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Reproduction parameters of wisent in *ex situ* condition

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Abstract: Actions aimed at restitution of the European bison have resulted in tangible effects. Status of the species in the Red List published by the International Union for Conservation of Nature (IUCN) has been changed from a *vulnerable* (VU) to a *near-threatened* (NT). Further management of the species requires updating the results of demographic research. The aim of this study was analysis of reproduction data of the European bison population kept in chosen enclosures. The analysis was carried out for period between years 1998–2017 on the basis of the information from the European Bison Pedigree Book about 8 selected herds. Most females gave birth to their first calf between the ages of 5 and 6 years. The mean number of calves per one female was 9.2 (SD = 3.08). The fertility rate was: 58.43% (SD = 21.33). The sex distribution at birth does not differ significantly from the expected 1: 1 ratio. An intensification of the phenomenon of unstable reproduction seasonality and the effects of breeders' activities aimed at lowering the parameters of reproduction were proofed.

Keywords: wisent, *Bison bonasus*, reproduction, captive breeding, population

Introduction

Implementation of the Status Survey and Conservation Action Plan for the European bison (the wisent) (Pucek *et al.* 2004) has brought very tangible effects (Olech & Perzanowski 2016). Over the past years, there has been a steady increase in the species population size, from 2842 individuals in 1998 (EBPB 1999) to 9554 individuals in 2021 (EBPB 2022) and the intensification of cooperation between scientists and practitioners associated with the European Bison Friends Society and the European Bison Conservation Center. As a result, the status of the species in the Red Book published by the International Union for Conservation of Nature (IUCN) has been changed from a *vulnerable* (VU) to a *near-threatened* (NT).

Three main factors affect the reproduction level of *ex situ* population of wisents. The first results from the biology of the species. In the European bison, all biological factors are affected by low genetic diversity resulting from

the history of the species. The second group of factors concerns the environment. In the conditions of the enclosure, it is possible to supply the fodder in the case of insufficient foraging base, but usually it is not possible to increase the available space. The third factor, that may often have a decisive impact on the dynamics of the *ex situ* population size changes is the anthropogenic influence. It includes, for example, translocations of individuals among herds and regulation of the age-sex structure of herds.

The fertility rate (the number of calves born vs. number of females at reproductive age: in wisents ≥4 years) is a common measure of the reproductive potential of the population. The age and sex structure of the population is one of the factors determining the reproductive potential of mammals (Quader 2005). The fertility rate observed in a free herd living in the Białowieska Forest changed in various time periods depending on the population structure. In the period 1960–2002 the average value was 49.1%. The highest level of the coefficient occurred during the formation of the population and was then at the level of 70.3%, later it dropped to the level of 44.0%. In the last five years (1998–2002) it was lower than the long-term average. This was related to the population large size and structure with large percentage of old females with a limited participation in reproduction, and the deterioration of the foraging base in the Polish part of the Forest (Krasińska & Krasiński 2004). According to long term studies in the Polish part of the Białowieska Forest, the optimal composition of the population is: adult females (≥4 years old): 35.7%, adult males (≥4 years old): 25.4%, adolescents (2–3 years old): 23.4% and calves (up to 1 year): 15.5%. In reserves, a reduced proportion of adult males (compared to free living herds) is maintained, i.e. it is recommended to keep one male with few females per a single herd. In European bison, females generally give birth to one calf, so the fertility rate is important for the increase rate of the herd. In studies on the sustainability of the wisent population in the Polish and Belarusian parts of the Białowieska Forest, it was noted, that the probability of population extinction increases sharply when the fertility rate drops below 30% (Daleszczyk 2009).

In studies on the population living in reserves, it was observed that each year 20% of breeding females do not calve (Krasiński & Raczyński 1967). Late calving (November, December) and calf loss (stillbirth or early mortality) were mentioned as reasons for the lack of calving. There are also cases where the falls occurred repeatedly in the same females, or persistent infertility occurred in the females after the period of regular calving (Krasiński & Raczyński 1967).

Regarding the influence of the environment, Krasiński and Raczyński (1967) noticed that only the starvation may be a natural limitation of repro-

duction in the case of European bison. The occurrence of the hunger factor (as was the case in Białowieska Forest in the 19th century because of very high density of all herbivores) may cause a delay in sexual maturation, low pregnancy rate and greater mortality of young animals (Wróblewski after Krasiński & Raczyński 1967). Another factor limiting reproduction is the climate, but this factor can be excluded if the wisents live in places coinciding with their natural range (Krasiński & Raczyński 1967). The decrease in reproductive potential is related also to keeping wisents in too small enclosures, as was the case in the early years of restitution in Pszczyna or Białowieża (Zabłocki after Krasiński & Raczyński 1967). In addition, intra-population factors, associated with grouping females and young into herds and periodic joining of bulls, affect the shortening of the reproductive period and increase the mating efficiency (Krasiński & Raczyński 1967; Krasińska & Krasiński 2004). In herds kept in enclosures without division into sections, this factor will not appear either.

The aim of the study was to analyze reproduction rate and calculate its some parameters for European bison living in breeding centers located in three European countries.

Materials and methods

Eight *ex situ* herds existing for at least 20 years before 1998 were selected for the analysis. Large-sized herds located in Poland, Germany and Sweden were preferred. In Table 1 there is provided detailed information on selected herds.

Table 1. Selected herds with information on the genetic line and the average size in the years 1998–2017

	Herd name	Country	Line*	Herd size average (SD)
1	Avesta	Sweden	LC	29.1 (±2.98)
2	Damerower	Germany	LC	32.4 (±3.12)
3	Eriksberg	Sweden	LC	29.9 (±17.02)
4	Gołuchów	Poland	LB	8.8 (±2.48)
5	Hardehausen I	Germany	LC	17.6 (±2.16)
6	Pszczyna	Poland	LB	36.2 (±6.85)
7	Sababurg	Germany	LC	16.3 (±2.53)
8	Springe	Germany	LC	26.8 (±6.00)

*LC – Lowland-Caucasian genetic line; LB – Lowland line

Analyzes on reproduction in the years 1998–2017 were carried out on the basis of the information from the European Bison Pedigree Book (EBPB), volumes published in the years 1999–2018. For females born before 1998, the data on offspring was found in the EBPB, volumes published in the years 1978–1998. Analyzes were made on the basis of the data concerning 199 females, including 74 females born before 1998. The traits analyzed were the age of the first calving, the length of the period between calvings, the fertility and the number and sex of the offspring.

The **age of the first calving** of females was calculated as a difference between the dates of birth of the mothers and their first offspring. The average for 199 females was calculated. The trait unit was the month.

The **fertility of females** – was the percentage of females calving in particular age class. In the case of one female of 8536 POLNA II imported to Gołuchów in 2003, one calf born by her in the herd of origin (Niepołomice) was included in the lifetime fertility analysis. In the case of exported females (N = 35), the length of their stay in selected herds was taken into account (not their lifespan), and their calves born within 8 selected herds were analyzed. The maximum and average number of calves in each herd born by the oldest cows (18 years and more) were compared. Then age limit implemented for the oldest females was 18-years.

The **fertility coefficient** was calculated as the proportion of the number of calves born vs. the total number of females of reproductive age. The results are presented for every herd/year group. A weighted mean was calculated for each herd. The reproductive age of females was assumed to be from 4 to 19 years (48 – 228 months). The lower age limit was established on the basis of literature data confirming that in the majority of cases, female European bison begin breeding in the third year of life, and the first calving occurs in the fourth year of life (Krasiński & Krasińska 2004). The upper age limit was selected on the basis of literature data confirming that female wisent calve regularly until the age of 17–19 years, but Krasiński and Raczyński (1967) claim that the last calving of cows living in the wild falls earlier.

The **length of the period between calvings** was calculated for 163 females (out of 199 analyzed) which calved at least twice. The average of this trait for every herd was calculated. The differences between herds were checked by one-way analysis of variance and the *post hoc* test.

The **sex distribution at birth** was analyzed in every herd and in the entire metapopulation. Compliance with the assumed sex distribution (1: 1) was verified using the Chi-square test.

Results

Age at the first calving

In the selected herds, females (N = 199) gave birth to their first calf between the ages of 3 and 11 years (29 and 123 months). The mean age of the first calving was 53.6 (SD = 16.1) months. The earliest calving was observed in a female at 29 months of age (female of the LC line, born in 2000, Eriksberg). The latest first calving was observed at 123 months of age (i.e. over 10 years of age) (LC female, born 2005, Damerower) (Table 2).

Table 2. Age of the first calving of females in reserves in 1998–2017

	Avesta	Damerower	Eriksberg	Gołuchów	Hardehausen	Pszczyna	Sababurg	Springe
Mean	54.5	55.7	60.6	45.7	59.7	50.0	47.5	51.0
SD	22.8	17.6	18.0	10.0	15.5	8.0	8.4	11.4
Minimum	30	31	29	34	36	34	36	31
Maximum	122	123	106	60	95	68	69	76
Number of cows	34	30	24	8	22	40	17	24

Krasiński and Raczyński (1967) recorded the first calving in females (N=52) between the age of 3 and 6 years. Daleszczyk (2011) in the study on the group of females (N=30) recorded the first calving between the age of 3 and 5 years. For females living in reserves between 1954–1965, the mean age of the first calving was 47.8 months (Krasiński & Raczyński 1967). In the study by Daleszczyk (2011), the age of the first calving was 48.48 months (age in years: 4.04). Urošević *et al.* (2021) compared the age of first calving in two German *ex situ* herds in 2000–2018. The mean age of first calving in this study was the lowest. In the first group of females (N = 8) it was 42.54 months (age in years: 3.55), and in the second group (N = 11) it was 31.67 months (age in years: 2.64).

The comparison of the age of the first calving in the current European bison population (1998–2017) and in the population living in the reserves in the years 1954–1965 (Krasiński & Raczyński 1967) is presented in Table 3.

Table 3. The percentage of the age of first calving for females in consecutive age classes between 1998–2017 and between 1954–1965

The year of female's life	3	4	5	6	Total
Females *ex situ* 1998–2017	12.4	**36.2**	33.0	18.4	100.00%
Females *ex situ* 1954–1965*	9.6	**53.9**	25.0	11.5	100.00%

*Based on Krasiński and Raczyński (1967).

For females from the current population, an upper age limit was introduced, in accordance with the study cited above, i.e. 72 months (6 years of age), because up to this age inclusive, 92.96% of females gave birth to the first calf.

In our studies the first calving at 3 years of age occurred for small percentage of females, the same as observed by Krasiński and Raczyński (1967). Then, in both compared populations, a similar percentage of females calved for the first time between the ages of 4 and 6 (87.6% vs. 90.4%). In the historical population, there is a clearly dominant share of females calving for the first time in the 4th year of life (53.9%) and a smaller share of the first calving in the 5th and 6th years of life (total: 36.5%). A reversal of this proportion can be observed in the current population. Although the highest share of calves is still in the 4th year of life (36.2%), 51.4% of the first calves are recorded at 5 and 6 years of age. For American bison, the first calving was usually also observed in the fourth year of life (45 months of age) (Wilson *et al.* 2002), analogously to the European bison.

European bison is a species with seasonality in reproduction. In free-roaming herds, the mating season lasts from July to October, and its peak falls in August and September (Krasiński & Krasińska 2004). In reserves, some unsteadiness in the seasonality of reproduction was observed (Olech 2003; Krasińska & Krasiński 2004).

The indicated differences between the age distribution of the first calving in the historical and current populations may result from progressive unsteadiness in the seasonality of reproduction. Moreover, the results regarding the historical population fertility (Krasiński & Raczyński 1967) refer to the period of intensive restoration of the population size. This involved a herd management aimed at maximizing reproduction in herds. Nowadays, in enclosures with appropriate infrastructure, it is common to separate males in the reproductive period in order to avoid the problem of surplus individuals.

The mean age of the first calving in 8 selected herds is presented in Figure 1. The lowest age of the first calving was in the herds of Gołuchów (45.71 months) and Sababurg (47.50 months). The average size of the Gołuchów herd is below 10 individuals, and in the Sababurg herd it is smaller than 20 individuals, therefore maintaining high fertility parameters is particularly important for their sustainability. The age of the first calving in these herds is slightly lower than that obtained by Krasiński and Raczyński (1967) or by Daleszczyk (2011). The highest age of the first calving was in the herds of Hardehausen (59.73 months) and Eriksberg (60.63 months).

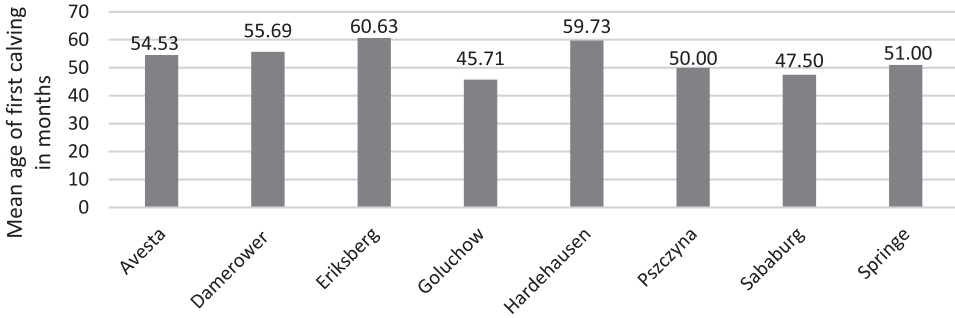

Figure 1. Average age of the first calving of females in various *ex situ* herds in 1998–2017

Lifetime fertility of females

From the age of 3 (25–36 months) up to the age of 23 years, female European bison give birth to offspring (Figure 2). The share of females calving at the age of 3 years accounted for approximately 21.7% of this age group. In the fifth year of life, the beginning of the period of the highest fertility in the life of females is observed. The share of calving females in this age group was 62.11%. In the studied population, the period of the highest fertility ends at 12 years of age (133–144 months), when the proportion of calving females is 65.0%.

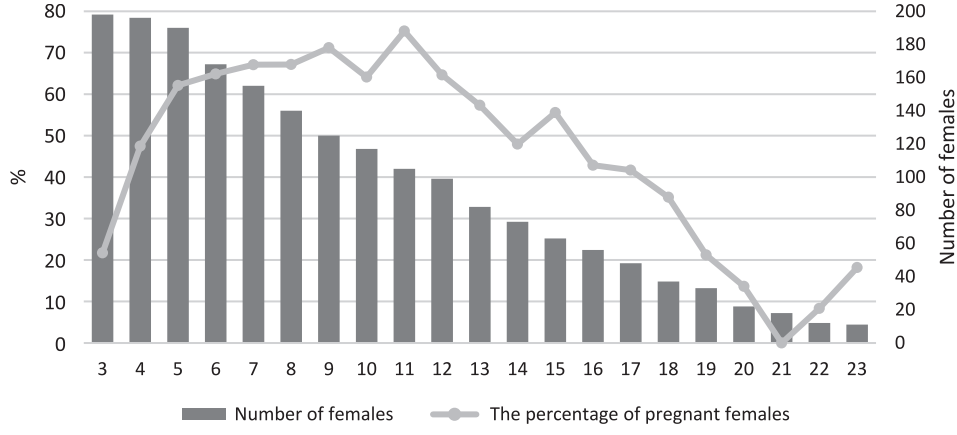

Figure 2. The share of the number of calving females and the percentage of pregnant females in individual age classes (3–23 years old)

The highest fertilily (75.0%) was found for females at 11 years of age (121 – 132 months). From the age of 16, the percentage of calving females begins to decline gradually. In the group of the oldest females, 2 calving at 23 years of age (268 months) were recorded (female 4045 KNIVA, Eriksberg and 5595 DAPHNIA, Damerower), which was 18.0% of this counting 11 individuals age group.

For comparison, the period of the highest fertility of wisent cows in the historical population began at the age of 5 and lasted until the age of 20 years, and the percentage of calving females in the age groups was similar, 72.0 – 85.0% (Krasiński & Raczyński 1967). According to Daleszczyk (2011), the period of the highest fertility was between 5 and 13 years of age of cows. According to the guidelines of the Central European Bison Reserve in the USSR, a wisent cow over 20 years old was considered as sterile (Krasiński & Raczyński 1967). In the American bison, according to Wilson *et al.* (2002), the "peak fertility" falls between the 5th and 14th year of the female's life, and the reproductive period ends around the age of 20. Table 4 shows the maximum and average number of calves born to the oldest cows, i.e. at the age of 18–23 years. tThe mean number of calves per a female during lifetime (N = 37) is in the range of 7.0 – 14.0 individuals. The highest number of calves (14) was recorded for females from Pszczyna and Sababurg, and the lowest for females from Avesta and Eriksberg (7 and 10, respectively). The mean number of calves born for oldest females ranged from 6.0 (± 0.82) in the Avesta, to 11.7 (± 1.7) and 11.4 (± 1.36) in Sababurg and Springe. The mean number of calves in all herds was 9.2 (SD = 3.08). Krasiński and Raczyński (1967) estimated the expected number of offspring in the lifetime of the female to be 8.83, i.e. almost 9 calves, similar to our study. Urošević *et al.* (2021) calculated the average number of calves in the years 2000–2018 in the group of 8 females to 3.0 (± 2.19), and in the group of 11 females 4.87 (± 4.08). The maximum number of calves per female in his study was 7 and 13 in two herds respectively.

Table 4. The maximum and average number of calves born by the oldest females (18–23 years old) during their lifespans

No.	Herd name	Number of cows	Maximum number of calves		SD
1	Avesta	**3**	**7**	6.0	0.82
2	Damerower	**13**	**13**	8.3	3.67
3	Eriksberg	**2**	**10**	9.0	1.00
4	Gołuchów	**2**	**11**	10.5	0.50
5	Hardehausen	**5**	**11**	8.6	1.36
5	Pszczyna	**4**	**14**	10.5	3.50
7	Sababurg	**3**	**14**	11.7	1.70
8	Springe	**5**	**13**	11.4	1.36

The fertility coefficient

For 8 herds, the weighted average fertility rate was: 58.43% (SD = 21.33). The obtained value is lower than that calculated by other authors for herds in the reserves: 63.6% (Daleszczyk & Krasiński 2005), 66.6% (Kashtalian 2019) and

76.82% (Krasiński & Raczyński 1967), but it is higher than the value (38.00%) calculated for a free living herd from the Belarusian part of the Białowieska Forest in 1971–2002 (Krasińska *et al.* 2003) and the value of 39.00% obtained for the population living in the Polish and Belarusian part of the Białowieska Forest, based on data from 1970–2005 (Polish population) and 1981–2005 (Belarusian population) (Daleszczyk 2009). The obtained value is also higher than 50.00%, i.e. the value of the fertility rate obtained in populations of wisents from the free living herd in the Polish part of the Białowieska Forest in the period 1960–2002 (Krasińska *et al.* 2003) and free living herd in the nature reserve "KRASNYJ BOR" (Belarus) in 2015–2018 (Kashtalian 2019).

Table 5. Values of the fertility rate in selected herds in 1998–2017

Name of the herd / Year	Avesta	Damerover	Eriksberg	Gołuchów	Hardehausen	Pszczyna	Sababurg	Springe
1998	30	60	0	75	60	80	71.4	57.1
1999	40	50	0	100	80	85.7	100	87.5
2000	18.2	58.3	100	50	20	88.9	85.7	50
2001	0	66.7	100	75	33.3	60	57.1	50
2002	21.4	50	100	33.3	80	75	42.9	50
2003	13.3	41.7	100	66.7	33.3	60	66.7	75
2004	33.3	25	60	100	33.3	80	87.5	41.7
2005	53.8	80	100	100	85.7	70	62.5	60
2006	38.5	70	83.3	100	71.4	50	71.4	37.5
2007	42.9	88.9	42.9	50	57.1	61.5	77.8	57.1
2008	33.3	72.7	87.5	100	50	64.3	50	33.3
2009	33.3	63.6	66.7	0	37.5	64.3	57.1	71.4
2010	88.9	40	70	100	75	57.1	80	42.9
2011	63.6	81.8	100	100	45.5	60	80	60
2012	80	53.8	83.3	66.7	70	71.4	100	25
2013	72.7	35.7	69.2	100	87.5	84.6	80	33.3
2014	66.7	30.7	57.1	66.7	20	68.8	60	85.7
2015	90	69.2	35.3	66.7	20	44.4	80	62.5
2016	70	25	59.1	66.7	80	50	40	62.5
2017	75	40	61.9	66.7	10	68.4	40	71.4
$\bar{X}$ (weighted)	**46.15**	**54.71**	**66.06**	**72.22**	**51.33**	**65.06**	**69.53**	**56.52**
SD	**25.37**	**18.18**	**19.47**	**24.22**	**25.29**	**11.83**	**17.28**	**15.81**

Comparing the information on the reproduction of the European bison with the data on the American bison, it can be noticed that the fertility rate of the European bison is lower. For American bison cows living in the Yellowstone National Park in 1995–2001, aged 4 and more, the coefficient was 81% (brucellosis-free females). For females with confirmed brucellosis it was at the level of 64% (Fuller *et al.* 2007). In semi-free American bison population in Elk Island National Park, the fertility rate range was 68–84%. In this study, obtained values apply to all females, without the division into sexually mature and immature females (Wilson *et al.* 2002), therefore they should be considered underestimated.

In the studied herds, over the period of 20 years, large differences between the values of the fertility coefficient can be noticed (Table 5). The fertility rate equalled to 0.0% in the herds of Eriksberg (1999) and Gołuchów (2009) resulted from limiting the age range of cows to the range of 4–19 years during the calculation of this parameter. In the European Bison Pedigree Book there is an information about calving by a cow 4045 KNIVA (age: 21) in the Eriksberg herd (EBPB 1999) and calving by a cow 10644 POLCIA in Gołuchów (age: 3 years) (EBPB 2009). The highest rates were recorded in small herds: Gołuchów and Sababurg (72.22% and 69.53% respectively). The average sizes of the Gołuchów and Sababurg herds were 8.8 and 16.3 animals, respectively. In all herds except Avesta, at least half (51.33%) of the total number of fertile females gave birth. The fertility coefficient recorded in the Avesta herd was 46.15%. In reserves, the reasons for low fertility include overcrowding and infertility of some males (as a consequence of inbreeding) (Daleszczyk & Krasiński 2005). In the free living herds of European bison, the factors influencing the level of reproduction were the quantity and quality of available food in the winter period (Daleszczyk 2009). The factors that influence the reproduction of the American bison are nutrition, climate and the incidence of diseases such as brucellosis (Wilson *et al.* 2002; Fuller *et al.* 2007).

The length of the interval between calving

Data on the length of interval between calving was obtained for 815 individuals. Their range was between 10 – 37 months, in accordance with the conclusions of the work by Krasiński and Raczyński (1967). The proportion of intervals between calving, outside the estimated range (over 37 months), was less than 4% (3.18%). In almost 65% of cases (63.55%), the length of the interval between calving was within the range of 10–14 months (Figure 3). The 12-month value was the most common – 20.90%. The next most frequent was the range of 22–24 months – a total of 9.23% of the calving intervals. The

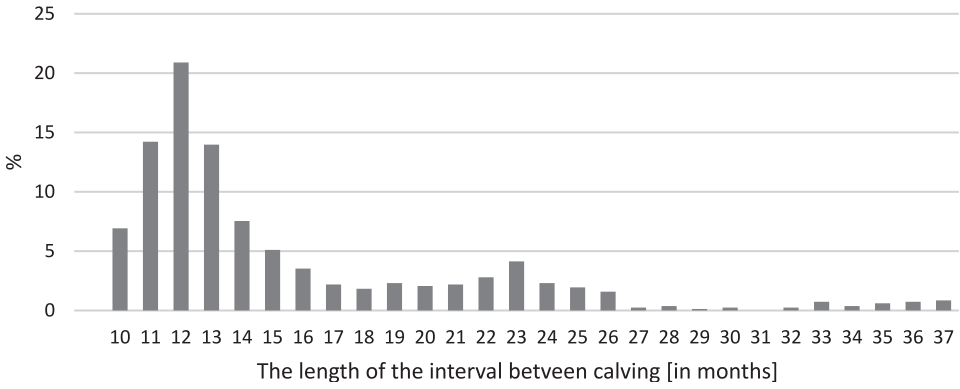

Figure 3. Distribution of the length of the intervals between calving estimated for the tested cows

mean length of the interval between calving, included in the range of 10–37 months, was 15.51 months (SD = 5.84).

In the wisent, it is theoretically possible for females to give birth each year. However, in practice, the occurrence of sterile periods is observed in most females. In females staying in enclosures, these periods are shorter – usually one year. Krasiński and Raczyński (1967) found that more than half of calvings (55%) occurs between 11 and 13 months after the previous one. In these studies, the mean length of the calving interval was approximately 14 months (14.4) (Krasiński & Raczyński 1967). The authors found that sterile periods longer than 11–13 months indicate an unsteadiness in calving regularity. The

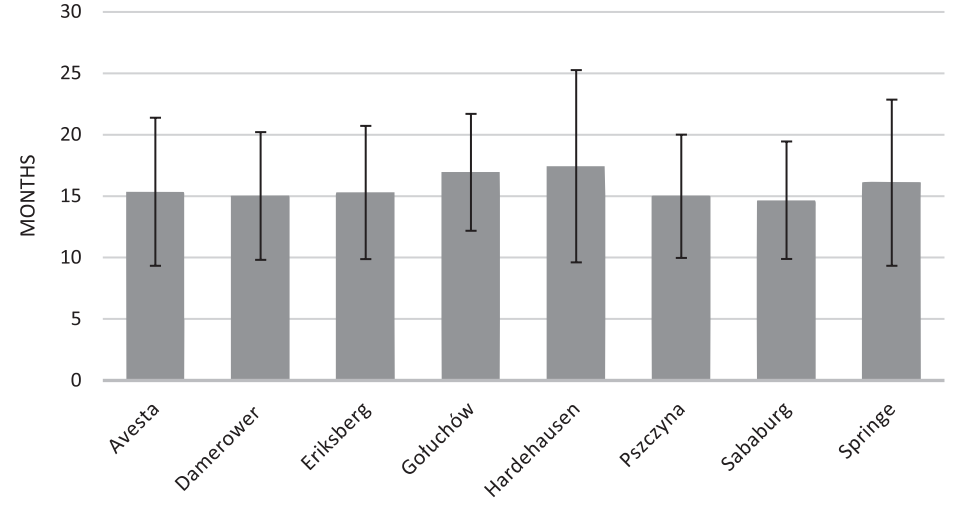

Figure 4. The average length of the intervals between calving along with the standard deviation estimated in selected herds in the years 1998–2017

lowest average interval length was recorded in the herds of Sababurg and Pszczyna (14.67 ± 4.79 and 14.99 ± 5.19 respectively), and then in the herds of Damerower, Eriksberg and Avesta (15.02 ± 5.20; 15.30 ± 5.43; 15.36 ± 6.03 respectively) (Figure 4). Higher than the average for all herds (15.51 ± 5.84) were the values obtained in the 3 remaining herds (Gołuchów, Hardehausen and Springe). The values closest to the average were recorded in the Springe and Gołuchów herds (16.10 ± 6.77 and 16.95 ± 4.76 respectively). The longest calving intervals were in Hardehausen (17.44 ± 7.83). Significant differences were found between the herds (p = 0.026), and these differences concerned only the pair: Sababurg – Hardehausen.

The sex distribution at birth

The sex distribution at birth is presented in Table 6. Within the metapopulation (all herds in total), 48.65% were males and 51.35% females, which did not differs significally from 1: 1 ratio $\chi^2_{(1)}=0.731$, p=0.383. Also for 7 from 8 herds, the distribution was like expected. The exception was the Hardehausen herd, where the share of males was significantly lower and equalled to 38.7%. In analyzed herds only in Gołuchów and Pszczyna the LB line is kept. In the remaining herds, and thus also in the Hardehausen herd, there are animals belonging to LC line.

Table 6. Proportion of females and males born in selected herds in 1998–2017

Herd	Number of females	Number of males	Value (%)	
			Male	Female
Avesta	66	85	43.71	56.29
Damerower	87	95	47.80	52.20
Eriksberg	60	49	55.05	44.95
Gołuchów	23	19	54.76	45.24
Hardehausen	57	36	61.29	38.71
Pszczyna	93	87	51.67	48.33
Sababurg	63	47	57.27	42.73
Springe	66	70	48.53	51.47
Total	515	488	51.35	48.65

According to Daleszczyk (2011), in the study for females (N = 30) in reserves the sex proportion significantly differed from the 1:1 ratio (45.82% males to 54.18% females) and no explanation was found. In the Russian Okskiy Reserve, for wisents born in 1960–2018, a greater proportion of males than females was observed (52.6% males to 47.4% females) (Tsibisova 2019). Krasiński and Krasińska (2004) report that in multiannual cycles, the sex ratio

at birth does not differ significantly from the 1: 1 ratio, both *ex situ* and *in situ*. Based on the analysis of the sex ratio at birth in a group of 1502 calves, during 45 years, in the free roaming herd in Polish part of the Białowieska Forest, this expected proportion was confirmed (734 females and 768 males) (Krasińska & Krasiński 2004). Olech (2003) analyzed the sex distribution at birth of all individuals registered in the European Bison Pedigree Book (from 1932 to 2002 inclusive) by comparing the LB and LC lines. In the sample of 1876 individuals of the LB line, she found that the sex ratio was significantly different from the expected one, due to the significant predominance of females (over 11.0%). In the sample of 5901 individuals of the LC line, no deviation from the 1: 1 ratio was observed. The predominance of female was found by Urošević *et al.* (2021) for the two herds of the LC line, studied in the years 2000–2018. In the first herd (number of calves: 33), the sex ratio was close to 1: 1 (48.48% males to 51.51% females), while in the second (number of calves: 40) the prevalence of females was significant (40.0% males to 60.0% female).

Conclusions

The age of the first calving in the current *ex situ* population (3–6 years of age) has not changed, but the dominant share of first calving has shifted to the last 2 years of the designated interval (in total: 51.4%). Lifetime fertility of the oldest females from the current population is in the range of 7.0 – 14.0 individuals. The mean number of calves per a female in all herds together was 9.2 (SD = 3.08). The fertility rate is: 58.43% (SD = 21.33). In more than half of the cases (63.55%), the length of the interval between calving was within the range of 10–14 months. The sex distribution at birth does not differ significantly from the expected 1: 1 ratio. The currently observed delay of the first calving may indicate the lowering seasonality of reproduction. Additionally, the practice of separating males during the breeding season is observed among breeders. In reserves, if their infrastructure allows it, males are separated during the rutting period. As a result, the age of first calving of females increases.

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Parametry rozrodu w populacji żubra *ex situ*

Streszczenie: Działania na rzecz restytucji żubra przyniosły wymierne efekty. Status gatunku w Czerwonej Księdze opublikowanej przez Międzynarodową Unię Ochrony Przyrody (IUCN) został zmieniony z *gatunku narażonego (VU)* na *gatunek bliski zagrożenia (NT)*. Dalsze zarządzanie gatunkiem wymaga aktualizacji badań demograficznych. Celem pracy było obliczenie parametrów rozrodu współczesnej populacji żubrów *ex situ*. Analizę przeprowadzono w 8 wybranych stadach, w latach 1998–2017, na podstawie informacji zawartych w Księdze Rodowodowej Żubrów. Większość samic urodziła swoje pierwsze cielę w wieku od 5 do 6 lat. Średnia liczba cieląt we wszystkich stadach wyniosła 9,2 (SD = 3,08). Współczynnik płodności wyniósł: 58,43% (SD = 21,33). Rozkład płci przy urodzeniu nie odbiega od oczekiwanego stosunku 1:1. Zaobserwowano nasilenie zjawiska rozchwiania sezonowości rozrodu oraz skutki działań hodowców w obniżeniu parametrów rozrodu.