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# Time and spatial trends in the brown bear *Ursus arctos* population in Slovakia (1900–2010)

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**Abstract**
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This work discusses several factors underlying changes in distribution of brown bears in Slovakia. Our evaluation was carried out based on historical records, map documents, and data from the bear census in Slovakia (2002–2010), and it was performed with using GIS tools. We concluded that: i) bears preferred well forested localities with colder climate at higher altitudes and that the influence of altitude was significantly stronger than the impact of forest cover density, ii) bear occurrence and relative density gradually decreased with decreasing altitude, iii) in the long term aspect, the most noticeable fluctuation occurred in medium altitudes from 400–1,100 m a.s.l. (SD > 10%), the highest stability was observed from 1,500 m a.s.l. (SD < 2%), and absence or very rare occurrence (less than 5%) was recorded below 300 m a.s.l, iv) unregulated interventions affected spatial distribution of brown bears across Slovakia in long term perspective. We presume, that evaluating of the data come from bear census in particular game grounds by using of spatial analysis will be possible to use as one of the indicator of the state of the population in Slovakia and for formulation of management of the brown bear.

**Keywords**
altitude, Carpathians, density, historical records, management, spatial analysis

## Introduction

The relation between the man and the nature was critical in the period of intensive development of pasturage and sheep breeding connected with the so called Walachian colonisation of the territory of today Slovakia. The general leitmotiv was intensive killing and hunting bears in all possible ways (shooting, catching in soil traps, iron chains, nooses). Eradication of wild game was ordered according to the hunting regulations ordered by the emperor Joseph II, and each kill of a bear was rewarded (Čajka, 1986). The most noticeable drop in the brown bear population in Slovakia probably occurred in the midst of the 19th century. The abolition of servitude (1848) and shifting the urbarium to the ownership of the former retainers were incentives for the people to fight against wild animals that endangered these people's proprieties. From 1857, there exist records about 99 bears killed only in the regions of Šariš and Zemplín (Eastern Slovakia), the number of the total kills for the rest of the country (97 individuals) seems incomplete (Molnár et al., 1984). This massive decline was probably caused by using strychnine for poisoning wolves (Blattný, 1965 cit. in Jamnický, 1993), with a „side effect" of death also to a large number of bears Kavuljak (1930 cit. in Jamnický, 1993). Then the kills in the regions of Zemplín and Šariš were negligible (Jamnický, 1993), incomparable with 1857 (Molnár et al., 1984). This allows us to suppose that the Slovak bear population was divided

into the East-Carpathian and West-Carpathian at that time (Straka et al., 2011, 2012). Figure 1 displays maps of bear distribution in Slovakia during the period from 18/19th century to the year 2010.

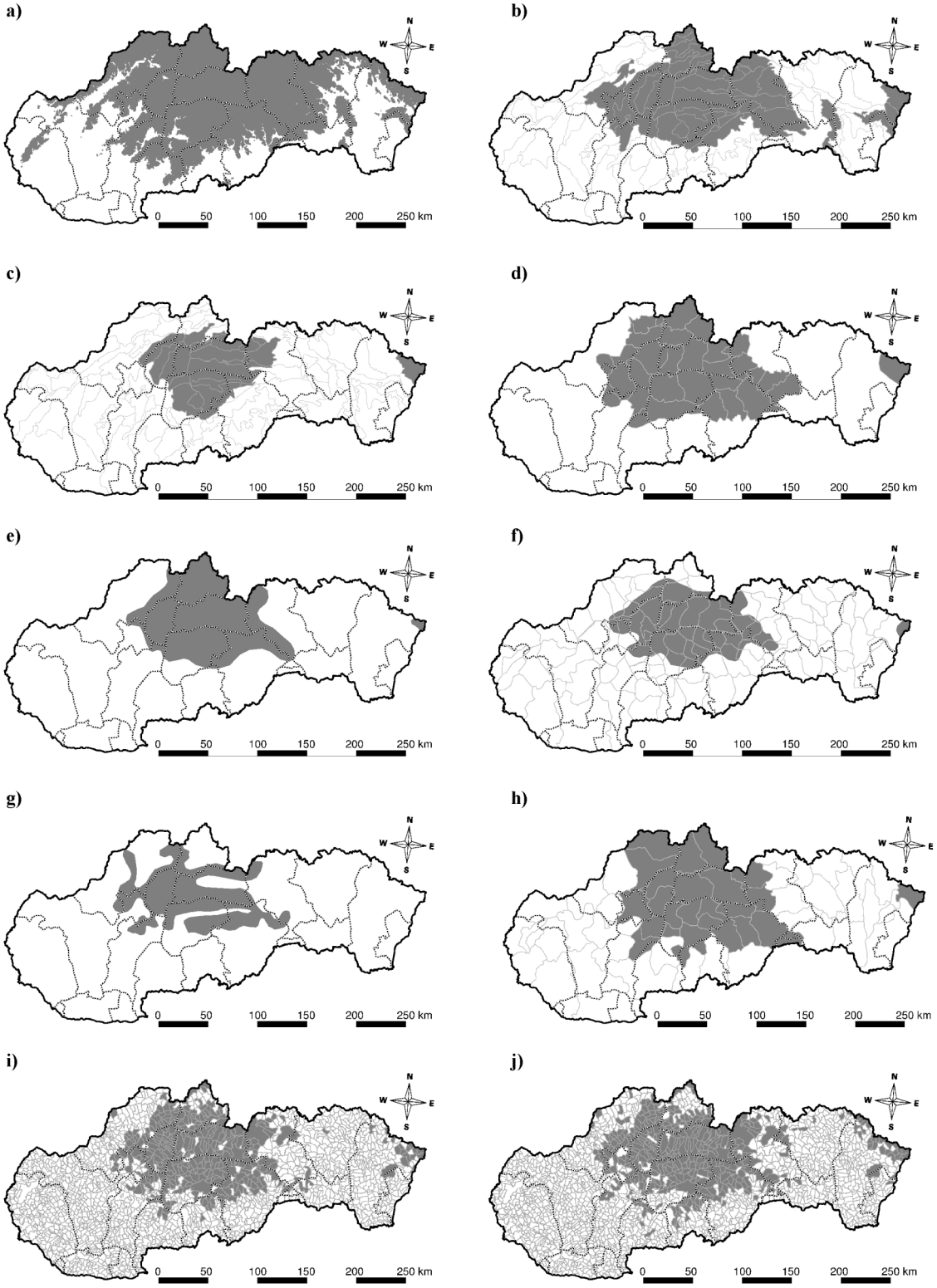


Fig. 1. Maps of bear distribution in Slovakia. a) 18/19th century (hypothesis); b) 19/20th century (Molnár et al., 1984, Štofík et al., 2010); c) WWI.–WWII. (Feriancová, 1955), d) 1953 (Feriancová, 1955); e) 1968 (Škultéty, 1970); f) 1972 (Hell and Sládek, 1974); g) 1977 (Sabadoš and Šimiak, 1981); h) 1980–1991 (Hell and Sabadoš, 1993); i) 2002 (©NFC SR, 2011); j) 2010 (©NFC SR, 2011).

The re-joining was probably hindered by the Act article XX/1883 on the game management allowing everybody to kill bears occurring on the land in their ownership. The act was valid for everyone, not only for the hunters, all around the year, so that were not any reasons to keep the kills in secret. This act was valid until the end of the WWII. By the Decree of the regional President No. 127, 203/14-1932 the bear has been given status of the over-the-year protection. This decree came in force on September 1 1932. However, the regional President was forced by hunters to issue a new regulation No. 208, 647/14-1932 allowing a subject to kill bears on the land in their ownership also in the case when the hunting right had been rented (Škultéty, 1970).

By the year 1932, the reduction of bear population was such dramatic that this required to accept legislative measures to keep the population in Slovakia viable. In this period, the number of brown bears in Slovakia was only several tens (Feriancová, 1955; Škultéty 1970; Janík et al. 1986; Hell and Sabadoš, 1993).

From 1958 to the earliest 80s, the game managers were focussing at killing old large individuals, especially males. During 1980s, there was initiated administrative regulation of killing large males. While in 1980–1982 was the average weight of killed indi-

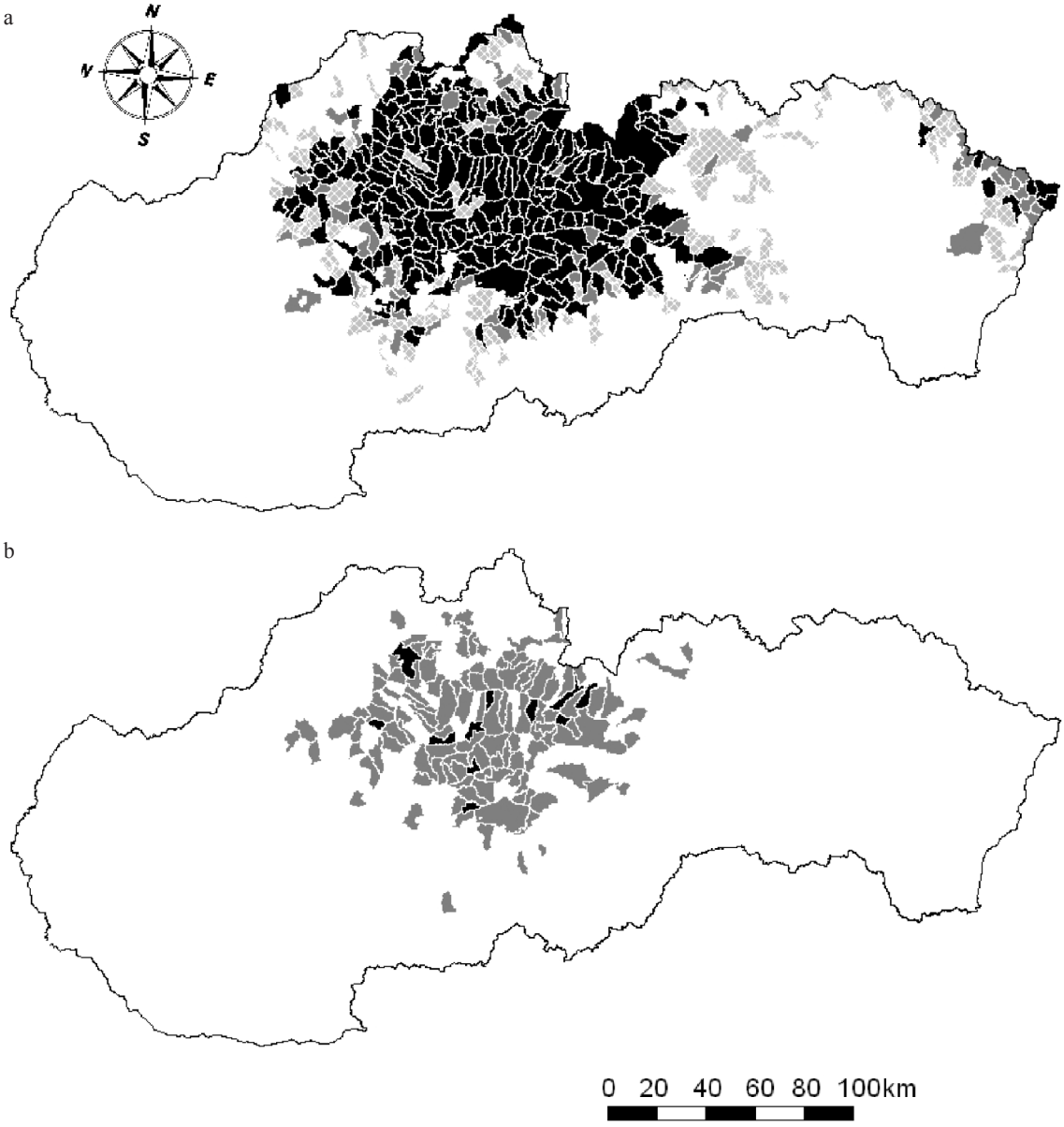


Fig. 2. State and management of the brown bear population in Slovakia (2002–2010). a) Occurrence stability S%: ■ = 100%, ■ = 67%, ▒ = 33%, b) kill rate: ■ < 0.1 ps km$^{-2}$, ■ > 0.1 ps km$^{-2}$.

viduals 142.5 kg, in years 1989–1991 it was only 101.8 kg (Hell and Slamečka, 1999). Since 1972 Sabadoš and Šimiak (1981) report that in 1972 was started also control of the stocks, which may have considerably influenced the distribution of brown bear in this period. Contrarily Hell et al. (1983) recommended an increase in kill from 5% to 8% of the existing stock. Hell et al. consider this value biologically acceptable, not endangering the game stocks. Today the bear kill rate is controlled only in smaller individuals, up to 100 kg, or with the front paw wide less than 12 cm (Adamec, 2007). State and management of the brown bear population in Slovakia (2002–2010) is presented in Fig. 2.

IUCN (2001) classifies the brown bear *Ursus arctos* as a low endangered animal – dependent on protection. According to the Act on Nature and Landscape Protection (No. 543/2002) and Decree of the Ministry of the Environment (No. 24/2003), forcing EU directives on habitats and birds, the brown bear is a species with a high protection priority of European importance. The paragraph § 35 (No. 543/2002) defines the brown bear as a protected animal, but it allows to ask for an exception (according to § 40 and § 56).

The number of brown bear population in Slovakia has been questioned by a range of authors the results of whom we use in this work. Our aim was to use spatial data on brown bear distribution in Slovakia and to analyse the factors affecting in long-term but also short-term aspect this bear population in this country.

## Material and methods

In this work we used: a) the layers of forests, districts and contour lines of SR – CVM 50 (Continuous digital vector map of Slovakia), background the Base maps of the Slovak Republic, scale 1 : 50,000, b) layer of map sets of Slovakia 1 : 5,000 (©Institute of Geodesy, Cartography and GIS), c) layer of hunting associations in Slovakia (©NFC SR – National Forest Centre Slovak Republic, 2002), d) data on shoots (mortality and similar.) from 1900–2010 (Molnár et al., 1984; Jamnický, 1993; Feriancová, 1955; Finďo et al., 2007; Sabadoš and Šimiak, 1981; Hell and Sládek, 1974, Hell et al., 1983; Hell and Slamečka, 1999; Kassa, 1998, 2001, 2002, 2006a, 2006b, 2007; Adamec, 2007; Štofik, 2010; ©NFC SR, 2011), e) data on damage to bee hives and agricultural facilities in Poland 1999–2010 (Sergiel et al., 2012), f) data on damage to bee hives and game management facilities in Slovakia in 1999–2006 (Hell et al., 2007), 2002–2010 (©NFC SR, 2011), g) generated historical data on bear distribution in Slovakia at the turn of the 19th/20th century Molnár et al. (1984), Štofík et al. (2010), h) generated historical data on bear distribution in Slovakia between WWI and WWII (Feriancová, 1955), i) map of bear distribution in Slovakia in 1953 (Feriancová, 1955), j) map of bear distribution in Slovakia in 1968 (Škultéty, 1970), k) map of bear distribution in Slovakia in 1972 (Hell and Sládek 1974), l) map of bear distribution in Slovakia in 1977 (Sabadoš and Šimiak, 1981), m) map of bear distribution in Slovakia in 1982 (Janík et al., 1984), n) map of forest enterprises with bear kill records from 1980–1991 (Hell and Sabadoš, 1993), o) data on spring game stocks (SGS), kills and damage caused by bears in individual hunting grounds in Slovakia from 2002 to 2010 (©NFC SR, 2011), p) data on number of inhabitants in individual districts of Slovakia to 31. 12. 2010 (©Statistical Office SR 2011).

The data were processed in the following steps:

i) Identification of the brown bear distribution in Slovakia from the data on hunting and occurrence of brown bears in the individual geomorphological units (Miklóš ed., 2002) at the turn of the19/20 centuries (Molnár et al., 1984; Štofík et al., 2010), between the WW I and WW II (Feriancová, 1955) and coupling these data with the layers of geomorphological units in Slovakia in the GIS environment (Miklóš (ed.), 2002).
ii) Identification of brown bear distribution from map sources: 1953 (Feriancová, 1955), 1967 (Škultéty, 1970), 1972 (Hell and Sládek, 1974), 1977 (Sabadoš and Šimiak, 1981), 1980–1991 (Hell and Sabadoš, 1993) and vectorised in GIS by visual interpretation (Olah et al., 2005, 2006).
iii) Identification of bear distribution and density (estimate) by coupling the data on spring game stock (SGS) reported by game associations in years 2002–2010 (©NFC SR, 2011) with the layer of game associations (©NFC SR, 2002). The layer for game grounds comprised 1,915 polygons, of which 91 which were not used within the spatial analysis of hunting grounds (non-hunting or closed areas). The reporting duty to assess the annual reports on the spring game stock (to March 31) is implied by the Act No. 540/2001 Z. z. on the national statistics. The hunting rights in the rented game grounds are provided for ca. 36,581 members of game associations and clubs (Dugovič, 2010), participating together with employees of state and military grounds in the game census.
iv) Creation of layers of uniformly dispersed area units – quadrates (segments 10 × 10 km and 5 × 5 km) in overlap with Slovakia.
v) Relative forest cover calculated in the GIS programme CVM 50 for individual game grounds and segments of map grid (2 × 2.5 km) and standard layers (Step iv).
vi) Digital terrain model (raster 500 × 500 m) created in GIS programme Grass 6.1 on the background of contour lines from SVM 50, and then derived a map of hypsometric zones (scaled by 100 m a.s.l.).

vii) Overlapping the data on human population and the layer of districts.
viii) Evaluation of long-term changes in bear area distribution (Steps i, ii, iii).
ix) Relative values were calculated by overlapping the layer of the evaluated time periods (Steps i, ii, iii) and the layer of hypsometric zones (Steps i, ii, iii vs. vi).
x) In GIS programme (period 2002–2010), there were compared the data on distribution, density (Step iii) and stability (S%: no occurrence = 0%, 3 and less years = 33%, 4 to 6 years = 67%, 7 and more years = 100%) of bear occurrence related to forest cover (Step v), altitude (Step vi) and human population density (Step iii vs. v vs. vii vs. viii) within game grounds (Step i) and uniformly distributed plots (Step iv, map grid 1 : 5,000). There were analysed segments covering the relevant area by +95%.
xi) The data from published works and the data assembled in this research used for assessment of numbers of bears extinct from the population (hunted or dead naturally) in years 1900–2010 (Molnár et al., 1984, Jamnický, 1993; Feriancová 1955; Finďo et al., 2007; Halák, 1993; Sabadoš and Šimiak 1981; Hell et al., 1983; Hell and Slamečka, 1999; Kassa, 1998, 2001, 2002, 2006a, 2006b, 2007; Adamec, 2007; Štofík, 2010; ©NFC SR, 2011).
xii) Comparing the data on damage with the changes in dispersal. Spatial analysis of hunting bears in Slovakia in years 2002–2010 (©NFC SR, 2011) performed in frame of game grounds.

## Results and discussion

### Hunting rate (killing rate and natural mortality)

Based on the records on bear kills in Slovakia (Molnár et al., 1984; Jamnický, 1993; Feriancová, 1955; Finďo et al., 2007; Halák, 1993; Sabadoš and Šimiak, 1981; Hell et al., 1983; Hell and Slamečka, 1999; Kassa, 1998, 2001, 2002, 2006a, 2006b, 2007; Adamec, 2007; Štofík, 2010; ©NFC SR, 2011), there were evaluated changes in number of the killed (naturally dead) bears from the year 1900 to the year 2010. The data from the beginning of the 20th century are only incomplete (Fig. 3).

By the year 1932, the number of brown bear individuals in Slovakia had been reduced to several tens (Feriancová, 1955; Škultéty, 1970; Janík et al., 1986; Hell and Sabadoš, 1993), which was also responded by reduction of the occurrence area of this species (Figs 1, 3). By regulation of the regional President No. 127, 203/14-1932 valid since September 1, 1932 the brown bear was being protected round the year (Škultéty, 1970), which was probably responded by its penetration into territories without any occurrence recorded before (Feriancová, 1955; Figs 1, 3).

From 1958 the earliest 80th, the hunters were focussing on shooting old large animals, mainly males (Hell and Slamečka, 1999), which probably affected reduction of the brown bear range in Slovakia (Figs 1, 3). In the 1980s, there was initiated control of the kill rate of large males, and this was responded by extension of the range and density of the brown bear in Slovakia (Hell and Slamečka, 1999). The map of kill

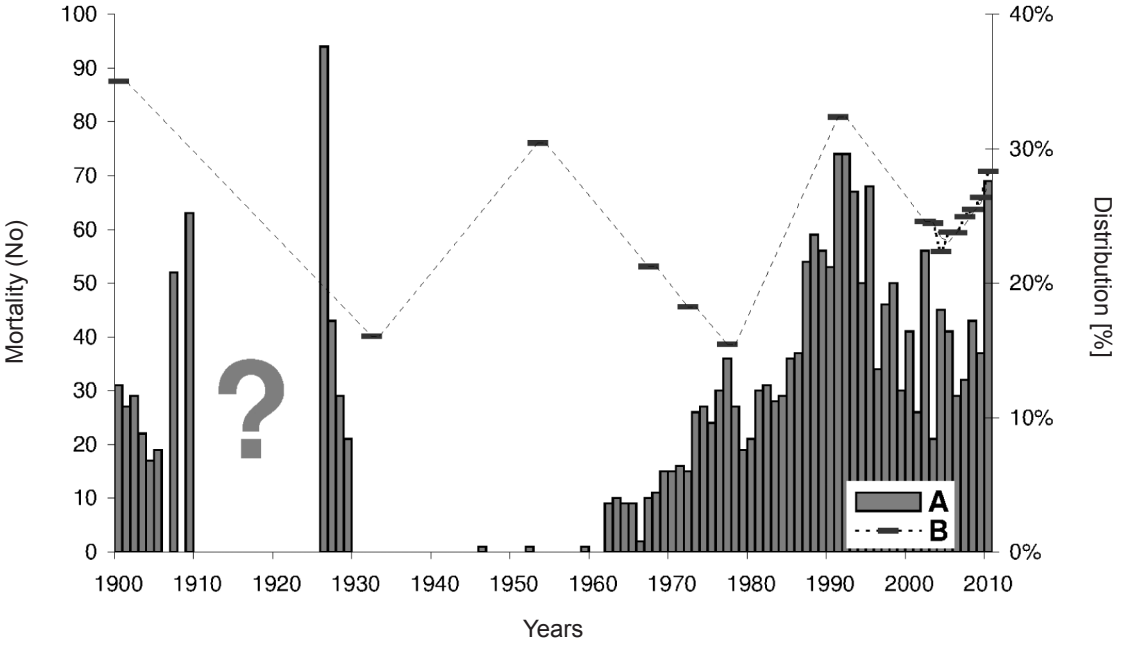


Fig. 3. Mortality of bears and changes in their distribution in Slovakia. A) Kill rate and mortality of bears in Slovakia [No]; B) Distribution of bears in Slovakia [%].

rate in 1991 (for individual forest enterprises) covering a relatively long time period (1980–1991) has excluded from analysis areas of the supposed overlapping of the East-Carpathian and West-Carpathian population (Hell and Sabadoš, 1993).

Selective control of killing individuals weighing up to 100 kg, with the width of the front paw up to 12 cm (Kassa, 2001; Adamec, 2007) was probably responded by penetrating brown bears in areas in which the species did not occur in formerly (Figs 2, 6).

**Altitude**

During the period 2002–2010, the bears showed preferences for higher situated localities (Table 1), which means colder climate (Lapin et al., 2000) and more days with snow cover (Šťastný 1988).

The bear population density was higher in the area with more stabile presence and at higher altitudes (Fig. 4), with lower human population density and denser forest cover (Table 1). Comparing the changes in spatial distribution patterns (2002–2010), there was detected significant influence of altitude on occurrence stability and density (Table 1).

From the long-term viewpoint, the largest fluctuations in dispersal were found in medium altitudes ranging 400–1,100 m a.s.l. (SD < 10%); the lowest in high mountains from 1,500 m a.s.l. and more (SD < 2%). Absence or only minimum occurrence (mean < 5%) was recorded in game grounds situated up to 300 m a.s.l. (Fig. 5).

The brown bear occurrence did not show significant differences in bear occurrence dependent on altitude. In higher situated localities, the bears receded between the WWI and WWII and in the 1970-s after unregulated hunting (Fig. 6).

Today, the confines of brown bear occurrence are shifted lower compared to the former data (Fig. 6), and there also exist hibernation records from lower situated localities in the Eastern Carpathians (Štofík and Saniga, 2012).

**Forest**

The bear occurrence was more stabile in game grounds (Table 1) with denser relative forest cover than in other game grounds, however, with significant differences only detected at altitudes showing positive effects on bear occurrence and density (Table 1). The forest cover in the regions of the Tatra Mts since 1855 (Olah et al., 2005) and in the region of the Eastern Carpathians Mts (Olah et al., 2006) is significantly increasing, which we suppose also in other regions, and this fact may be reflected in bear occurrence in lower situated localities.

Probably several times increased human population (Dubcová et al., 2008), changes to landscape infrastructure and patchy character of forest cover accounted for the discontinuity between the East and

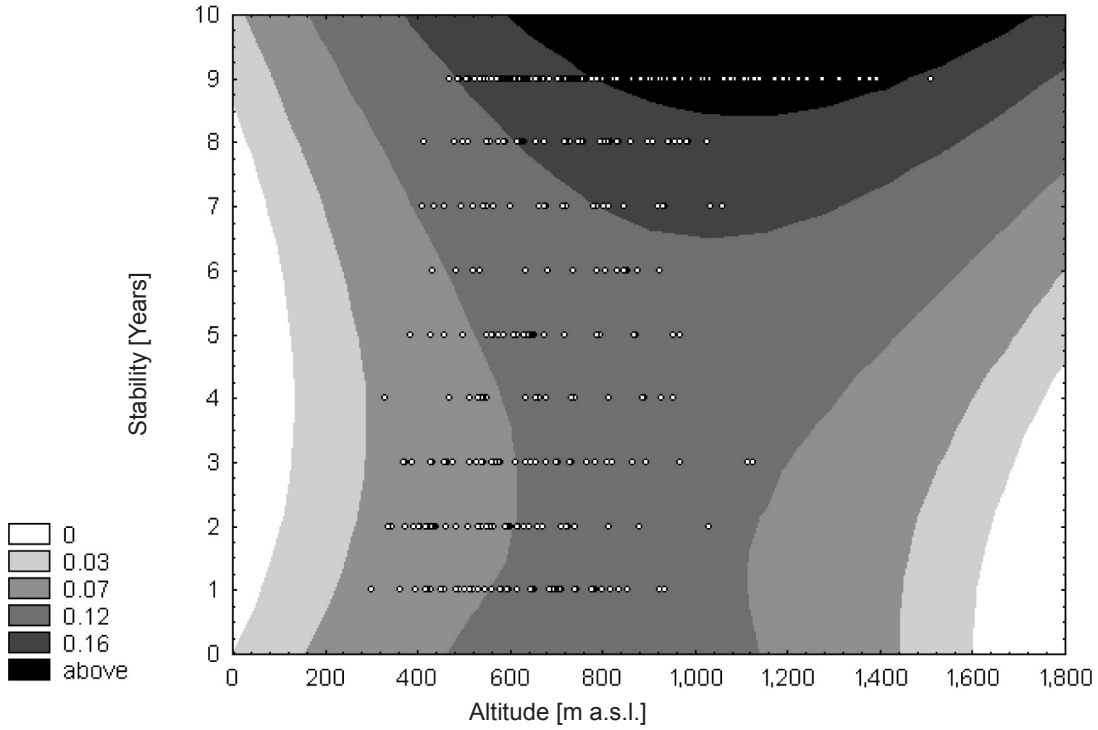


Fig. 4. Changes in the density (estimate) of bears [No km$^{-2}$] in Slovakia (2002–2010) related to stability of presence and average altitude (evaluated layer of game grounds; n = 1,824).

Table 1. Stability of bears [S%] in Slovakia (2002–2010) related to selected attributes

| S% | Evaluated attributes | Game grounds |
|---|---|---|
| 0% | No | 1,371 |
| | Altitude: average / SD [m a.s.l.] | 340 / 163 |
| | Forest cover: average / SD [%] | 28% / 28% |
| | Density of human population: average / SD [No km$^{-2}$] | 127 / 126 |
| 33% | No | 123 |
| | Altitude: average / SD [m a.s.l.] | 608 / 167 |
| | Forest cover: average / SD [%] | 56% / 21% |
| | Density of bears (SGS estimate): average / SD [No km$^{-2}$] | 0.07 / 0.08 |
| | Density of human population: average / SD [No km$^{-2}$] | 88 / 61 |
| 67% | No. | 67 |
| | Altitude: average / SD [m a.s.l.] | 672 / 157 |
| | Forest cover: average / SD [%] | 60% / 20% |
| | Density of bears (SGS estimate): average / SD [No km$^{-2}$] | 0.09 / 0.06 |
| | Density of human population: average / SD [No km$^{-2}$] | 87 / 64 |
| 100% | No. | 263 |
| | Altitude: average / SD [m a.s.l.] | 806 / 203 |
| | Forest cover: average / SD [%] | 60% / 19% |
| | Density of bears (SGS estimate): average / SD [No km$^{-2}$] | 0.15 / 0.09 |
| | Density of human population: average / SD [No km$^{-2}$] | 96 / 45 |
| Slovakia | No. | 1,824 |
| | Segment area: average / SD [km$^2$] | 26.54 / 21.00 |
| | Altitude: average / SD [m a.s.l.] | 438 / 244 |
| | Forest cover: average / SD [%] | 36% / 29% |
| | Density of bears (SGS estimate): average / SD [No km$^{-2}$] | 0.12 / 0.09 |
| | Density of human population: average / SD [No km$^{-2}$] | 119 / 113 |

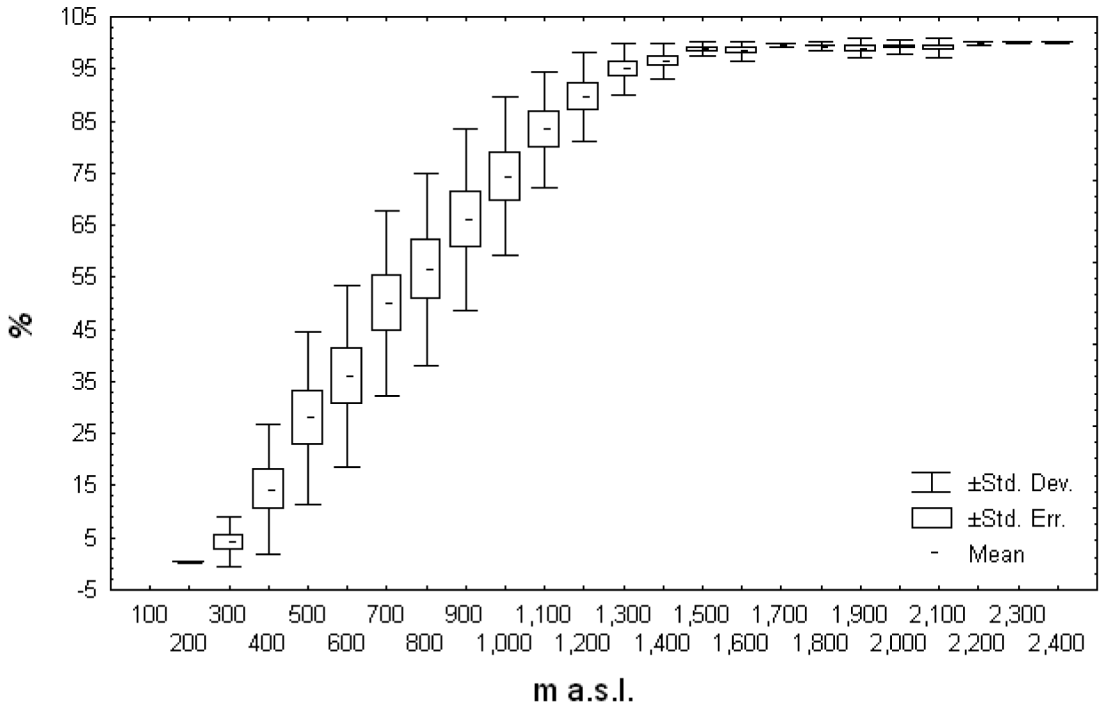


Fig. 5 Analysis of long-term changes in the distribution of bears related to relative values of hypsometric zones of altitude in Slovakia. Data sources from: 1900 cca, 1932 cca, 1953, 1968, 1972, 1977, 1980–1991, 2002 and 2010.

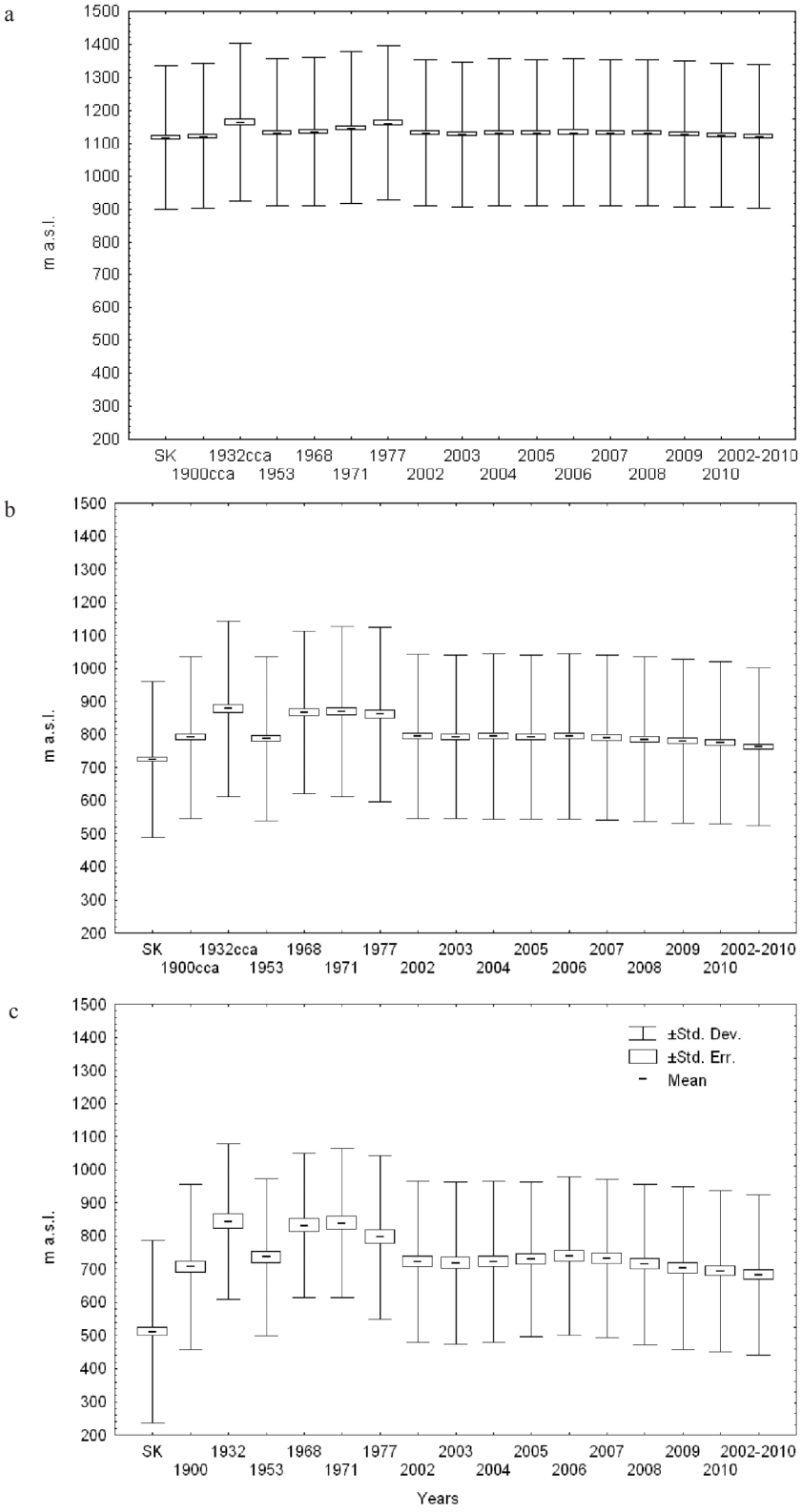


Fig. 6. The presence of bears in relation to average altitude in different evaluated layers of segments in Slovakia (1900–2010) (evaluated segments of the territory of Slovakia covered +95%): a) evaluated layer of segments 2 × 2.5 km; b) evaluated layer of segments 5 × 5 km; c) evaluated layer of segments 10 × 10 km.

West Carpathian populations of brown bear in Slovakia (Straka et al., 2011, 2012). Some link between these two populations seems to follow from a genetic analysis carried out in Polish Carpathians (Śmietana et al., 2012), the results, however, could be influenced due to re-introduction of 8 synanthropic individuals from the Western Carpathians into the Eastern Slovakia (Štofík et al., 2010).

**Long-term changes in range**

The data on brown bear occurrence (Fig. 1b) at the turn of the 19th and 20th century have been probably underestimated (Molnár et al., 1984, Štofík et al., 2010), as there exist records on several bear kills at the western boundary with the Czech Republic, dated into the 19th century, and a report on bear occurrence observed in 1908 (Bartošová, 2002). The map of brown bear dispersal from the period between WWI and WWII (Feriancová, 1955, Fig. 1c) illustrating districts with re-occurrence of brown bear may a bit over-estimate the dispersal of the bear population in the given period.

The first map (Fig. 1d) illustrating the dispersal of bears across the territory of Slovakia is dated from 1953 (Feriancová, 1955). The material for the map creation was collected in form of questionnaires submitted by Commissioners for forests to the directors of individual forest districts. The map evaluated the bear distribution according to individual districts (Feriancová, 1955). The map from 1968 (Fig. 1e) was compiled with the data on spring stock of brown bear in individual forest enterprises (Škultéty, 1970), the attached map, however, was prepared for units smaller than forest enterprises. In the earliest 1970s, Sládek carried out a mapping evaluation of bear dispersal in Slovakia (Hell and Sládek, 1974) based on the data reported from forest enterprises (Fig. 1f). Also this map seems elaborated for units smaller than forest enterprises.

Kalina et al. (1980) inform about the reduction of forest enterprises (state forest enterprises) in the former ČSSR to 113 in 1978 from 278 in 1945 (with a minimum area of 23,000 ha). So we may suppose that the evaluation according to forest enterprises might result in over-estimation of data about spatial distribution, and therefore, they have been attached map sets providing more details on bear dispersal. In year 1977 Sabadoš and Šimiak (1981) processed the data supplied in questionnaires and statistic records of bear stocks in forest enterprises (Fig. 1g).

The map that was used for the analyses was not elaborated for individual forest enterprises, and it may be supposed that also the attached map was prepared from units smaller than forest enterprises. We also must make remark that Sabadoš and Šimiak (1981) didn't depict presence of the bears in the area of Eastern Carphatians on the map from 1977 in spite of confirmed data of presence of brown bear from that period (Štofík et al., 2010). The brown bear distribution in year 1982 was documented in the work Janík et al. (1984). Despite the link between the East Carpathian and West Carpathian population evident in the map, the authors conclude that the ecological conditions in the area of the Ondavská vrchovina Mts are not suitable for brown bear permanent sites. Such sites are possible only with preserved migration corridors along the state boundary with Poland.

Due to these discrepancies between the text and the map, the map was excluded from spatial evaluation. The bear dispersal in 1991 was evaluated based on the data on bear kills in years 1980–1991 (Hell and Sabadoš, 1993, Fig. 1h). The map base was created for forest enterprises representing bigger area units and longer time periods in comparison with the other map bases – which may results in bigger errors loading spatial analyses.

From the long-term point of view we may suppose that while the bear population was severely affected by unregulated hunting, the occurrence in high-situated localities was continual even under the strongest hunting pressure.

**Short-term changes in range and density**

More detailed data concerning changes in the bear range are available from the period 2002–2010, recorded in spring game census in game grounds (n = 1,824; mean 27 km$^2$; SD 21.13 km$^2$). This evaluation did not include areas outside the game grounds (Koreň et al., 2011). In the short-term aspect, the population was found expanding into lower situated localities (Fig. 6), with more stable occurrence in higher altitudes with rare human presence and also significantly denser bear population (Fig. 4). The effects of disturbance of bears on their time and spatial distribution and animals avoiding areas with possible disturbance were discussed in several works (Nellemann et al., 2007; Rode et al., 2006.).

The bear stocks are rising also in the surrounding countries: Ukraine (Delehan et al., 2011), and Poland (Jakubiec, 2001); increasing numbers have also been reported from Slovakia (Štofík et al., 2010; Rigg and Adamec, 2007). As well as the area of distribution (Śmietana et al. 2012) also in eastern part of Polish Carpathians is increasing.

**Damage**

Unlike in the neighbour Poland, there have not been recorded evident changes in damage to beehives since 2006, nevertheless, with exception of a moderate increase in 2010. On the other hand, a more distinct damage increase has been evident since 2007 on hunting facilities (Fig. 7), probably due to strengthening (Rigg and Adamec, 2007) and extension of the bear population (Fig. 3). Beginning with 2006, we observe brown

bears retreating into localities at low altitudes and with sufficient forest cover (Table 1). The increase in damage to bee hives (Poland – Sergiel et al., 2011) and hunting facilities (Slovak Republic – ©NFC SR, 2011), may be to some extent explained by roof game feeding – and so also indirect feeding of bears.

Recently there has been also evidence that another big omnivore – wild boar increased its population (Geisser and Reyer, 2004, 2005; Bieber and Ruf 2005; Taschalidis and Hadjisterkotis, 2008; Keuling et al., 2010) thanks to supplementary feeding (Geisser and Reyer, 2004). To avoid this trend, it is recommended either to stop supplementary feeding and reduce, in such a way, the negative impact of game management (Bieber and Ruf, 2005), or to use hunting as an alternative for preventing damage to the agricultural crops (Geisser and Reyer, 2004).

## Conclusions

In long-term aspect, the brown bear distribution in Slovakia was responded sensitively by unregulated shooting. The reduction of brown bear stock is primarily evident on receding in higher situated colder localities. In short-term aspect, we can observe more stable, denser population at higher altitudes in colder climatic regions. The restricted allowable hunting rates and easy accessible sources of anthropogenic food are factors promoting the increase of bear population in Slovakia.

We are conscious of the fact that the data from the historical maps are only attempt to the most exact depiction of the presence of bear at that time and the data processed from the spring census are only approximate, not corresponding to the factual stocks of this animal. Therefore we propose the spatial analysis within the game grounds as a suitable supplementary method to the data processed from the spring census, data about presence and data about bear mothers with cubs, all together to use for formulation of management of the brown bear in Slovakia.

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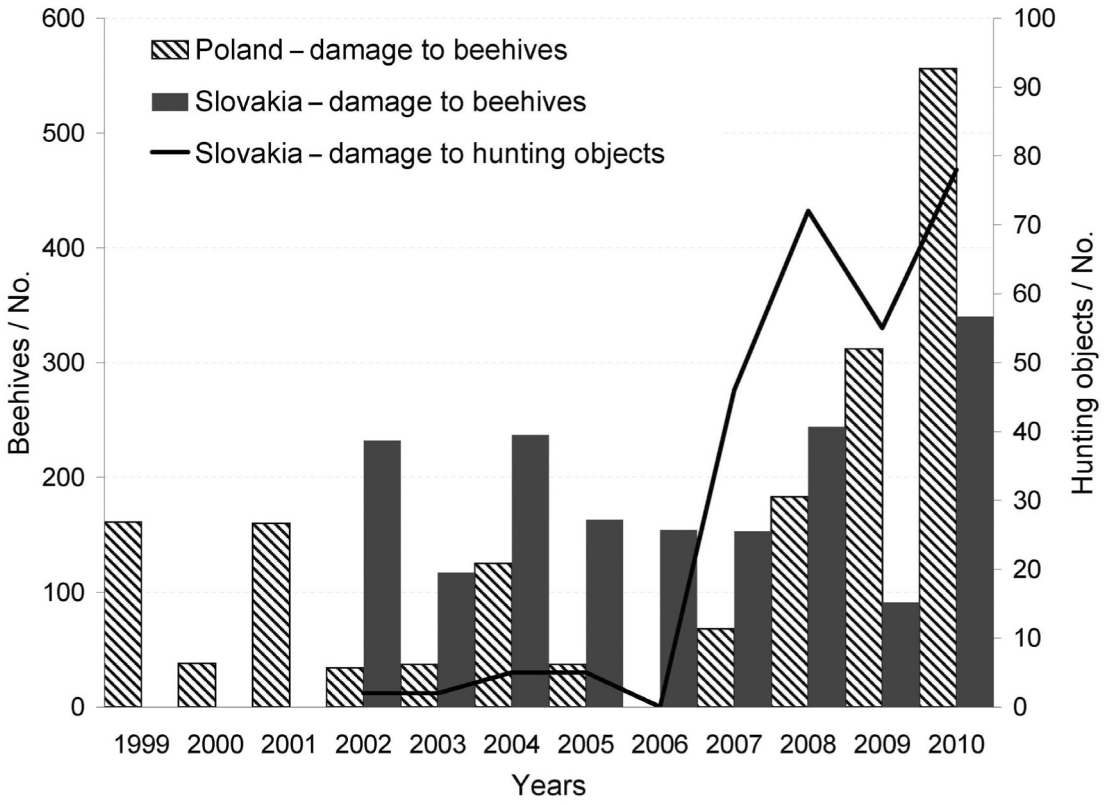


Fig. 7. Damages caused by bears.

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# Časopriestorové zmeny populácie medveďa hnedého *Ursus arctos* na Slovensku (1900 – 2010)

## Súhrn

V tejto práci, na základe historických údajov, mapových podkladov a údajov o medveďoch v rámci JKS (jarné kmeňové stavy) – sčítania zveri na Slovensku (2002 – 2010), za pomoci GIS programov vyhodnocujeme vybrané faktory ovplyvňujúce zmeny v rozšírení medveďov na Slovensku. Vyhodnocujeme, že: i) medvede preferujú chladnejšie oblasti, vyšších nadmorských výšok s dostatočnou pokrývkou lesa, pričom výraznejšie vplýva na výskyt medveďov nadmorská výška ako pokryvnosť lesa, ii) so znižujúcou sa nadmorskou výškou postupne klesá frekvencia výskytu a relatívna hustota medveďov, iii) dlhodobo k najvýraznejším výkyvom v rozšírení dochádza v stredných nadmorských výškach 400 – 1 100 m n. m. (SD > 10 %), k najmenším od 1 500 m n. m. (SD < 2 %) a žiadny, alebo minimálny výskyt (do 5 %) bol zaznamenaný do 300 m n. m., iv) neregulované zásahy v dlhodobom horizonte ovplyvňovali priestorovú distribúciu medveďov na území Slovenska.

I keď mapové údaje z minulosti boli len pokusom o čo najpresnejšie znázornenie rozšírenia medveďov (ich spoľahlivosť je sporná) a údaje z jarného sčítania zveri v rámci poľovných revírov pravdepodobne nevystihujú skutočný stav populácie (absolútne hodnoty), predpokladáme, že priestorové analýzy z jarného sčítania zveri po prípadnom doplnení o výskytové údaje a údaje o vodiacich medveďoch môžu prispieť (ako jeden z indikátorov) k skvalitneniu manažmentu medveďov na Slovensku.

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