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BURROW DENSITIES OF EURASIAN BADGER (*MELES MELES*) AND RED FOX (*VULPES VULPES*) IN BÖRZSÖNY MOUNTAINS

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ABSTRACT
Due to their common spread in Hungary, Eurasian badger (*Meles meles*) and red fox (*Vulpes vulpes*) play key role in most Hungarian communities' life, and have decisive importance in both of wildlife management and nature conservation. Thus, development of a biologically well based carnivore management for these species is a relevant task that requires to getting to know their population statuses and to tracking the changes of these statuses. Our study aim was to verify the accuracy of stripe transect method that is commonly used for estimating burrow densities of carnivores, in a hilly area, that has always been a habitat for both of these two species. We were looking for answer to how the estimated burrow densities of the study area are related to data of countywide questionnaires, and to results of other, similarly detailed surveys. Burrow estimation was done in February 2011, and complete counting in January, February, and March of 2012. Our results showed 20.0% underestimation of Eurasian badger, and 2.2% overestimation of red fox burrows. Comparing to similarly detailed surveys, burrow density of badger in Börzsöny is equivalent to results from hilly areas, whilst definitely exceeds the level of densities on plain habitats. Red fox burrow density of the study area is multiple of the countrywide mean value that may refer to a remarkable systematic underestimation by wildlife managers. Our data, which are based on detailed assessment, show reliable burrow density values and offer a feasible method for practitioners.

Keywords: Eurasian badger, red fox, burrow, Börzsöny Mountains, density

INTRODUCTION

Eurasian badger *(Meles meles)* and red fox *(Vulpes vulpes)* are widespread, middle sized carnivores in most of the European countries, just like in Hungary, too (NEAL AND CHEESEMAN, 1996; MITCHELL-JONES ET AL., 1999; HELTAI, 2010). The key of their high population densities is the excellent adaptability both in habitat selection and feeding (KRUUK, 1989; LANSZKI ET AL., 1999; HELTAI, 2010). In Hungary Eurasian badger became protected in 1974. Due to its expanding population and range between the late 80's and early 2000's badger was removed from the national list of protected species (13/2001. (V.9.) KöM decree) (HELTAI AND KOZÁK, 2004). Eurasian badger is currently a game species, hunted between 1st of July and the end of February. Red fox has never been protected in the history. Its hunting season includes the whole year. Having broad tolerance and lacking big carnivores let them to be top predators of most of Hungarian natural communities (HELTAI, 2010). Their steadily growing stock may cause further strengthening in their predatory role and other impacts (HELTAI AND KOZÁK, 2004; HELTAI, 2010). This may manifest in stronger impact on species more important for wildlife management (HELTAI, 2010), raising damage on agriculture in case of badger (BÍRÓ et al., 2010), and increasing impacts on animal and human health of illnesses transmitted by both species (SRÉTER et al., 2003; TAKÁCS et al., 2012). Thus, development of a biologically well based carnivore management for these species is a relevant task both for nature conservation and wildlife management that requires knowledge on densities of local carnivores, and their population changes. Our study aim was to verify the accuracy of band-transect method that is commonly used for estimating burrow densities of these carnivores, and in conservation biology in general with the method of complete counting in a hilly area that has always been a habitat for both of these two species (NEAL AND CHEESEMAN, 1996; HELTAI, 2010). We were looking for answer to how the estimated burrow densities of the study area are related to data of countywide inquiries, and to results of other, similarly detailed surveys.

MATERIAL AND METHOD

Study area

The study area is located in the southern side of Börzsöny Mountains close to Márianosztra villages. The terrain is indented, cut by ditches, hills, streams, and ravines. The lowest point of the area is 140 m. a. s. l., the highest peak reaches 335 m. a. s. l. The main tree species of this highly forested (54.8%) area are Turkey oak *(Quercus cerris),* and sessile oak *(Quercus petraea)* but common hornbeam (*Carpinus betulus*), and Scots pine (*Pinus sylvestris*) have remarkable stands, too (*Figure 1*). The shrub stratum is rich. A part of the opened area (73.9%) is in agricultural use; almost its half is meadow, whilst the other part is for crop production. The other 26.1% is shrubby-grassy, natural-like area.

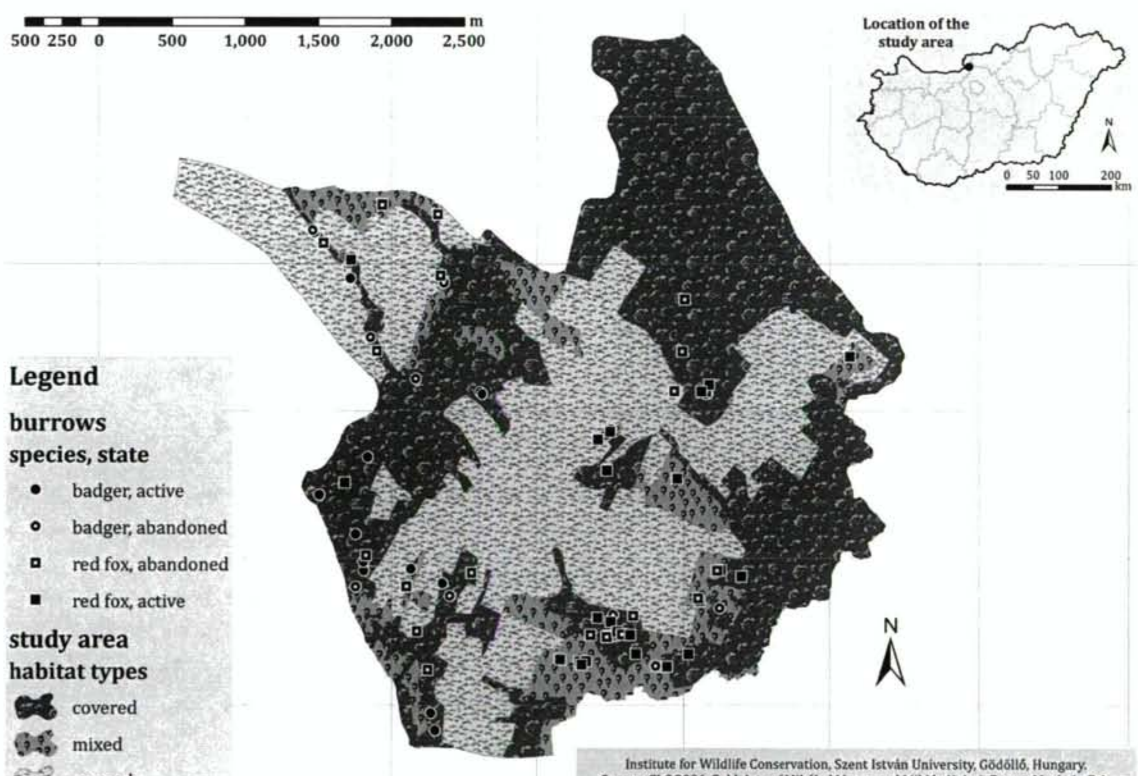

Figure 1. Study area, and burrow locations

Burrow estimation and the calculation of density

Field data were collected on 18th, 19th, 20th, and 25th of February 2011 with stripe transect method (HELTAI AND SZEMETHY, 2010). Nine, north-south oriented parallel lines were delineated, 500 meter between each. Lines were followed in field in order of to the serial numbers by help of compass and GPS. Localisation of burrow sites, marking borders of different vegetation classes, and registering the visible stripe width were done both by

GPS, and on a 1:25000 scale field map. This way, de facto 265 ha area were mapped, that is 21.1% of the whole 1257 ha study site, so the sampling can be considered as representative (HELTAI AND KOZÁK, 2004). HD72/EOV (EPSG code: 23700, Egységes Országos Vetületi Rendszer) was used as spatial reference for the GPS data recording. The following data were noted down during the recording: number of transect, use of burrow (inhabited or abandoned), type of vegetation, number of entrances/exits, and other signs referring to species (odour, footprints, latrine, faeces, prey remains). Statistical evaluations were done by Microsoft Excel and GraphPad InStat software. Random sample of transects were taken for estimating burrow density. Five transects were chosen in each case in order to calculate the mean burrow density. This sampling was repeated seven times and the mean of the resulted seven data was considered as estimator of burrows density of the study area (HELTAI AND KOZÁK, 2004). Welch test was implemented to compare burrow densities of the two species. Use of burrows found in February 2011 was controlled again on the 3rd, and 4th of August, 2011. Accuracy of burrow density estimation was re-checked on the 17th, 23rd, 27th, 30th of January, 2012, 2nd, 25th, 26th of February, 2nd, 3rd, and 4th of March, 2012 via complete counting, when use of burrows found in the previous year was re-investigated. Then, number of burrows found and estimated density of 2011 were descriptively compared. Burrow density of the study area was compared with data of detailed studies found in Hungarian publications and with general national figures, as well (HELTAI AND KOZÁK, 2004; HELTAI, 2010; MÁRTON ET AL., 2012).

RESULTS

Estimation of burrow densities based on the data of 2011 are for Eurasian badger 1.58 ± 0.64 burrow/100 ha, for red fox 3.66 ± 1.75 burrow/100 ha (*Table 1*). Welch-test proved, that, both for active ($t_w = 2.967$, df = 7, p = 0.021, n = 14) and abandoned ($t_w = 2.648$, df = 7, p = 0.033, n = 14) burrows, burrow density of red fox is significantly higher in the study site.

Table 1. Burrow density estimation of the two carnivore species (pcs./100 ha)

Sample	Badger		Red fox	
	Active burrows	All burrows	Active burrows	All burrows
1	1.83	1.83	3.45	3.45
2	0.36	0.73	6.37	6.37
3	1.36	1.36	2.50	2.50
4	2.20	2.56	5.88	5.88
5	1.36	1.36	2.50	2.50
6	2.20	2.56	2.94	2.94
7	1.73	2.09	1.99	1.99
Mean:	1.58	1.79	3.66	3.66
SD:	0.64	0.68	1.75	1.75

When comparing estimation of 2011 to results of the complete counting in 2012 badger seems to be 20.0% underestimated, whilst red fox looks to slightly (2.2%) be overestimated (*Table 2*).

Table 2. Comparison of the interpolation of estimated burrow density to the whole study area ($\bar{x} \pm SD$) and the results of the complete counting

Species	2011	2012
	Burrow density (pcs./1256.7 ha)	All burrows (pcs.)
Badger	22.5 ± 8.6	27
Red fox	46.0 ± 22.0	45

These values of burrow density of Eurasian badger are similar to what was found in studies conducted on hilly areas, but remarkably exceed values found in studies done on plain study areas. Difference between hilly and plain areas' burrow densities is statistically certified ($t = 2.885$, $df = 9$, $p = 0.018$, $n = 11$).

Table 3. Burrow densities of Eurasian badger on different study areas

Sample area	Active burrow (pcs./100 ha)	Difference from Börzsöny (%)
Borsodivánka (1998)	0.000	100.0
Abádszalók (1998)	0.000	100.0
Abádszalók (2001)	0.120	92.4
Egyek (1998)	0.061	96.1
Egyek (2001)	0.220	86.1
Pély (1998)	0.032	98.0
Dévaványa (2001)	0.480	69.6
Erdőspuszták (Nagycsere-Debrecen) (2004)	1.070	32.3
Ágota-puszta-Farkassziget (Hortobágy-Püspökladány) (2004)	0.300	81.0
Pécel-Isaszeg (2006)	1.660	-5.1
Nagyrét (Kiskunság) (2005)	1.490	5.7
Mátyás király vadaskert (Bakony) (2007)	1.070	32.3

Burrow density of red fox found in the Börzsöny (36.6 burrow/1000 ha) is similarly high compare to a figure found in a study from the Bakony (40.8 burrow/1000 ha) (MÁRTON ET AL., 2012). However, in comparison with the general national average figures, our results suggests much higher values, than the data based on the country-wide questionnaires (*Table 4*).

Table 4. Countrywide burrow density of red fox (pcs./1000 ha) (source: HELTAI, 2010)

Year	Transdanubia			Danube to the East		
	Mean	SD	N	Mean	SD	N
1988	2.3	1.7	101	2.0	1.4	144
1990	2.1	1.4	75	2.1	1.6	117
1994	3.1	2.1	129	2.2	1.5	180
1995	3.0	2.1	141	2.6	1.8	215
1997	3.9	2.8	169	4.1	7.4	243
1998	4.3	2.6	215	3.4	2.6	293
2000	4.4	3.4	222	2.6	1.9	333
2001	4.2	2.9	191	2.7	2.0	301
2002	3.74	2.62	197	2.73	2.03	346
2003	3.16	2.28	204	2.76	1.86	328
2004	3.00	5.82	197	2.70	1.98	331
2005	2.99	3.14	193	2.62	1.91	335
2006	2.94	1.97	182	2.41	1.55	256

CONCLUSIONS-DISCUSSION

Based on the number of the explored active burrows, burrow density of red fox is double of Eurasian badger's. This result, however, does not necessarily apply to abundance, since social behaviour of the two species is different. Fox lives solitarily, whilst badger in family groups (clan) (KRUUK, 1989; HELTAI, 2010). Number of active burrows may let us draw conclusions about the size of red fox population, but this is not possible in case of the badger taking into consideration that the size of clans may range from 2-3 to dozen of individuals depending on the food supply (NEAL AND CHEESEMAN, 1996). In order to establish a reliable value of Eurasian badger population density, our presented method should be supplemented by footprint counting and whole-year observation (HELTAI AND KOZÁK, 2004). Comparing the estimation of 2011 and the complete counting of 2012 we can conclude, that estimation was more precise in case of red fox. For Eurasian badger burrows, 20% underestimation was found; however, the result of the complete counting is still within the standard deviation of the estimated value (*Table 2*). Burrow densities of badger statistically differ in plain and hilly habitats. Its background may be the expanding Europe-wide range seen in the last decades (GRIFFITHS, 1993; HELTAI ET AL, 2001). In Hungary, in the recently occupied plain areas, badger abundance has not reached such level yet, as in its original hilly habitat (HELTAI, 2010). In case of red fox, the low value of the general national population density figure may refer to a remarkable systematic underestimation by wildlife managers. Using the method of population-reconstruction, CSÁNYI AND TÓTH (2000) found 200% underestimation for red deer. One may wonder, if in case of such an important, emblematic big game species as red deer, underestimation may be so large, what accuracy we can expect for species with far less economic concerns. Both Eurasian badger and red fox shows raising population trends in Hungary (HELTAI, 2010). Thoughtful management of these species is a more and more often occurring question in fields of both nature conservation and wildlife management; and animal and human health consequences of illnesses transmitted by these species are not negligible sources of threats (SRÉTER ET AL., 2003; TAKÁCS ET AL., 2012). High density found in Börzsöny points out the "storehouse" role of "big-game"-type Game Management Units, meaning that the intensive carnivore rearing only on small game areas is not sufficient alone. In order to reach smaller abundances, carnivore-rearing must be implemented and continued in big game areas, too. Otherwise a source-sink type system is being realised

(CSÁNYI, 2007); carnivore backup will continuously arrive from big game areas to places, where carnivore rearing is properly implemented. The basis of a well designed, feasible, and economically controllable carnivore management is the accurate estimation of population. Our data that are based on detailed assessment, show reliable burrow density values and offer a feasible method for practitioners of wildlife management.

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