

# How large the European bison population in Białowieża Forest should be in future?

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**Abstract:** The aim of the study was to analyze the results of the winter inventory of the European bison population, both in terms of structure and distribution within the Natura 2000 site and beyond. We focused on the dynamics of population size and structure and the distribution of the European bison population in the Białowieża Forest region to assess trends over the last decades. It is important to note that the entire Białowieża Forest is a Natura 2000 site with an area of 631 km<sup>2</sup>. This compact complex is dominated by deciduous forests with a high degree of naturalness. Outside the Natura 2000 site, there are mainly agricultural areas. The Białowieża population is constantly increasing, with a higher growth rate in recent years. The proportion of wintering European bison in the Natura 2000 site Białowieża Forest has decreased significantly over time, although the absolute number of animals has not changed. In 2012, almost 2/3 of the European bison population was observed in the Natura 2000 site. Currently, only about 1/3 of them remain there. In winter, in 2011–2023 there was an average of 314 animals in the Natura 2000 site, which indicates that this is the capacity of this area at this time of year. It should also be noted that the proportion of calves and young animals in the herds recorded in the Natura 2000 site was lower compared to the part of the population living outside this area (24% compared to 31.1%), which may be due to the aging of the population.

**Keywords:** Natura 2000 site Białowieża Forest, *Bison bonasus*, population size

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## Introduction

The beginnings of the restitution of the European bison (wisent) *Bison bonasus* to the Białowieża Forest date back to 1929, when the first individuals were brought to Białowieża after ten years of absence of this species (Kraśiński 1994; Kraśińska & Kraśiński 2017). The European bison were housed in a specially constructed enclosure in the central part of the forest. This marked the beginning of the first stage of restitution – breeding in

an enclosure. Another goal was the rebirth of the lowland European bison, whose ancestors came from the Białowieska Forest. The last European bison with an admixture of Caucasian blood left the reserves in Białowieża in 1950. The experiment to release the European bison back into the wild by reintroducing the first animals into the forest began in 1952 (Krasinski 1983; Pucek *et al.* 2004). The success of this experiment is reflected in the size of the free-ranging wisent population in the Polish part of the Białowieska Forest and its surroundings, which numbered almost 900 animals at the end of 2023 (Raczyński 2024).

The entire Białowieska Forest is a Natura 2000 site with an area of 631 km<sup>2</sup>. This compact complex is dominated by deciduous forest stands with a high degree of naturalness. About 11 thousand species represent the fauna. In many ways, the nature of the forest is unique on a national and even global scale. Almost half of the area consists of oak-hornbeam forests, i.e., forests in which the tree population consists mainly of oak, linden, and hornbeam. The hollows and river valleys are covered with alluvial forests dominated by ash and alder. Spruce forests on peat, alder, bog birch, and bog pine-birch forests can be found in these damp habitats. Mixed forests predominate on sand and gravel soils, and here and there are relicts of tall oak-hornbeam forests and sparse oak forests. There are willow thickets, wet meadows, herbaceous vegetation, and meadows in the woodless parts of the river valleys. The total area of the 260 meadow fragments in the entire forest is 522 ha. According to Krasinski *et al.* (2011), the maximum size of the European bison population within the area of the Białowieska Forest is 450–500 individuals. Assessing the optimal population size of European bison in a given population is important for the conservation measures for this species. This results from the fact that European bison have limited migration capabilities, which causes populations to be partially or almost completely isolated. This situation is observed almost throughout the entire range of European bison (Olech & Perzanowski 2022). Moreover, such a distribution of European bison populations is also due to economic reasons. These animals live in a forest-meadow mosaic, usually in the areas of larger forest complexes, and the surrounding areas are usually used for agriculture. For this reason, European bison outside the forest-meadow mosaic is not desirable. The effect of the mismatched population size of European bison on the carrying capacity of a given location is not only damage to agriculture and forestry but also the exposure of these animals to health hazards (Klich *et al.* 2020; 2021; 2023).

The study aimed to analyze the results of the winter inventories of the European bison population, both in terms of structure and distribution within the Natura 2000 site and beyond this area. We focused on the dynamics of the

population size and structure as well as the distribution of the European bison population in the Białowieża Forest region to assess the trends in recent decades in relation to the estimated optimal population size by Krawiec *et al.* (2011).

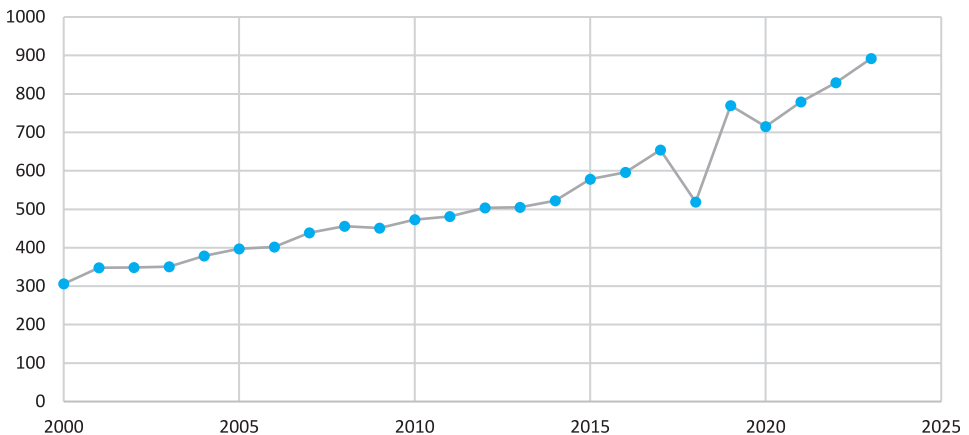
## Material and methods

The material is the results of the inventory carried out by the Białowieża National Park and the Białowieża, Browsk, Hajnówka, and Bielsk Forest Districts in the area where the European bison population lives. The data included the location and number of animals, mostly divided into sex-age groups. Based on the location, the observations were assigned to one of the groups, i.e., inside and outside the Natura 2000 site. The analysis involved determining the numbers in two groups and displaying them on maps using QGIS (3.22). Based on the last year of the inventory (winter 2023/2024), the sex-age structure was determined in both parts.

## Results

### *Group size and localization of observed animals*

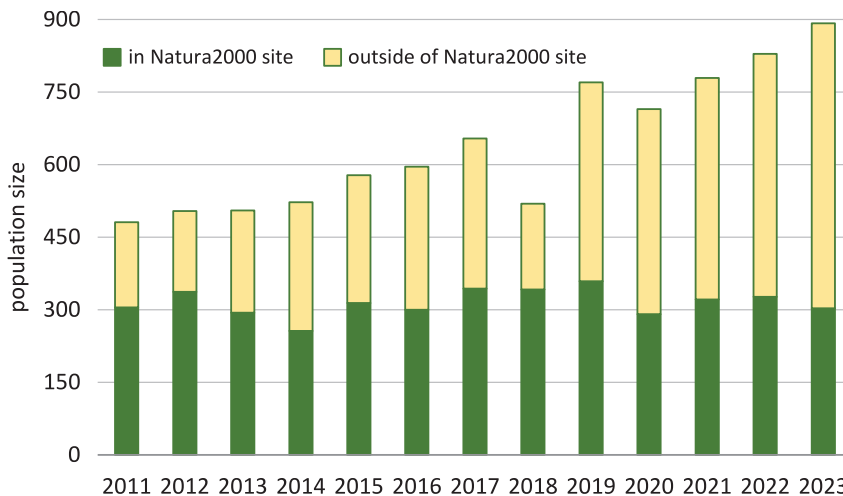
At the end of 2023, the wisent population in the Polish part of the Białowieża Forest amounted to 892 individuals, and compared to 2022 (829 animals), the population increased by 7.6 % in one year. The size of the total population has grown systematically (Table 1, Fig. 1). In the period 2018–2022, 16 surplus



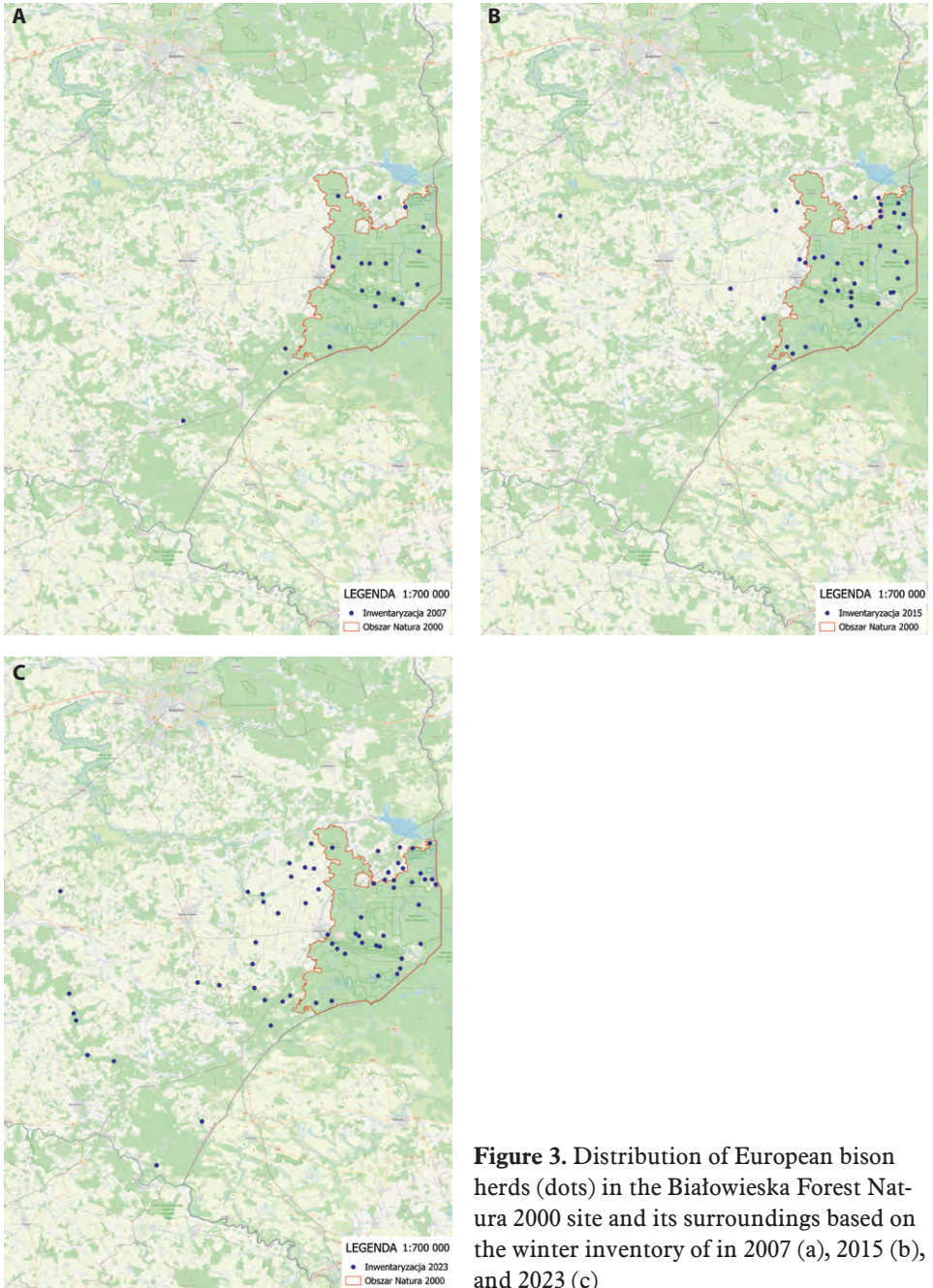
**Figure 1.** The size of the Białowieża population of European bison in the period 2000–2023 (source: European bison Pedigree Book data)

males (three one-year-olds, eight two-year-olds, and five three-year-olds) were released from the Białowieża reserves, and two one-year-old females escaped (Raczyński 2019–2023).

The Białowieża population was constantly growing, with the growth rate in recent years being higher than at the beginning of the century. The area occupied by this population was also increasing. European bison occupied the Białowieża Forest mainly in the northern and western parts. The proportion of wintering European bison in the Natura 2000 area of the Białowieża Forest decreased significantly with time (Table 1; Fig. 2; Fig. 3a-c), although the number of animals in the Natura 2000 site was not changing. In 2012, over 60% of all European bison from the Białowieża population were observed in the Natura 2000 site; currently, only about  $\frac{1}{3}$  of this population remains there. At the beginning of the 21<sup>st</sup> century, groups of European bison were occasionally observed outside the Natura 2000 site. Over time, however, the presence of winter herds far outside the forest became the norm (Fig. 3c). There were about 300 animals in the Natura 2000 site in the winter (the average for the years 2011–2023 is  $314 \pm 27$ ), suggesting that this is the capacity of this area at this time of year. Determining how many European bison return to the forest during the growing season is difficult. Although there is no precise knowledge on this subject, data from only one telemetry collar suggests that a herd left the forest for the winter and returned for the growing season (Fig. 4). From the information provided by forest district employees, it is also known that there are several hundred animals in the Bielsk, Browsk, and Hajnówka forest



**Figure 2.** Number of animals observed in and outside Natura 2000 site ( data from the winter inventory in 2011–2023)

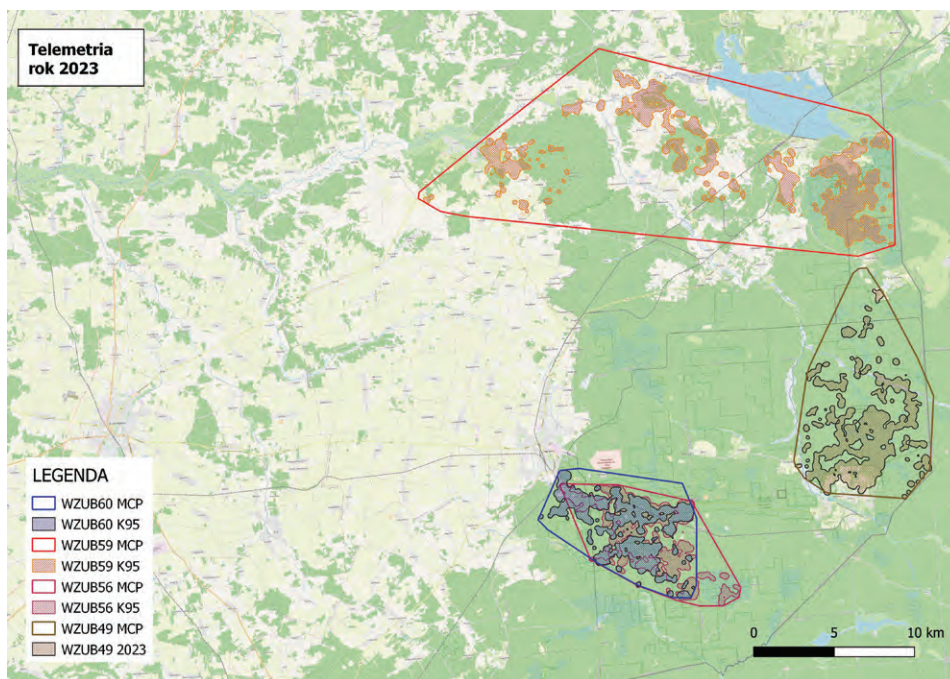


**Figure 3.** Distribution of European bison herds (dots) in the Białowieża Forest Natura 2000 site and its surroundings based on the winter inventory of in 2007 (a), 2015 (b), and 2023 (c)



**Table 1.** Data from the winter inventory in 2011–2023, broken down by animals observed in the Natura 2000 area and their percentage

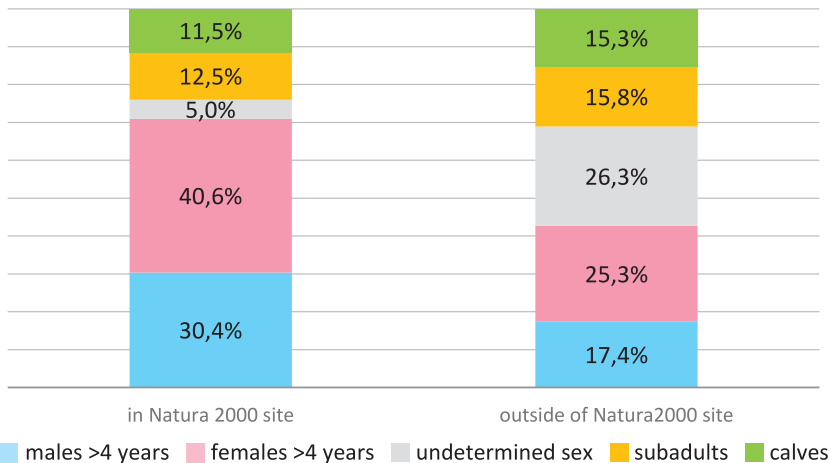
Year	Number of European bison		Part of observed in Natura 2000 site[%]
	In the Natura 2000 site	Whole population	
2011	305	481	63,4
2012	337	504	66,9
2013	294	505	58,2
2014	256	522	49,0
2015	314	578	54,3
2016	300	596	50,3
2017	344	654	52,6
2018	321	519	65,9
2019	359	770	46,6
2020	291	715	40,7
2021	321	779	41,2
2022	327	829	39,4
2023	303	892	34,0

**Figure 4.** Locations of two European bison herds equipped with telemetry collars in the 2023 growing season and the 2023/2024 winter period

districts outside the Natura 2000 site. It is impossible to record them during the growing season, and the lack of this knowledge results from the lack of telemetry in the herds outside of the forest complex.

### *Sex-age population structure*

The population structure in 2021–2023 is shown in Figure 5, distinguishing between the population inside and outside the Natura 2000 site. The size of the observed groups, especially in open areas, makes it impossible to determine the sex and age structure of wisents accurately. The large concentration of animals only determines the number and proportion of calves in their first year. For this reason, outside the Natura 2000 area, 26.3% of individuals were assigned to the group of undetermined sex, while the proportion of this group in the N2000 area is low (at 5%). It should also be noted that the proportion of calves and young in the European bison herds recorded in the Natura 2000 site is lower compared to the part of the population living outside this area (24% vs. 31.1%) (Fig. 4), with values fluctuating around 35% in previous years (Kraśiński *et al.* 2011). The lower proportion of calves and young animals could be due to the aging population due to a lack of selection. The influence of wolf predation can also be as a driver of the decrease of the proportion of young in population, as the population of this predator is growing and there are good conditions for European bison hunting in the Natura 2000 area.



**Figure 5.** Structure of the European bison population inside and outside the Białowieśka Forest Natura 2000 site, based on the 2021–2023 winter inventories

## ***Discussion***

The need to determine the size of the European bison population in the Białowieska Forest has been discussed for almost several decades. In 1971, the size of the free ranging population exceeded 200 individuals, and specialists began to think about the target size of this population. Although introducing the concept of “optimal population size” itself is controversial, more and more people see the need to set an upper limit for the number of European bison that should occupy the Białowieska Forest. At that time, the principle of taking active measures to maintain the population at 250 individuals was adopted (Pucek 1991; Krasińska & Krasiński 2017). In 2001, the population exceeded 300 individuals, and a new target size of 400 individuals was set (Pucek *et al.* 2004), later extended even to 450–500 (Krasiński *et al.* 2011). The basic assumption formulated in the “Strategy for the Conservation of European Bison in Poland” (2007) is that the herd in the Białowieska Forest must be treated as a whole. Still, indicating the optimal number may refer to the N2000 site. Currently, the population is much larger, as over 60% of the European bison population spends winter outside the forest. In the 19th century, the Białowieska Forest was inhabited by the last natural population of lowland European bison. The number of animals in the entire area, consisting of present Polish and Belarussian parts, fluctuated wildly, generally around 700–900 individuals (Karcov 1903, Krasińska, Krasiński 2017). Currently, the population of the European bison is permanently divided by the existing fence. The habitat conditions on the Polish and Belarussian sides differ significantly and the Polish part of the forest accounts for about 40% of its total area. On this basis, the population size on the Polish side of the Forest could be around 360 individuals. According to data from the 19th and 20th centuries, there was no increase in the population numbers when the density of wisents exceeded 0.5 individuals per km<sup>2</sup> (Samojlik & Jędrzejewska 2010). This relation can also help to determine the target number of European bison in the Białowieska forest complex.

For any population, the parameter that ultimately limits its numbers in a given area is its food capacity. It can be estimated by knowing the food requirements of an individuals and the supply of potentially available natural food. Still, its exact determination is difficult due to changing environmental conditions (fluctuations in the biomass of individual plant species and their seasonal availability) and competition from other species whose food niche overlap.

Populations of rare species that remain in small numbers usually meet a high level of acceptance, which is linked to the increased attractiveness of



a particular area, which is reflected, for example, by higher income from tourism or an increase of the prestige of a specific region. However, suppose conflicts are connected to economic loss, cases of animal aggression, or the risk of frequent traffic accidents. In that case, social acceptance decreases. Consequently, there may be social pressure against further protection and rational management of such a population. As a rule, the threshold of social acceptance is lower than the numerical limit set by the limitation of the food base. In the case of the Białowieska population, the acceptance threshold for a further increase in the European bison population seems to have been exceeded, and it would be optimal to limit their numbers or at least stop their further growth.

Based on long-term observations, it can be stated that in the case of European bison in the Białowieska Forest, a good indicator is the persistent number of approx. 300–320 individuals in the Natura 2000 site in winter. Such numbers should be recorded in subsequent population surveys, and a decline should be an alarming symptom of deteriorating environmental conditions for European bison, i.e., a decrease in winter feeding capacity.

Therefore, for further sustainable management of the European bison in Białowieska Forest, the minimum number of animals in the Natura 2000 site in winter inventory is more important for population stability than its maximum size.

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### **Jak duża powinna być populacja żubrów w Puszczy Białowieżskiej w przyszłości?**

**Streszczenie:** Celem pracy była analiza wyników zimowej inwentaryzacji populacji żubrów, zarówno pod względem struktury, jak i rozmieszczenia w obrębie obszaru Natura 2000 i poza nim. Skupiliśmy się na dynamice wielkości i struktury populacji, a także na rozmieszczeniu populacji żubrów w regionie Puszczy Białowieżskiej, aby ocenić trendy na przestrzeni ostatnich dziesięcioleci. Należy zauważyć, że cała Puszcza Białowieża jest obszarem Natura 2000 o powierzchni 631 km<sup>2</sup>. Obszar ten jest zwartym kompleksem zdominowanym przez lasy liściaste o wysokim stopniu naturalności. Poza obszarem Natura 2000 znajdują się głównie tereny rolnicze.

Populacja żubra w Puszczy Białowieżskiej stale rośnie, przy czym w ostatnich latach odnotowano większy wzrost. Odsetek zimujących żubrów w obszarze Natura 2000 Puszczy Białowieżskiej znacznie zmniejszył się w czasie, chociaż bezwzględna liczba zwierząt nie uległa zmianie. W 2012 r. na terenie Natura 2000 obserwowano prawie 2/3 żubrów, obecnie pozostało jest to wartość około 1/3. Zimą na terenie Natura 2000 przebywało w latach 2011–2023 średnio 314 osobników, co wskazuje, że jest to pojemność tego obszaru o tej porze roku. Należy również zauważyć, że udział cieląt i młodych zwierząt w stadach inwentaryzowanych na terenie Natura 2000 był niższy w porównaniu do części populacji żyjącej poza tym obszarem (24% w porównaniu do 31,1%), co może być spowodowane starzeniem się populacji.

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