BALTIC FORESTRY

http://www.balticforestry.mi.lt
ISSN 1392-1355
eISSN 2029-9230

Baltic Forestry 2020 26(2): 514
Category: research article
https://doi.org/10.46490/BF514

Differences in ungulate population use in different hunting ground units in Lithuania

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Barkauskas, T., Belova, O. and Griciuvienė, L. 2020. Differences in ungulate population use in different hunting ground units in Lithuania. *Baltic Forestry* 26(2): article id 514. https://doi.org/10.46490/BF514.

Received 19 August 2020 **Revised** 30 October 2020 **Accepted** 19 December 2020

Abstract

Abundant ungulate populations are considered ecosystem drivers that affect forestry and agriculture. Their management is ecologically and economically based on game density regulations, considering the balance between density and carrying capacity of the territory, population status and dynamics, as well as hunting needs.

Although the population status and dynamics are not new questions, it is still unclear how to manage populations properly depending on the hunting intensity. We aimed to analyse and compare the ungulate population status like moose, red deer, roe deer and wild boar in the Punia pine forest, where the commercial hunting is conducted, and in the hunting grounds managed by hunter clubs in Prienai forest. We performed the study during four hunting seasons of 2009–2010, 2010–2011, 2011–2012, and 2012–2013. The data on harvesting and abundance were obtained from the field works and using the official statistics of the Ministry of Environment.

The moose local populations are not abundant, or animals occur occasionally, and their density does not reach the minimum permissible rate. At the same time within the study area, moose hunting is remained to be insufficient. The red deer population is rather stable in the hunting grounds used by hunter clubs while hardly reaches the minimum density rate. On the commercial hunting area, the population density 2–3 times exceeds the permissible density rate. The red deer population should be harvested more intensively. The wild boar is used intensively in the grounds of hunter clubs, while animal density is close to the permissible rate. Unfortunately, on the areas of commercial hunting, wild boar is not actively managed that is why their density exceeds permissible rate even four times.

The main harvested species are red deer and wild boar in both hunting grounds. Their abundant populations stay close to permissible density rate. However, gamekeepers keep the larger animal numbers on the areas of commercial hunting. As the main aim is the trophy hunting, the stags and boars are most used when compared to females and young. Therefore, on the areas of commercial hunting, use of wild boar and red deer is unreasonable and their density exceeds permissible rate several times.

Keywords: commercial hunting, hunting clubs, population, status, ungulate

Introduction

Abundant ungulate populations play important roles as drivers of ecosystem functions and, simultaneously, affect agriculture and forestry (Reimoser and Gossow 1996, Reimoser 2003, Belova 2006, Ramirez et al. 2018). The management of game populations ecologically and economically related to regulations of the game density, considering the balance between the density and carrying capacity of the territory, status and the population dynamics as well as hunting needs (Padaiga 1996, Belova 2006, Morellet et al. 2007, Belova and Šežikas 2017, Apollonio et al. 2017). Game management is increasingly influenced by land holders (farmers, forest owners, etc.) tolerating the damages caused by game.

Population dynamics in ungulates is affected by human activities and environmental factors that require more intensive monitoring (Coulson et al. 2001, Milner et al. 2007). The rapid habitat changes are associated with processes like vegetation succession, human activities and environmental variations and, therefore, influencing species richness, population abundance and distribution (Gurd et al. 2001, MacKenzie et al. 2011). Species number and spatial distribution are important parameters to assess the state of ungulate populations (Myslenkov and Miquelle 2015). Herbivores are an important part of the most ecosystems, influencing a diverse forest structure, composition, productivity, nutrient cycling, and soil structure (McNaughton 1979, Crawley 1983, Müller et al. 2017). Lithuania is inhabited by four ungulate species like moose (*Alces alces*), red deer (*Cervus elaphus*), European roe deer (*Capreolus capreolus*) and wild boar (*Sus scrofa*). The largest ungulate as the European bison is classified as endangered in the Lithuanian and IUCN Red Lists of Threatened Species (Andersone-Lilley et al. 2010, Krasińska and Krasiński 2013). Fallow deer (*Dama dama*) is alien species; 90 deer were brought to Lithuania from Europe in ca. 1980. They were later released to inhabit the forests. Recently, fallow deer are bred and kept mainly for owner's purposes including hunting. Species ditribution depends on the location of enclosures and release.

The habitats of Lithuanian game animals are categorized by forest types as follows: pure pine, mixed coniferous, mixed, spruce-deciduous and deciduous ones with spruce (Padaiga 1996, Belova 2012, 2013, 2017). The forest coverage also affects the abundance and the density of populations (García-Marmolejo et al. 2015). The density of the roe deer population is the highest in less and moderately forested regions, red deer and wild boar prefer moderately forested areas. Moose prefer areas of higher forest cover (Padaiga 1996). Datasets from hunting statistics are commonly used to obtain information of population parameters (Mysterud and Østbye 2006, Imperio et al. 2010, Bosch et al. 2012).

There are many data on the ecology of ungulate populations and their management in Lithuania like moose (*Alces alces*) (Padaiga 1996, Baleišis and Bluzma 2000, Kučinskas and Pėtelis 2000, Baleišis 2002, 2003, Belova 2012, 2013, 2017), European roe deer (*Capreolus capreolus*) (Padaiga 1996, Pėtelis 2002, 2003, Baleišis 2003, Pėtelis and Brazaitis 2005), red deer (*Cervus elaphus*) (Padaiga 1996, Pėtelis 2002, 2003, 2004, 2005, Baleišis et al. 2003, Pėtelis and Brazaitis 2003, Belova 2012, 2013), and wild boar (*Sus scrofa*) (Padaiga 1996, Baleišis 2003). The majority of prior research has focused on the population dynamics and status of the native ungulate species. However, it is still unclear how to manage populations properly depending on the hunting index.

The purpose of this study was to analyze and compare the population status of native populations of ungulates like moose, red deer, roe deer and wild boar inhabiting the Punia pine forest, where the commercial hunting is conducted, and in the southern part of Prienai forests, where the main holders of hunting ground units (HGU) are hunter clubs.

Materials and methods

The population numbers of ungulate game and the hunting dynamics were analyzed in the southern part of Prienai forests and in the Punia pine forest (Figure 1).

Hunting areas in the southern part of Prienai forest cover an area of 4,660 ha, 139 ha of which is prohibited to hunt. Forests is dominated by pure pine stands with an admixture of more than 10% of other tree species covering 2,376.3 ha, mixed coniferous stands with deciduous trees (25 to 50% deciduous trees) amounting 335.0 ha, and deciduous and mixed deciduous stands with coniferous trees (up to 50% coniferous) constituting 179.8 ha.

In the Punia pine forest, hunting grounds cover about 2,969.3 ha, 524.5 ha of which is an area where hunting is prohibited. This forest is dominated by mixed coniferous and deciduous stands (25–50% of deciduous species) constituting 683.5 ha, pure pine stands with more than 10% of other species, 613.3 ha, deciduous and mixed deciduous stands with coniferous species (up to 50%) amounting 419.6 ha, and mixed coniferous stands with deciduous species (11–24% of deciduous) cover 405.4 ha.

The study was performed during four hunting seasons in 2009–2010, 2010–2011, 2011–2012, and 2012–2013. The data on harvesting and abundance were obtained from the official statistics of the Ministry of Environment and from the field works in the different HGUs. The Ministry of Environment of the Republic of Lithuania collected the game survey data from the holders of HGUs. The data on the regional and district levels are available online and in the Lithuanian Statistical Yearbook of Forestry.

Monitoring of the ungulate populations using hunting bags

The data of previous investigations performed at the Vytautas Magnus University Agriculture Academy (former Lithuanian University of Agriculture) (Kučinskas and

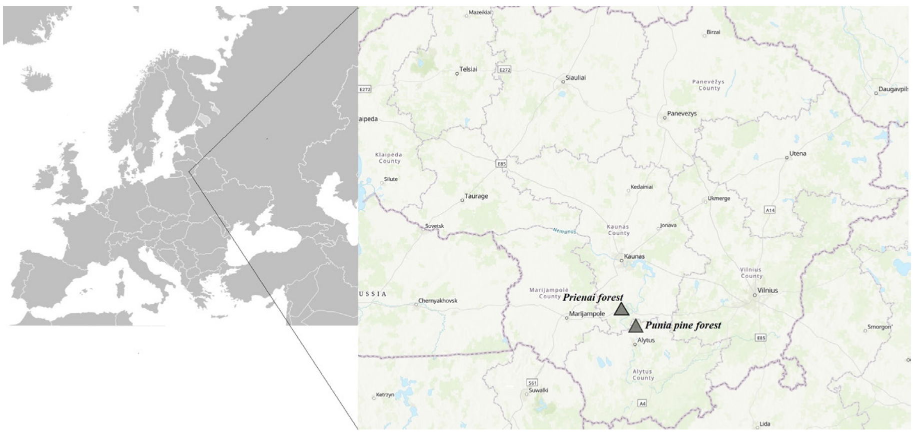

Figure 1. Location of the study area showing Prienai forests and the Punia pine forest (marked by triangles)

Pėtelis 2000, Šmitas and Pėtelis 2002) were used for this study. Calculations of the density of game animals in the study areas were performed by the following formula (Padaiga 1996, Navasaitis and Pėtelis 1998):

$\boldsymbol{T} = G / P$,

where G is the animal number within the territory, individuals, P is the territory unit, 1,000 ha.

The hunting index of game (S_t) was calculated using the formula:

$S_t = S / P$,

where S is the number of harvested animals on the territory, individuals, P is the territory unit, 1,000 ha.

The main terms used in this manuscript are as follows: *hunting index* for each site, defined as the number of ungulates hunted in a particular area, i.e., hunted ungulates/ha; in Lithuania, the hunting bags are limited by hunting legislation. *Minimum density rate* is the density when animals are randomly distributed in space, foods are consumed in negligible quantities, and the negative impact on the environment is invisible; extensity and intensity of animal infection by parasitic diseases is insignificant while species population is growing; animal emigrations is low, and immigration is usual event. *Minimum permissible rate* is the minimum level of available carrying capacity or minimum game abundance in the different habitats. *Permissible or target density* is density when animals distributed unevenly, food consumption does not exceed food supply yet, and negative economic impact on the environment is insignificant; consumed foods are renewing annually, intensity and extensity of infections is still low, and the abundance is increasing intensively; the emigration is low while immigration is usual event. The ungulate density rates including minimum, permissible or target ones, ecological and the threshold of ecological density rates are scientifically based on the long-term research performed at the Lithuanian Forest Research Institute (recently, the Institute of Forestry LAMMC) and adopted by the Ministry of Environment even in 1995 (Ministry of Environment 1995).

We analyzed the hunting data and censuses of moose, red deer, roe deer and wild boar population. All analyses were performed using MS Excel and Statistica 8.0 software packages (StatSoft 2008). The relationships between individual abundance and the number of hunted animals were determined using the methods of linear regression analysis.

Results

The abundance, density and hunting of the local populations of ungulates in Prienai forest are shown in the Figures 2–4. Red deer population abundance and, correspondingly, its density decreased from the 2009–2010 season. For this reason, red deer were not hunted from the next season and later. Moose occurred only from the last season (2012–2013) and the density did not exceed the permissible level. Their population was not harvested. The most abundant and increased populations of roe deer and wild boar were used intensively (Figure 2).

In the Punia pine forest, the local populations of ungulates are more abundant and more fluctuated in comparison with hunting grounds of Prienai forest (cf. Figure 2 and Figure 3). The density of red deer exceeds maximum permissible level (15 deer/1,000 ha) almost 3 times, roe deer density is corresponded to the permissible level. The local population of wild boar is the most abundant and exceeds permissible level almost 4 times. Moreover, presence of the fallow deer introduced from enclosures enriches the local populations of ungulates allowing increase in the hunt-

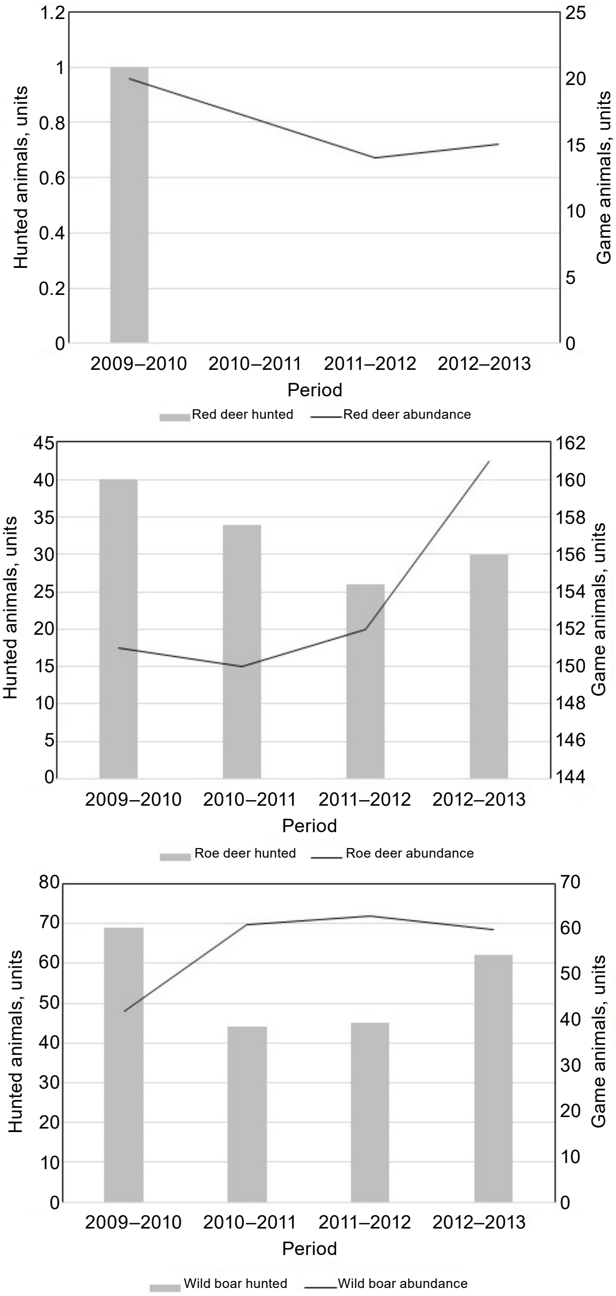

Figure 2. The abundance, G, and number of harvested animals, S, in the southern part of Prienai forests from 2009 to 2013

ing bag. However, objectives of commercial hunting have contributed to the decline in the ungulate populations and, consequently, fallow deer decreased too.

Consequently, hunting index on the area of amateur hunting decreased and less increased for roe deer in comparison with wild boar in the last season in Prienai forest (Figure 4). The roe deer population stayed quite stable in Prienai forests, whereas the density of roe deer declined in the Punia pine forest (Figure 5). The wild boar population was rather abundant and hunting index is also high in both study areas (cf. Figure 4 and Figure 5).

A regression analysis between abundance and the number of harvested animals for Prienai forest and the

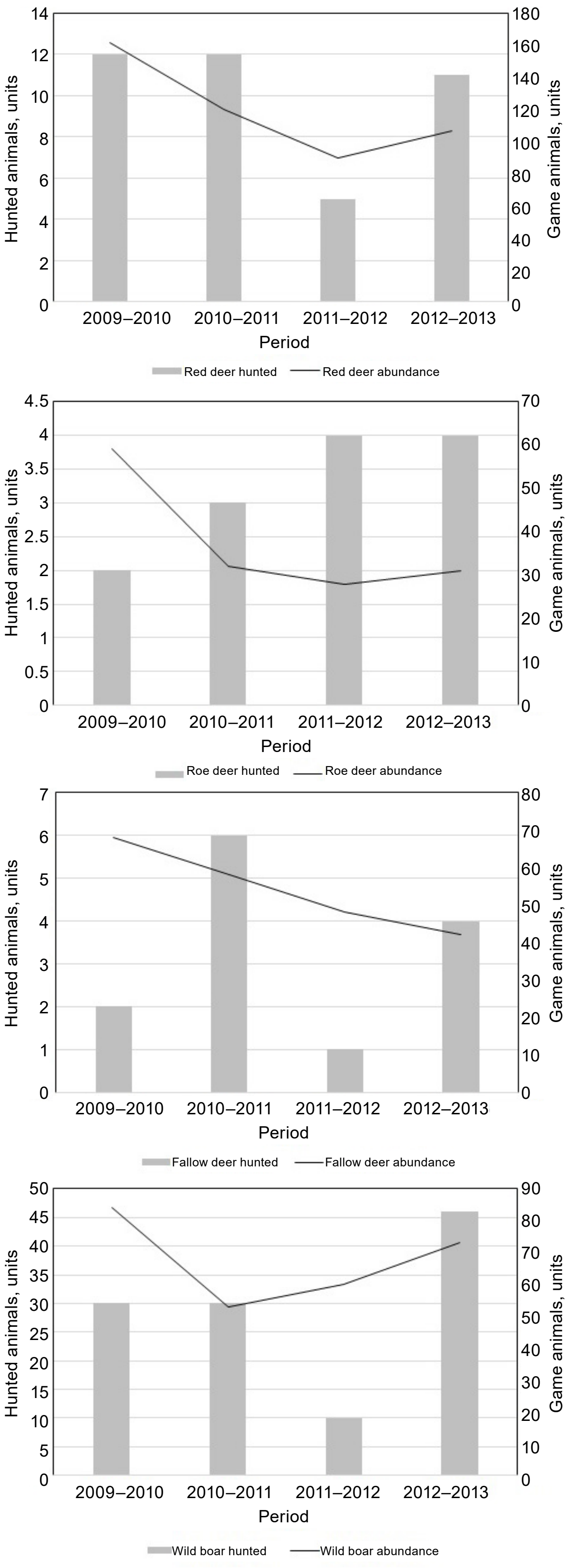

Figure 3. The abundance, *G*, and number of harvested animals, *S*, in the Punia pine forest from 2009 to 2013

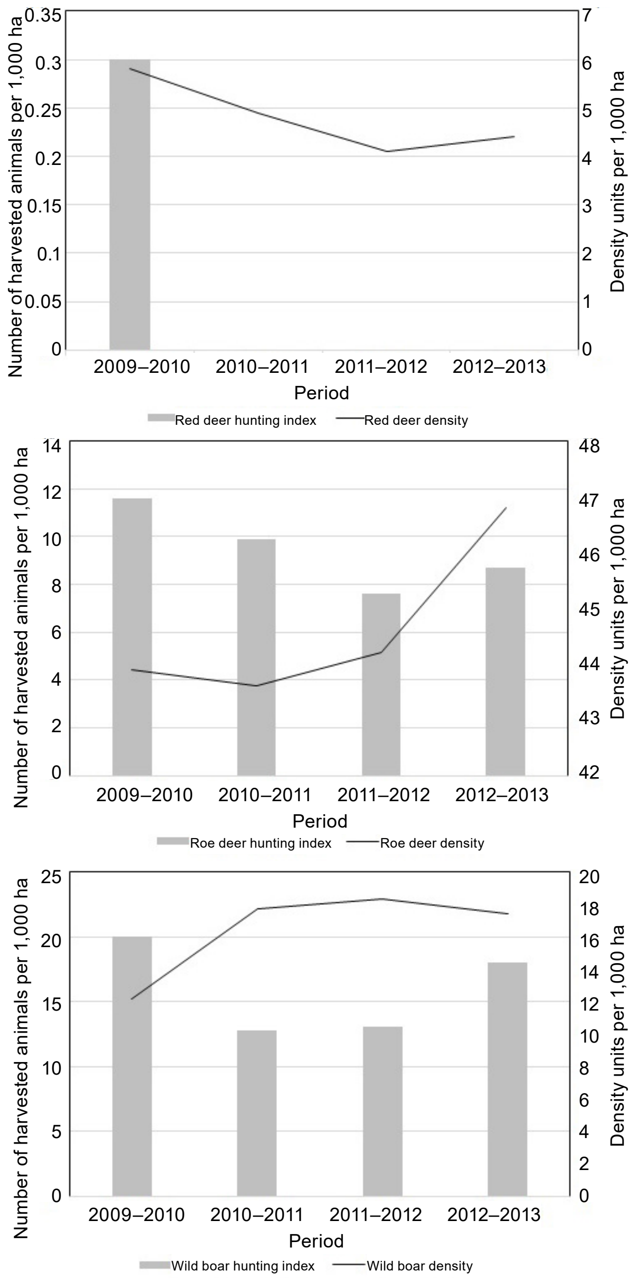

Figure 4. The hunting index, S_t, and density, *T*, of game animals in the southern part of Prienai Forests from 2009 to 2013

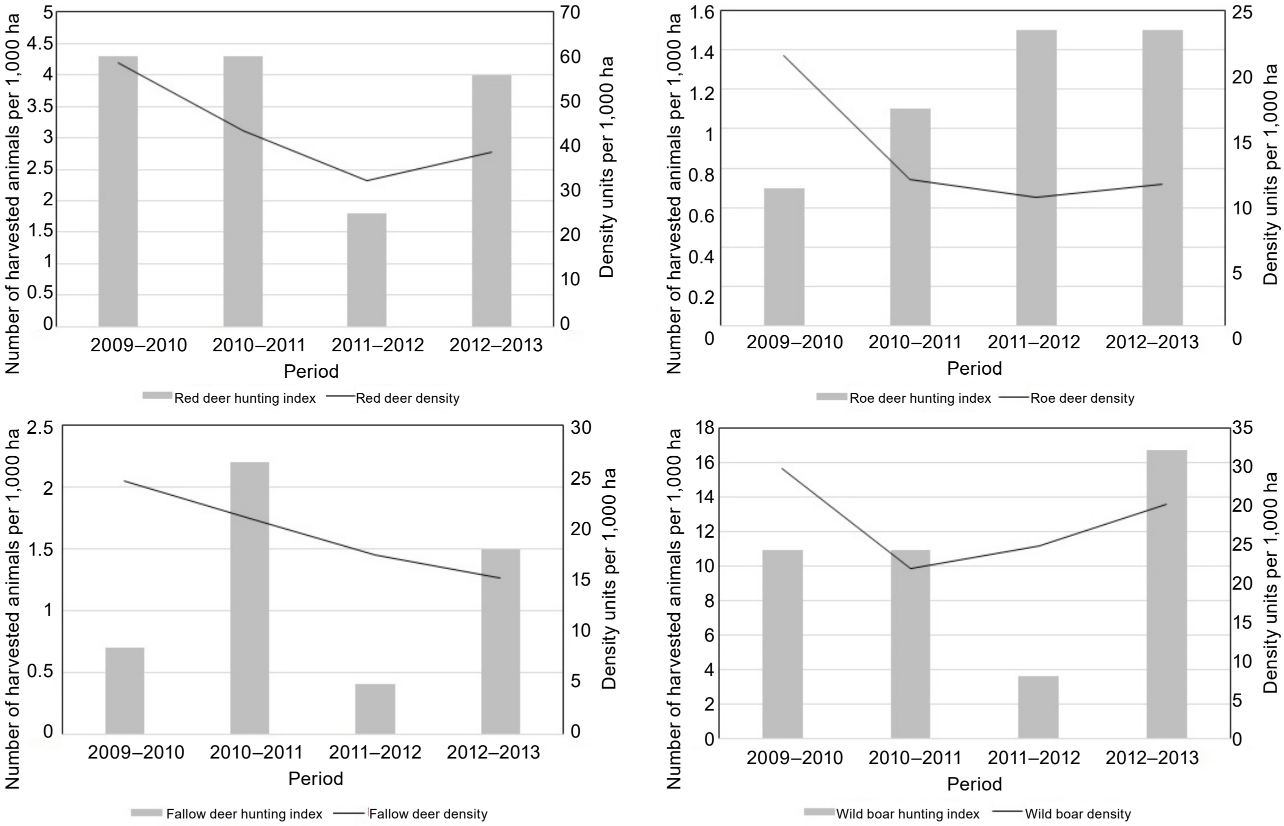

Figure 5. The hunting index, S_t, and density, *T*, of game animals in the Punia pine forest from 2009 to 2013

Table 1. Correlation coefficients of abundance and the number of harvested animals at two hunting areas

Ungulate species	Prienai forest				Punia pine forest			
	N	S	*r*	*P*	N	S	*r*	*P*
Capreolus capreolus	614	130	–0.3635	0.636	150	13	–0.9045	0.095
Cervus elaphus	66	1	0.8800	0.118	479	40	0.7121	0.288
Sus scrofa	226	220	–0.8039	0.196	270	116	0.3907	0.609
Dama dama	-	-	-	-	216	13	–0.0263	0.974

Note: N – number of individuals; S – number of harvested animals; *r* – correlation coefficient; *P* – significance of correlation, $p < 0.05$.

Punia pine forest has shown that the total numbers of hunted and counted animals statistically correlate only for roe deer and wild boar in Prienai forests, and red deer and wild boar in the Punia pine forest.

We excluded other ungulate species (red deer and moose in Prienai forest, roe deer, moose and fallow deer in the Punia pine forest) as their abundance and numbers of harvested animals were too low in the study area and were excluded from the regression analysis model. The results of the present study revealed that there was a strong and negative correlation ($r = –0.8507$) between the abundance and the number of hunted animals in Prienai forests. These estimates shown that abundance of roe deer and wild boar were dependent on the hunting index in Prienai forests. On the contrary, correlation coefficient was observed weak and negative ($r = –0.4321$) in the Punia pine forest. This result can be explained by the weak strength of that relationship between two variables.

Discussion and conclusions

We found that the local populations of moose are not abundant, or animals occur occasionally. Their density does not reach the minimum permissible level. Some increase in the number observed only in the last years. Therefore, the control of moose local populations is non- purposeful and insufficient both in the commercial hunting areas and in the areas of hunter clubs. Apollonio et al. (2017) indicated that wildlife management should recognise the impacts of hunting beyond simply reducing population densities. The local population of red deer on the areas of hunter clubs is rather stable, but it hardly reaches the minimum density level. In the commercial hunting areas, the abundance of red deer 2–3 times exceeds the permissible density of this species. This population should be used more intensively. The populations of roe deer on hunting areas of both categories significantly differ in their abundance and use while population parameters are comparatively stable. As it was indicated earlier (Fraser 2000), recreational hunting (in our case, hunting by hunter clubs), is less effective in comparison with commercial hunting but more stable because the economic consideration (like price for venison) is not so important. Conversely, commercial hunting pressure is largely determined by economic considerations and the density of animals on the areas available for hunting. As we have recognized, the local population of wild boar is used more intensively on the areas rented by hunter clubs, and their density is nearly to the permissible level. However, in the areas of commercial hunting, the population of wild boar is used passively, that is why the animal density exceeds permissible levels even four times. We note that the hunting of wild boar is the effective regulatory means to prevent the spread of African Swine Fever (ASF). Belova et al. (2019) emphasized that the harvesting of 70–100% of the total wild boar population per year will not reduce population as further reproduction recover losses. The mean annual increment of wild boar population may be partially the result of warming temperatures and global climate change (Bieber and Ruf 2005, Vetter et al. 2020). The intensive hunting up to 150% of the pre-reproductive population abundance, will allow keeping the population stable (Belova et al. 2019).

In the areas of hunter clubs, the main harvested species are red deer and wild boar. As their populations are abundant, they are used intensively. That is why the populations stay comparatively stable and keep their permissible level of density.

In the areas of the commercial hunting, the main harvested species are red deer and wild boar, and gamekeepers try to keep the larger number of these species. As the main aim is trophy hunting, the stags and boars are most under spotlight while females and young animals less used. Therefore, in the areas of commercial hunting, wild boar and red deer populations are used unreasonably and their density exceeds permissible level several times. We emphasize that hunting is an important tool to control game populations and, moreover, manage populations of problematic species (Quirós-Fernández et al. 2017). Hunted deer populations are more abundant in comparison with non-hunted ones. By way of example, the non-hunted white-tailed deer population consisted of 57% of pregnant females and produced 0.7 fawns per one pregnant doe. After two years of harvesting the population, 100% females produced 1.8 fawns per one pregnant doe. Birth rates in the hunted population doubled; therefore (Pianka 1978, Ricklefs et al. 1999). After Bolen and Robinson (2003), the growth and recruitment of non-hunted population depends on natural mortality and the average growth rate of a population at its carrying capacity is zero. Despite hunting reduces the population size, but the reduction results in an increase in the growth rate of the population.

Our findings highlight the limitations in hunting bag statistics of ungulate species. Therefore, future research should focus on wild ungulate population control through hunting regulation. Hunting plays an important role by providing information and in the surveillance of wildlife diseases. Further studies are required to reveal interdependence among population structure, abundance, distribution, hunting methods and sustainable use of ungulate resources.

Acknowledgements

Authors express their sincere gratitude to Vytautas Magnus University Agriculture Academy (former Lithuanian University of Agriculture) for the technical and financial support for this study.

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