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PRELIMINARY RESEARCH OF DAMAGES BY RED DEER TO FOREST TREES IN THE AREA OF MOSLAVAČKA GORA (MIDDLE CROATIA)

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Summary: Damages by red deer (Cervus elaphus) on trees in forest habitats make permanent and large problem in many European countries, including Croatia. Researches on this topic in Croatia have been done occasionally, without systematic monitoring of impact and intensity of damage on forest stands. Experimental determination of damages was done in 2012 in the hunting ground VII/15 "Zapadna Garjevica" (hunting surface 23,759 ha), located in the middle part of Moslavačka Gora Mountain. Field surveys were performed on selected plots with total surface of 584 ha. The composition of dendro flora, number of trees, diameter breast high and tree age were determined on each plot. Data were collected according to methodology for forest management and inventory. Total of 196,031 trees were measured, of which 58,255 were damaged, and 137,776 were undamaged. Damages in the forest stands are permanently present because man with its management practice changed and imposed living conditions for deer and other game species. Regulations in the hunting ground and proper management by creating surface convenient for pastures, sufficient and quality food and feeding sources, facilitate setting up a balance between forest management and size of red deer population in the hunting ground.

Key words: damage, red deer, hunting ground, Moslavačka gora, Croatia

Introduction

Forests are one of the most valuable renewable natural resource in the Republic of Croatia. In relation to total land surface of the national territory, forests cover 2,402,782 ha or 42%, and Croatia is with 0.5 ha of forest per inhabitant among densely afforested European countries (Anić 2012). The forest ecosystems in Croatia contain about 260 autochthonous species of dendroflora, 60 of which have an economic importance (Franjić and Škvorc 2010). In the current forest management plan at state level for the period 2006-2015, the growing stock in forests of Croatia amounts to 398 million m3, and annual increment is 10.5 million m3. According to management principles, each year less wood is exploited than it is growing, which ensures the future of the sustainable management.

Hunting is an economic activity which is associated with forests, because forest ecosystems include numerous communities of wilds plants and animals. Forests provide all life needs for those wild animals classified as game species in Croatia, according to the Hunting Act (Anonymous 2005). Rehabilitation and revitalization of forests are, due to various approaches and expectations, still a cross-cutting issue between forestry and hunting management practice in Croatia.

Red deer (Cervus elaphus L.) in Croatia belongs into big furred game, protected by closed season (Janicki et al. 2007). The prevailing breeding model of deer game is still extensive, natural breeding which emphasize preservation of native game species in their natural environment. The aim is to ensure living of an optimal number of game animals in satisfactory health status, as well as desirable trophy value (Konjević et al. 2012). It is widely recognized that in forest ecosystems ungulates can markedly alter a forest structure and species composition by browsing, fraying trees with antlers and stripping bark.

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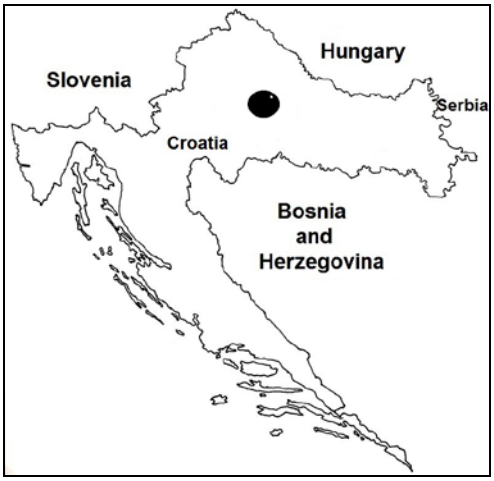
The most serious damage to forest is bark stripping because affected trees readily recover and a considerable number of trees may die (Vospernik 2006). Damages by deer game on trees in managed forests are large and permanent problem in many of countries, including Croatia. Reimoser (2003) reported estimation of damage losses in amount of 200 million euros for 10,000 km2 surface of damaged forests in Austria. Damages by red deer were investigated in selected forest hunting grounds in Serbia during 2007 and 2008 (Gačić and Danilović 2009), and following damage causes were reported: oversize population; disturbed age and sex structure; shortage in natural food and lack of suitable pasture habitats; inconsistency between management in forestry and hunting. First report on damage by red deer in Croatia was given by Dragišić (1959), suggested that improper selection and breeding of large number of deer game in the hunting ground affects trees in forest stands. In the surrounding of Vinkovci (eastern Croatia), damages in the forest were investigated on seven permanent plots (Andrašić 1981). Identified damage types were browsing of buds and shoots, rubbing and bark stripping. Damage intensity ranged from 5% for pedunculate oak (Quercus robur) to 70% for narrow-leafed ash (Fraxinus angustifolia). Knepr (1989) during 1988 determined and measured intensity of damage by red deer in two forest management units: Garjevica and Dišnica-Zobikovac-Petkovača, located in the area of Moslavačka Gora Mountain.

Material and Methods

Field investigation was carried out in 2012, in the open state hunting ground VII/15 "Zapadna Garjevica" located in the middle part of Moslavačka Gora Mountain (Figure 1).



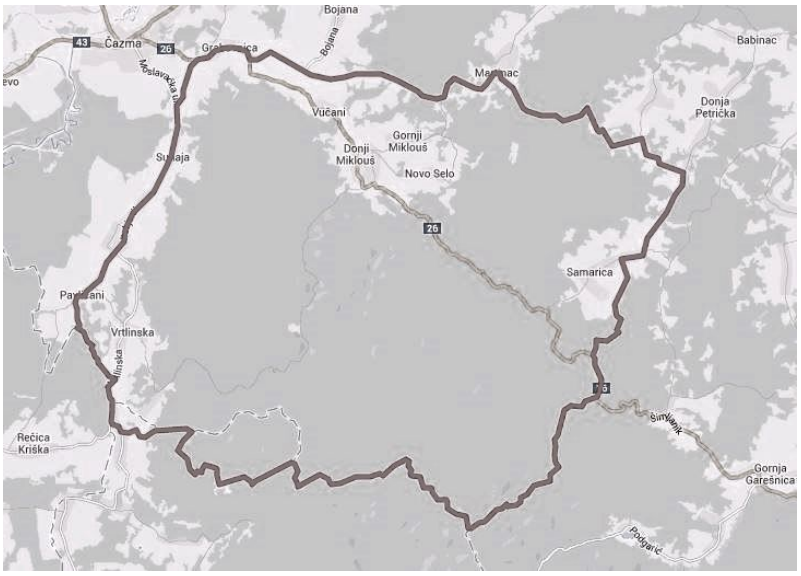


Figure 1. Geographical locations of the hunting ground VII/15 "Zapadna Garjevica"

The altitudinal range is from 120 to 489 m above sea level, and hunting ground is of combined lowland and mountain type. Total surface of hunting ground available for hunting activities is 23,759 ha, of which 19,650 ha (83%) makes forests, while agricultural land comprise 4,095 ha (17%). Forest vegetation is distributed within two altitudinal belts. The hills (altitude of 100-250 m) are characterized by forests of sessile oak and hornbeam (*Epimedio-Carpinetum betuli*). In the montane belt (250-489 m) prevails beech forests with sweet woodruff (*Asperulo odoratae-Fagetum*). There are smaller watercourses, streams and springs which are permanently active all year long.

Experimental determination of damages caused by red deer was carried out in 2012, as repetition on identical locations where the first investigation had been undertaken in 1988 (Knepr 1989).

Field surveys were performed on selected plots with total surface of 584 ha. In the forest management unit "Garjevica-Garešnica", 31 forest section (from 157b to 197c) with surface of 500.27 ha was visited; while in the forest management unit „Dišnica-Zobikovac-Petkovača", 12 sections (from 27c to 33e) with surface of 83.78 ha was visited. The composition of dendroflora, number of trees, diameter breast high and tree age were determined in each plot.

Data were collected according to methodology for the forest management and inventory (Čavlović and Božić 2008). Analyzed samples in each plot contain forest stands from all age classes. Firstly, botanical determination of tree species was done. Diameters at breast high of trees were measured at 1.30 m above ground, using a forestry caliper.

Occurrence and intensity of damage on trees in all age classes was assessed by ocular inspection and, by using the same methodological approach as in Knepr (1989), damaged trees were classified into categories of low, moderate and high damaged. Data on population size of red deer, structure and dynamics were taken from the valid Hunting Management Plan for the hunting ground, and were compared to data from 1988.

Results

During the experimental field research a total of 196,031 trees were measured, of which 58,255 (29.7%) were damaged, and 137,776 or 70.3% were undamaged.

In the surveyed area of hunting ground VII/15 "Zapadna Garjevica", population size of red deer in 1988 amount to 92 individuals on 2,269 ha surface. According to observations and counting in 2012, red deer population is estimated to 950 individuals on total surface of the hunting ground (23,759 ha).

Obtained data about damages by red deer on trees in the surveyed experimental plots, according to botanical classification and categories of damage intensity, were presented in Table 1 for year 1988, and for year 2012 in Table 2.

Damage intensity above 50% was determined in 1988 for the following tree species: pedunculate oak (91.1% of total examined sample); common hornbeam, *Carpinus betulus* (50.5%); sweet chestnut, *Castanea sativa* (100.0%); lime tree, *Tilia* spp. (90.7%); black poplar, *Populus nigra* (100.0%); Norway spruce, *Picea abies* (82.0%), and Weymouth pine, *Pinus strobus* (54.9%).

Damage intensity above 50% was determined in 2012 for two tree species: common hornbeam (63.0%) and Norway spruce (74.2%). Increase in damage was determined for European beach, *Fagus sylvatica*, from 1.7% in 1988 to 20.2%, and common hornbeam, from 50.5% to 63.0%, respectively. For other tree species a decline in damage occurrence was recorded.

For some tree species it was not possible to record damages because they were not present on the surveyed plots. During the 24-year period, trees on which damage was recorded in 1988 were removed from the forest stands, as a part of the regular forest management measures.

Table 1. Data on damages caused by red deer on trees determined in 1988

Tree species	Total	Undamaged tress		Damage intensity							
				Low damaged		Medium damaged		High damaged		TOTAL	
	n	n	%	n	%	n	%	n	%	n	%
Que rob	3240	289	8.9	0	0.0	0	0.0	2951	91.1	2951	91.1
Que petr	129130	115086	89.1	697	0.5	1956	1.5	11391	8.8	14044	10.9
Fag syl	407127	400038	98.3	3523	0.9	1779	0.4	1787	0.4	7089	1.7
Fra ang	246808	238164	96.5	2691	1.1	1731	0.7	4222	1.7	8644	3.5
Car bet	260493	129066	49.5	20721	8.0	21273	8.2	89433	34.3	131427	50.5
Cas sat	1171	0	0.0	0	0.0	0	0.0	1171	100.0	1171	100.0
Pru avi	738	738	100.0	0	0.0	0	0.0	0	0.0	0	0.0
Til spe	11137	1035	9.3	1295	11.6	1215	10.9	7592	68.2	10102	90.7
Aln glu	41542	32252	77.6	4635	11.2	1580	3.8	3075	7.4	9290	22.4
Bet pen	632	632	100.0	0	0.0	0	0.0	0	0.0	0	0.0
Sal alb	7322	5851	79.9	0	0.0	1009	13.8	462	6.3	1471	20.1
Pop nig	132	0	0.0	0	0.0	0	0.0	132	100.0	132	100.0
Pic abi	49035	8835	18.0	12294	25.1	13025	26.6	14881	30.3	40200	82.0
Pin syl	1849	1741	94.2	72	3.9	36	1.9	0	0.0	108	5.8
Pin str	14293	6449	45.1	2656	18.6	1626	11.4	3562	24.9	7844	54.9
Lar dec	30870	25790	83.5	1053	3.4	816	2.6	3211	10.4	5080	16.5
TOTAL	1205519	965966	80.1	49637	4.1	46046	3.8	143870	11.9	239553	19.9

Table 2. Data on damages caused by red deer on trees determined in 2012

Tree species	Total	Undamaged tress		Damage intensity							
				Low damaged		Medium damaged		High damaged		TOTAL	
	n	n	%	n	%	n	%	n	%	n	%
Que rob	5181	5181	100.0	0	0.0	0	0.0	0	0.0	0	0.0
Que petr	30030	29733	99.0	82	0.3	195	0.6	20	0.1	297	1.0
Fag syl	80108	63894	79.8	4812	6.0	5454	6.8	5948	7.4	16214	20.2
Car bet	61350	22727	37.0	1715	2.8	4622	7.5	32286	52.6	38623	63.0
Pru avi	489	489	100.0	0	0.0	0	0.0	0	0.0	0	0.0
Aln glu	6295	6213	98.7	0	0.0	82	1.3	0	0.0	82	1.3
Bet pen	269	269	100.0	0	0.0	0	0.0	0	0.0	0	0.0
Pic abi	3823	986	25.8	319	8.3	919	24.0	1599	41.8	2837	74.2
Pin syl	1636	1594	97.4	21	1.3	21	1.3	0	0.0	42	2.6
Pin str	2816	2739	97.3	21	0.7	0	0.0	56	2.0	77	2.7
Lar dec	3922	3839	97.9	0	0.0	62	1.6	21	0.5	83	2.1
Fra ang	112	112	100.0	0	0.0	0	0.0	0	0.0	0	0.0
TOTAL	196031	137776	70.3	6970	3.6	11355	5.8	39930	20.4	58255	29.7

Abbreviations used: Que rob (*Quercus robur*); Que pet (*Quercus petraea*); Fag syl (*Fagus sylvatica*); Fra ang (*Fraxinus angustifolia*); Car bet (*Carpinus betulus*); Cas sat (*Castanea sativa*); Pru avi (*Prunus avium*); Til spe (*Tilia* spp.); Aln glu (*Alnus*

glutinosa); Bet pen (*Betula pendula*); Sal alb (*Salix alba*); Pop nig (*Populus nigra*); Pic abi (*Picea abies*); Pin syl (*Pinus sylvestris*); Lar dec (*Larix decidua*)

A few hypotheses were proposed to explain why red deer strip tree bark, as follows: low availability of other food sources, the need for nutrients contained in bark, the need for a constant basal component of fibre, and deer ranging behavior. Most authors agreed that food shortage is the most frequent cause of bark stripping (Ueda et al. 2002). In the period of prolonged winter, mainly deep snow cover reduces the resource availability and may lead to more bark stripping. The extent of bark stripping damage is known to depend on red deer population density, although other factors such as stand age, tree species, stand density and winter snow cover may modify this relationship. Red deer typically removes bark from the main stem at a height from 0.8–1.7 m (2.0 m) above ground. The smallest trees are preferred by red deer because of their thin bark with high water content (Prien 1997).

Conclusion

This comparative research, carried out at time distance of 24 year, indicates inter-relation between red deer population and forest habitats in the surveyed hunting ground in the area of Moslavačka Gora Mountain. Those damage firstly determined in 1988 and checked in 2012 did not disturbed stability of the forest habitats. Successful damage management strategy in the hunting ground should include accurate estimation of current population density and population trends of red deer (and other free-ranging ruminants), creation and enlargement of land areas suitable for pastures and insurance of sufficient and quality food and feeding sources.

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