

The peculiarities of bear numbers dynamics in the Eastern Carpathians

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Abstract. There have been two periods of change in the dynamics of bear population in the Eastern Carpathians. The first period lasted over 50 years, starting in the late 1940s and ending in the year 2001. The second period started in the early 21st century. The bear population reached its maximum – of about 1100 individuals – in the early 1970s. Over 85% of recorded bear deaths have resulted from poaching.

Key words: *Ursus arctos*, population dynamics, poaching

1. Introduction

Bear population in the Eastern Carpathians was high till mid-19th century. Then, it decreased due to excessive hunting and reduced forest areas. As a result a ban was placed in 1930s on hunting for the species. After the World War II, at the end of the 1940s, the bear population recorded was only few dozens (70–80) (Turânin 1969; Slobodân 2008). In 1970s bear population increased in the Eastern Carpathians, due to protective undertakings to improve bears' living conditions, which exceeded their number to 1000. Yet another decrease of bear population in the 1990s elicited anxiety over the species' future (Hun'čak 1999; Bondarenko, Hoeckij 2000; Hoeckij 2000). Extinction of the species at the beginning of the 21st century was forecasted (Zagrodnîk, Slisarenko 1999) due to the decrease in bear population which was 28 individuals each year on average. *Ursus arctos* was registered in the Ukrainian Red Book as the endangered species only on the basis of decrease in their numbers, avoiding detailed analysis of bear population dynamics and reasons that influenced it. The aim of these studies was to estimate bear population dynamics in the Eastern Carpathians on the basis of hunting statistics, my own research and professional literature sources.

2. Research materials and methodology

Changes in bear numbers were analysed between 1960 and 2009 in the Eastern Carpathians, on the Ukrainian territory, in four oblasts: Lviv Oblast, Ivano-Frankvisk Oblast, Chernivtsi Oblast and Zakarpattia Oblast. The total area of species habitat reached 923.100 ha.

Research was conducted according to conventional hunting methods (Filonov, Kaleckaâ 1986; Slobodân 1987, 1991, 2008). For analysing bear population dynamics we used materials provided by the State Statistics Service of Ukraine, Ministry of Ecology and Natural Resources of Ukraine, National Agency for Forest. We also used results of our own research and data taken from professional literature (Tatarynow 1956; Hun'čak 1999; Hoeckij 2000; Slobodân 2008).

An index, which reflects yearly changes in numbers in relation to the previous year, was used to analyse bear population dynamics. The index is called an index of increasing or decreasing population and is formulated in percentage. Amplitude of changes characterises a direction and pace of changes in population.

Correlation analysis was used in order to define the strength of relation between bear numbers in the Eastern Carpathians in general and bear numbers in the area of

oblasts used for hunting. A character of the relation was determined using the following scale (Horoško, Mykluš, Homůk 2004):

- $r = 0 \pm 0,30$ – poor;
- $r = |0,31 - 0,50|$ – mediocre;
- $r = |0,51 - 0,70|$ – critical;
- $r = |0,71 - 0,90|$ – high;
- $r = |0,91 - 1,00|$ – very high

Mean value ($M \pm m$), coefficient of variation (V) and standard deviation (S) were evaluated. Calculations were done using Microsoft EXCEL.

3. Research result and discussion

Counting animals in Ukraine has been officially carried from 1960; therefore, data about bear numbers in the Eastern Carpathians between the 1940s–1950s is fragmentary and not always reliable. According to Turânin's data (1969), in 1947 there were over 70 individuals in the Carpathians and after 9 years (in 1956) the numbers raised up to 484 individuals. In other parts of the European bear home range, in Kaliningrad Oblast (Russia) particularly, bear numbers increased twice during the 15-year period. For 400 individuals it increased by 13 individuals every year (Makarov, Hohlov 1972). In Byelorussia a micro-population of 20 individuals increased by 4 individuals every year, one or two of which did not live longer than one year (Lavov 1987). Therefore an increase of bear numbers in the Carpathians by 6,5 times during the 9-year period (1947–1956) is unlikely. In Darwin Nature Reserve in Russia (Darvinskij gosudarstvennyj prirodnyj biosferyj zapovednik) an increase of bear numbers by 5–6 times has been observed during the 25–30-year period (Filonov, Kaleckaâ 1986). According to Tatarynow (1956), at the beginning of 1950s total bear numbers was about 150–200 individuals and in comparison with the number in the 1940s it rose 2,1–2,8 times. Assuming there were over 70 individuals in 1947, bear population could have reached 200 individuals in the 1950s at an yearly increase of 17–18%, and to 600 individuals in 1960 at the yearly increase of 20%. Slow pace of reproduction is a characteristic feature for big mammals like bears. It can be explained by factors such as late puberty, non-annual reproduction and relatively low fertility (Slobodân 1981). Therefore, in the 1960s the yearly increase of bear population by 17–18% is significant for the Eastern Carpathians.

According to Hun'čak (1999), in 1990s an increase of bear numbers in some hunting areas totalled 19,6%.

However to confirm this, additional research and analyses are required. Between 1960 and 2009, 22 years characterised by an increase of bear numbers have been recorded in the Eastern Carpathians. In 1970, the highest increase in number (19,8% in relation to the previous year) has been recorded (Fig. 1).

In the selected period (1960–2009) an average yearly increase number totalled $6,3 \pm 0,9\%$ ($S=4,5$; $V=71,6\%$). Bear numbers showed an increasing trend until the 1970s when it achieved the maximum number of 1100 individuals (Fig. 2).

Information about bear numbers in the Eastern Carpathians in 1970s is fragmentary (Kerečun 1975; Slobodân 1987, 1991, 2008; Lobačev, Čestin, Gubar' 1989). Sometimes the difference between researchers' and hunters' calculations reaches over 250 individuals

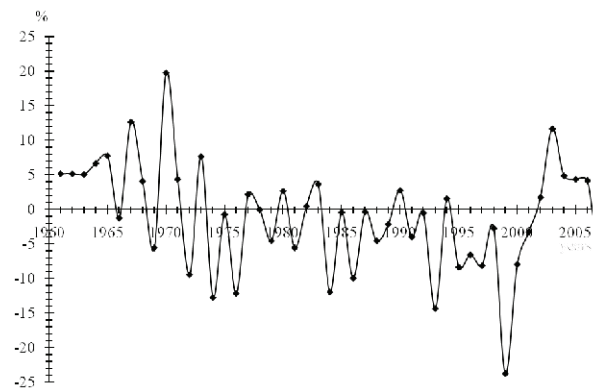


Figure 1. Changes in the *Ursus arctos* numbers (%) in the Eastern Carpathians

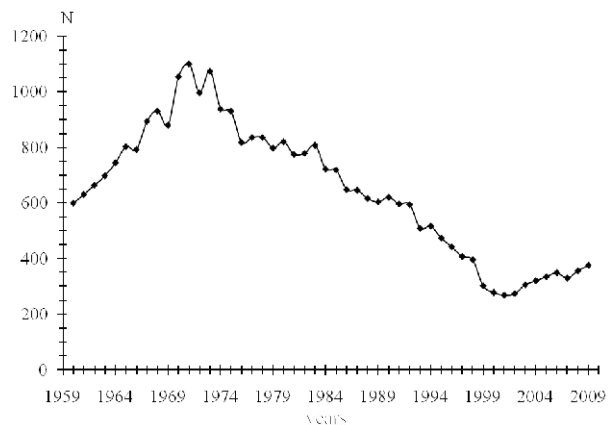


Figure 2. The numbers (N) of *Ursus arctos* in the Eastern Carpathians

(25%). According to Slobodân (1987, 1991, 2008), in the aforementioned period, the total numbers amounted to 1300 individuals. Slobodân has explained the 15% difference by inaccurate counting methods (which can cause even 20% observational error), by insufficient preparation of data loggers, and by non-observance of proper counting methods, as well as by other reasons. Overrating of bear numbers has been registered not only in Ukraine, but also in other European countries like Poland (Gula, Frąckowiak 2000) or Slovakia (Lehocky 1999).

At the beginning of the 1970s, the density of bear population in the Eastern Carpathians numbered 1,0–1,2 individual per 1000 ha of the bear habitat. The density decrease has been registered continuously since then. The minimal number (240–270 individuals) has been registered at the beginning of the 21st century, and the density totalled 0,2–0,3 individual per 1000 ha (Fig. 3).

Periodic, regular changes in bear numbers is a natural process, which is controlled by intra-population mechanism. Two types of population dynamics are identified within wild animals. The first one – labile – is distinguished by high, multiple amplitude of number fluctuation. The period of change in the numbers lasts 4–8 years. This type of number dynamics is distinctive for small animals (for instance small rodents) of the short lifespan and high fertility.

The second type – stable – is characterised by low amplitude and long period of change in the numbers, even up to few decades. It is distinctive for big animals that live longer, and have late puberty and low fertility (Khojetsky 2011).

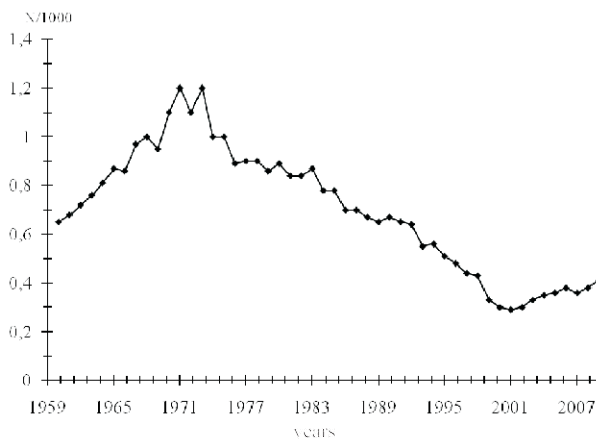


Figure 3. The density (N/1000) of the *Ursus arctos* population in the Eastern Carpathians

In case of each species, number dynamics is a result of the interaction between population and environment. It is a result of the adaptation to living conditions, which is conditioned by biological characteristics of the species. Therefore, the type of population dynamics is species-specific. According to one of the hypothesis, the duration of the period of change in the number of species corresponds approximately to the life expectancy of individuals (Lobkov 1999). The recorded life expectancy of bears in zoological gardens was 47 years (Geptner, Naumov 1961), and in the wildlife was 20 years (Kudatkin, Kozin 1991). However, there could be individuals living up to 27–30 years. Siivonen (1979) has claimed that it allowed calculating the life expectancy of bears to be within 30–50 years.

Two periods can be distinguished in bear population dynamics in the Eastern Carpathians between 1960 and 2009. The first one finished in 2001. The period of increase was registered until 1970. Population decrease was observed from 1972–1973 until the beginning of the 21st century; the minimum number (270 individuals) was observed in 2001. The length of the period of decrement estimated is nearly 30 years. Compared to the 1970s at the beginning of the 21st century number of bears was 4 times lower, and an amplitude of number fluctuation was nearly 830 individuals. During the 42-year period (1960–2001) the average yearly population numbers of $703,9 \pm 20,8$ individuals ($S = 134,9$; $V = 19,2\%$) have been registered.

The second period of changes began in 2001–2002. During the past 8 years (2001–2009) the number of bears has increased by 39,8%. Average annual population growth registered has been $330 \pm 11,1$ individuals ($S = 31,5$; $V = 9,5\%$), which is an increment of $5,8 \pm 1,2\%$ ($S = 3,2$; $V = 54,9\%$). Coefficient of variation indicates significant annual changes in increased numbers. In the analysed period the lowest increase (1,8% of population) was registered in 2002, and the highest in 2003 (11,7%).

Between 1960 and 2009, the average yearly number of bears in the Ukrainian Carpathians was $643,7 \pm 19,1$ ($S = 134,9$; $V = 20,9\%$), at the increase level of $6,3 \pm 0,9\%$ and elimination level of $7,0 \pm 1,1\%$ ($S = 5,6$; $V = 15,9\%$).

Direct and indirect human activity, hunting and poaching in particular, can be the factors causing changes in animal numbers and its dynamics. However, an influence of the official hunting on bear numbers is unknown and it may not cause decrease of numbers. In the 1950s 50 individuals were hunted in the Eastern

Carpathians in accordance with hunting permits. At the end of the 1960s and at the beginning of the 1970s, hunting (official hunting and poaching) totalled almost 9% of the population (Verešagin 1972) and it is worth mentioning that the maximum of 15% of the total numbers comes under permissible hunting. Further increased hunting can lead to decrease in population numbers. Between 1991 and 1998 only 4 individuals were hunted in the Carpathians in accordance with hunting permits, which is much less than the permissible hunting (Verešagin 1974).

According to statistical data, decline in bear numbers began at the beginning of the 1970s. At that time, the hunting area protection system was much better compared to the one in 1990s. At the time of the mass impoverishment of the society, impairment of national game animal protection system, and larger accessibility of rifling and smoothbore guns an increase of the unlawful bear exploitation, and consequently a high decrease of the population has been observed.

At the beginning of the 21st century, cases of poaching have appeared more often which can influence bear population dynamics. According to the author's own research, over 85% of the registered bear death cases were caused by poaching. Almost 8,7% of animals hunted by poachers die trapped in snare. In total, anthropogenic factors cause over 95% of the registered bear deaths (Fig. 4).

The number of captive bears is an indirect evidence of poaching. These individuals are most often young bears whose mothers get killed by poachers or were left by mothers as a result of being persecuted by people.

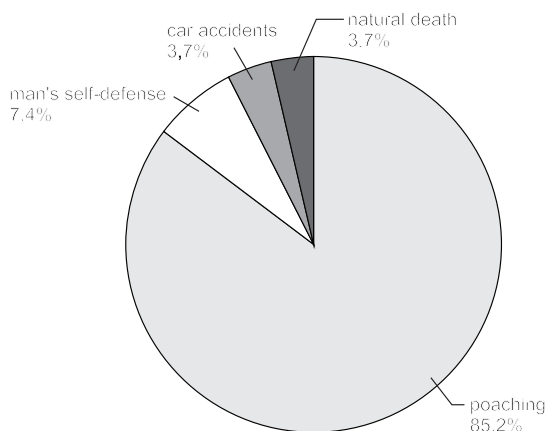


Figure 4. Causes of *Ursus arctos* death in the Eastern Carpathians, in %

According to my own research, in three Carpathians oblasts (Lviv Oblast, Chernivtsi Oblast and Ivano-Frankvisk Oblast) 19 bears of different age and gender were captivated in cages (Fig. 1). Most animals were captivated in cages situated close to hotels, motels and restaurants.

Nearly 58% of captive animals were in reproductive age. Sex ratio was approximately 1:1. To eliminate instances of bears kept in cages it is necessary to organise a rehabilitation centre in one of nature sanctuaries in the Carpathians (for example in “Skoliwskie Beskidy” National Park or in the Carpathian National Park). This will help to keep young orphaned bears alive as well as to re-introduce them to the natural environment in future. The International Fund for Animal Welfare could help in establishing the centre.

Such rehabilitation centre works in Russia. Employees in the centre were able to save and return to the natural environment over 90 young bears. After rehabilitation, young bears were released in the “Brianski Forest” Sanctuary where animals acclimatised and they contributed to renew local population of bears that degraded due to long-lasting isolation and inbred crossbreeding.

Bear numbers on the hunting area in the Ivano-Frankvisk Oblast can be an evidence of the human activity influence on bear population dynamics. In number dynamics three periods (not two) were distinguished: the first one lasted till 1978, the second one between 1978 and 2002, and the third one is a present period. There is close relationship between the total bear numbers in the Eastern Carpathians and

Table 1. The number of *Ursus arctos* in enclosures in three regions: Lvivskij, Cernoveckij and Ivano-Frankivskij (as of 2011 r.)

Sex	Age (years)				
	<2	2-3	4-10	>10	not determined
Male	1	1	3	2	1
Female	1	1	3	1	1
Not determined	-	-	1	-	3
Sum	2	2	7	3	5

bear numbers on hunting areas of the Ivano-Frankivsk Oblast which a correlation efficient $r = 0,91$ confirms. The hunting areas of the oblast bear numbers has been known only from 1965; however, regarding current relation between population numbers in the Carpathians and numbers in the Ivano-Frankivsk Oblast, it can be stated that the increase in numbers occurred between the end of the 1940s and the beginning of the 1970s.

In 1971 the maximum number of animals (390 individuals) was recorded on hunting areas of the oblast. After reaching the maximum, a decrease in bear numbers was recorded during the next 8 years. The first period (lasting over 30 years) finished in 1978. In comparison to the beginning of the 1970s bear numbers decreased by 2,4 times (Fig. 5).

The second period lasted from 1978 to 2002. In the first 9 years (1978–1987) an increase of bear numbers up to over 220 individuals was registered. Between 1984 and 1991 bear numbers was stable and totalled over 200 individuals. From 1992 a decrease in bear numbers was recorded, unlawful hunting being one of the causes. The lowest number (about 90 individuals) was recorded in 2002. The second period lasted 24 years which was shorter than the first one. Probably due to poaching, at the beginning of the 1990s, the increase in numbers period led to the period of decrease which lasted 11 years. The third period (unfinished) is characterised by the annual increase at the average level $9,9 \pm 2,7\%$ ($S = 6,1$; $V = 61,5\%$), so it is higher than in all Eastern Carpathians. Numbers increased by 1,6 times during the 7-year period (2002–2009).

Bear numbers also increased on hunting areas in other oblasts. In Chernivtsi Oblast, the bear population

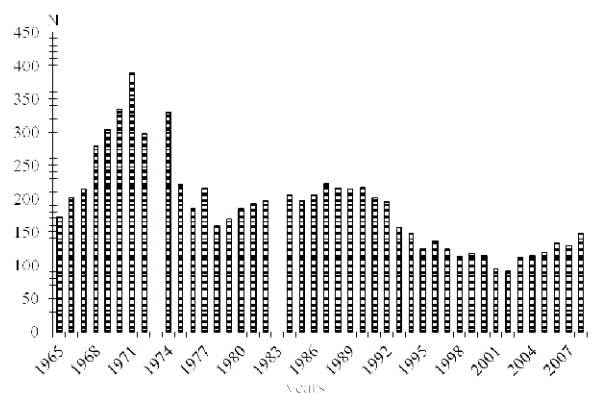


Figure 5. The *Ursus arctos* numbers (N) in the game lands of Ivano-Frankivsk region

increased twice between 2000 and 2009. However, bear numbers in the Eastern Carpathians consist of individuals from Ivano-Frankivsk Oblast and Zakarpattia Oblast. There is high correlation ($r = 0,98$) between population numbers on hunting areas in Zakarpattia Oblast and the total number in the Eastern Carpathians. Though, there is weak relationship between the total numbers in the Eastern Carpathians and numbers on hunting areas in Chernivtsi Oblast ($r = 0,16$) which results from small bear numbers in this oblast – nearly 12% of the total population. Weak and negative relation registered between bear numbers on hunting areas in Lviv Oblast and population numbers in the Eastern Carpathians can be explained either by the inaccuracy of the inventory work or by a significant fragmentation of the environment and occurrence of the local bear subpopulation which – without the contact with the main group – acquires features of the aggregated population. This problem requires further investigation.

Bear population in the Eastern Carpathians remains in contact with populations in the Southern and Western Carpathians. There is a constant flow of animals between Romania and Ukraine. During spring and summer time animals come from Romania to Zakarpattia Oblast which causes concern of local communities, as it is the sheep pasturage time in the mountain meadows. In hunting areas of the Wyzkowski forest sub-district (Khust State Forest Management enterprise), which border upon Romania, regular animal flow has been registered.

On the border with Poland, a part of the border fence was dismantled that allows animals to migrate easily from Poland to Ukraine and vice versa, i.e. to Poland. A cross-border flow of animals is constantly registered. In Poland, the border guard has registered migration of Eurasian elks, roe deers, European bisons and bears. Migration of bears from the Bircza commune (that borders upon Ukraine) to the Dobromyslki forest sub-district (Staryi Sambir State Forest and Hunting Management enterprise) was registered.

4. Conclusions

Including the brown bear in the Ukrainian Red Book went on without considerations of natural population dynamic processes. In bear population dynamics in the Eastern Carpathians, there are two recorded periods of change in the numbers from the second half of the 20th century. The first one lasted 50 years and the second one (unfinished) began in the early 21st century. Human activity, poaching in particular, has influenced significantly the population number dynamics.

Unlawful hunting have rapidly decreased bear numbers in the Eastern Carpathians in the 1990s; it has presently also slowed down the process of population rebuilding. Hence, the efforts of environment protection authorities, as well as hunter services of the hunting districts, and the police should focus on revealing unlawful hunting instances and preventing poaching. Establishing rehabilitation centre and creating wildlife corridor can help in rebuilding bear population.

In order to renew the homogeneity of bear population in the Carpathians, creating wildlife corridors is required. Above all, it is worth creating such corridors in the west part of the Eastern Carpathians, which is characterised by significant fragmentation of the forest complexes and high population density in comparison to other parts of the Eastern Carpathians.

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