Invited paper UDC: 639.112

THE MANAGEMENT ANALYSIS OF HARE POPULATION IN VOJVODINA FOR THE PERIOD 1997 - 2011.

Beukovic, M. [1], Popovic, Z.[2], Djordjevic, N.[2]

Summary: In order to explore the management of hare populations in Vojvodina, in the period 1997-2011. we analyzed the data on spring abundance, population density, harvesting, degree of utilization, the number of samples and the eye lens supplied to the test,% of young hares in the shooting, according to which the recommendations were given in terms of hunting suspension, shooting and hunting correction by the management plan. Based on this study it was found that the number of hare populations in Vojvodina was stable with significant cyclicality. The average density in spring was 262.048 hares. The density of hare population in Vojvodina is an average of 13.20 ind/100ha. The average annual hare hunt in Vojvodina in the last 15 years is 38.403. The level of the hare population used in the observed period amounted to an average of 14.65%. The average percentage of young hare in the observed period was 56% , which was rated as "very good". For the past 15 years, users of hunting grounds, the proposed annual average of 6.16% suspension of hunting grounds, and 25.48% of hunting grounds hunting correction plan in terms of reduction, while in 55.04% of hunted as planned. Regardless of the cyclic, hare populations in Vojvodina is stable and under control of the user of the hunting ground, thanks to recommendations based on the continuous examination of old hares based on dry weight of eye lenses from early autumn hunts.

Key words: hare, quantity, utilization,% of young, eye lens.

Introduction

Brown Hare (*Lepus Europaeus Pall.*) is one of the most widespread and the most hunted game in Europe [4]. As the original game of the steppe expanses, hares accommodated to the agro-environment with the development of an agriculture. The most widespread hare populations are in the agricultural regions [18]. In Serbia, the best habitat for the hare is plain areas, mainly in Vojvodina [3]. According to Beuković and Marinkovic [2] the intensification of agriculture changed the typical habitat for hares, especially with the drastic increase in area under arable crops, where is the intensive use of pesticides, and at the same time the reducing of area under forage crops, which reduce the possibility of high-quality hare diet [9] . The rational use of the hare micro populations is one of the most important form of protection of hares in deteriorated environmental conditions [5], [8], [13], [6] and which is wholly and exclusively in the hands of the users of the hunting grounds [1].

The determination of the hare's age can be determined on the base of the ossification of bumps on the bottom of the elbow bone, and on the state of the lacrimal bone [22]. Due to the lack of reliability of both methods, a method of age determination based on the weight of the eye lens is in use [20]. The method is based on the fact that the eye lens grows throughout life and eye lens of young individuals contains a lot of water whose percentage decreases with age [21].

Andersen and Jensen [20], following the dry weight of eye lenses of hares of familiar years, determined the weight limit of the hares in the first year of age and older, which is 280 mg. The same limit value determined Rick for the West Germany, and Cabbon-Račinski Račinski for Poland, Hell and Herz for Czechoslovakia. The limit value of 260 and 280 mg were found for Kovac Heltai and Hungary, while Pepin [11] found that in France it is 250 mg. In Vojvodina Šelmić [20] on a large collected material (10 999) of the eye lens of the determined the limit value of 277.5 mg. In our area the research of age structure has been introduced by a prof. Vojislav Jovanović in 1967 [22] and then the research continued prof. Vukoman Šelmić and mr Dara Đaković. Since 1967. this researches has been permanently done in Vojvodina, began at the Agricultural Faculty in Novi Sad, and then continued in the Hunting Federation of Vojvodina.

More than 40 years, from all users of hunting grounds in Vojvodina during the hunting season, eyes of hunted hares are collected (one eye of each hare), followed by processing of the sample in a predetermined procedure. Based on these studies and data of the number of hares in the spring, and also on the data of hunted hare from the previous year, shall be determined the abundance of hare micro population and based of that to give the recommendations to the users of the grounds about possible revision of hunted plans [17]. In the hunting grounds, with low population density and high real growth increase must take care that the rational isolation of hare number close to the capacity

[1] Miloš Beuković, PhD, professor, Faculty of Agriculture, Novi Sad, Serbia;
Corresponding author: Miloš Beuković,, Faculty of Agriculture, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia; E-mail: milos.beukovic@stocarstvo.edu.rs; Phone: +381 21 4853332.
[2] Zoran Popović, PhD, professor; Nenad Đorđević, PhD, professor; Faculty of Agriculture, Zemun-Belgrade, Serbia;

of hunting [15], [12]. Hunting areas that have high population density in relation to capacity may have little real growth and a relatively good autumn abundance, as sometimes happens [14]. Since the proportion of young hares in a population varies from year to year, since that it depends on many biotic and abiotic factors [7], [13], [16], therefore, after the first hunt and performed test, the recommendations submit to the hunters on the further use of the hare population compared to planned volume for the current year [4]. Recommendations for each hunting district are as follows: 1) hunting as planned, 2) suspension of hunting, 3) correction of plan, 4) small and incomplete sample.

The introduction of the test methods in the planning management of the hare population in Vojvodina was introduced in 1980 and represents a significant step forward in the use of popular-dynamic hunting in the hunting management [4], [23]

Material and method

In the order to investigate the state of the hare population in Vojvodina, on total area of 1,985,626 hectares, in the fifteen-year period from 1997-2011. the processed data on the spring number of livestock, the average density, total harvesting, degree of utilization, the number of examined eye lens,% of young hares for all hunters organizations' 57 hunting grounds. The data were processed for 131 252 ophthalmic lenses from all the hunting grounds in Vojvodina. These data are official data from the hunting records of the Hunting Association of Vojvodina and the test results of eye lens. Method of determining age of hares on dry weight of eye lenses is based on the fact that the eye lens grows throughout life. Among young hares lens of the eye contains a lot of water that decreases with age. Using a modification of (i Šijački Đaković 1997) eyeballs of hares receiving from the field of early autumn hunts immediately clean and keep in 10% formalin for fixation, then dried in a thermostat for 3 days at 37 ^{0}C, and then measure on a precise Metler scale. Based on the weight, they classified in six age classes as follows: <100 mg hares to 3 months old, of 100 -200 mg of 3 - 6 months, 200 - 280 mg to 1 year old, of 280 -310 mg old 1-2 years, from 310-370 mg 2 - 3 years and> 370 mg over 3 years. In the practical application two age groups are used and that hares under 1 year of age where the masses of the eye lens is up to 280 mg and older than 1 year where the mass of over 280 mg. The rating% of youth is identified in the following limits: <50% poor, 51% -55% good, 56% - 64% very good and> 65% excellent. Statistical analysis of results was performed by the software package "Statistica 10" (StatSoft, Inc. 2011), [19] and this method was used in the regression analyzes, where were calculated a simple correlation coefficients (R) between the dependent variable (number of hares in the current year) and potential independent variables (number of hares from the previous year and hunting hares from the previous year).

Results and discussion

According to the data shown in Table 1 the number of hare populations in Vojvodina is stable, with prominent cyclicality, which is even better seen in Figure 1. The average number of hare population for the period of 15 years is 262 048 hares.

Table 1. Number, density, harvesting, and usage of hare population in Vojvodina throughout years

Year	Number	Density	Harvesting	Usage level,%
1997	263.570	13,27	39.115	14,84
1998	252.540	12,72	33.637	13,32
1999	215.554	10,86	30.175	14,00
2000	250.614	12,62	27.698	**11,05**
2001	**204.528**	**10,30**	26.148	12,78
2002	222.522	11,21	**25.753**	11,57
2003	254.786	12,83	33.846	13,28
2004	288.419	14,53	41.003	14,22
2005	285.806	14,39	49.198	17,21
2006	**300.971**	**15,16**	50.030	16,62
2007	289.897	14,60	47.012	16,22
2008	261.540	13,17	**51.926**	**19,85**
2009	275.909	13,89	50.389	18,26
2010	291.302	14,67	33.516	11,51
2011	272.760	13,73	36.598	13,42
Average	**262.048**	**13,20**	**38.403**	**14,65**

The largest number of hare populations in Vojvodina was recorded in 2006. with amount of 300 971 individuals while the lowest number recorded in 2001 was only 204 528 hares. Statistical analysis revealed a standard deviation (size variations), the number of hares for 15 years of 29 303 hares. The average densityof the hare population in Vojvodina was (Tabel1. Figure 2), for the observed period of 15 years was 13.20 individuals/100 ha. The highest density of population was recorded in 2006. year and amounted 15.16 hares, while the lowest density was recorded in 2001, and was only 10.30. Statistical analysis revealed the standard deviation (size variations) of the hare population density for 15 years of 1.48 the hare.

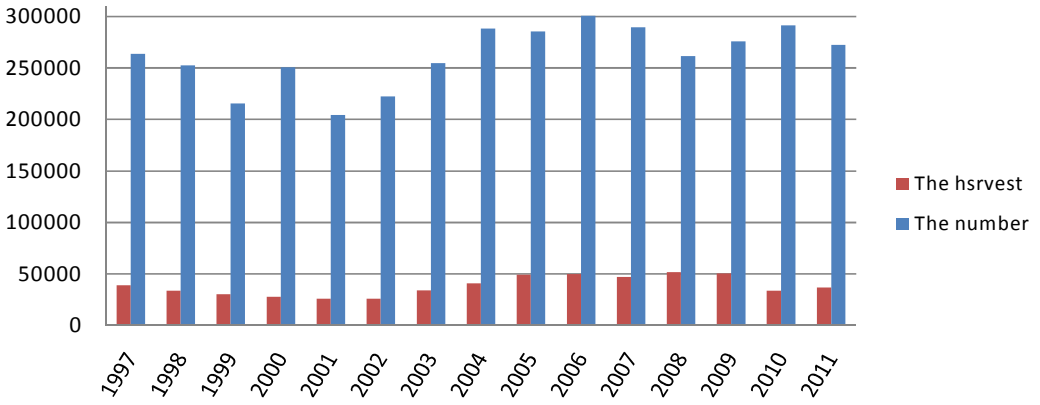

Figure 1. Numbers and hare hunted in Vojvodina

The average annual hare hunt, in Vojvodina, for the observed period of 15 years was 38 403 individuals. The highest harvest recorded in 2008. years from 51 926 hares, and the lowest harvest recorded in 2002. year was only 25 753 animals (Table 1 and Figure 1). Statistical analysis revealed a standard deviation (size variation) hunting hares for 15 years of 9345 individuals.
Spring strength of the hare from the previous year had a statistically significant effect on hare numbers in the coming year, with a positive correlation r = 0.61, which is a significant association. The hunting of hares in the previous year also had a statistically significant effect on hare numbers in the coming year, while the correlation coefficient is positive and on the border between the significant and high correlation r = 0.70.

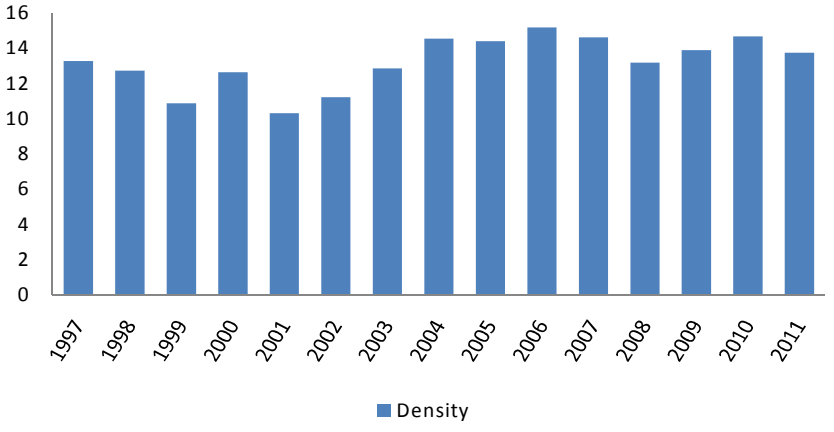

Figure 2 The density of hare populations in Vojvodina since 1997. - 2011.

The coefficient of determination obtained by multiple regression analysis was $R^2 = 0.50$, which explains that 50% of changes occurring in the hare population (observed over 15 years) are the result of the hare population density from the previous year as well as hunting from the previous year.
According to the data shown in Table 1 and figure 3 can be seen that the level of use the hare population in the period of 15 years, was an average of 14.65.%. Compared to with research on the use of the hare population in Hungary [10] that was on average 27.4% this is a very low level of the use. The highest level of use the hare population in Vojvodina was recorded in 2008. year of 19.85%, the lowest usage level of in 2000. year was only 11.05%. Statistical analysis revealed a standard deviation of the level of the hare use for 15 years of 2.6%.

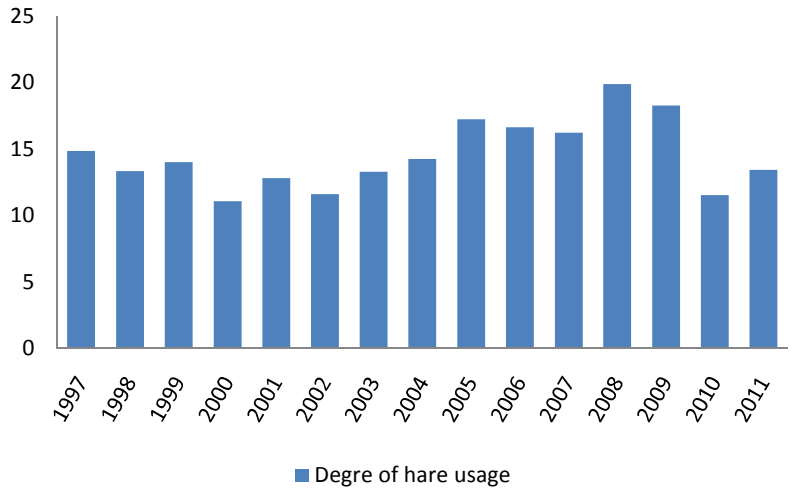

Figure 3. The degree of the hare population use in Vojvodina since 1997. - 2011.

Table 2. The number of samples, examined eyes of young hares % and in Vojvodina

Year	Number of samples	Examined eyes	% young	Mark
1997	236	7.341	62	Very good
1998	240	7.658	54	Good
1999	226	**7.139**	62	Very good
2000	244	8.656	54	Good
2001	264	8.581	61	Very good
2002	242	8.482	59	Very good
2003	269	8.691	55	Very good
2004	260	8.235	59	Very good
2005	287	9.301	62	Very good
2006	296	10.029	50	Bad
2007	268	9.459	55	Very good
2008	295	10.020	54	Good
2009	300	**10.227**	59	Very good
2010	276	8.371	**38**	Bad
2011	278	9.062	53	Good
Total	**3981**	**131.252**		
Avg,.	**265**	**8.750**	**56**	**Very good**

According to the data in Table 2 the average number of samples submitted for testing, for the preceding period of 15 years, was 265. Most samples of the eye lens were delivered in 2009. total of 300, while the smallest number was submitted in 1999. total 226 samples.
The total number of eye lenses submitted for the age examination for 15 years, amounted 131 252 8750 what is the annual average of 8.750 eye lens. Most eye lens for the examination was delivered in 2009. year, 10 227 spectators, and the least was delivered in 1999. year 7139 eyes.
Based on the data in Table 2 and Chart 4 it can be seen that the average percentage of young hares, observed in 15 years, was 56%, which is a very good score. Lowest percentage of young hares was recorded in 2010. Year, only 38% and it was assessed as weak, and the best percentage of 62% was found in 1997., 1999. and 2005. and it was rated as very good.

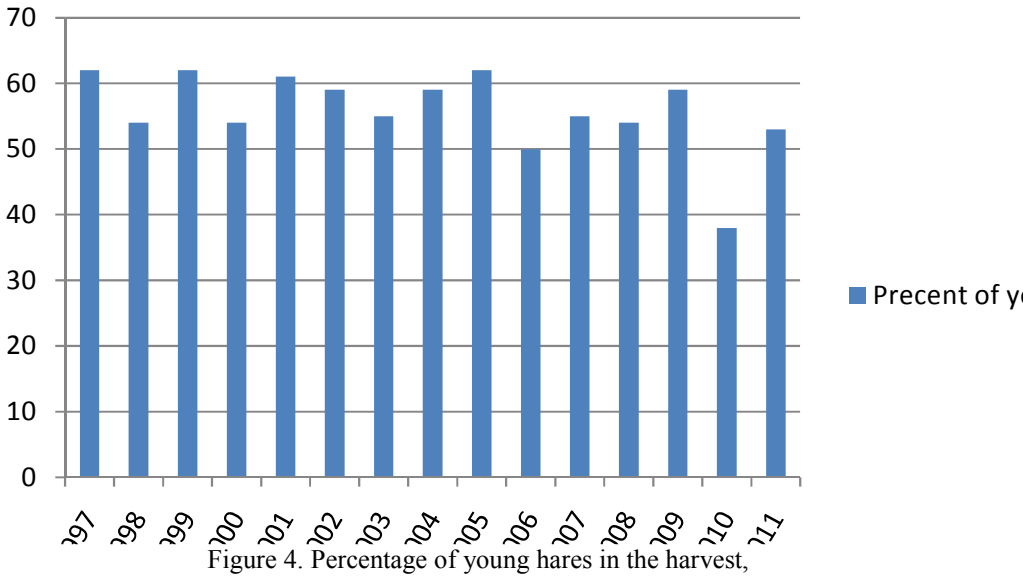

Figure 4. Percentage of young hares in the harvest,

Table 3. Recommendations for the use of micro-populations of the hares by the hunting grounds,%

Year	Planed hunting	Suspension of hunting	Plan correction	Small and not full sample
1997	33,47	8,90	27,12	30,51
1998	30,42	9,58	35,42	24,58
1999	31,86	6,64	30,97	**30,53**
2000	25,83	**15,16**	42,21	16,80
2001	51,52	7,58	25,75	15,15
2002	53,73	9,09	28,51	8,67
2003	57,26	7,06	26,39	9,29
2004	68,85	1,15	16,54	13,46
2005	73,87	2,44	11,15	12,54
2006	67,90	3,38	22,64	*6,08*
2007	79,48	2,61	10,45	7,46
2008	79,66	2,03	***7,46***	10,85
2009	**86,00**	2,33	8,33	**3,34**
2010	**18,12**	13,41	**63,40**	5,07
2011	67,63	**1,08**	25,90	5,39
Avg.	**55,04**	**6,16**	**25,48**	**13,32**

According to the data in Table 3 and Figure 5 it can be seen that for the last fifteen years, to the users of hunting grounds in Vojvodina, was proposed the annual average of 6.16% suspension of hunting of the planned harvest.

Most of the proposed suspension of hunting was in 2000. 15.16%,and the least was suggested in 2011. of 1.08% of all hunting areas.
Correction Plan of hunting in relation to the annual hare population management plan in terms of reduction, for the past fifteen years, suggested an average of 25.48% in the hunting grounds in. Most proposals for correction of hunting plan was in 2010. 63.40%, while the lowest proposal for the reduction of hunting was recorded in 2008. of 7.46%

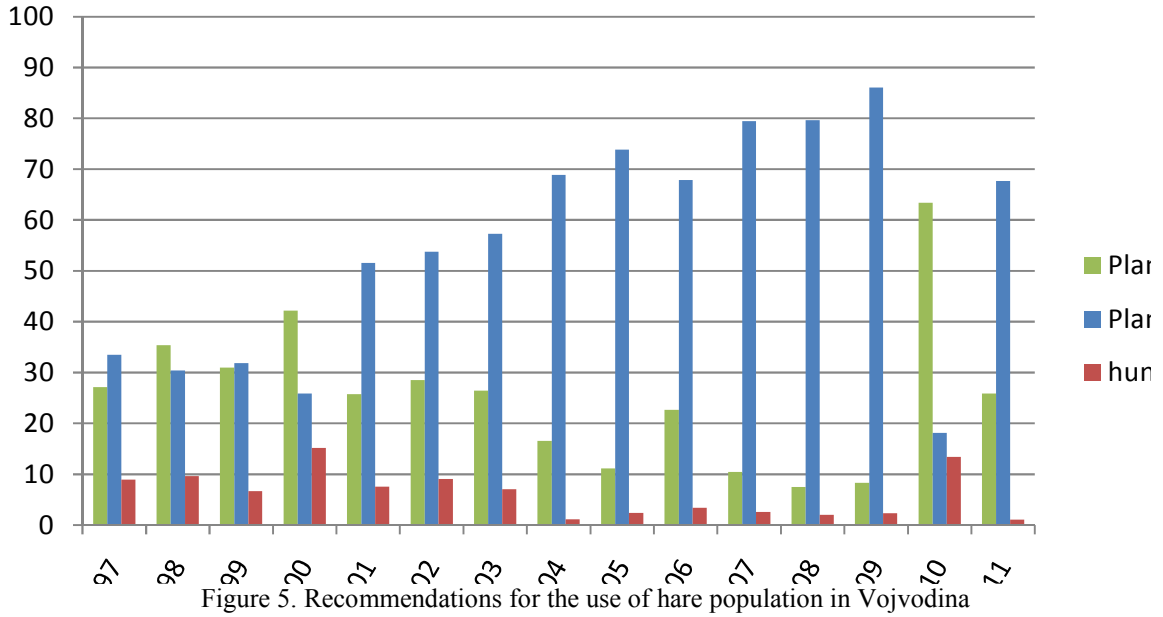

Figure 5. Recommendations for the use of hare population in Vojvodina

The users of hunting grounds in Vojvodina for the period of fifteen years, since 1997. to 2011. the average of 55.04% of hunting ground hunted the hare population according to management plan. A minimum recommendations for hunting according to the management plan was recorded in 2010. of 18.12%, while the most of the recommendations for hunting according to the management plan was proposed in 2009. 86.00% of hunting ground .
Due to the uncompleted data and small sample of approximately 13.32% of hunting grounds, it could not be given the reliable recommendations.

Conclusion

Based on the analysis of forest hare population in Vojvodina in the period from 1997 to 2011. year may be the following conclusions:
- The number of hare populations in Vojvodina is stable with significant cyclic, and the average was 262 042 individuals.
- The number of hare from the previous year had a statistically significant effect on hare numbers in the coming year,
- The density of hare populations in Vojvodina for the period, an average of 13.20 ha individuals/100ha.
- Average annual hare harvest for the observed period amounted to 38 403 individuals.
- The hunting of hare in the current year has a statistically significant effect on hare numbers in the coming year.
- Level of use of hare population in the reference period, amounted to an average of 14.65%
- The average percentage of young hares was 56%, which was assessed with "very good".
- During the monitoring period, an average of 6.16% hunting grounds suggested the suspension of hunting,was 25.48% of the correction of hunting plan in terms of reduction, while 55.04% of suggested hunting plane.
- Half of the hare population changes in Vojvodina in the last 15 years can be explained as the result of hare population density from the previous year, and hunting from the previous year (R2 = 0.50).

Based on the above it can be concluded that the hare population numbers for the last 15 years in Vojvodina, is stable, and that's controlled hunting areas. This is the result of rational management based on continuous examination of the age of the hare based on the weight of eye lenses in whose giving proposals on the plan for the current hunting year, and in order to preserve the number of population in the coming year.

Acknowledgments

The authors would like to thank the hunting association of Vojvodina. This study was funded by a research grant from the Ministry of Education and Science TR: 31084.

References:

[1] Beuković M, Šelmić V, Jović D, Vapa, M, Puzović M, Pantelić A, et al, Dugoročni program razvoja lovstva Vojvodine 2000-2010. godine. Novi Sad 2000. **[2]** Beuković M. Marinković B. Simpozijum Zec i jarebica u savremenom agroekosistemu, Zbornik radova Lovački savez Vojvodine 144-126,1997. **[3]** Beuković M., Bošnjak B., Popović Z., Simpozijum «Veterinarska medicina, stočarstvo i ekonomika u proizvodnji zdravstveno bezbedne hrane« St. 111. Herceg Novi 2007, **[4]** Beuković, M., Beuković, D., Popović, Z., Perišić, P., XXIII savetovanje agronoma, veterinara i tehnologa, 26.-27.02.2009, Institut PKB Agroekonomik, Beograd. Zbornik naučnih radova, Vol 15. br.3-4: 173-179, 2009a. **[5]** Beuković, M., Popović, Z. Maletić, V., Beuković, D., Đaković Dara, IV International symposium of livestock production, proceedings. Pp. 232, 2009b. **[6]** Beuković M., Beuković D., Popović Z, Đorđević N. Simpozijum stočarstvo, veterinarska medicina i ekonomika u ruralnom razvoju i proizvodnji zdravstveno bezbedne hrane, divčibare 20-27 jun 2010, Zbornik kratkih sažetaka 136. 2010. **[7]** Beuković, M., Tepavac, K., Beuković, D., Đorđević, N., Popović, Z., Đorđević, M., 22nd International symposium «Safe food production», Trebinje, Bosnia and Hercegovina, 19-25 June, 2011. Proceedings, 19-21, 2011a. **[8]** Beuković, M., Beuković, D., Đorđević, N., Popović, Z., Đorđević, M., 22nd International symposium «Safe food production», Trebinje, Bosnia and Hercegovina, 19-25 June, 2011. Proceedings, 16-18, 2011b. **[9]** Beuković, M., Đorđević, N., Popović, Z., Beuković, D., Đorđević, M., Contemporary Agriculture, 3-4, 403-413, 2011c. **[10]** Katona K, Biro Zs, Szemethy L, Demes T, Nyeste M,;Acta zoologica academiae scientiarum Hungaricae, 56, 89-101, 2010. **[11]** Pepin D., 17. Congr. Int. Union Game Biol., Brusseles, Part 2, 553-560, 1985. **[12]** Pintur K, Popović N, Alegro A, Severin K, Slavica A, Kolić E, Vet. arhiv 76, 199-209, 2006. **[13]** Popović Z, Gajić I, Bogdanović V., 5. kongres ekologa Jugoslavije, Beograd, 22-27. septembar 1996., Zbornik sažetaka, 74. 1996. **[14]** Popović Z, Bogdanović V, Gajić I, Savetovanje u Prokuplju i Kikindi 1995. godine, Lovački savez Jugoslavije, Zbornik radova, str. 121-132, 1995. **[15]** Popović Z, Bogdanović V, Gajić I.; V Kongres Ekologija Jugoslavije, Beograd, Proceedings, 32, 139-144, 1997. **[16]** Popović, Z., Đorđević, N., Beuković, M., Beuković, D., Đorđević, M., Jahorina, Bosnia and Hercegovina, 10-12 November, 2011. Proceedings, 111-113, 2011a. **[17]** Popović, Z., Đorđević, N., Živković, D., Beuković, M., Beuković, D., Đorđević, M., XVI međunarodno naučno-stručno savjetovanje agronoma Republike Srpske „Prirodni resursi u funkciji razvoja poljoprivrede i ruralnog područja“, Trebinje, 22-25.03.2011. Zbornik sažetaka, 92. 2011b. **[18]** Slamečka J, P Hell, R Jurčík., Acta Sc. Nat. Brno 31, 21-28, 100-103, 1997. **[19]** StatSoft, Inc., 2011, Electronic Statistics Textbook. Tulsa, OK: StatSoft. WEB: http://www.statsoft.com/textbook/ **[20]** Šelmić V., Simpozijum Zec i jarebica u savremenom agroekosistemu, Zbornik radova Lovački savez Vojvodine, Novi Sad, 1-32, 1997. **[21]** Šelmić V i Đaković D., Simpozijum Zec i jarebica u savremenom agroekosistemu, Zbornik radova Lovački savez Vojvodine, Novi Sad, 127-134, 1997. **[22]** Šijački N i Đaković D; Simpozijum Zec i jarebica u savremenom agroekosistemu, Zbornik radova Lovački savez Vojvodine, Novi Sad, 148-156, 1997. **[23]** Vapa M. i Šelmić V.; Simpozijum Zec i jarebica u savremenom agroekosistemu, Zbornik radova Lovački savez Vojvodine, Novi Sad, 33-55, 1997.