

# Population dynamics and actual density of free ranging wisents in the Bieszczady mountains

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**Abstract:** Data for wisent population inhabiting Bieszczady mountains S-E Poland, on population numbers, density and the area of home range, were analyzed from the period between winter of 2002/2003 and vegetative season of 2022. During that time this population grew up from about 170 to almost 730 individuals. Its home range (estimated as MCP) increased from about 300 km<sup>2</sup> in winter 2002/2003 to almost 820 km<sup>2</sup> in summer 2022. However, the density of this population fluctuated constantly between 0.40–1.40 individuals per km<sup>2</sup>. High correlation between the population numbers and the area of home range, as well as the lack of correlation between population numbers and its density found in the winter season and the lack of correlation between the area of the home range and population density in vegetative seasons indicate, that wisents have a tendency for adjusting their home range to an increase of population numbers.

**Key words:** European bison, Bieszczady Mountains, population numbers, home range, density

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## Introduction

For the management and conservation of wildlife species, it is very important to have knowledge of the numbers and density of their populations. On one hand, small isolated populations do not guarantee their long-term survival, but over-dense, fast-growing populations may deplete their food resources or cause damage to agriculture and forestry. Therefore, in many cases, there are attempts to assess the carrying capacity of a given habitat and introduce measures leading to the control of population numbers (Caughley 1994; Sinclair *et al.* 2006; Stokes 2012).

Such a challenge occurs often when large herbivores are introduced either to the parts of their former, historical ranges or to formerly uninhabited but considered suitable habitats. In contemporary Europe, where patches of natural habitats are usually small, scarce, and isolated, conditions appropriate for the establishment of viable populations of large mammals are very rare. Hence, decisions regarding the target numbers of introduced animals are frequently controversial and based upon uncertain estimates (Pucek *et al.* 2004; Perzanowski *et al.* 2019).

Good examples of such cases are wisent (*Bison bonasus* L.) herds dwelling in Białowieża Forest and the Bieszczady Mountains. By the 80s of the 20th century, the carrying capacity of Białowieża Forest for wisents was estimated for some 250 individuals, but now, this population counts about 900 animals. Plans for the population in Bieszczady, prepared some 12 years ago, assumed the target number of 400 individuals, while there are now about 800 wisents. In both sites, damages to forest stands, and especially at Białowieża – to neighbouring agriculture, are reported (Pucek *et al.* 2004; Marszałek, Perzanowski 2018; Olech & Perzanowski 2022; Nieszafa *et al.* 2022).

Nevertheless, together with growing population numbers, the area of the home range of those populations also considerably increased. In this paper, we have compared changes occurring in the Bieszczady Mountains, with extension of their home range and resulting population densities. This comparison may provide arguments for the discussion whether the effective reintroduction for creating a viable population should be regarded as a success, or as a growing problem.

## Study area

Data on population numbers and spatial distribution of wisent herds was collected in the Bieszczady Mountains, a part of the Carpathian range situated in south-eastern Poland, along borders with Slovakia and Ukraine. This mountain range is among the regions of Poland with the lowest density of human population and is forested in over 80%. Elevations there vary between about 302 m above sea level in valleys located in the northern part, and over 1000 m above sea level at open, alpine-type meadows along the highest ridges. The highest peak, Tarnica, has an elevation of 1346 m a.s.l. Since 1963, the region has been inhabited by free-ranging population of wisents but there are also numerous populations of red deer, wild boar, wolf, and brown bear (Zarzycki & Głowaciński 1970).

## Materials and Methods

Population census of wisent herds was performed during the routine, annual monitoring program, based on direct observations at the end of the winter season, performed by the staff of the Carpathian Wildlife Research Station of the Polish Academy of Sciences and the Regional Directorate of State Forests at Krosno. Spatial distribution of wisents was estimated on the basis of field data on all available signs of wisents' presence (direct observations, tracks, feces, signs of foraging, and telemetric fixes) collected year-round (Fig. 1). We used 170 248 records of wisents' presence in total. Calculation of the home range (MCP) was done with ArcMap 9 software.

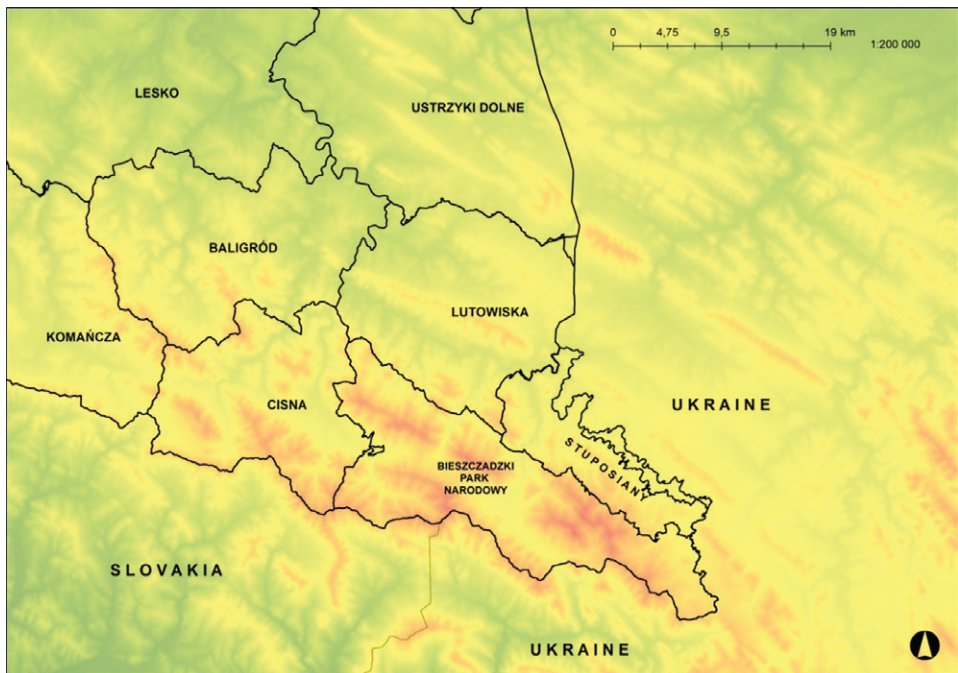


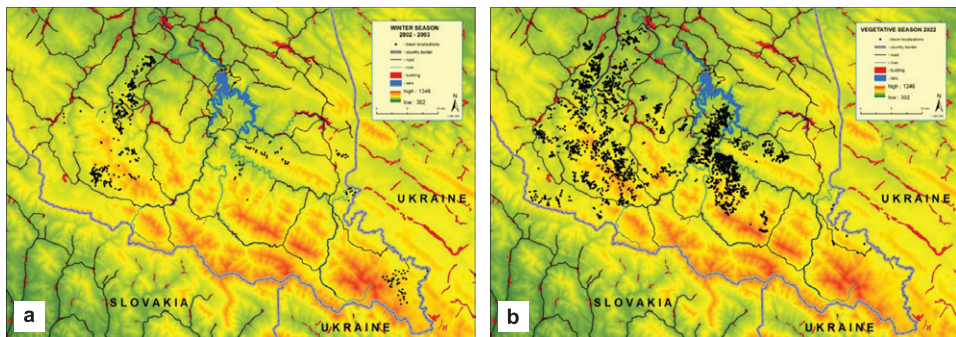
Fig. 1. Forest districts of Bieszczady Mountains inhabited by wisents

Analyzed were data on population numbers, home range, and density of wisent population in the Bieszczady Mountains from winter and vegetative seasons. Relationships between population parameters – namely, between population numbers and density, population numbers and home range, as well as home range and density – were examined using Pearson's correlation coefficient and regression analysis. Seasonal differences were assessed using the paired Student's t-test in order to examine whether significant differences exist between the seasons.. All analyses were conducted using Microsoft Excel.

Analyzed were data on population numbers, home range, and density of wisent population in the Bieszczady Mountains from winter and vegetative seasons. Relationships between population parameters (correlations and regressions) and differences among seasons were tested with Student's t-test.

## Results

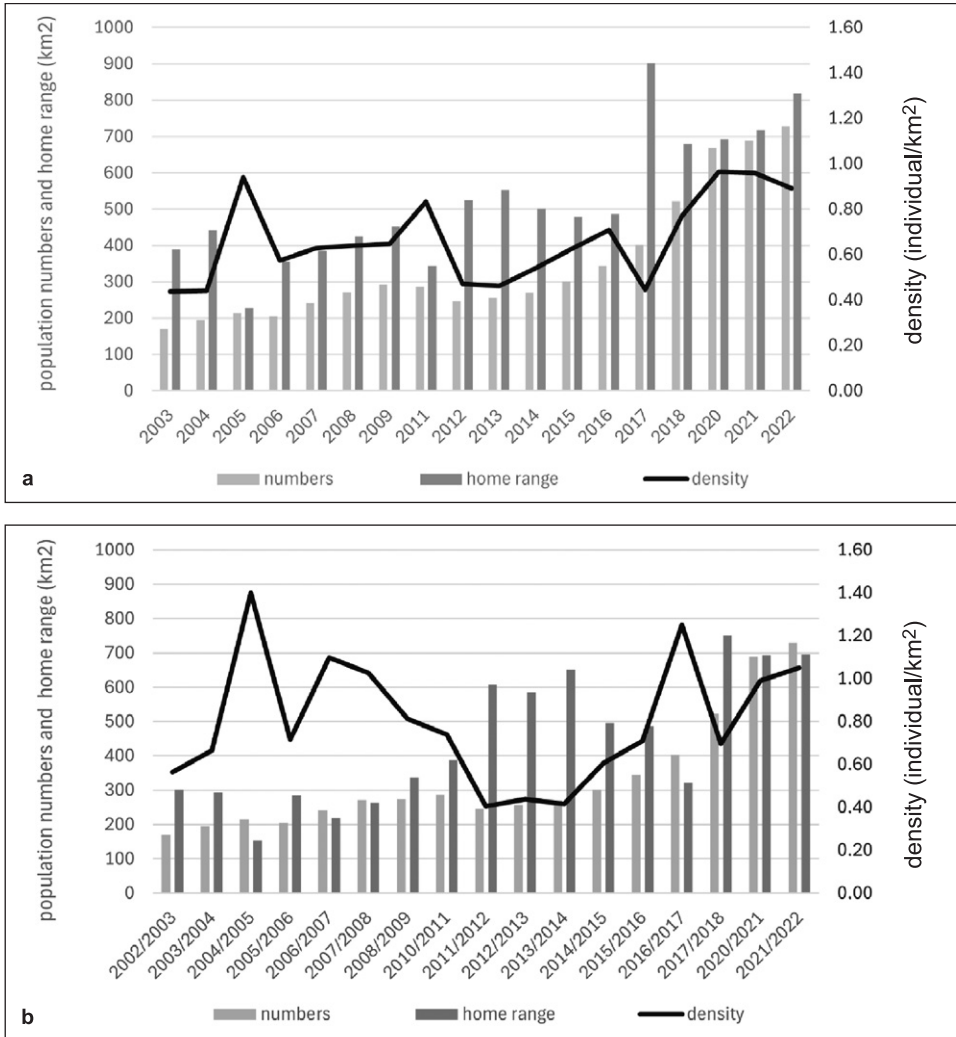
During 20 years, the extent of the home range of the wisent population in the Bieszczady Mountains estimated as MCP has increased significantly. From 301.5 km<sup>2</sup> in the winter season of 2002/2003 to 695.5 km<sup>2</sup> in winter of 2022/2023 and from 388.5 km<sup>2</sup> in the vegetative season of 2003 to 818.2 km<sup>2</sup> in summer 2022 (Fig. 2).



**Fig. 2.** A comparison of the spatial distribution of the wisent population in Bieszczady Mountains at the beginning of the study, i.e. winter season of 2002/2003 (A) and its end, i.e. vegetative season of 2022 (B) (after: Final report for years 2003/2004 and the Report for years 2020/2023).

During that time, the size of this population grew from about 170 to almost 730 individuals, i.e. by over four times. Nevertheless, in that period, the population density estimated in vegetative seasons fluctuated between 0.44 individual/km<sup>2</sup> in 2003, up to 0.96 individual/km<sup>2</sup> in 2020. However, low values of 0.44 and 0.46 individual/km<sup>2</sup> were recorded in 2004 and 2013, and high values of 0.94 and 0.96 individual/km<sup>2</sup> in 2005 and 2021 (Fig. 3A).

In winter, the highest density – 1.4 individual/km<sup>2</sup> was recorded in the season 2004/2005, while the lowest – 0.4 individual/km<sup>2</sup> was in the season 2011/2012. Low densities about 0.4 individual/km<sup>2</sup> occurred also in seasons 2012/2013 and 2013/2014, and high densities over 1 individual/km<sup>2</sup> in seasons 2006/2007 and 2016/2017 (Fig. 3b).



**Fig. 3.** A comparison of changes in the area of the home range (MCP), population numbers, and fluctuations of population density of wisents estimated for vegetative seasons (a) and winter season (b) in the Bieszczady Mountains.

The results of the analysis of relationships between population parameters were presented in Table 1. Highly significant was the strong positive correlation between the population numbers and the area of its home range in both winter and vegetative seasons (0.673 and 0.774,  $p < 0.01$ ) (the higher the population numbers, the higher was the area of its home range MCP). The negative correlation between the occupied home range and population density was at the threshold of statistical significance.

In vegetative seasons, highly significant was the moderate positive correlation between the population numbers and its density (0.610,  $p < 0.01$ ).

Differences between areas of the home range in winter and vegetative season assessed with t-test for dependent samples were statistically insignificant ( $t = -1.727$ ,  $p \geq 0.05$ ). However, differences between values of population density in winter and vegetative seasons were significant ( $t = 2.461$ ,  $p < 0.05$ ) and higher during the winter

**Table 1.** Correlation and regression parameters for the studied relationships between population numbers (N), density (D), and home range (HR) in winter and vegetative seasons.

Season	Relationship	Correlation	P-Value (Correlation)	Slope	Intercept	R <sup>2</sup>	P-Value (Regression)
Winter	N-D	0.290	0.2596	0.0005	0.628	0.084	0.2596
	N-HR	0.673**	0.0031	0.7745	187.024	0.452	0.0031
	HR-D	-0.451	0.0693	-0.0007	1.108	0.203	0.0693
Vegetative	N-D	0.610**	0.0090	0.0007	0.431	0.372	0.0090
	N-HR	0.774**	0.0003	0.831	235.428	0.599	0.0003
	HR-D	0.026	0.9200	0.0003	0.635	0.001	0.9200

\* $p < 0.05$ , \*\* $p < 0.01$

## Discussion

In many cases, planned limits for population numbers of free-ranging wisents are overpassed. In the Białowieśka Forest, such a limit was estimated for 250 and later for 400–450 individuals, while the present population counts about 900 animals. In Bieszczady Mountains, optimal population numbers were assumed to be 400, and currently there are over 800 wisents. Similarly, in Knyszyńska Forest where the upper limit for wisent numbers was set for 200, there are now over 300 individuals (Pucek *et al.* 2004; Krasiński *et al.* 2011; Perzanowski *et al.* 2013; Perzanowski & Olech 2014; Raczyński & Bołbot 2024).

This trend is connected with the constant extension of home ranges of free-ranging populations. More than 60% of the wisent population of Białowieśka spends winter outside of the forest. In Knyszyńska Forest a considerable part of the population seasonally leaves the forest to feed at surrounding agricultures (Kowalczyk *et al.* 2013; Perzanowski *et al.* 2013; Olech *et al.* 2024). In Bieszczady, according to this study estimated area of the home range increased by twofold.

Such population growth and the extension of its home range raise concerns about potential damage to forest stands and field crops. Considerable problems with damages in agriculture were reported, e.g. from the surro-

undings of Białowieska and Knyszyńska Forests (Sobczuk & Olech 2016; Krasińska & Krasiński 2017). Due to the specific structure of land cover in Bieszczady, this issue is of minor importance there (Perzanowski *et al.* 2011). A study on the effects of wisents' foraging upon woody vegetation performed in Bieszczady has proved that damages to forest stands caused by wisents are generally negligible. However, some considerable losses due to debarking can be observed in the vicinity of game feeders supplied with concentrated food (Paszkievicz, Januszczak 2010; Baraniewicz, Perzanowski 2015; Nieszafa *et al.* 2022).

The analysis performed in this study shows that the growing population of wisents extends at the same time its home range, sometimes even outside optimal forest habitats. Fluctuations of population density observed over almost 20 years in Bieszczady Mountains were not proportional to the population numbers. Such a pattern indicates that high values of population density are quickly compensated with an increase of the home range, in this region somehow preventing therefore the threat of overpopulation.

A significant relationship between the population numbers and the area of population home range during the whole year indicates that wisents tend to increase their home range together with the growth of their population. However, the positive correlation between the population numbers and density in vegetative seasons may suggest a tendency for stronger aggregation of wisent groups during the period of food abundance.

Nevertheless, the obtained data on fluctuations in population density show, that wisents are able to adjust the extent of their home range to the growth of their population numbers. This can be an important mechanism preventing depredation of their natural food resources.

On the other hand, the constant extension of the area of occurrence must finally cause conflicts with human infrastructure and agriculture. Therefore, so important is the adequate planning of target numbers of wisent populations and careful selection considering the potential carrying capacity of sites foreseen for their reintroduction.

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### **Dynamika populacji a rzeczywiste zagęszczenie wolnościowej populacji żubrów w Bieszczadach**

**Streszczenie:** Analizowane były dane dla populacji żubra (*Bison bonasus* L.) bytującej w Bieszczadach dotyczące liczebności, zagęszczenia i powierzchni areалу tej populacji, pochodzące z okresu pomiędzy sezonem zimowym 2002/2003 oraz sezonem wegetacyjnym 2022. W ciągu tego czasu populacja powiększyła się od ok. 170 do prawie 730 osobników. Powierzchnia jej areálu oceniona jako MCP wzrosła od ok. 300 km<sup>2</sup> w zimie 2002/2003 to prawie 820 km<sup>2</sup> latem 2022. Niemniej, zagęszczenie tej populacji ciągle fluktuowało pomiędzy 0,40–1,44 osobników/km<sup>2</sup>. Wysoka wartość korelacji pomiędzy liczebnością populacji oraz powierzchnią jej areálu jak również brak korelacji pomiędzy jej liczebnością a zagęszczeniem w sezonach zimowych oraz brak korelacji pomiędzy wielkością areálu a zagęszczeniem populacji w sezonach wegetacyjnych wskazują, że żubry wykazują tendencję do dopasowania rozmiarów areálu swojej populacji do wzrostu jej liczebności.

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