silver fir can be also an indicator supporting an assumption of the predominating roe deer browsing. EIBERLE & HOLENSTEIN (1985) found that silver fir was very intensively searched for just by roe deer. In the area with the proportion of silver fir 11% among suitable browsing species it accounted for even 50% of the total browsing damage.

The higher damage to artificial regeneration as compared with natural regeneration corroborates our previous experience from other localities (ČERMÁK, 2000). There are several potential interpretations of the fact. Plants from artificial regeneration are usually more developed showing larger annual shoots and increments being thus visually more marked and more attractive for browsing (larger food profit). Plantings are mostly implemented in more or less regular spacing which also leads to the increased flagrance of planted species. Moreover, access of game to the plants is often facilitated thanks to the method of planting (hole planting) or thanks to mowing. On the other hand, in natural regeneration young trees are often relatively hidden in underwood for a long time (important eg in uninterrupted covers of *Vaccinium myrtillus*). Self-seeding is often intensely cluster-like distributed on a plot, protection of trees within particular clusters is provided by border trees and game often does not enter the dense advance regeneration and takes up with browsing of trees along cluster edges. Advantages of planting as compared with natural regeneration can consist in the fast growth of plants out of the reach of browsing (if the intensity of browsing makes possible the growth of plants).

The reality of these interpretations can be, for example demonstrated on results of the survey of reforestation of infested plots in mountain regions of Slovakia (ZACHAR & TUŽINSKÝ, 1988).

In plots with the full-area preparation of soil where plants grew more slowly being completely without any weed protection damage to spruce plants reached 90%. In plots with hole planting where plants grew well being visually less striking as compared with the full-area site preparation damage reached only 2–9%.

The marked decrease in the number of trees found after intensive browsing in a wintering game preserve in winter 2003–2004 proves that after marked da-

mage a relatively fast decrease occurs in the self-seeding density.

The immediate decrease in the number of trees can be even more intensive than in case of the monitored wintering game preserve. In the Vrapáč National Nature Reserve, we found 32% dieback of trees up to a height of 2 m in research plots after repeated intensive winter browsing in 2003, viz mainly sycamore maple, European ash, hornbeam and field maple (ČERMÁK & MRKVA, 2003b). Marked mortality or increment losses after browsing can be expected in coniferous species characterized by lower tolerance to marked browsing damage (FIŇDO, 1992; FIŇDO & ŽILINEC, 1993).

An increase in damage with a distance from an additional feeding device can be also interpreted as the result of predominating damages caused by roe deer. As compared with red deer the game does not show such a noticeable tendency to stay in groups in the vicinity of feed troughs. Roe deer comes obviously to feed racks to consume mainly served feed. On the other hand, in remote parts of the region it probably consumes mainly woody species. Of course, a certain role can be also played by the higher rate of distur-

bing effects in the vicinity of additional feeding places (roads etc.)

Results of the browsing damage monitoring in the region of Rýchory show that even localities using wintering game preserves can demonstrate problems related to game damages. Although the ascertained browsing damage does not threaten the regeneration of main species, ie of beech and spruce it effects, however, other tree species and their successful regeneration we are interested in. The preservation of attractive and relatively vulnerable species (particularly silver fir) in natural regeneration in a proportion which corresponds to the given forest community is not realistic at present without chemical or mechanical protection. The necessity of effective roe deer management also follows from our research results. The game was often out of interest of management in mountain regions with respect to an opinion that the problem of damage to trees was particularly the problem of red deer. Results from Rýchory but perhaps also from border parts of NPR Šumava (ČERMÁK & MRKVA, 2003c) show that also in these regions roe deer can unfavourably affect natural regeneration.

SOUHRN

Vliv okusu na stav a vývoj obnovy dřevin na území Rýchor (KRNAP)

Na území Rýchor (KRNAP) byl v letech 2003–2004 sledován vliv okusu srnčí a jelení zvěří na stav a vývoj přirozené a umělé obnovy porostů. Na 14 dvojicích ploch (vždy jedna s mechanickou ochranou, druhá bez) a jedné dvojici kontrolní v přezimovací obůrce pro jelení zvěř byl sledován zimní a letní okus. V obou letech v oblasti dominoval zimní okus, lze tedy předpokládat, že hlavním okusovačem je srnec. Z výrazněji zastoupených dřevin byly nejvíce poškozovány jedle bělokorá (26 % v zimě 2003), jeřáb ptačí (36 % v zimě 2003) a javor klen (26 % v zimě 2004). V přezimovací obůrce s vysokou zimní koncentrací jelení zvěře poškození všech dřevin přesahovalo 40 %, vysoké poškození vykazovaly i dřeviny mimo obůrku relativně slabě poškozené, jako je smrk (63 %) či buk (75 %). Umělá obnova byla ve všech termínech monitoringu poškozována výrazněji než přirozená obnova.

okus, jelen lesní, srnec obecný, přirozená obnova, umělá obnova

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Address

Ing. Petr Čermák, Ph.D., Ing. Pavel Grundmann, Ústav ochrany lesů a myslivosti, Mendelova zemědělská a lesnická univerzita v Brně, Zemědělská 3, 613 00 Brno, Česká republika, e-mail: cermacek@mendelu.cz