

## **MANAGEMENT MEASURES IN BROWN HARE POPULATION IN VARIOUS HABITATS IN SERBIA**

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### **Abstract**

Brown hare in Serbia lives in various habitats although the best brown hare habitats are lowland areas and river valleys. Brown hare has successfully adapted to agroecosystems in agricultural areas. In the last two decades in Serbia a number of studies was conducted associated with the analysis of the management measures in brown hare population, which recorded some cyclic oscillations in population abundance, density, age structure and exploitation rate. These measures are key elements in management of wildlife population so their implementation should be enforced. Problems related to brown hare population management in Serbia arise because there are neither proper guidelines to determine hare hunting productive areas nor how to define the solvency and capacities of hunting grounds that are not adapted to newly created habitat conditions in certain hunting grounds. Methodology of conducting and defining the number of hare population in various types of hunting grounds does not match given habitat conditions. Taking into account various habitat conditions in hunting grounds of Vojvodina and central Serbia it is very important to define in a correct manner population spring abundance, population density, age structure and exploitation rate for the purpose of sustainable management in hare population.

**Key words:** *brown hare, management, Serbia*

### **Introduction**

Brown hare (*Lepus europaeus* Pall.) is one of the most widespread and most hunted game species in Europe. It inhabits many various habitats but lowland regions suit him the best (Jennings, 2006; Beuković et al., 2007). As an original game of open steppe grasslands hare has, during a long time period and due to intensive development of agriculture adapted to agroecosystem. The most abundant hare population can be found in agricultural areas. In Serbia the best hare habitats are lowland areas, primarily in Vojvodina. By intensifying the agriculture typical hare habitats have changed, primarily due to drastic increase of crop farming and intensive use of pesticides and simultaneous reduction in the areas covered with green fodder (Beuković and Marinković, 1997.).

Despite expressed fertility, in a previous period a significant decline in hare population in Europe and Serbia was recorded what can be explained by drastically changed living conditions (Beuković et al., 2009a; Popović et al., 1996). Intensive agriculture changed typical hare habitats particularly due to increased crop farming and intensive use of

pesticides as well as decline in areas covered with green fodder (Beuković et al., 2011a; Đorđević et al., 2008, 2009, 2010; Laslo, 1996; Popović and Đorđević, 2010). For that reason the abundance of hare population depends mostly on its possibility to adapt to such changes (Katoaet al., 2010). In such changed conditions it is possible to act in two ways - first to protect the hare population by complete prohibition or reduction of hunting, and the second way would be to conduct the process of reintroduction of animals from other hunting grounds or in other words to reintroduce artificially raised animals.

With the intensification of agriculture, predation is the most mentioned cause for hare declines (Schmidt et al., 2004; Panek et al., 2006). In Slovakia in the last 40 years the number of foxes has doubled. In 1970 there were 9900 shot foxes and since 2000 there have been on average 18688 individuals shot annually. In comparison with hare shooting, the fox shooting has been stable since 2002 but the hare shooting has gradually declined so that since 2010 more foxes have been shot compared to hares (Slamečka et al., 2013).

In order to improve management and protect hare population it is necessary to increase their number in hunting grounds. Therefore all factors that can affect hare population should be identified and the possibility to remove or reduce the impact of those factors considered (Popović et al., 2008; Andrašić, 1971; Vasović, 1971). The effect of climate factors in reproduction period affects the juvenile hare ratio in hare population (Popović et al., 1997; Beuković et al., 2009c; Beuković et al., 2013c). Since we cannot influence certain factors the engagement should be directed to those factors which can be directly or indirectly influenced upon by farmers. Improved results regarding hare population management can be achieved also by improved way of management, or by shifting corresponding parameters (growth rate, losses) within acceptable biological limits (Perišić et al., 2009).

The biggest impact on the number of wildlife population in hunting grounds is exerted by the users of hunting grounds through utilization of populations of game species-i.e. hunting. Population exploitation rate has to correspond to the size of registered game fund and has to follow its oscillations (Popović et al., 2006, 2008, 2011, and 2012). Rational use of hare populations and micropopulations is one of the most important modes of hare protection in impaired ecological conditions and it is completely and exclusively in the hands of the hunting grounds users (Beuković et al., 2009b, 2011b, 2013b, Popović et al., 1996), while the exploitation rate should be completely controlled by hunting ground users (Beuković et al., 2000). There is no unique rate of game utilization in different regions or hunting grounds since it varies from one year to another and should depend upon hare population registered fund, growth rate, losses during reproduction, as well as planned winter losses which may vary within certain regions (Popović et al., 2013).

### **Management measures in the hunting grounds of Serbia**

Management in the hunting grounds of Serbia is carried out in accordance with the Law on Game and Hunting (2010), which obliges the users of hunting grounds to develop a 10-year hunting management plan, adopt it, and obtain the approval of the competent Ministry of Agriculture, Forestry and Environmental Protection for it. Apart from the hunting management plan for the current hunting year a hunting ground user must develop an annual hunting management plan. Programme for the development of hunting areas has not been passed yet by the competent ministry and the draft hunting development strategy in the Republic of Serbia (2014) is being compiled.

For conducting the hare population management, the hunting ground user in his hunting management plan must specify the following: hare hunting productive area within the hunting ground, site class of hunting ground for hare hunting and optimal stock of hare in the hunting ground.

According to the Law on Game and Hunting (2010), hare hunting productive areas within the hunting ground are determined by persons licensed for the preparation of planning documents. There are no more specific guidelines for the participants in the project, but there is great difference in % of hare hunting productive area even between similar hunting grounds.

Site class of hunting ground for hare hunting, as an indicator of the necessary complex living conditions for certain game species in Serbia, is determined according to the guidelines of Tomašević et al. (1997).

Optimal stock of game, as optimum population size for certain species of game which should be present in the hunting ground, which is established on the basis of the assessment of the hunting grounds in Serbia, is also determined according to Tomašević et al. (1997). Recommended norms for number of individuals per unit of hunting productive area from these guidelines of Tomašević et al. (1997) are now questionable in the altered habitat conditions.

Determination of the population abundance is carried out in the lowland hunting grounds using method of sample plots. Selected plots are representative of a hunting ground, and the counting is done at 3-4 plots accounting for at least 10-12% of the total hunting ground. In the hilly hunting grounds method of "transects" or lines is applied, with rectangular sample plots 100-300 meters wide and 2000 to 5000 meters long. Counting of game by this method is incomplete as part of the game remains undetected because of the vegetation and terrain configuration. Abundance of hare population in mountain hunting grounds is usually established by identifying tracks and seats of hares, which is quite unreliable method.

Density is the most important element of a population. The number of individuals of a species living per unit of an area (habitat) at certain period of time is the result of various internal and external relationships of species and influence of many abiotic and biotic factors. Therefore the density is an indicator of the overall state of the population. Determination of the density (abundance) of hare populations and their parts at certain periods of the year is of great importance for the planning of harvest. There are two types of density: spring density – at the end of winter and before the start of the breeding season and autumn density – after completion of the breeding season and before the hunting season. Both types of density are important for monitoring population dynamics. Spring density shows how the game survived over winter and the reproductive potential while autumn density shows the reproductive success and what portion of the population may be used. The density of the breeding stock of hare in the Republic of Serbia without provinces in 2012 was 50.76 animals, while in the autonomous province of Vojvodina it was 142.24 per 1000 ha (Hunting Development Strategy of the Republic of Serbia – Draft 2014).

Exploitation rate of a hare population is the most important factor in hunting, as the proper setting of the annual catch limits for hares is significant for the rational exploitation and conservation of the hare population. The utilization rate is under the direct influence of man, and if not applied properly it can cause major damage under all habitat conditions. Determination of the utilization rate was carried out in hunting management most often based on the density (abundance) and the actual growth rate taken for the purpose of assessing the site class of habitat, which was pre-assessed and graded. Recent research has

shown that the actual growth rate is not positively correlated with the density and that the statistical norms of exploitation based on the site class of habitat are unviable. Actual growth rate varies from year to year and is different for the two neighbouring populations of similar environmental conditions. Realised hare game bag records in hunting year 2012/2013 in relation to breeding stock in the Republic of Serbia without provinces was 11.43 animals, while in the autonomous province of Vojvodina it was 9.43 per 1000ha (Hunting Development Strategy of the Republic of Serbia – Draft 2014).

Determining the age structure of the hare population at the end of the reproductive period is an important indicator of the growth rate and as such it is used in planning the hare exploitation rate on a hunting ground. In nature, only 3% of hares survive the age limit of 4 years. Majority of hares do not survive until the hunting season. Yet the leverets account for 50-75% of the autumn population, while the adults account for 25-50%, mainly 1-2 year-old animals. The most reliable method for determining the age of hares is based on the weight of the eye lens. The method is based on the fact that the eye lens grows throughout life (Lord, 1959; and Rieck, 1962). In Vojvodina, this method has been applied for more than 40 years, where the eyes of hunted animals (one eye of each animal) are collected from all hunting grounds users in Vojvodina during the hunting season, followed by treatment of the samples according to a pre-established procedure. Determination of the age structure is not used in Central Serbia or they use it in some hunting grounds on their own initiative used, but without organized collection by hunting organizations. However, recent attempts by Popović et al. (2013) suggest the importance of this measure in the hare management in the hunting grounds of Central Serbia.

Reintroduction of hares into the hunting grounds is carried out in order to increase their breeding stock. Apart from increasing the abundance, the hunting ground users have the view that "bloodrefreshing" will influence the abundance and quality of the population. Considering the fact that a number of environmental factors influence the population and reduction in its abundance and the overall decline, it is necessary to determine the causes and assess the effect of "bloodrefreshing", because otherwise this measure will not give the desired effect.

In Serbia in 2008, 2.20% of the total hare population exploitation was realised by catching and selling (Popović et al., 2012). During 2011, hares were reintroduced into seven hunting grounds in central Serbia, bringing 709 animals from hunting grounds in Vojvodina. In relation to the total hare abundance in Vojvodina in 2011 amounting to 272,760 animals (Beuković et al., 2012), only 0.26% of the total stock, or 1.94% of the total game bag record, was caught.

### **Hare population management in lowland habitats of the Autonomous Province of Vojvodina**

Observing the period 1989-2008, an average spring hare abundance in Vojvodina amounted to 258,454 animals, the average population density was 13.02 individuals per 100 ha, and the average annual hare game bag record was 41,850 animals. Exploitation rate of the hare population in the above period was 16.23% on the average (Beuković et al., 2009b). Number of hare eyes submitted for examination to the Hunting Association of Vojvodina during the said period amounted to 159,040, i.e., an average of 7,952 per year. The average percentage of young hares in the observed period was 60%, which is very good, and during the observed twelve years (1989-2008) the hunting ground users were proposed hunting prohibition in 6.30% of hunting districts each year on average, and correction of game bag record plan towards its reduction in 23.72% of hunting districts, while in 54.49% cases

they hunted according to the plan (Beuković et al., 2009b). Based on the Serbian Hunting Development Programme for 2000 - 2010 (Group of authors, 2001), in 2009 it was planned to achieve the hare abundance in Vojvodina of 324,518 animals, and the realization of the plan was 85.02%.

Hare breeding stock in the Autonomous Province of Vojvodina in 2012 was 285,200 animals, with realized game bag record of 27,740 which accounted for 9.73% of the breeding stock (Hunting Development Strategy of the Republic of Serbia - Draft 2014).

Observing certain areas in Vojvodina such as Tisa part of Bačka, Beuković et al. (2009a) in his study of the hare population dynamics and exploitation rate pointed out that the abundance of hare population in the hunting grounds of Tisa part of Bačka in the period 2002-2007 increased from 39,371 to 47,398 animals, which is an increase of 20.38%. Population density substantially followed the abundance and increased from 20.09 to 24.23 animals per 100 ha (Beuković et al., 2009a). Density of hares in Vojvodina in the period 2000-2009 ranged from 12.62 to 15.16 animals per 100 ha (Popović et al., 2012). In Tisa part of Bačka, depending on the year, density of hares ranged from 20.09 to 25.6 animals per 100 ha. In some hunting grounds the attained density was close to 30 animals, and in Bačko Petrovo Selo it was 41.6 animals per 100 ha (Beuković et al., 2007, 2009a, 2011b). When it comes to the exploitation rate of hare populations in the observed period in this region, the same authors suggest that it increased from 0.10 to 0.15. In 2012, the density of the hare breeding stock was 142.24 individuals per 1000 ha (Hunting Development Strategy of the Republic of Serbia - Draft 2014).

Based on the research of hare population management in Vojvodina for the period 2003-2012 Beuković et al. (2013) noted that in 2012 the highest percentage of leverets was reported in the area of Srem with 51.75%, followed by Banat with 42.07%, while the lowest percentage of young hares was recorded in Bačka with 39.76%. Ten-year average (2003-2012) for the percentage of young hares was 53%, which can be assessed as "good". Year with the lowest average percentage of young hares in Vojvodina in the observed ten-year average is 2010 with only 38%, which is rated as "weak", while the highest percentage of leverets was recorded in 2005 with 62% and it is rated as "very good" (Beuković et al., 2013). When it comes to spring hare population abundance in Vojvodina in the period 2003-2012, it was recorded as cyclic with the average abundance of 278,379 individuals, and the average annual game bag record of 42,501 animals (Beuković et al., 2013). Also, the same authors pointed out that game bag record in the observed year did not have a statistically significant effect on the population abundance in the next year.

### **Hare population management in hilly-mountainous habitats of the Republic of Serbia without provinces**

Hare abundance in the Republic of Serbia without provinces in 1991 amounted to 311,210, with hare bag record of 25.31% (Popović et al., 1996). In 1998, the hare abundance was 322,538, while in 2005, the hare abundance increased by 5.4% compared to 1998. The percentage of game bag record in 2000 was 16.64%, while in 2005 it was 20.34% (Popović et al., 2008). In Serbia, hare harvest record in the period 1980-2000 showed a linear declining trend by 1.7% annually, from 8 to 29.4% (average 24.5%) of the breeding stock harvest rate (Ranković and Popović, 2002). In the period from 2000 to 2009, the exploitation rate of hare population in Serbia ranged from 14.26% to 18.02%. Exploitation rate of the hare population in 2008 in Serbia by game bags amounted to 97.80% of the total population use. Tourist hunters participated in this with only 3.95% and domestic hunters with 93.85% (Popović et al., 2012), which is significantly smaller exploitation rate of the

hare population than in the period 1991-1993 when in Serbia this percentage ranged from 21.23% to 25.61 (Popović et al., 1996).

Hare density in central Serbia in the period 2000-2009 ranged from 6.16 to 6.97 animals per 100 ha, while the average hare density in the Republic of Serbia ranged from 8.17 to 9.10 animals per 100 ha (Popović et al., 2012). Population density in northwest Croatia in hunting season 2004/2005 ranged between 13 and 20.3 animals per 100 hectares of hunting grounds (Pintur et al., 2006), while in Bulgaria, in habitats at up to 600 m above sea level, the density was 1.8 individuals, and only in 5% of the hunting grounds the density was 5 to 8 individuals (Zhelev et al., 2013).

Based on the Hunting Development Strategy of the Republic of Serbia - Draft (2014), hare breeding stock in the Republic of Serbia without provinces in 2012 amounted to 283 760 individuals, which is 79.56% of the optimal fund, with the density of the breeding stock of 50.76 animals per 1000ha and realized game bag record of 11.43% of the breeding stock.

In the research during 2011-2012 in 34 hunting grounds of central Serbia on 862.579 ha, Popović et al., (2013) suggested that the optimal stock of hare is 9.48 animals per 100 ha. Depending on the area, the optimal stock ranges from 8.05 to 13.95 animals per 100 ha of hunting grounds, and breeding stock varies from 6.16 to 12.01 per 100 ha.

Hare breeding stock in the investigated hunting grounds in 2011 was 82.81% compared to the optimal stock that was provided for in the hunting management plan for the hunting ground. Hare game bag record varied depending on the area, from 0.76 in Drina-Kolubara area to 1.67 animals per 100 ha in Šumadija area. Hare game bag record in the investigated hunting grounds was 15.54% compared to the breeding stock in 2011. By observing the hare abundance and game bag record in Serbia in different periods it was found that there was a mismatch, i.e. that the increase in population abundance or its reduction was not accompanied by coordinated game bag record (Popović et al., 1996, 2012). Comparing the exploitation rate of hare population in our country with the research on the exploitation rate of hare population in Hungary (Laszlo, 1996; Katona, 2010) amounting to an average of 27.4%, this is a very low exploitation rate.

Based on the analysis of the age structure of the population, there has been established that the exploitation rate of the hare population on the basis of the annual hunting management plan would lead to the reduction of the breeding stock in 66.66% hunting grounds. Forestation of hunting areas did not show statistical significance for the proportion of leverets in the population in the hunting grounds of Central Serbia (Popović et al., 2013).

In 2011, hares were reintroduced into seven hunting grounds in central Serbia, with 709 animals. However, 44 to 249 individuals were introduced into the hunting grounds, or 1.1% to 15.56% compared to the optimal stock of hare for the given hunting ground, which is not enough. The reasons for the reduced introduction of hares into hunting grounds were the prices of live hares, weakened economic power of hunting ground users, as well as the long period for obtaining approval for the introduction of hares in the hunting ground by the competent ministry, unless it was envisaged in the long term plan at adopting the hunting management plan (Popović et al. 2013).

Since 2011 the campaign of oral vaccination of foxes against rabies in Serbia was initiated. Increasing the abundance of this predator of hares as well as other species of beasts in hunting grounds will affect the abundance of hare in the forthcoming period. A particular problem in the regulation of abundance of foxes and jackals is also the obligatory marking of the shot game, their delivery to specific places in the hunting ground, processing and

evaluation of their trophies, which will affect the indifference of hunters to hunt these predators and their further expansion.

## **Conclusion**

In 2012, hare breeding stock in the Republic of Serbia without provinces amounted to 283,760 individuals, with density of breeding stock of 50.76 animals per 1,000 ha and realized game bag record of 11.43% of the breeding stock.

Hare breeding stock in the Autonomous Province of Vojvodina for 2012 was 285,200 individuals, with realized game bag record of 27,740 which is 9.73% of the breeding stock, while the density of the hare breeding stock per 1000ha was 142.24 animals.

Compared to the year 2000, hare abundance in the Republic of Serbia was reduced; particularly hare abundance and density in Serbia without provinces.

In order to prevent further hare population decline in the Republic of Serbia certain measures must be taken in accordance with relevant habitat conditions in certain hunting grounds:

- Establish hare hunting productive areas, determination of site class and capacity of the hunting ground for this type of game must be carried out by new, established and prescribed criteria and in accordance with the new changes in the habitat conditions in the hunting grounds of Serbia.
- Exercise determination and control of population abundance:
  - Implementation of adequate methods for determining the abundance.
  - Proper identification of the experimental plots, which were selected according to the site classes of the hunting ground and surface structure of a given hunting ground.
  - Counting control.
  - Transition to other counting methods that would be carried out by hunting professionals.
- It is necessary to regularly conduct control of investigation of the age structure of the hare population based on the weight of dried eye lenses from early autumn hunts and provide recommendations on population exploitation as not to jeopardize the hare breeding stock in the given hunting ground. In the hunting grounds in the area of Vojvodina this investigation is carried out regularly, while it is not practiced in other hunting grounds.
- Percentage of introduction of hares in hunting grounds in Serbia is low and it is necessary to introduce hare into hunting grounds with hare abundance below 50% of the optimal stock, but with the previous analysis of the reasons for the decline and elimination of the causes.
- Reducing losses in the hare population by control of predator abundance in hunting grounds, as well as the prevention of poisoning hares by pesticide use control.
- Education of hunting staff regarding the hare population management in hunting grounds, with particular stressing the importance of sampling of eyes in the first days of autumn hare hunting as well as education of hunters and population in order to reduce losses in this type of game.

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