

## NUMBERS AND POPULATION DYNAMICS OF THE WHITE STORK (*Ciconia ciconia*) COLONY IN BELOZEM - THE EUROPEAN WHITE STORK VILLAGE IN BULGARIA - IN 2020-2022

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### Abstract

*The White Stork is one of the iconic bird species that is easily recognized by humans as it inhabits and nests in settlements as well as other places and structures located near lakes, rivers, dams, rice fields, wet meadows, and others. Given its feeding habitats, the species is a typical farmland bird. In many settlements in Bulgaria, including the village of Belozem, several dozen nesting pairs have been established, and this number is significantly higher than the average for the country. Some of the largest rice fields in the country, which are key foraging habitats for the species, are located around Belozem. In the village of Belozem, the stork colony formed on the roof of the local school is very impressive and counts over 20 nests, which represent almost half of the pairs nesting in the village - about 40 in total. In the current study, 41 to 53 stork nests were recorded, and 35-37 pairs successfully reared at least one juvenile each. The number of fledglings leaving the nest ranged from 94 to 115.*

**Key words:** *breeding parameters, farmland birds, rice fields.*

### INTRODUCTION

The White stork (*Ciconia ciconia* Linnaeus, 1758) is one of the iconic bird species that is easily recognized by humans as it inhabits and nests in lowland settlements without the central parts of large cities (Simeonov et al., 1990), places, and structures located near lakes, rivers, dams, rice fields, mesophytic grasslands, wet meadows, abandoned arable fields, etc. (Milchev et al., 2013; Petrov et al., 2015). Considering its foraging habitats, which it uses, the species can be described as a representative of farmland birds (Tobolka et al., 2012). The species is a top predator in these habitats, feeding on voles, fish, amphibians, reptiles, etc., thus storks indicate the abundance and diversity of other species in agricultural lands. This defines it as particularly sensitive to changes in agricultural areas, where with the intensification of agroecological practices in the last century, the capacity of ecosystem services from these sources has significantly decreased (Emmerson et al., 2016). To reduce the negative impact of these factors, compensatory measures could be applied, such as the maintenance of territories with low pesticide treatment, the construction of

artificial reservoirs and flooded areas, the securing of risky nests, and the installation of nesting platforms. Along with conducting regular monitoring, the direct environmental protection measures described above are extremely important for the conservation of the species, especially in areas with aggregation of breeding pairs.

In many settlements in Bulgaria, including the village of Belozem, several dozen nesting pairs have been established, and this number is significantly higher than the average for the country. In Belozem, Rakovski municipality, are located some of the largest rice fields in the country, which represent key foraging habitats for the species. The White stork colony in Belozem formed on the roof of the local elementary school "Geo Milev" counts over 20 nests, which represent almost half of the pairs nesting in the village - about 40 in total. The colony on the roof (more than 20 nests) is the largest gathering of stork nests in the country, in a single location with total area of about 1200 m<sup>2</sup>. In this regard, after proposal by Green Balkans NGO since 2005, the village has been included in the European Stork Villages Network, uniting settlements from different

countries, where not only the number of these birds is high, but also the local communities take care of their conservation, and maintain their habitats ([www.storkvillages.net](http://www.storkvillages.net)). The “European Stork Villages” have been designated for their exemplary dedication to the protection of the White stork. Since 1994 the EuroNatur foundation has honoured 15 villages in 15 European countries for their engagement in White stork and nature conservation with the title “European Stork Village” (Figure 1). With that initiative EuroNatur has set up a movement to help counterbalance the habitat loss for storks in Europe.

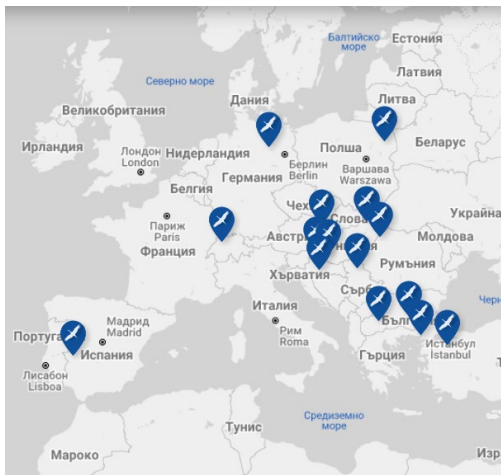


Figure 1. Map of European Stork Villages.  
Source: [www.storkvillages.net](http://www.storkvillages.net)

Implementing monitoring of this species using standard field survey methods is greatly facilitated due to the proximity of its breeding habitats to human settlements. The national number of the White Stork in Bulgaria, based on national censuses of White Stork in Bulgaria during 1994-2015 varies as follows: 1994-1995 - 4228 breeding pairs; 2004-2005 - 4818 breeding pairs; 2014-2015 - 5825 breeding pairs (Petrov 1997; Petrov et al., 2007; Cheshmedzhiev et al., 2016). In some settlements in Bulgaria - villages Belozem, Dragushinovo, Kulata, Belchin, Samuilovo – several tens of pairs are nesting, and thus the abundance of White storks there is significantly higher than the national average (Cheshmedzhiev et al., 2016). According to the Methodology for national counts of the White

stork, in most cases, the assessment is based on a single visit to the nests, as well as conducting a poll survey among local people. In Bulgaria, surveys on nesting behavior and breeding parameters are presented from several successive national censuses (carried out once every ten years) of the number and nesting distribution of the species. The earliest data at the national level are from the second half of the last century - Milchev & Stoyanova (1986) and Michev et al. (1989), when Bulgaria joined the international initiative of White stork census. Afterwards, national censuses of the species were conducted once every 10 years: 1994-1995 (Petrov, 1997); 2004 - coverage of about 1/3 of the country's territory (Kmetova & Michev, 2006); 2004-2005 (Petrov et al., 2007); and 2014-2015 (Cheshmedzhiev et al., 2016).

## MATERIALS AND METHODS

The object of the study is the White stork (*Ciconia ciconia* Linnaeus, 1758). It belongs to the Order Ciconiiformes, Family Ciconiidae. The species is breeding and migratory, transiting, and sometimes wintering on the territory of Bulgaria. In the Red Data Book of Bulgaria, the conservation status of the species in Bulgaria is determined as Vulnerable (VU) (Petrov et al., 2015). According to national legislation, the species is protected and listed in Biodiversity Act’s annexes 2 and 3.

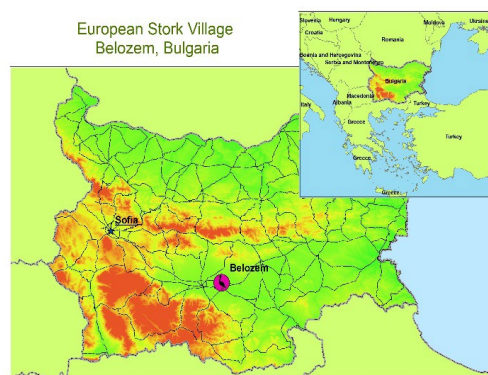


Figure 2. Location of Belozem

The study was conducted in 2020-2022 in the village of Belozem (Figure 2). It is situated in the central part of southern Bulgaria, in the Thracian lowlands close to the largest Bulgarian

river - Maritsa. This area is known in the country for its rice production and its wet soils. Each year more than 400 ha of rice fields are cultivated here. The land of the Belozem village, which represents the main feeding grounds of the village's stork colony, covers an area of 4200 ha. The region includes also small parts of NATURA 2000 sites in Bulgaria: SPA "Maritsa - Parvomay" (BG0002081, Area: 11,512.83 ha) and SCI "Reka Maritsa" (BG0000578, Area: 14,696.07 ha) (MOEW, 2015) (Figure 3).



Figure 3. Rice fields in Belozem area

For the present study, detailed monitoring of all nests in Belozem was carried out, with a minimum of 8 visits during each of the three breeding seasons in the period 2020-2022. The field surveys and observations of the White stork nests are carried out according to standard methodology, reporting absolute values from each point observation. The data were collected in a standard field form as well as a specialized mobile application - Smart StorkBelozem, part of SmartBirds. Implementation standard established methods are used, including observations and follow-up with binoculars (Zeiss Conquest HD 8 x 42), field scope (Swarowski 80HD), camera (Nikon D 71000, Nikon AF-S Nikkor 200-500 mm), Drone MAVIC PRO with camera Sensor 1/2.3 (CMOS) (Figure 4), and video surveillance which is constructed on a similar type to that described by Stamova et al. (2017), which allows monitoring of several nests simultaneously without disturbing the birds in the nests (Fig. 5).

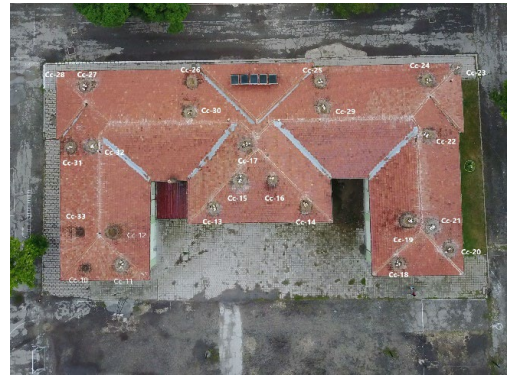


Figure 4. Location of the nests on the roof of the school in Belozem village photographed by a drone

The reporting of breeding parameters was carried out using the following indicators: **HPa** - stork pair present during the breeding season at the nest; **HPm** - stork pair with fledged offsprings; **HPo** - stork pair without fledged offsprings; **JZG** - total number of fledged offsprings in the area; **JZa** - the average number of fledged offsprings per breeding pair HPa; **JZm** - the average number of fledged offsprings per HPm (Wobus, 1963).



Figure 5. Video surveillance of the White stork nests in Belozem village

The assessment of this type of indicator has also been used in several other studies on the subject, both at the national (Petrov 1997; Kmetova & Michev, 2006; Petrov et al., 2007; Cheshmedzhiev et al., 2016) and international level (Nowakowski, 2003; Daniluk et al., 2006; Denac, 2010; Kósa, 2015). Back in the middle of the last century, in Germany, a study of the same breeding parameters in the period 1956 – 1960 was carried out (Wobus, 1963). This is a

good basis for comparability and analysis of the data obtained.

The raw data were processed and then analyzed by ANOVA statistical models.

## RESULTS AND DISCUSSIONS

During the three years of the current study (2020-2022), 41 to 53 stork nests were recorded (HPa), and 35-37 pairs successfully reared at least one juvenile each (HPm) (Table 1, Figure 6).

Table 1. Breeding parameters of the White stork colony in Belozem village during the study period

Parameters/Year	2020	2021	2022
HPa	41	47	53
HPm	37	35	36
HPo	4	12	17
JZG	115	94	111
JZm	3.108	2.686	3.083
JZa	2.805	2	2.094

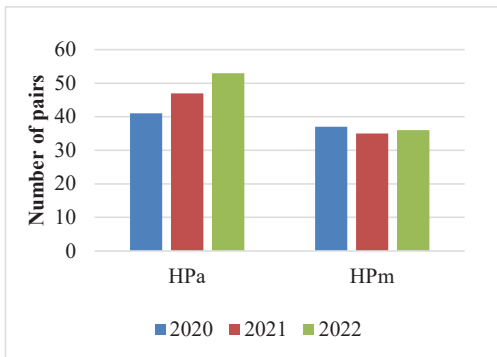


Figure 6. The number of pairs (HPa) and pairs with fledged offsprings (HPm) of the White stork *Ciconia ciconia* in 2020-2022 in Belozem village

Despite the increase in the number of occupied nests (HPa) by 12 in only three years, the number of pairs with juveniles rearing success (HPm) keeps approximately close values of 35-37 pairs per year. There is a clear trend in the number of pairs with no reared juveniles (HPo) concerning occupied nesting territories. As the number of occupied nests increases, the number of pairs with no reared juvenile also increases, from 4 to 17 (Table 1, Figure 7):

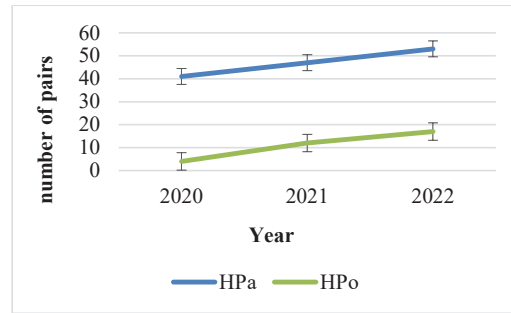


Figure 7. The trend of breeding parameters HPa and HPo for the period 2020-2022

On average, from each occupied, successful nest (HPm, N = 108),  $2.9 \pm 0.23$  nestlings were fledged (JZm N = 320) during 2020-2022. In most nests (67%), 3 fledglings were found (Figure 8). Our findings are in unison with the results obtained from Daniluk et al. (2006) in Poland.

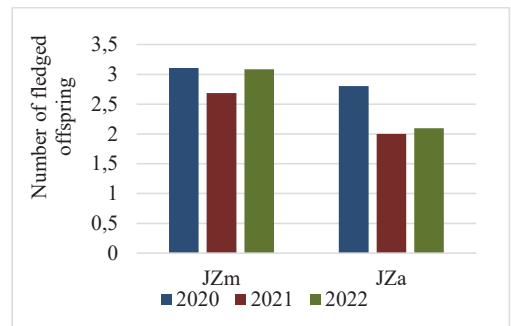


Figure 8. Comparison of fledged offsprings regarding pairs for the period 2020-2022

There is a clear tendency in increasing the numbers in our country, as well as in other European countries such as France, Netherlands, Germany, and Italy (Chodkiewicz & Sikora, 2020). Being one of the 20 stork species in the world, the White stork is the most studied one - the studies on the White stork are more than one-third (37.5%) of all known publications on the storks (family Ciconiidae) (Gula et al., 2023). Table 2 and Figure 8 present the average values of the breeding parameters JZa and JZm in Bulgaria, based on data from national censuses of the species during 1994-2015, and the average values for each of the parameters JZa and JZm in the present study during 2020-2022



(current study Table 2). In total, the data covers 25 years.

Table 2. Breeding parameters JZa and JZm in Bulgaria 1994-2022

Source	Current study	Cheshmedzhiev et al., 2016	Petrov et al., 2007	Kmetova & Michev 2006	Petrov 1997
JZm	2.96	2.73	2.8	2.75	2.8
JZa	2.3	2.44	2.5	2.48	2.5

The average values for each of the presented periods are close and comparable, which confirms the reliability of the data in the period studied by us. There are no significant differences between seasons in the average number of fledglings per successful breeding pair ( $F_{17,8402}=19, P > 0.005$ ). The best season was in 2020 when on average 3.1 nestlings fledged, and the worst was in 2021, with 2.68 fledglings per successful breeding pair (JZm) (Figure 8).

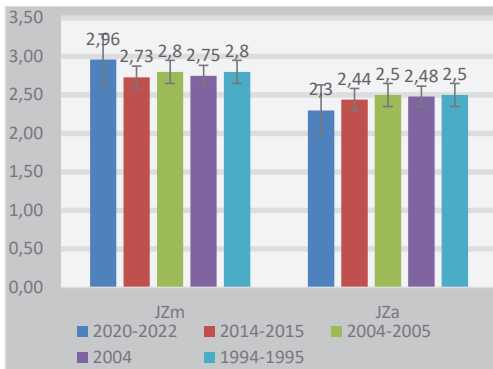


Figure 9. Average values for breeding parameters JZa and JZm for the period 1994-2022

The number of fledglings does not depend entirely on the number of successfully nested pairs (HPm). Most likely, environmental factors also have influences such as temperature, food availability, etc.

Average values for breeding parameters JZa and JZm in the colony of Belozem are relative to national data collected from the last three national censuses of White stork in Bulgaria during 1994-2015. Still, the average values of JZm for the three years in Belozem are slightly

higher than, the same parameter for any other of the studied periods at the national level.

Statistically significant differences were observed between years 1994-2022 (Figure 9) at national level in average number of fledged offspring per successful nesting pairs and average number of fledged offsprings per stork pair present during breeding season at the nest ( $F_{5,3176} = 43,5601, P < 0.0001$ ).

## CONCLUSIONS

Many factors are crucial for breeding success and vary between seasons and stork pairs.

For the farmland birds, food abundance, lack of disturbance, and ecologically friendly agricultural practices are essential. Fluctuation in breeding success depends also on environmental conditions and varied between years.

The large aggregation of a high number of birds at the same time in the same place, in the Belozem village, determines the high importance of this area for the conservation and survival of the birds of this species, and at the same time shows the high sensitivity of the individuals to changes in the quality of their habitats. This also necessitates the implementation of direct environmental protection measures targeting protecting the nesting substrate, reducing disturbance, and sustainable management of habitats.

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