

Impact of forest management on wild boar (*Sus scrofa*) population in south Lithuania

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We assessed the effect of the investigated felling types on the abundance of the wild boar population in south Lithuania. The study was carried out in the southern part of Prienai forest, Punia pine forest, and Kalviai forest, all located in southern Lithuania. The data on the number of the wild boar population and the hunting dynamics were gathered from six hunting seasons, from 2008 to 2014. Our results highlighted that some types of felling had negative effects on the density of the wild boar population in south Lithuania. We observed that changes in the wild boar population were not only affected by the felling of the current year, but also by that of the previous year. Further analysis of data collected over a larger area is needed to check these findings.

Keywords: *Sus scrofa*, forest management, south Lithuania

INTRODUCTION

The wild boar (*Sus scrofa*) is one of the most successful, abundant, and widespread species of wild ungulates in Europe (Apollonio et al., 2010; Lombardini et al., 2017; Lacolina et al., 2018). A high level of adaptability of this species to various environmental conditions and their successful expansion in Europe are explained by a high reproductive capacity, adaptability to a variety of habitats, dispersal potential, and high plasticity of wild boar (opportunistic, omnivorous diet) (Cahill et al., 2003; Gethöffer et al., 2007; Herrero et al., 2008; Ballari, Barrios-García, 2014). In most European countries, wild boar is the most widely hunted big

game (Nores et al., 2008; Apollonio et al., 2010). The Central European wild boar (*Sus scrofa*) is considered one of the subspecies inhabiting the Baltic countries (Baleišis et al., 2003). Climatic trends, human impacts, and ecological factors influence the distribution and abundance of the ungulates (Acevedo et al., 2005). According to some authors, the distribution of ungulate species depends on the habitat structure and suitability (Cahill et al., 2003; Acevedo et al., 2005, 2006). Considerable research has been conducted into the impact of intense hunting on wild boar dispersal (Keuling et al., 2008; Tolon et al., 2009; Thurfjell et al., 2013; Massei et al., 2014), but the data on the assessment of the impact of forestry on the wild boar population are still scarce. Disturbing forest management influences habitat suitability, population

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density, behaviour, and movement of the ungulates (Long et al., 2008; Avgar et al., 2015; Stergar, Jerina, 2017). Investigation of demographic measurements is important in understanding how populations respond to forest management. The purpose of this study is to analyze how changes in forest management could affect the wild boar population in Lithuania.

MATERIALS AND METHODS

The study was carried out in the southern part of Prienai forest, Punia pine forest, and Kalviai forest, all located in southern Lithuania (Fig. 1). We analysed the effects of felling intensity and felling types on the wild boar population. This research was based on two primary types of felling, which were divided into smaller categories: final felling (clear, clear salvage, shelterwood cutting, and selective felling) and intermediate felling (pre-commercial thinning, commercial thinning, selective salvage cuttings, and special felling). The data on the population number of wild boar and the hunting dynamics were gathered from six hunting seasons, from 2008 to

2014. The data on the number and abundance of animals were obtained from the official census of the Ministry of Environment and from the censuses of different hunting areas.

The population density of wild boar (T) was calculated by the following formula (Navasaitis and Pėtelis, 1998):

$$T = G/P \quad (1)$$

where: G – the number of animals in the territory, individuals, P – a territory unit of 1,000 ha.

The relationship between the population density of wild boar and changes in forest management was analysed using Pearson product-moment correlation coefficient that measures the strength and direction of a linear association. Statistical analysis was performed using the Statistical Software R.

RESULTS AND DISCUSSION

We analyzed the effect of the investigated felling types on the abundance of the wild boar population in south Lithuania. Variables that affect wild boar population abundance are given in the Table.

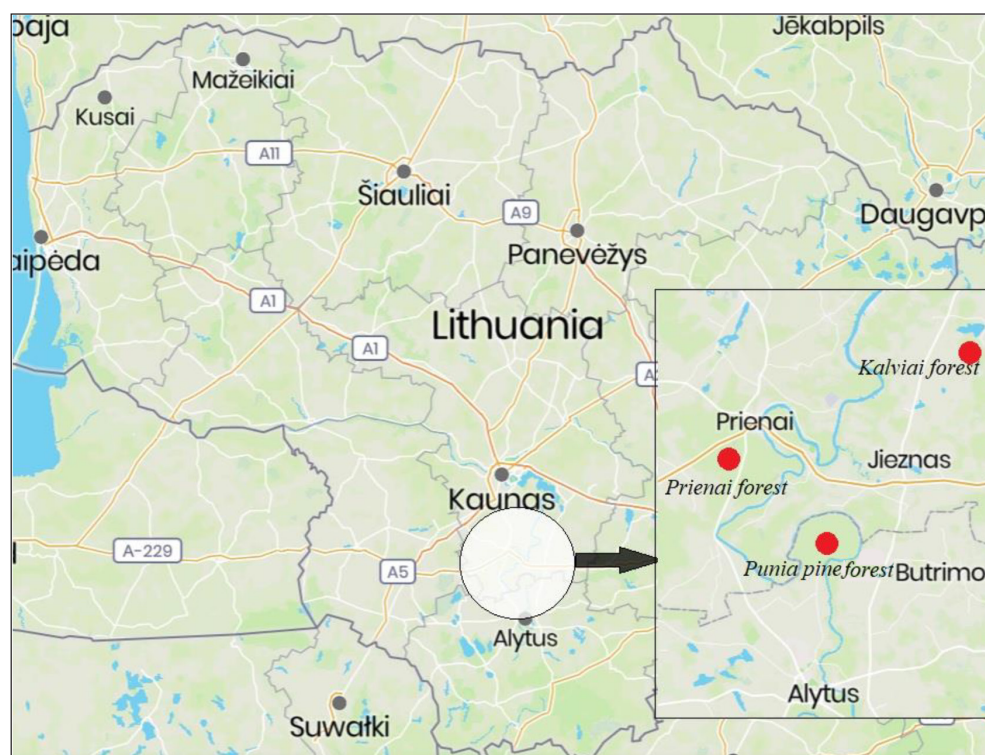


Fig. 1. Map of the study area in the southern part of Lithuania

Table. Effects of forest felling on the wild boar population in southern Lithuania

Year	Monitoring of wild boars			Final felling						Intermediate felling						Total				
	Abundance	Density	Hunting	Clear felling	Clear salvage	Shelter-wood cutting	Selective felling	Pre-commercial thinning	Commercial thinning (1)	Commercial thinning (2)	Selective salvage cutting	Special felling	ha	m ³	ha	m ³	ha	m ³		
<i>Kalviai forest</i>																				
2009	80	61.8	47							0.9	45.8	26.2	40.1		27.1	85.9				
2010	90	69.5	43	2.6	849.51	41.9	10589.05			2.5	159.33	445.2	3618.22		492.2	15216.1				
2011	90	69.5	51	50	10148.61									123.4	5806.9		173.4	15955.5		
2012	80	61.8	59					7.5	78.15		86.7	589.88		94.2	668.03					
2013	15	11.6	46	3.3	102.97						149.6	325.66		152.9	428.63					
2014	21	16.2	92					26.1	698.1		94.7	228.18		120.8	926.28					
<i>Punia pine forest</i>																				
2009	84	30.4	30	3.5	243	5	361	4.5	4.5	9.9	709	84.2	414		107.1	1727				
2010	53	19.2	30			2.8	136	17.2	17.2			55.5	105		75.5	241				
2011	60	21.7	10	4.6	561	7.2	405					150.3	107		162.1	1073				
2012	73	26.4	46	1.3	220	0.7	92	2.6	163	0.5	5	11.3	651	273.6	1511	290	2642			
2013	6	2.2	66	0.9	1.69	3	309	2.2	215	3.7	3.2	68	13.4	960	95.5	1901	121.9	3454.69		
2014	12	4.3	34	9.9	863	5.3	391	28.6	28.6	13.9	75	62.3	2491	47.2	1329	167.2	5149			
<i>Prienai forest</i>																				
2009	42	12.2	69	8.08	2953	5.27	694	16.1	822	15.2	3.2	148	103.1	7005	490.4	979	2.2	3.8	643.55	12604.8
2010	61	17.7	44			3.8	974			23.3	6.3	221	46.9	2688	1054.8	2917			1135.1	6800
2011	63	18.3	45	5.72	1445	1.3	253	1.3	253	32.3	20.9	706		1331.7	4926	4.6	758	1398.22	8399	
2012	60	17.4	62	4.7	1856			0.3	39	16.7	18.3	328	96	6063	1016.2	1077	2.2	3.8	1152.2	9363
2013	48	13.9	73	6.4	1646			13.3	2220	25.7	8.3	173	4835	1158.8	1285			1311.8	10159	
2014	93	27	94	6.1	1837	0.3	78	4	1158	28.3	12.1	474	41.7	1911	1212.3	948	4.6	758	1304.8	6406

N – number of individuals; T – density, N/1000 ha; ha – hectare; m³ – cubic metre

Correlation analysis was performed to identify the strength of relationships between wild boar abundance/density and felling types. In the six-years observation period, a weak positive correlation between wild boar abundance and total felling rate in hectares was observed ($r = 0.28$) (Table). However, the abundance of wild boar was strongly correlated with total felling in m^3 ($r = 0.59$). These results illustrate that the wild boar population increases with increasing cases of felling (in hectares and in m^3). We suppose that low levels of clear felling was carried out in small study areas, meanwhile selective salvage cutting in large plots has led to a positive effect in the growth of the wild boar population.

The Kalviai forest is dominated by selective salvage cutting, which is controlled by a small

volume of wood over a large area (Table). This cutting does not impair the nutritional quality and does not reduce the number of hiding places. We found that there was a weak positive relationship between wild boar abundance and selective salvage cutting (ha) ($r = 0.25$); meanwhile, a stronger positive relationship was obtained by investigating the relationship between the measure of wood cutting in m^3 ($r = 0.58$) (Fig. 2). The correlation coefficient of 0.59 indicates a strong positive correlation between wild boar abundance and total volume of wood cutting (m^3), because in Kalviai forest, the largest amount of timber volume (m^3) is felled by clear salvage felling that consists of a relatively small area but a large amount of wood (Fig. 3). In the interpretation of such

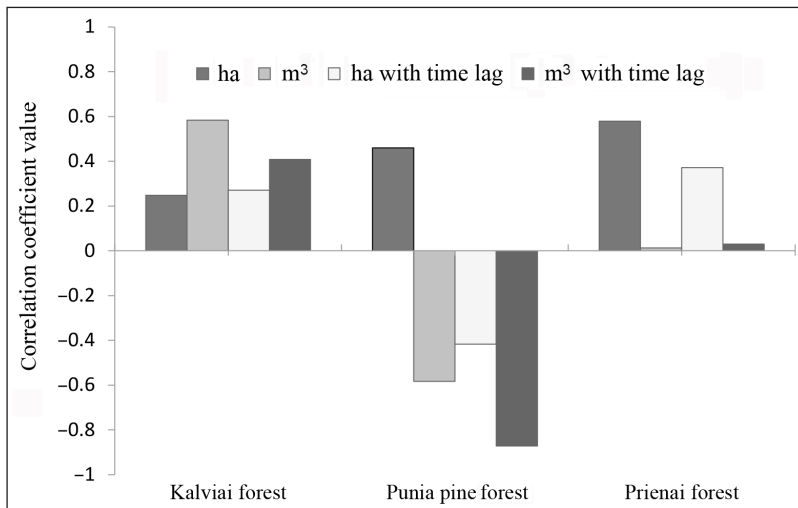


Fig. 2. Estimates of correlation coefficients of the abundance of wild boars and selective salvage cutting

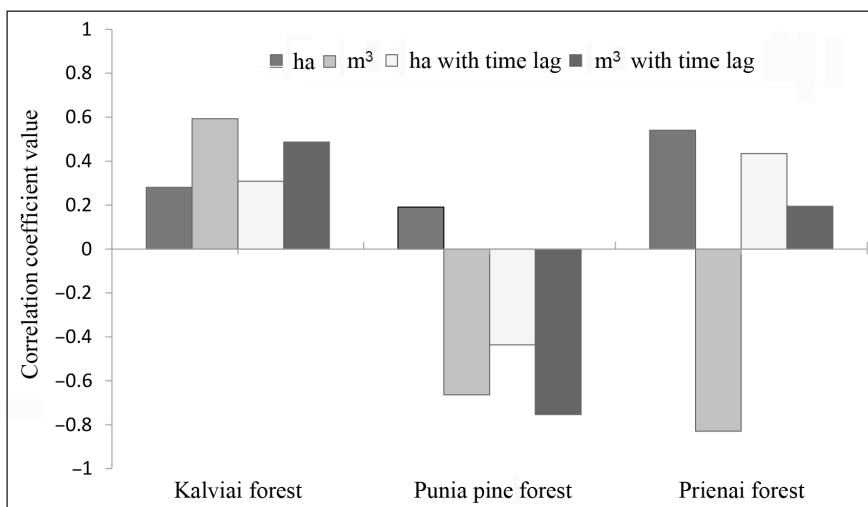


Fig. 3. Estimates of correlation coefficients of the abundance of wild boars and deforestation

correlations, we can conclude that clear cutting affects the soil mechanically during the felling process and after the preparation of logging sites for planting. This improves the nutritional base of wild boars by grubbing and searching for cockchafers in the soil. Clear salvage cutting is carried out in premature and mature stands that are not attractive to wild boars. Forestry measures alter forest succession that can affect the ungulates by changing forage quantity and quality (Schrempp et al., 2019).

A similar situation was found in Punia pine forest, where the positive correlation between wild boar abundance and total felling (ha) was weak ($r = 0.19$); it might be explained by prevalent selective salvage cutting (Fig. 3). Moreover, the results indicated a strong negative correlation ($r = -0.67$) between the abundance of wild boar and the volume of wood cutting (m^3) (Fig. 3). In contrast to Kalviai forest, the observed negative correlation implies that the number of wild boars decreased with increasing felling intensity. The correlation is further strengthened if a one-year change is taken into account ($r = -0.75$) (Fig. 3). These results demonstrated that the changes in the wild boar population were affected not only by the felling of the current year, but also by that of the previous year. Assessment of the correlation coefficient value ($r = 0.46$) between the abundance of wild boar and selective salvage cutting revealed that this felling type had a positive effect on the wild boar population (Fig. 2). A similar pattern is also reported by other authors (Gasperini et al., 2016). They found that that different types of forest management had strong positive effects on the density of rodent population. A sufficiently strong correlation was observed between the quantity of wild boar and total felling in m^3 ($r = -0.67$). Contrary to the results obtained in Kalviai forest, this relationship is negative and could be explained by the impact of increased cutting intensity on the decrease in the number of wild boars. This finding is unsurprising considering that a bigger volume of logging is realized by final cutting of shelterwood and selective felling. In these types of thinning, the intent is

to harvest a large volume of timber (m^3) over a large area, thus reducing the stocking level of a stand. Therefore, conditions of breeding and hiding places are affected by a reduced selection of the habitat. According to Son et al. (2017), tree affects the abundance of animals due to their preferences of the habitat. Wilson and Forsman (2013) previously demonstrated that thinning reduced the abundance of some tree-dwelling rodents.

A similar trend involving a strong positive correlation between wild boar abundance and total felling in hectares ($r = 0.54$) and negative correlation with felling in m^3 ($r = -0.83$) was also reported in Prienai forest (Fig. 3). Clearly, there was a weak correlation in terms of time, indicating that the felling of the current year has a greater impact for wild boar subpopulation from Prienai forest compared to the felling of the previous year. The selective salvage cutting dominates in Prienai forest and the correlation coefficient of 0.57 indicates a strong positive correlation (Fig. 2). These results confirmed that selective salvage cutting improved nutritional conditions for wild boar. The reason for the negative correlation of felling in m^3 was similar to that in Kalviai forest. The maximum volume of timber (m^3) was harvested by final cutting of shelterwood and intermediate cutting of commercial thinning (Table). These types of felling may be associated with a reduction of the stocking level of stands and activities in stands of all ages in a large area. Moreover, in this situation the conditions of breeding and hiding places worsened, because females of wild boars choose shaded forest areas and high stocking level plots suitable for the birth of their young.

CONCLUSIONS

Our results demonstrated that some types of felling had a negative effect on the density of the wild boar population in south Lithuania. Further analysis of data collected over a larger area is needed to check these findings.

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MIŠKININKAVIMO POVEIKIS ŠERNŲ POPULIACIJAI PIETŲ LIETUVOJE

Santrauka

Šio tyrimo tikslas buvo įvertinti skirtingų miško kirtimo rūšių įtaką šernų populiacijos skaitlingumui Pietų Lietuvoje. Tyrimas buvo atliktas Prienų šilo, Punios šilo ir Kalvių miško dalyje. Duomenys apie šernų populiacijos skaitlingumą ir medžioklės dinamiką buvo surinkti iš šešių medžioklės sezonų (2008–2014 m.). Rezultatai rodo, kad kai kurie kirtimų tipai turėjo neigiamą įtaką šernų populiacijos gausumui Pietinėje Lietuvos dalyje. Pastebėjome, kad šernų populiacijos pokyčius paveikė ne tik einamųjų, bet ir praėjusių metų kirtimai. Norint patvirtinti šias išvadas, reikalingi platesni tyrimai.

Raktažodžiai: *Sus scrofa*, miškininkavimas, Pietų Lietuva