ISSN 2710-1142(online)
SIS Conservation, 2021, 3, 50-54
RESEARCH ARTICLE

The impact of climate change on Black Stork (*Ciconia nigra*) population in Belarusian Polesie

Marina DMITRENOK*, Pavel PAKUL, Ruzana VIACORKA, Oleg OSTROVSKI, Maxim TARANTOVICH, Valery DOMBROVSKI

[1]The State Scientific and Production Amalgamation "Scientific and practical center of the National Academy of Sciences of Belarus for biological resources, Minsk, Belarus
*Corresponding author; e.mail: marinabittern@gmail.com

Abstract This study presents ten years of monitoring the Black Stork *Ciconia nigra* population in the Belarusian Polesie. Black Storks breed at a high density – up to 25 pairs per 100 sq. km. in the floodplain forests of the Pripyat River. However, there have been almost no floods in the valley of the Pripyat River since 2014. This might have provoked a slight decrease in the number of the Black Stork breeding pairs but led to a significant decrease in the breeding success of this species (up to a 74.4% decrease). The decrease in breeding success can be attributed to a significant drop in the population of one of the primary food sources of the Black Stork in Belarues – brown frogs – by 242 times relative to the norm.

Keywords Belarus, Black Stork *Ciconia nigra*, climate change, monitoring, Polesie.

Introduction

The Black Stork *Ciconia nigra* is a protected species in Belarus and is included in the Red Book of the Republic of Belarus (Category 3) (Samusenko et al. 2015). About 11% of the European population of the Black Stork breeds in Belarus (BirdLife International 2017). The monitoring of the Black Stork population started in Polesie in 2006, as an accompanying study during monitoring of the Greater Spotted Eagle *Clanga clanga* and Lesser Spotted Eagle *C. pomarina*. Specific studies on the Black Stork began in 2011. The preliminary results suggest a very high density of the Black Stork population in the floodplain forests of Polesie. It is one of the highest observed local densities in Europe when compared with other close populations (Strazds *et al*. 2001, Tucakov *et al*. 2006, Tamas 2012). Old deciduous forests and wide floods of the Pripyat River make these places an optimal and key habitat for the Black Stork. The study of population status and trends of the Black Stork population in such locations is significant for understanding the state of the species in Europe as a whole. In recent years, there have been changes in weather conditions that affected the hydrology of rivers, which in turn affects the state of populations of birds and other animals. The relationships between the flood level, the number of brown frogs, the number of the Black Stork pairs and the breeding success were analyzed in the research.

Study area

The study was carried out in the Belorussian part of Polesie in the Southern part of the country, zone of Broadleaf-Pine forests (Geltman 1982) in the valley of the Pripyat River. Monitoring studies of the Black Stork population were carried out on the part of territory of reserve "Middle Pripyat" on the forest area of 95 km^2

Article history
Received: 05 August 2021,
Received in revised form: 03 February 2022,
Accepted: 25 March 2022,
Published online: 05 August 2022.

(Brest region, Stolin district N 52° 05', E 27° 03'). The boundaries of Middle Pripyat monitoring plot are shown in Figure 1.

Extensive and not very high spring floods are typical for this hydrological regime. Floods continue from 40–45 days to 2–3 months annually. There are extensive floodplain meadows and fen mires to the north of the forest in the floodplain. The meadows are partially mown. There are many willow thickets here. The forest stands are dominated by Black Alder *Alnus glutinosa* (average age 40–50 years) and oak-hornbeam forests (order Carpinetalia) (average age of oaks 85–100 years). Meadows and forests are flooded during floods. In the south, the forest is adjoined by reclaimed land used for arable land, hayfields and pastures. There are many channels in this area.

Methods

A monitoring programme with binoculars and telescopes (a modified method of predatory birds counting) was started in 2010 (counts) – 2011 (nests) in the region (Dmitrenok *et al*. 2016). Counts were carried out in April. Observation points were located at a distance of 0.5–1 km from the edge of the forest. Distance between observation points was 3–5 km. The duration of observation was 4 hours at every point (from 0900 to 1300 h). The following parameters were observed: location of take-off (landing) of the bird (azimuth, approximate distance) and behaviour. Points of permanent birds' activity were taken as nesting territory of one pair, and nest searching took place at this point. All nests were checked personally from 2011 to 2015, but trail cameras (Bushnell, Sokol+, BolyGuard, Seelock) were used to identify breeding success since 2015. Ringing and measuring of chicks occurred in June-July with the maintenance work of trail cameras. Since 2013, food availability was measured by counting frogs, one of the means preys of the Black Stork. It was carried out with the method of transects (routes). The mean length of the transects was 3.6 (± 2.8 SD) km long and 1 m wide (0.5 m in each direction) (Krapivniy 1957, Pikulik 1985). The average frog population density was calculated from the obtained data (1,000 individuals per 1 km^2). There are two species of brown frogs that inhabit the region: *Rana arvalis* and *R. temporaria*. Brown frogs were not determined to the species (just *Rana* sp.), and all age groups were analyzed together. Counts were conducted in June-July in the morning or evening. The following parameters were analyzed: average water level of flow in April, taken from open-source statistical data centre (Summary information bulletin about inland waterways of the Republic of Belarus). Black Stork population density (according to the counts); the number of chicks on a successful pair (ratio of nestlings to the number of breeding Black Stork pairs in early July); the number of chicks on a pair (ratio of nestling to the number of Black Stork pairs in the year); the number of successful pairs (in early July); the ratio of successful pairs (a ratio of successful Black Stork pairs to a number of the total number of pairs on a monitoring plot in a year); the density of brown frogs (number of brown frogs according to the counts). Data on breeding success start in 2013. All data were analyzed in GraphPad statistical program.

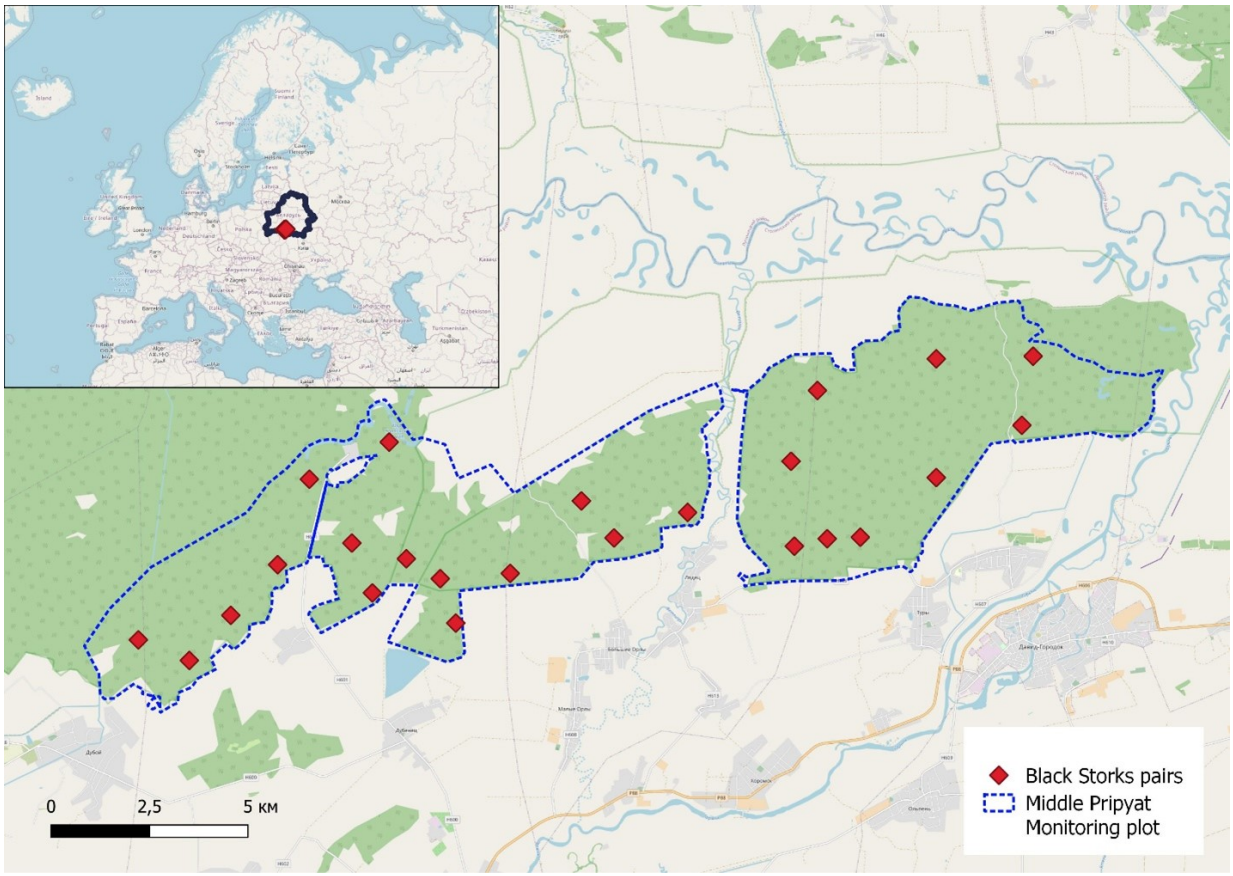

Figure 1. Study area (Red boxes – Black Stork pairs in 2013 – maximum density since 2011).

Results

The number of Black Stork pairs varied from 17 to 24 pairs between 2011 and 2021. The maximum number of the Black Stork pairs was observed in 2013, and the minimum was in 2020. The number of successful pairs changed significantly - it gradually decreased and reached a minimum in 2020.The ratio of successful pairs decreased as well. The primary reason the inactivity of pairs rather than clutch or nestling loss. Most pairs protected territory, repaired nests, sometimes mated but did not lay eggs. The main threats to Black Stork nestling and reasons for brood failure were interspecific competition with White-tailed Eagle *Haliaeetus albicilla* and Goshawk *Accipiter gentilis*, and intraspecific competition among Black Storks.

Belarus has experienced low rainfall since 2014 resulting in a series of dry years with several environmental consequences. The River Pripyat has almost stopped flooding in spring (Rusetski *et al*. 2010; Maksimchuk 2019; Volchek 2019). Following an extremely dry spring in 2020, the entire floodplain of Pripyat experienced fires in April that year. All the water meadows were burned and the fire also reached some forested areas. It was the worst year for the Black Stork in the study area. The situation improved only in 2021 as the flood was normal during spring for the Pripyat.

The density of brown frogs decreased 100 times in the study area from 2013 to 2015. Many amphibians probably died due to poor wintering conditions and the drying up of small water bodies. The surviving amphibians did not have suitable puddles and other reservoirs for breeding in the spring. The maximum decrease was in 2016 at 298 times compared with 2013. Slow recovery of brown frogs' density was noted in the last years, but hydrological conditions were still unfavourable until 2021.

At the beginning of the study, no attention was yet paid to the collection of material on the nutrition of the Black Stork. However, it was observed that mainly brown frogs were among the food regurgitated by chicks in the Middle Pripyat reserve before 2014. However, when the number of brown frogs sharply decreased, only fish was in the chicks' diet.

Breeding success was noted since 2013. From 2013 to 2021, the relative number of chicks per successful nest varied from 1 to 3.5 chicks, on average 2.75 (± 0.96 SD). The maximum number of siblings in a nest was 5. A significant decline in breeding success was noted in 2015. During 2015–2018 breeding success was 0.76–1.05 chicks per pair. The slump continued in 2019–2020 (0.41–0.42 chicks per pair). The breeding success began to increase only in 2021 up to 0.52 chicks per pair (Figure 2).

With a decrease in the number of amphibians, fewer pairs of storks start nesting. In particular, with a decrease in the density of brown frogs by 100 or more, the number of chicks per territorial pair decreased from 1.1–1.4 in 2013–2014 up to 0.3 in 2019.

It was noted that there is a positive correlation between Black Stork population density and average water level in April (r = 0.75, d.f. = 9, p =

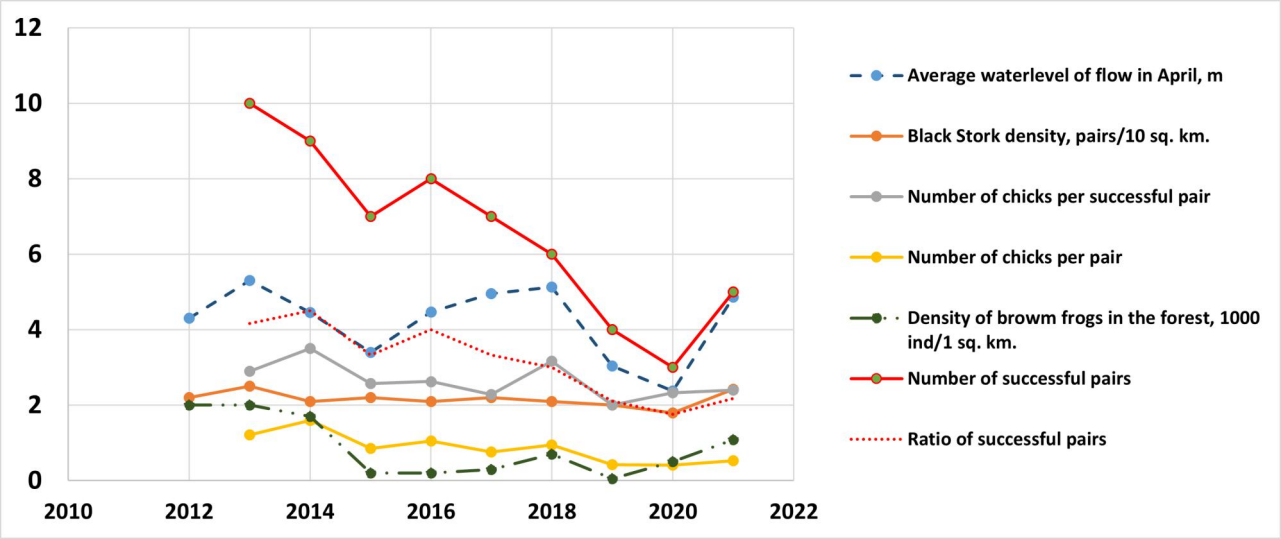

Figure 2. Reproductive parameters of Black Stork population, average water level and density of brown frogs between 2010 and 2022 in the study area.

0.012), significant positive correlation between the number of chicks per successful nest and the density of the brown frogs (r = 0.67, d.f. = 8, p = 0.049) and positive correlation between breeding success (number of chicks on 1 Black Stork pair) and density of frogs (r = 0.66, d.f. = 8, p = 0.049).

Discussion

The density of Black Stork on the Middle Pripyat monitoring plot was observed at about 20–25 pairs in 100 km^2 of forest. Known highest density of Black Stork is marked in Latvia – 4 pairs in 5 km^2 (Strazds *et al*. 2001), Danube floodplain – 8.4 pairs in 100 km^2 of forest (Tucakov *et al*. 2006) and 21.1 pairs in 100 km^2 forest (Kalocsa and Tamas 2006). Thus, we can say the density of Black Stork in Middle Pripyat is one of the highest in Europe.

The study area is located in reserve Middle Pripyat where logging is limited and nest protection is ensured by the government. Thus, the decreasing population of Black Stork on the Middle Pripyat River can be attributed to prey availability or quantity than on forest management.

The trail-cameras revealed that most Black Stork pairs were active and occupied nests, but they did not begin breeding even if two birds were present on the nest. This is probably due to a decrease in prey availability. Significant positive correlation between the number of chicks per successful nest and the density of the brown frogs and between the breeding success and density of frogs points towards brown frogs as an important food source for the Black Stork in Belarus. Their decline has led to a catastrophic effect on Black Stork reproduction.

Before the drought period, brown frogs were present in large numbers in the forest under the nest of the Black Stork. The Storks could easily catch the frogs; trail cameras have repeatedly shown that the Black Stork can descend right under the nest and walk there. In addition, many observed traces of the Black Stork and encounters of birds in the forest indicate that the Black Stork can hunt directly in the forest and near the nest. However, after the catastrophic decline in the number of brown frogs, presumably because of weather events and intensification of agriculture (in particular, clearing of canals and ploughing of meadows in agricultural areas located to the south of the studied forest area), brown frogs can no longer be the main food for Black Storks. Although switching to alternative prey is a well-known phenomenon in some of the birds of prey (Lohmus and Vali 2004) and it should be typical for Black Stork, alternative preys are usually less accessible as main prey and should degrade population status and breeding success as a marker of population condition.

Additionally, we also recorded some clutch and chick elimination cases due to different causes: aggression from Black Stork intruder, predation by Goshawk or White-tailed Eagle which is also described in other Black Stork populations (Cano-Alonso and Sundar 2018). These cases are rare and cannot explain the population decline in the short term. For example, there was no case of predation on known Black Stork nests in 2020 or 2021. However, we have to consider the effect of clutch and chick elimination from the perspective of breeding population (Strazds 2011). Our monitoring shows a long-term impact, the most important being that the pairs abandon the nests and territories for years after such events. Finally, it should be noted that the flood attracted Black Storks; during the regular flooding of the Pripyat River, the number of territorial pairs was again high, almost maximum for this plot.

Acknowledgments

We thank Ciconia foundation for financing the project, our colleague T.E. Pavluschik and the members of the children's ecological club "Poisk" and its leaders A. Mukhlya and M. Tsvirko for their help in collecting field material.

References

BirdLife International. 2017. *Ciconia nigra* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22697669A111747857. https://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T22697669A111747857.en. Downloaded on 31 July 2021.

Cano-Alonso, L. S. and K. S. G. Sundar (Eds.). 2018. *VII International Conference on Black Stork* Ciconia nigra*: Programme and abstracts*. IUCN-SSC Stork, Ibis and Spoonbill Specialist Group Special Publication 1. Seville, Spain and Mysuru, India.

Dmitrenok, M., V. Dombrovski and P. Pakul. 2016. A methods of estimating numbers and searching for Black Stork's nests: results of a study in Belarus. *Ornithos* 1: 142-147.

Geltman, V. S. 1982. Geographical and typological

animalizes of forest vegetation in Belarus. Minsk: Nauka I Technika: 306 pp. (*In Russian*)

Kalocsa, B. and E. A.Tamas. 2006. Analysis of the nesting data of Black Storks *Ciconia nigra* in the Gemenc region of the Danube-Drava National Park (1992-2003). *Biota* 7: 47-50.

Krapivniy, A. 1957. To the ecology of Black Stork (*Ciconia nigra*). *Bulletin of the Instute of Biology Academy of Science BSSR for 1956* 2: 242-249. (*In Russian*)

Lohmus, A. and U. Vali. 2004. The effects of habitat quality and female size on the productivity of the lesser spotted eagle Aquila pomarina in the light of the alternative prey hypothesis. *Journal of Avian Biology* 35: 455-464.

Maksimchuk, M. V. 2019. Changes in the characteristics of the maximum flow of the rivers of the Belarusian Polesie. *Collection of abstracts of the scientific student conference "Science Week-2019", Brest. BrSU, Brest, Belarus*: 66-67. (*In Russian*)

Pikulik, M. 1985. *Amphibians in Belarus*. Science and technic, Minsk, USSR: 191 pp. (*In Russian*)

Rusetski, A. P., E. A. Lukyanova and L. A. Trukhan. 2010. State and hydrological regime of the river Pripyat floodplain after land reclamation of Polesye. Bulletin of Polessky State University. *Series in Natural Sciences* 2: 42-49. (*In Russian*)

Samusenko, I. E., V. V. Ivanovski and M. G. Dmitrenok. 2015. Black Stork. In: *The Red Book of Belarus Republic*. *Animals: rare and endangered species of wild animals*. Ministry of natural resources and environmental protection of the republic of Belarus, Minsk, Belarus: 53-54. (*In Russian*)

Strazds, M. 2011. *Conservation ecology of the Black Stork in Latvia*. Dissertation, PhD in Biology, Zoology, University of Latvia, Riga, Latvia. 96 pp.

Strazds, M., A. Liepa and J. Kuze. 2001. Organisation spatiale des territoires de la Cigogne noire dans le Parc National de Kemeri – Lettonie. In: Jadoul, G., Libois, R., van den Bossche, W., Strazds, M. (Eds.), *Proceedings of the Third International Conference on the Black Stork, 28–31 March 2001, Fourneau Saint Michel, Belgique*: 51.

Summary information bulletin about inland waterways of the Republic of Belarus. State Administration of the Water Transport. https://gawt.by/informatsionnyj-byulleten/, accessed 1 August 2021. (*In Russian*).

Tamas, E. A. 2012. *Breeding and migration of the Black Stork (*Ciconia nigra*), with special regard to a Central European population and the impact of hydro-meteorological factors and wetland status*. Dissertation, PhD in Biology, Zoology, Debrecen, Hungary. 96 pp.

Tucakov M., B. Kalocsa, T. Mikuska, E. A. Tamas, A. Zuljevic, B. Erg and T. Deme. 2006. The Black Stork *Ciconia nigra* between the Sió channel and the Drava river in the central Danube floodplain: transboundary monitoring and protection plan. *Biota* 7: 109-118.

Volchek, A. A. 2019. Forecast estimation water regime of Belarusian rivers. *Actual problems of Earth sciences: studies of cross-border regions: book of abstracts to the IV conference devoted of 1000-years of Brest*. *Part 2*. BrSU, Brest, Belarus: 25-33. (*In Russian*)