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MANAGEMENT IN HARE POPULATION (*Lepus europaeus Pall.*) IN SERBIA

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Summary: Paper presents the production results on management in brown hare population, as one of the economically most important small game species in hunting grounds of the Hunting Association of Serbia. The analysis includes the trend of brown hare abundance in registered breeding stock,, density, and utilization rate of population per separate regions of Serbia.

The most abundant brown hare populations are in farming areas. In Serbia the most suitable habitats for brown hare are plain lowland regions, primarily in Vojvodina. However, density of brown hare population in Vojvodina in observed period varied from 12.62 to 15.16, while in central Sebia it varied from 6.6 to 6.97 individuals at 100 ha and is considerably below habitat`s carrying capacity. In observed period a mismatch between brown hare population abundance and hunting bags is present. Rational use of brown hare populations and micropopulations is one of the most important modes of hare protection in aggravated ecological conditions, which have to be kept under control by hunting grounds users.

Key words: Brown hare, abundance, density, hunting bags, management

Introduction

New Law on game and hunting in Serbia was passed in 2010 [26], anticipating a new management of hunting grounds and their assignment to stakeholders. In 2012 the management of hunting grounds and their assignment was carried out in most parts of Vojvodina, while in central Serbia these activities have not begun yet. Until a new assignment has been performed, the management of game populations in Serbia, according to the Law on Hunting from 1993 [27], is being realized through former users of hunting grounds, what is shown in Table 1. It can be seen, in this table, that the greatest number of hunting grounds and the biggest area (almost 90%) is managed by the Hunting Association of Serbia, through its hunting fellowships.

Table 1. Number and area of hunting grounds by users

User	Number of hunting grounds	Area (ha)	%
Hunting Association of Serbia	227	7.891.318,13	89,39
State Enterprise "Srbijašume"	67	731.910,00	8,29
Fishponds	16	19.769,00	0,22
National Parks	5	159.356,56	1,81
Yugoslav Army	3	10.806,60	0,12
Others	3	15.278,00	0,17
TOTAL	**321**	**8.828.438,29**	**100,00**

Source: *Serbian Hunting Development Programme from 2001 to 2010* [10]

The most important game species managed in the hunting grounds of the Hunting Association of Serbia are: brown hare, pheasant, gray partridge, roe deer and wild boar. It is beyond doubt that their spatial distribution and presence in certain hunting grounds is influenced primarily by natural conditions, but the effect of anthropogenic influence is considerably expressed, especially for some species.

In Serbia the brown hare (*Lepus europaeus Pall*.) now occupies very different habitats, and is, therefore, a representative of numerous and heterogeneous biocenoses. However, brown hares are most abundant in the regions of former steppes and in plain lowlands. Over a long period in the past the abundance of hares varied due to forest coverage

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, i.e. larger open surfaces [9]. Brown hare was once the most represented small game species in Serbia, but in the last decades its abundance has considerably decreased. This decreasing trend shows that it is necessary to make an analysis on the state of hare population in Serbia, and to think about the directions of management aimed to preserve this population.
The objective of this paper is to make an analysis on the results of management in the hare population in hunting grounds of the Hunting Association of Serbia until the moment of passing the Law on game and hunting in 2010. Based on the performer analysis the directions and measures for management improvement will be suggested in order to preserve the population of this autochthonous game .

Material and method

For this analysis we used the records of the Hunting Association of Serbia, referring to the region of Vojvodina and central Serbia, with no records available for the region of Kosovo and Metohija. The analysis included the trend in abundance of brown hare breeding stock, density per 100 ha of total hunting area, and a population utilization rate, per separate regions of Serbia. The records refer to the period from 2004-2009, while the year 2000 served as a basis for comparison and calculation of the index of abundance and hunting bags when the hunting development programme was passed [10], wherefrom the records on overall hunting area in Serbia were used. The abundance of the hare population in 2009 and its hunting bags in 2008 were compared with the shooting plan in the hunting development programmed [10], with the aim of monitoring the accuracy of a long-term planning in the dynamics of hare population.

Results and discussion

The brown hare abundance in Serbia in 2009 dropped by 0.43% in relation to 2000, while in central Serbia this drop is 8,33%, and in Vojvodina there is an increase in abundance by 10.09%. If we look at the tendencies in brown hare abundance trend in Serbia (Table 2) we can see the differences between separate regions in Serbia. The abundance in brown hare in central Serbia and the Republic of Serbia has been increasing until 2005, when the number reached 343.833, i.e. 629.639 individuals. That year was followed by drop in brown hare number until 2008, when the number in the Republic of Serbia was 565.591 individuals, i.e. in central Serbia 304.051 individuals. In Vojvodina this rising trend was present until 2006, when there were 300.971 individuals, followed by drop, except for 2009, similarly to Serbia. On the basis of the Hunting Development Programme of Serbia *2000 - 2010* [10], in 2009 it was envisaged to reach the number of 324.518 heads in Vojvodina, 374.177 heads in central Serbia and 698.695 heads in the Republic of Serbia, with the realization of this plan being 85.02%, 82.98% and 83.93%, respectively (Table 3).
Brown hare abundance in Vojvodina in observed period varied from 12.62 to 15.16 , while in central Serbia the variation was from 6.16 to 6.97 heads at 100 ha. Average brown hare density in Serbia varied from 8.17 to 9.10 heads per 100 ha. Brown hare density per 100 ha was observed on the basis of overall surface of all hunting grounds in Serbia, although productive hunting surfaces for hare depending on hunting ground vary and they are about 85% of total surface of hunting grounds. In the part of Bačka near the Tisa river the brown hare density varied from 20.09 to 25.6 heads at 100ha depending on the year. In some hunting grounds density of nearly 30 individuals was reached, in B.P. Selo even 41.6 individuals at 100 ha [3, 4, 6]. Population density in north-west Croatia in 2004/2005 hunting season varied between 13 and 20.3 heads at 100 h hunting ground [16]. The most abundant hare population is in farming regions. In Serbia the best hare habitats are flat lowland regions primarily in Vojvodina. By intensifying agriculture a typical habitats for brown hare have been changed mostly by a simultaneous drastic increase in surfaces under arable crops, on which the use of pesticides is intensive, and a decrease of surfaces under forage crops [1].
Density is the most important element of one population and indicator of overall state in a population. Number of individuals of one species on certain unit of space (habitat) in certain time is the result of different interior and exterior relationships of species and action of many abiotic and biotic factors [8], where climatic factors during the period of brown hare reproduction (April-June) have a great influence [5, 18]. For proper shooting plan it is of great importance to determine density (number) of hare population and its share in certain periods of the year. We distinguish two types of density: spring – at the end of winter before the onset of reproduction and autumn – after the reproduction before the start of hunting season. Both densities are important for monitoring of the dynamics of population [30]. Spring density shows how a game survived a winter and what are likely possibilities for reproduction, whilst the autumn density shows the success in reproduction and the amount of individuals that could be used in a population.
Number of shooted bron hares was greatest in 2005 being 108.952 individuals. The utilization rate of brown hare population in Serbia in observed period increased from 14.26% to 18.02% (Table 2). The utilization rate of hare population in central Serbia and Vojvodina almost equaled in 2005-2007, in difference to 2000, 2004 and 2008. Observed period shows a considerably lower utilization rate of brown hare population in Serbia in relation to period 1991-1993, when it varied from 21.23% to 25.61% with mismatch between the increase-decrease

relationship of total number and number of hunting bags in relation to a previous year on one hand, and a percent of hunting bags in overall number of a current year on the other hand [17]. In Hungary, in period 1969-1994 an average use of brown hare population was 27.4% (20.5%-38.4%), what is much more compared to our country, especially for the region of Vojvodina [15]. In Serbia during the period 1980-2000 a linear trend in decrease in the number of shooted brown hares by 1.7% annualy was present, where there were from 8-29.4% shooted individuals (average 24.5%) of breeding stock [25]. The use of hare population in 2008 in Serbia for hunting purposes was 97.80% of total population use. Foreign hunters participated in this with only 3.95%, while domestic hunters with 93.85%. By way of catching and selling 2.20% was realized.

Table 2. Brown hare abundance, hunting bags, percent of hunting bags in relation to breeding stock and abundance index and brown hares' hunting bags (2000=100)

Year	Area	Total number	Number of hares per 100 ha	Hunting bags	Hunting bags per 100 ha	% Hunting bags	Index	
							Total number	Huning bags
2000	Vojvodina	250.614	12,62	27.698	1,39	11,05	100,00	100,00
	Central Serbia	338.306	6,85	56.296	1,14	16,64	100,00	100,00
	Republic of Serbia	**588.920**	**8,51**	**83.994**	**1,21**	**14,26**	**100,00**	**100,00**
2004	Vojvodina	288.419	14,52	41.003	2,06	14,22	115,08	148,04
	Central Serbia	319.949	6,48	65.089	1,32	20,34	94,57	115,62
	Republic of Serbia	**608.368**	**8,79**	**106.092**	**1,53**	**17,44**	**103,30**	**126,31**
2005	Vojvodina	285.806	14,39	49.198	2,48	17,21	114,04	177,62
	Central Serbia	343.833	6,97	59.754	1,21	17,38	101,63	106,14
	Republic of Serbia	**629.639**	**9,10**	**108.952**	**1,57**	**17,30**	**106,91**	**129,71**
2006	Vojvodina	300.971	15,16	50.030	2,52	16,62	120,09	180,63
	Central Serbia	320.666	6,50	53.028	1,07	16,54	94,79	94,19
	Republic of Serbia	**621.637**	**8,98**	**103.058**	**1,49**	**16,58**	**105,56**	**122,70**
2007	Vojvodina	289.297	14,57	47.012	2,37	16,25	115,44	169,73
	Central Serbia	313.593	6,35	51.305	1,04	16,36	92,70	91,13
	Republic of Serbia	**602.890**	**8,71**	**98.317**	**1,42**	**16,31**	**102,37**	**117,05**
2008	Vojvodina	261.540	13,17	51.926	2,61	19,85	104,36	187,47
	Central Serbia	304.051	6,16	49.996	1,01	16,44	89,87	88,81
	Republic of Serbia	**565.591**	**8,17**	**101.922**	**1,47**	**18,02**	**96,04**	**121,34**
2009	Vojvodina	275.909	13,89				110,09	
	Central Serbia	310.475	6,29				91,77	
	Republic of Serbia	**586384**	**8,47**				**99,57**	

Table 3. Planned and realized percent in total number of hare and its hunting

Area	Total number planned 2009	% in planned	Hunting bags planned 2008.	% in planned
Vojvodina	324518	85,02	38825	133,74
Central Serbia	374177	82,98	62749	79,68
Republic of Serbia	**698695**	**83,93**	**101575**	**100,34**

By observing the abundance index and brown hares' hunting bags (Table 2) it can be seen that the hunting bags indices were considerably higher than abundance indices. This suggests the mismatch between the abundance and hunting bags, that is, that the increase and/or decrease in population abundance is not followed by matching in hunting bags. The shooting plan for Serbia is, according to the Hunting Development Programme of Serbia *2000 - 2010* [10], completely fulfilled, but if separate regions are observed (Table 3) in Vojvodina the plan is 133.74% fulfilled while in central Serbia the plan fulfillment is only 79.68%. This clearly shows that we should work much more on planning the dynamics in hare population in future strategy of hunting development in Serbia which should be outlined and adopted this year.

By the Law on game and hunting of 2010 [26] the stakeholders will have to increase the profit of management in this game population in hunting grounds in order to survive financially. In order to improve a material base of

hunting associations the hunting and trade of hares should be undertaken, along with the expansion of hunting tourism. Hunting tourism, as a very specific branch of tourism, represents a very important source of profit in hunting [2]. However, the problems faced by foreign tourists are related to the fact that it is impossibile for them to take the meat out of our country what competent government organs have to solve in order for hunting tourism to gain importance again. Important improvement of economic results of management in brown hare population can be performed also by improving the way of management, i.e., by shifting the reference parameters (gains, losses) within acceptable biological limits [20]. Surviving of a young per female varies from 1.33 to 3.40. The mean value of reproduction coefficient was 1.07 [16], while in Vojvodina in period 1973-1993 the real gain coefficient varied from 1.32 to 2.33 [29].

An accurate determination of annual use of brown hares is significant for successful management and preserving of brown hare population. Utilization rate is planned on the basis of real live weight gain for each hunting ground calculated on the basis of spring abundance and age composition of population [31]. The increase or decrease of the abundance in brown hare population is not followed by the oscillation of hunting in given direction [17]. The utilization rate of population is directly influenced by the stakeholders and if hunting grounds are not used properly they can drastically disturb population abundance.

In hunting grounds or parts of hunting grounds with average spring density below 5 individuals at 100 ha, the use of populations and micropopulations should not be conducted regardless of the gain height. In populations whose density is acceptable the intensity of hunting can run up to 25% of spring abundance depending on the real gain, i.e., participation of the young in autumn. In the years when the participation of youngsters is less than 44% the hunting should be stopped.

In determining the utilization rate the attention should be directed to the losses from the beginning of hunting season until the start of the next reproduction period. The losses are not the same every year and they change under the influence of factors from season to season. Average winter losses, i.e., losses from the onset of hunting season until the start of next reproduction period, on territory of Vojvodina are 28.7% as regards autumn abundance [28]. This value is variable and under constant influence of a great number of factors. The losses in brown hare are provoked by different ecological factors, abiotic and biotic ones. The effect of anthropogenic factor is much different depending on habitat conditions and human activities in the same habitat, but also on habits and level of general and hunting culture of people. The losses in game made by illegal hunting and poaching are one of the more serious problems in management of certain brown hare population. These losses should be decreased, so that the use of population should be greater [19], [24].

Greater real annual increase in brown hare can be realized if there is no disturbance in hunting ground during the mating period, decrease of predators' abundance and prevention of dogs' presence and training in hunting grounds [20]. In order to preserve brown hare population in a hunting ground its utilization has to be based on metodologically properly established brown hare spring abundance and annual gain estimated in that year. Therefore stakeholders, at the start of a hunting season, have to estimate an annual gain before setting hunting quotas.

According to above mentioned it is not recommended to use constant utilization percentage in different regions or hunting grounds. It will vary within each year and will depend on brown hare breeding stock, gain, losses during reproduction, and planned winter losses which are different in certain regions.

In order to reduce negative influence of climate factors in winter period it is necessary to provide additional feeding. The best way to provide food for game during winter period is the sowing of fields for game (corn, broomcorn, artichoke...), depending on species abundance in a hunting ground. Besides, in hunting grounds a cultivated plant cultures can be grown for the purpose of production of more quality food for game [7, 9, 11,12, 13, 14, 21, 23]. In this way the improvement in the quality of trophy in certain kinds of game is achieved, and damage on agricultural crops and forest stands made by some game reduced [13, 22].

Brown hare low abundance populations can be influenced by its reintroduction from hunting grounds or its parts with higher density. If we want to conduct this process successfully an abundance of predators should be controlled and brown hare hunting should be prohibited in the next two or three years.

The education of professional hunting stuff, through courses and seminars on wildlife management, protection and rational use of this species, wherein a special attention should be given to proper estimation of spring abundance, real gain and use of brown hare population in hunting grounds is necessary. It is also necessary to work on education of hunters, primarily young ones and training employees, in which, through hunting examination, the candidates have to adopt primary information on management in hare population. Besides hunting newspapers, there should be much more news articles and TV programmes on the aforementioned for the educational purposes [19, 21].

In the strategy of hunting development of Serbia, which ensues from the Law on game species and hunting the measures aimed to preserve hare population have to be predicted separately in order to avoid what happened to gray partridge which completely disappeared from some habitats of Serbia.

Conclusion

On the basis of analysis of management in brown hare population in the period from 2000-2009 the following conclusions can be made:

Brown hare density in Vojvodina in observed period varied from 12.62 to 15.16 , while in central Serbia a variation was from 6.16 to 6.97 heads at 100 ha. Average brown hare density in Serbia varied from 8.17 to 9.10 individuals per 100 ha.

Number of brown hares in Serbia in 2009 decreased by 0.43% in relation to 2000 what is much below habitat natural capacities. In this period in central Serbia the number dropped by 8.,33%, while in Vojvodina there is an increase in number by 10.09%.

Increase or decrease in the number of brown hare population is not followed by the oscillations of the same volume and direction as regards hunting bags.

Planning of the brown hare population dynamics should be adapted to hunting grounds.

For the purpose of improvement of management in brown hare population in hunting grounds the following should be carried out:

Accurate determination of brown hare spring abundance in hunting ground.

The use of population should match with spring breeding stock and real gain realized in given year.

In the first hunting week the eye lenses should be collected and a real brown hare gain for given hunting ground established.

With the aim of proper planning of winter losses in brown hare the research on different types of hunting grounds should be conducted, in order to obtain the exact parameters for calculation.

During the reintroduction of brown hares in certain part of hunting ground the terrain should be prepared and hunting banned in the next 2 to 3 years.

To ban the hunting in hunting ground or parts of hunting grounds with the density of hare below 5 individuals per 100 hectares.

Manage the habitats and food production within the habitats for this game.

To educate a hunting professionals on management of brown hare population in hunting grounds, as well as hunters and people for the purpose of decreasing the losses in this species.

In the strategy of hunting development of Serbia, the measures for preservation of brown hare population should be predicted separately.

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