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THE STATE OF THE BROWN BEAR POPULATION ON THE TERRITORY OF HUNTING GROUNDS IN SLOVAKIA – THE TRANSBOUNDARY AREA CORRESPONDING WITH POLAND AND UKRAINE (EASTERN CARPATHIANS)

Stan populacji niedźwiedzia brunatnego zgłaszany przez obwody łowieckie na Słowacji – na obszarze przygranicznym z Polską i Ukrainą (Karpaty Wschodnie)

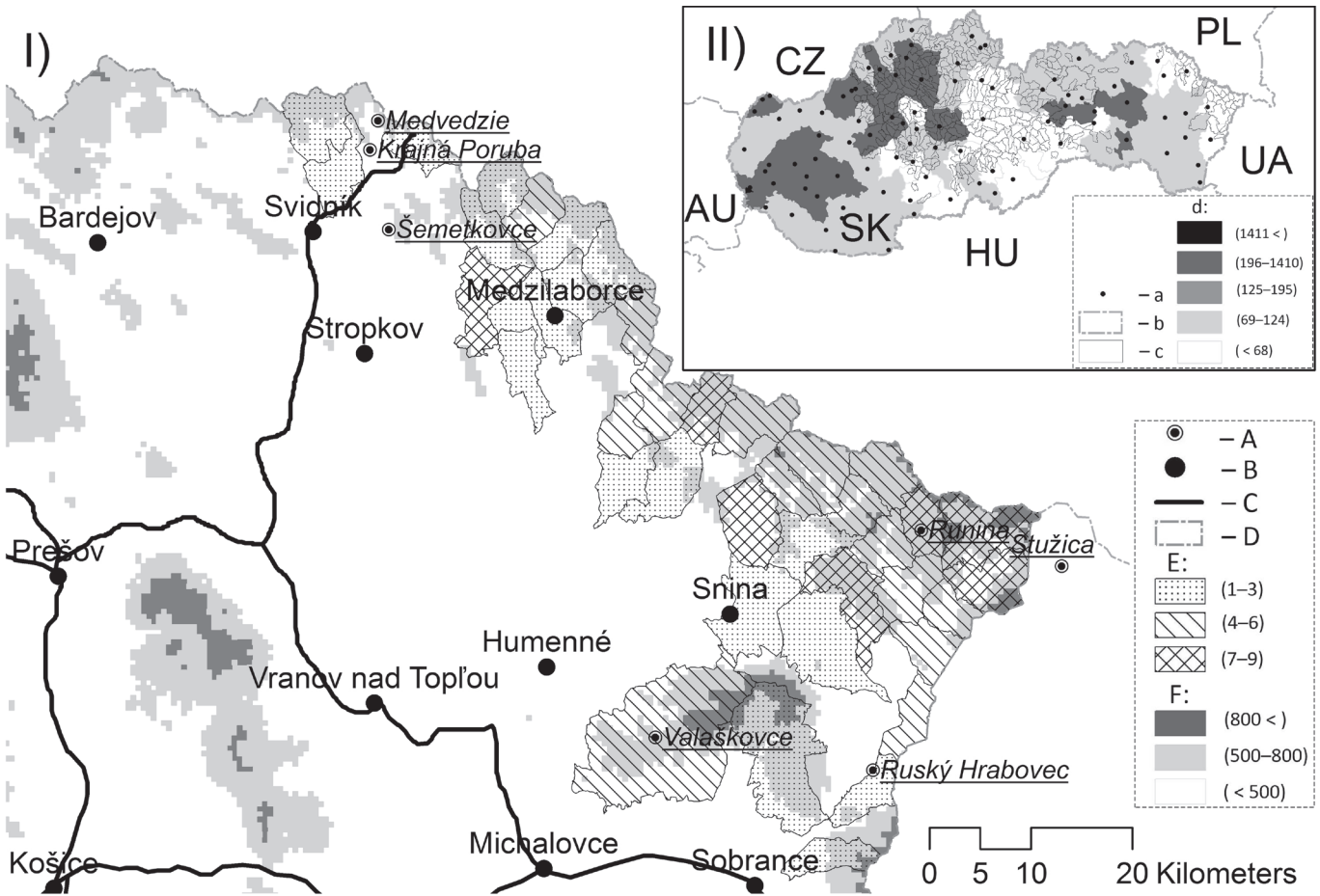
Abstract: In this study we analyse the data of bear distribution on the basis of the data from spring game stock reports (2002–2010). We recorded: I) the stability of distribution and density of bear population decreased in relation to decreasing altitude, II) stabilization of the bear population in the transboundary area corresponding with Poland of the study area in 2002–2010, III) the present state of bear distribution is comparable to the area of the villages with symbol of brown bear in administrative seals 150 years ago. We can predicted that spatial analysis of the data from the spring game stock may be helpful in determining the status of the population.

Key words: *Ursus arctos*, spatial data, historical records, density, spring game stock.

Introduction

Study area (Fig. 1) is situated at the boundary between Eastern and Western Carpathians (48.75°–49.45° N; 21.49°–22.57° E). The northern border is formed by the state boundary line with Poland and in the east neighbours with Ukraine. According to orographic structure of Slovakia (Mazúr, Lukniš 1986), study area represents following orographic units: Bukovské Hills, Laborecká Uplands, Vihorlat Mountains, Zemplínske Hills, Východoslovenská Lowlands, Beskydské Foothills and part of Ondavská Uplands.

Human population density is evidently lower in the study area (district / inhabitants per km^2: Snina / 47.2, Humenné / 84.6, Medzilaborce / 28.2, Stropkov / 53.3 and Svidník / 60.3 – the statistical data to 31.12.2010) (©Statistical Office


I)
II)
CZ
PL
UA
AU
SK
HU
d:
(1411 <)
(196–1410)
(125–195)
(69–124)
(< 68)
– a
– b
– c
Medvedzie
Kalná Poruba
Bardejov
Svidník
Šemetkovce
Medzilaborce
Stropkov
Prešov
Snina
Humenné
Vranov nad Topľou
Ruská
Stužica
Valaškovce
Ruský Hrabovec
Michalovce
Sobrance
Košice
– A
– B
– C
– D
E:
(1–3)
(4–6)
(7–9)
F:
(800 <)
(500–800)
(< 500)
0 5 10 20 Kilometers

of SR 2011) in comparison to whole Slovakia – 110 inhabitants per km^2 (Dubcová et al. 2008).

Historical data shows that the largest decrease in the number of bear individuals took place in the middle of 19th century. In 1857 (Molnár et al. 1984) the amount of 99 individuals of bear were killed only in Šarišská and Zemplínska župa (historical administrative units in the eastern Slovakia). The high number of killed bears was probably caused indirectly (Kavuljak 1930, cit. in Jamnický 1993) by using of strychnine to poison wolves at that time (Blatný 1965 cit. in Jamnický 1993). Since 1857, lower annual numbers of killed bears were recorded in Šarišská and Zemplínska župa (Jamnický 1993). It was probably the indication of separation of population to eastern and western part in given period (Straka et al. 2011) and re-connection was not possible because of non-regulate hunting of bears (Feriancová 1955; Jamnický 1993). Despite of that Janík et al. (1986, 1997) drown figure of re-connection of these two subpopulation on Slovak side of territory, the same author (Janík et al. 1986) only assumed connection in short time in close future. Also Hell, Slamečka (1999) assumed connection of bear population on Polish side of territory.

There are only a few data about mortality of bears from recent time in the study area. The carcass of bear was found cadaver of near the village Ulič in 1984. In 1988 big bear without a part of left back paw was shot near the village Runina. In 2001 dog killed cub of bear near the village Príslop. In 2005 the carcass of bear was found near the village Vyšná Jablonka. In 2010 the bones from rib cage of young bear were found near the village Runina (Štofík 2010) - it was confirmed as a case of poaching.

The presence of brown bear has been recorded in the study area during the whole 20th century (Štofík et al. 2010), but we assume that in fact it was only

Fig. 1. I) The present state of distribution of bear in the north-east of Slovakia in 2002–2010: A – villages with the symbol of bear in the administrative seal, B – towns, C – main roads, D – state boundary, E – evaluated hunting grounds with presence of the bear (number of years), F – hypsometric zones (m a. s. l.). **II)** The present state of distribution of bear in Slovakia in 2002–2010 (Štofík et al. 2013a): a – towns, b – state boundary, c – hunting grounds with presence of bear, d – population density of particular districts of Slovakia to 31.12.2010 ©Statistical Office of SR 2011 (inhabitants per km^2).

Ryc. 1. I) Stan rozmieszczenia populacji niedźwiedzia brunatnego w północno-wschodniej Słowacji w latach 2002-2010: A – wsie z symbolem niedźwiedzia w pieczęci administracyjnej, B – miasta, C – główne drogi, D – granice państwowe, E – badane tereny łowieckie, w których występuje niedźwiedź brunatny (liczba lat); F – strefy hipsometryczne (m n.p.m.). **II)** Stan rozmieszczenia populacji niedźwiedzia brunatnego na Słowacji w latach 2002–2010 (Štofík i in. 2013a): a – miasta, b – granice państwowe, c – tereny łowieckie, w których występuje niedźwiedź brunatny, d – gęstość zaludnienia w poszczególnych powiatach Słowacji do 31.12.2010 ©Statistical Office of SR 2011 (liczba mieszkańców na km^2).

sporadic. We deduced it from the fact of absence of legal hunting quarries of bear between 1907 (Jamnický 1993) and 1988 (Štofík et al. 2010) and from known data about size, density and structure of bear population at that time (Komárek 1955; Feriancová 1955; Škultéty 1970; Terray et al. 1980; Sabadoš, Šimiak 1981; Janík et al. 1986; Hell, Slamečka 1999). We have recorded the process of strengthening of population of bear since the end of the 20th century. Pčola (2002) estimated 16 individuals of bear in the territory of Eastern Carpathians in 1997 and 18 individuals of bear only in the territory of Poloniny NP in 2001 (that is 0.04 bear per km^2 in 2001). This bear population (Straka et al. 2011) has significantly increased in the last years (Štofík et al. 2010). The population consisted of minimum 15 individuals from October 2008 to March 2009 (Straka et al. 2013). On the basis of the non-invasive DNA samples collected from November 2008 to January 2013, the amount of 48 (23 ♂; 25 ♀) unique genotypes of bear were identified over the whole period, and amount of 16 (95%CI = 10–23) over the selected 5 sub-periods (Holbová 2013).

The bear is strictly protected by law and it is forbidden to hunt it in the eastern part of Slovakia (Štofík et al. 2013b). This prohibition is valid also in neighbouring countries in Poland (Selva et al. 2011) and Ukraine (Delehan et al. 2011). This is the fact, which could help to increase of population of the bear in the study area (Jakubiec 2001; Delehan et al. 2011; Štofík et al. 2010) and enable us to analyse changes of population without noticeable (legal) intervention to the structure of population by hunting in the study area.

Material

In this study we used:

a) the layer of contour lines of SR – CVM 50 (Continuous digital vector map of Slovak Republic), background the Base maps of the Slovak Republic, scale 1: 50,000,
b) the layer of hunting grounds in Slovakia (©NFC SR 2002),
c) the data on spring game stock (SGS) reported by game associations to NFC SR (National Forest Centre of Slovak Republic) in years 2002–2010 (©NFC SR 2011).

The SGS is the event, which happens in whole Slovakia on one chosen day determined in advance every year. On this day hunters count all species of game in the area of their hunting grounds (©NFC SR 2011). They have been participated 33 private game associations with 994 km^2 of managed area and 8 state game associations with 433 km^2 managed areas in the spring counting of game according to data of SGS in the study area.

1. Methodology

The methods consisted of following steps:

1. Connection data of bears from spring game stock (SGS) in years 2002–2010 (©NFC SR 2011) with the layer of hunting grounds (©NFC SR 2002).
2. Evaluation of stability (presence 1–9 years) and calculation of density of bears in particular hunting grounds (bear per km^2) without the zero data (2002; 2003…2010 and 2002–2010).
3. Digital terrain model (raster 500×500m) was created in GIS software Grass 6.1 on the background of contour lines from SVM 50, and a map of hypsometric zones (scaled by 100 m a. s. l.) was derived from it.
4. The establishment of buffer zones (each 1,000m) from borders with Ukraine and Poland and using method of superposition from landscape ecology (Olah et al. 2006) to create layer of polygons of "segments" with regular distances from neighbouring countries Poland and Ukraine.
5. There have been calculated data about maximal altitude, stability and average data about density (point 2) of the bear (2002–2010) for particular segments (point 4).
6. There have been calculated stability (point 2) of bears depending on altitude (point 5) in 2002–2010 (9 years in all) for particular segments (point 4).
7. There have been calculated the influence of altitude on frequency of presence (%F) for segments (point 4): 1 to 3 years = 33%, 4 to 6 years = 67%, 7 to 9 years = 100%.

Results and discussion

We observed presence of bear in 41 hunting grounds (Fig. 1) in the area of 1,427 km^2 (mean 35; SD 25 km^2) during 2002–2010.

There have been registered higher level of bear density (Table 1) and presence in higher altitude (Table 2) in evaluated segments (n = 1,468; mean 1; SD 0.4 km^2). In Slovakia bears preferred well forested localities with colder climate at higher altitudes (Štofík et al. 2013a). We assume that it is related to colder climate (Lapin et al. 2000) and longer snow cover (Šťastný 1988) in this altitude. It's been registered the most stabile presence of the bear in this part of study area (Table 3; Fig. 2).

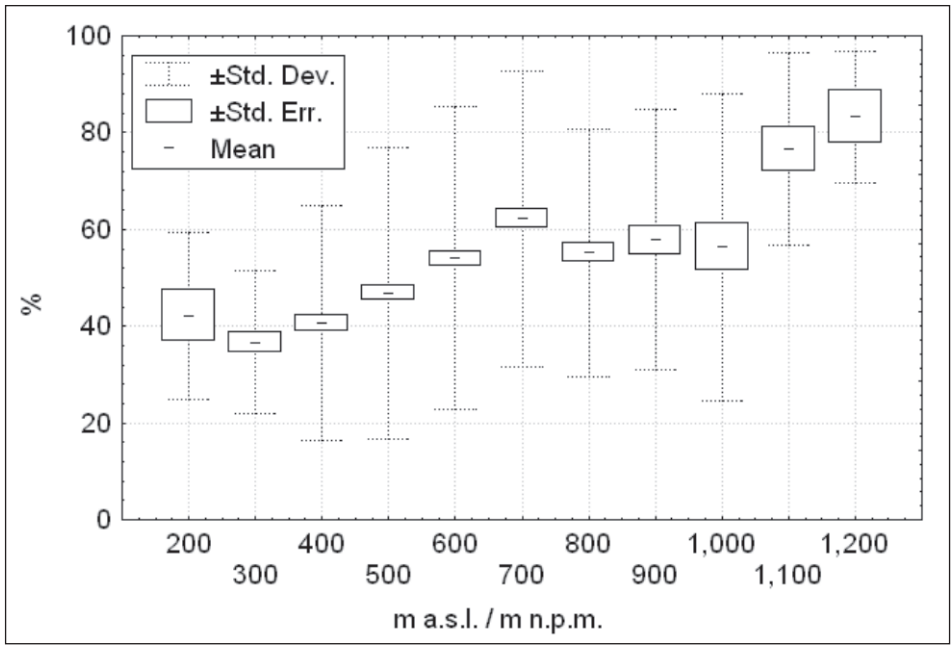


Fig. 2. The influence of the altitude on the stability of bear occurrence (2002–2010) (%) in the study area in evaluated segments (n = 1,468).
Ryc. 2. Wpływ wysokości n.p.m. na stabilność występowania (2002–2010) niedźwiedzia brunatnego (%) na obszarze badań w oszacowanych przedziałach (n = 1,468).

There were recorded the highest stability (n = 6; mean 83; 95%CI = 69–98%) in the area with maximal altitude 1,200 m a.s.l. and the lowest stability (n = 43; mean 37; 95%CI = 32–41%) in the area with maximal altitude 300 m a.s.l. (Fig. 2). We assume that higher value of stability (n = 10; mean 42; 95%CI = 30–55%) in the area with altitude to 200 m a.s.l. (Fig. 2) is caused by evaluation of significantly higher area (166 km^2) of hunting ground (Fig. 1, above Michalovce) in comparison to other 40 hunting grounds (mean 32; SD 13 km^2) and also to whole Slovakia (mean 27; SD 21 km^2; Štofík et al. 2013a).

In the Central and Southern Europe bears prefer mainly mountain areas which are Carpathians, Alps, Pyrenees, Cantabrian Mts, Dinaric-Pindus Mts, etc. The same distribution is recorded in our study (Fig. 2). In the Northern Europe bear is more widely distributed (Chapron et al. 2014).

In the areas with higher values of stability of bears we noticed increasing of bear density from 0.04 to 0.07 (Table 1). Data from the non-invasive DNA samples of bears (Straka et al., 2013; Holbová 2013) of their study area (cca 440 km^2) with minimal density identified over the selected sub-periods (0.02–0.05 bear per km^2) are not different as minimal data according to SGS (Table 3). The mean data of density from SGS in area, where DNA analyses were made (Table 3,

Holbová 2013) are not different as value of population size estimate obtained by rarefaction method of Chessel, Eggert and CAPWIRE (Straka et al. 2013). However there are lower than data of the non-invasive DNA samples (Holbová 2013) over the whole period (0.11 bear per km^2). In Slovakia the bear population density from SGS was higher (mean 0.15; SD 0.9 bear per km^2) in the area with more stable presence and at higher altitudes (Štofik et al. 2013b). Bear densities in Slovenia regions were ranging from 0.07 to 0.20 bear per km^2, locally over 0.40 bear per km^2 were one of the highest reported in the world (Jerina et al. 2013). That is (0.40 bear per km^2; Jerina et al. 2013) noticeably higher than max of bears from SGS (Table 3).

Table 1. The interdependence of mean density of bear per km^2 (2002–2010) and altitude and frequency of presence (%F) in evaluated segments.
Tabela 1. Zależność pomiędzy średnim zagęszczeniem niedźwiedzi na km^2 (2002–2010) a wysokością n.p.m. oraz frekwencją występowania w badanych przedziałach (%F).

Altitude (m a.s.l.) *Wysokość n.p.m. (m)*	F 33%	F 67%	F 100%	F all *F razem*	Area *Powierzchnia*
	bear per km^2 *l. os./km^2*	bear per km^2 *l. os./km^2*	bear per km^2 *l. os./km^2*	bear per km^2 *l. os./km^2*	km^2
200	**0.06**	0.02		0.04	1
300	**0.05**	0.02		0.04	24
400	0.03	0.04	0.04	0.03	148
500	0.04	0.04	**0.05**	0.04	322
600	**0.05**	**0.05**	**0.06**	**0.05**	362
700	0.04	**0.06**	**0.07**	**0.06**	238
800	0.02	**0.06**	**0.11**	**0.06**	176
900	0.04	0.04	**0.09**	**0.06**	83
1,000	0.02	**0.05**	**0.10**	**0.06**	40
1,100		0.04	**0.10**	**0.08**	24
1,200		**0.14**	**0.05**	**0.06**	7
All / *Razem*	0.04	**0.05**	**0.07**	**0.05**	1,427

Table 2. Representative attributes of changes in evaluated segments (n = 1,468) of brown bear (Slovakia) distribution in the cross-border area with Poland and Ukraine (2002–2010; 1,427km^2).

Tabela 2. Istotne atrybuty rozmieszczenia niedźwiedzia brunatnego na Słowacji (ocenionych zostało 1,468 przedziałów co 1,000 m) w obszarze przygranicznym z Polską i Ukrainą (2002–2010; 1427 km^2).

Years/*Lata* Attributes/*Atrybuty*	2002	2003	2004	2005	2006	2007	2008	2009	2010	2002–2010
Number of buffer zones with bear presence (starting from UA border) *Liczba stref buforowych z obecnością niedźwiedzia (od granicy z Ukrainą)*	56	62	59	58	62	49	68	61	78	84
Maximal distance from UA border *Maksymalna odległość od granicy z Ukrainą (km)*	62	62	65	65	84	61	75	61	80	84
Number of buffer zones with bear presence (starting from PL border) *Liczba stref buforowych z obecnością niedźwiedzia (od granicy z Polską)*	41	41	41	37	24	19	24	41	38	41
Maximal distance from PL borders *Maksymalna odległość od granicy z Polską (km)*	41	41	41	37	24	19	24	41	41	41
Density of bears *Zagęszczenie niedźwiedzi* (No. per km^2 / *szt. na km^2)*	0.03	0.04	0.03	0.05	0.05	0.07	0.07	0.05	0.06	0.05
Number of bears *Liczba niedźwiedzi*	27	25	27	31	40	44	59	51	73	
Area/*Powierzchnia* (%)	55	46	52	45	49	42	53	69	78	100

We have recorded process of increasing distribution of population (Table 2) along the border with Poland (Fig. 1). It is probably caused by strengthening of population in the surrounding area (Jakubiec 2001; Delehan et al. 2011; Śmietana et al. 2014) and by higher number of damages caused by bears recorded in Poland (Sergiel et al. 2012; Śmietana 2012). Contrary to this observation the temporary decrease of bear presence has been recorded along Slovak–Ukrainian border in 2005–2008 (Table 2).

The highest values of stability together with the highest values of mean and maximum density of bears were recorded in the north-eastern part of study area (Table 3). The comparison of the attributes of density and stability of bear population along the borders with Ukraine and Poland (Fig. 1) shows that higher values of density and stability were evaluated along Slovak–Polish border compared to the situation on Slovak–Ukrainian border (Table 3). The same results were recorded by using of method of snow-tracking (Štofík 2012). We recorded decreasing values of density and stability of bear presence (Table 3) in relation to increasing distance from Poland (Bieszczady National Park), that is why we assume the positive influence of the vicinity of Poland on bears. The similar tendency was recorded also in Poland (Śmietana et al. 2012). The next probable reason could be influence of poaching (Štofík 2010).

There were recorded decreasing values of bear density and stability in area with higher values of mean altitude in distance 30,001–40,000 m from Poland in the vicinity of Ukrainian border (Table 3). This situation is probably result of proximity of bigger villages Ulič (922 inhabitants) and Ubľa (832 inhabitants). Only the noticeably area with higher value of bear density (Table 3) was recorded in the vicinity of town Sobrance (Fig. 1), but the stability was low (observation took only 2 years).

When we compare the present and the known oldest historical data of bear population distribution (Štofík et al. 2010) there is evident process of population redistribution from small area along the Slovak–Ukrainian–Polish border (Feriancová 1955; Škultéty 1970; Teray et al. 1980) back to the area (Fig. 1), where bear population probably have been historically present (Štofík et al. 2013a). We assumed historical area of bear distribution on the basis of bear symbol in the historical seals of local villages originated from 18th and 19th century (Fig. 1, 3).

There was observed (Chapron et al. 2014) restoration of bears almost in whole Europe (from WWII to the 1970s versus 2011) although authors used tendentious spatial data for Slovakia (f.e. Štofík et al. 2013a). Increasing of number of bear individuals (Štofík et al. 2010) and increasing of bear population distribution in the study area (Štofík et al. 2013a) and surrounding area as well (Śmietana et al. 2014), are probably results of increasing supplemental feeding for ungulates (Štofík et al. 2013b; Kavčič et al. 2015). Supplemental feeding for ungulates is common in Slovakia, also in Poland (Bojarska, Selva 2013), except for Bieszczady

Table 3. The influence of distance from neighbouring countries (Poland, Ukraine) to chosen values of attributes (0–10,000 m = 10,000 m; 10,001–20,000 m = 20,000, etc.; in evaluated segments each 1,000 m) from borders with Ukraine and Poland (2002–2010). Bold font – above average values, grey background of text – area of collecting of the non-invasive DNA samples of bears (2008–2013, Holbová 2013).

Tabela 3. Wpływ odległości od sąsiadujących krajów (Polska, Ukraina) na wybrane wartości atrybutów istotnych dla rozmieszczenia niedźwiedzia (0–10 000 m = 10 000 m; 10 001–20 000 m = 20 000 m, itd.;w ocenianych przedziałach co 1000 m od granicy z Ukrainą i Polską. Dane z lat 2002–2010. Pogrubione liczby – wartości powyżej średniej, szare tło – obszar gdzie zbierano próby genetyczne niedźwiedzi (2008-2013, Holbová 2013).

		Evaluated attributes / *Oceniane atrybuty*			Distance from Ukraine (m) / *Odległość od Ukrainy (m)*									Total *Razem*
					10,000	20,000	30,000	40,000	50,000	60,000	70,000	80,000	90,000	
Distance from Poland (m) / *Odległość od Polski (m)*	10,000	Segments / *Przedziały*		n	100	100	93	100	70	100	40	64	15	682
		Altitude/*Wysokość*	Mean	m a.s.l. / *m n.p.m.*	**692**	**644**	**600**	511	**545**	521	521	476	**577**	**573**
		Area / *Obszar*		km²	125	114	91	117	75	119	47	57	19	763
		Density *Zagęszczenie*	mean	bear per km² *l. niedźwiedzi na km²*	**0.10**	**0.09**	**0.08**	**0.06**	**0.06**	**0.07**	0.04	0.04	0.03	**0.07**
			min		0.05	0.04	0.05	0.03	0.03	0.03	0.03	0.03	0.03	0.03
			max		0.20	0.18	0.14	0.14	0.09	0.14	0.05	0.05	0.03	0.20
		Stability/ *Stabilność*	mean	years / *lata*	**9**	**9**	**9**	**9**	**9**	8	7	2	1	**9**
	20,000	Segments / *Przedziały*		n	90	100	48	36	15	53	1	4		347
		Altitude/ *Wysokość*	mean	m a.s.l. / *m n.p.m.*	463	473	417	370	382	457	400	309		443
		Area / *Obszar*		km²	83	103	36	30	11	57	0	1		321
		Density *Zagęszczenie*	mean	bear per km² *l. niedźwiedzi na km²*	**0.05**	0.03	**0.05**	**0.07**	0.04	0.04	0.03	0.03		0.04
			min		0.02	0.02	0.02	0.05	0.04	0.03	0.03	0.03		0.02
			max		0.07	0.05	0.06	0.08	0.05	0.06	0.03	0.03		0.08
		Stability/ *Stabilność*	mean	years / *lata*	**9**	**9**	**9**	4	3	8	7	1		**9**
	30,000	Segments / *Przedziały*		n	57	94	42							193
		Altitude/ *Wysokość*	mean	m a.s.l. / *m n.p.m.*	470	**687**	524							**588**
		Area / *Obszar*		km²	40	80	31							151
		Density *Zagęszczenie*	mean	bear per km² *l. niedźwiedzi na km²*	0.03	0.02	0.02							0.02
			min		0.01	0.01	0.02							0.01
			max		0.04	0.02	0.02							0.04
		Stability/ *Stabilność*	mean	years / *lata*	6	7	7							7

Distance from Poland (m) / *Odległość od Polski (m)*														
40,000	Segments / *Przedziały*		n	74	61	94	6						235
	Altitude/ *Wysokość*	mean	m a.s.l. / *m n.p.m.*	**531**	475	511	404						505
	Area / *Obszar*		km²	53	46	88	2						189
	Density *Zagęszczenie*	mean	bear per km² *l. niedźwiedzi na km²*	0.04	0.01	0.02	0.02						0.03
		min		0.01	0.01	0.02	0.02						0.01
		max		0.06	0.02	0.02	0.02						0.06
	Stability/ *Stabilność*	mean	years / *lata*	3	5	5	5						5
50,000	Segments / *Przedziały*		n	3		7	1						11
	Altitude/ *Wysokość*	mean	m a.s.l. / *m n.p.m.*	200		334	400						303
	Area / *Obszar*		km²	0		4	0						4
	Density *Zagęszczenie*	mean	bear per km² *l. niedźwiedzi na km²*	**0.06**		0.02	0.02						0.03
		min		0.06		0.02	0.02						0.02
		max		0.06		0.02	0.02						0.06
	Stability/ *Stabilność*	mean	years / *lata*	2		5	5						5
Total / *Razem*	Segments / *Przedziały*		n	324	355	284	143	85	153	41	68	15	1468
	Altitude/ *Wysokość*	mean	m a.s.l. / *m n.p.m.*	**548**	**578**	522	470	517	499	518	466	**577**	**531**
	Area / *Obszar*		km²	300	343	249	149	85	176	47	58	19	1427
	Density *Zagęszczenie*	mean	bear per km² *l. niedźwiedzi na km²*	**0.06**	0.04	0.04	**0.06**	**0.06**	**0.06**	0.04	0.04	0.03	**0.05**
		min		0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.01
		max		0.20	0.18	0.14	0.14	0.09	0.14	0.05	0.05	0.03	0.20
	Stability/*Stabilność*	mean	years / *lata*	**9**	**9**	**9**	**9**	**9**	8	7	2	1	**9**

National Park, and sporadically used in Ukraine (Kvakivska I. in verb. 2013). In the areas, where supplemental feeding for ungulates increase (Štofík, Merganič 2013b), were recorded higher values density from SGS (Table 3) compared to „estimated" density (0.01–0.06 bear per km^2) from the end of the 20th century (Janík 1997).

Fig. 3. The prints of administrative seals of the villages from the Eastern Carpathians with symbol of brown bear: a) Runina (1837), b) Ruský Hrabovec (1837), c) Stužica (1838), d) Valaškovce (village, which has been removed in 1937), e) Medvedie and Krajná Porubka (1787), f) Šemetkovce (made on the basis of the seal from 1868).
Ryc. 3. Odciski pieczęci administracyjnych wsi z Karpat Wschodnich, z symbolem niedźwiedzia brunatnego: a) Runina (1837), b) Ruský Hrabovec (1837), c) Stužica (1838), d) Valaškovce (wieś, która przestała istnieć w 1937), e) Medvedie i Krajná Porubka (1787), f) Šemetkovce (wykonana na podstawie pieczęci z 1868).

The fragmentation of bear population in Slovakia into Eastern Carphatian and Western Carphatian, resulted from fragmentation of bear habitat (Fig. 1). By reason of connection these population is necessary to connect territory between them. It is necessary to protect and care about all this area to preserve suitable habitat for bear (Fernández et al. 2012). The significant contribution to fragmentation of population of the bear (Straka et al. 2011) were also human population increase in the study area (Dubcová et al. 2008), changes in infrastructure of the territory (urbanisation, building of road system, etc.) and discontinuity and isolation of remained fragments of forests (Fig. 1).

Slánske Hills (Fig. 1, surrounded by big cities Košice, Prešov, Trebišov, Michalovce and Vranov nad Topľou) is a locality with high probability of presence of bear (Koreň et al. 2011). It is area, where the bear has been present in the past, what is documented in a work that deals with hunting of bears in the hunting ground of Slánske manor at the beginning of the 20th century (Molnár et al. 1984). According to Molnár (1984) 1–2 bears were shooted per year at that time. Also location of Slánske Hills in higher levels of altitude (Fig. 1) and continuous cover of forest over a large area are next positive factors for presence of the brown bear there (Koreň et al. 2011; Fernández et al. 2012). On the other hand isolation of this volcanic mountains and anthropogenic factors (Fernández et al. 2012) that are road network (Fig. 1) and density of human population (in the west – Košice 76 to 1,410 inhabitants per km^2, in the north – Prešov 179 inhabitants per km^2 and Vranov nad Topľou 103 inhabitants per km^2, in the south – Trebišov 98 inhabitants per km^2 and in the east Michalovce 108 inhabitants per

km²; ©Statistical Office of SR 2011) probably have formed barriers for spreading of bear to Slánske Hills (©NFC SR 2011). Although some study describe presence of the bear on the territory of Slánske hills in 2004 (f.e. Finďo et al. 2007).

Conclusions

This study work analyses spatial identification of Eastern Carphatian bear population in Slovakia by using of methods of landscape ecology. We used data on spring game stock (SGS) reported by game associations in years 2002–2010 (©NFC SR 2011) for analytic data processing in GIS software and evaluated of changes in bear distribution. Despite the present tendency to using modern and exact methods for monitoring (telemetry, DNA analyse, etc.) for the purpose of bears management in extended area in practice method of SGS is mainly preferred. We suppose that this method with all its disadvantages (diverse sizes of territories hunting grounds, unknown observers, changes of observers, biased way of data evaluation, etc.), has also positive sides (long-term observations within relative stable areas, wide basis of observers who know the area, evaluation of extended area, „free of charge" method). From our own experience with SGS we presume that there are not really data collected within one day, but generally there are data transfer from last year to next year. Despite the fact that data on SGS related to bears are only approximate and do not reflect the real state of bear number, the spatial analysis of those data and addition of the data on guiding mother may be helpful in determining the status of the population (Selva et al. 2011). Bears in the study area are evidently localised mainly along the border with Poland and Ukraine. We evaluated influence of neighbouring countries on Slovak part of population. We recorded stabilisation of bear distribution along the border with Poland, which means decreasing values density and stability of bear presence in relation to increasing distance from Poland (Bieszczady National Park). We assume that it could be caused by decreasing altitude, habitat fragmentation and probably poaching. Stability of presence and density of bear population is decreasing in relation to decreasing altitude. Despite the fact that we have only partial data from distant past on state of bear in the study area, we used indirectly historical data on bear presence from administrative seals with pictured particular animals. On the basis of them we can predict presence of concrete species typical of that area. The present distribution of bear is comparable to the area of the villages with symbol of bear in administrative seals 150 years ago (Fig. 3).

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Streszczenie

Niniejsza praca analizuje rozmieszczenie przestrzenne wschodniokarpackiej populacji niedźwiedzia brunatnego na Słowacji, przy pomocy metod ekologii krajobrazu. Wykorzystane zostały dane z wiosennych ocen zasobów zwierząt łownych (SGS) podawanych przez stowarzyszenia łowieckie w latach 2002–2010 (© NFC SR 2011) do analizy przestrzennej danych w GIS w celu oceny zmian w rozmieszczeniu niedźwiedzia brunatnego. Pomimo faktu, że wiosenne dane dotyczące liczebności niedźwiedzi są jedynie orientacyjne i nie odzwierciedlają rzeczywistego stanu liczby osobników, analiza przestrzenna tych danych jest

dobrą alternatywą. Ze względu na fakt, że niedźwiedzie na badanym obszarze są obecne wzdłuż granicy z Polską i Ukrainą, oceniano również wpływ tych krajów na populację słowacką. Stabilność występowania niedźwiedzi oraz zagęszczenia populacji maleją wraz z obniżeniem wysokości n.p.m. Stwierdzona została stabilizacja rozmieszczenia niedźwiedzia wzdłuż granicy z Polską, jak również określono, że obecny areał niedźwiedzia jest podobny jak przed 150 laty (co wywnioskowano na podstawie odcisków pieczęci administracyjnych wsi z Karpat Wschodnich, z symbolem niedźwiedzia brunatnego).