The current state of Black Stork *Ciconia nigra* in Armenia

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Abstract - The state of Black Stork *Ciconia nigra* in Armenia was last updated in 2009. Since then, the knowledge of this species has significantly increased, and there is a need for an update on its conservation status. Results of 2003-2024 data collection and analysis show that its population makes 7-9 breeding pairs, and the population trend demonstrates a moderate increase ($p<0.05$). The area of occupancy is 764 km^2, and the extent of occurrence is 6,977 km^2. While some pairs of the species could be overlooked, there is an objective increase in breeding pairs by at least two. The species qualifies for the category Critically Endangered (criteria D1). The existing conservation measures require improvement. The proposed conservation measures include revision of the Emerald Network of Armenia to better cover nesting ranges of the species, official adoption of the candidate Emerald Sites and development of management plans for them, securing proper Environmental Impact Assessments of constructions in the buffer zone of the known nests, and restriction of the outdoor activities, including drone video shooting, in the buffer zone of the known nests in the breeding season. The monitoring of the species should accompany these measures.

Key words: black stork, *Ciconia nigra*, Armenia, conservation status, population dynamics, threats.

Riassunto - Lo stato attuale della cicogna nera *Ciconia nigra* in Armenia.

Lo stato delle conoscenze sulla cicogna nera *Ciconia nigra* in Armenia è stato aggiornato l'ultima volta nel 2009. Da allora, la conoscenza della specie è aumentata in modo significativo e si rende necessario un aggiornamento sul suo stato di conservazione. I risultati della raccolta e dell'analisi dei dati 2003-2024 mostrano che la popolazione è composta da 7-9 coppie riproduttive e la tendenza mostra un aumento moderato ($p<0,05$). L'area di occupazione è di 764 km^2 e l'estensione dell'areale è di 6.977 km^2. Alcune coppie della specie potrebbero essere sfuggite al conteggio; c'è un aumento oggettivo delle coppie riproduttive di almeno due. La specie rientra nella categoria in pericolo critico (criterio D1). Le misure di conservazione esistenti richiedono miglioramenti; quelle proposte includono la revisione dell'*Emerald Network of Armenia* per coprire meglio gli areali di nidificazione della specie, l'adozione ufficiale dei siti Emerald candidati e lo sviluppo di piani di gestione per essi, la garanzia di adeguate valutazioni di impatto ambientale delle costruzioni nella zona cuscinetto dei nidi noti e la limitazione delle attività all'aperto, comprese le riprese video con droni nella zona cuscinetto dei nidi noti nella stagione riproduttiva. Il monitoraggio della specie dovrebbe accompagnare queste misure.

Parole chiave: cicogna nera, *Ciconia nigra*, Armenia, stato di conservazione, dinamiche della popolazione, minacce.

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INTRODUCTION

The Black Stork *Ciconia nigra* breeds across Palearctic, as well as in scattered populations from Malawi and Namibia to South Africa (Cramp & Perrins, 1977; Elliot *et al*., 2020). The species is a habitat specialist that breeds in undisturbed open woodlands with low human disturbance while foraging in streams, ponds, marshes, riverbanks, and grasslands (Elliot *et al*., 2020). Populations, which breed in southern Italy, Iberia, and sub-Saharan Africa, are associated with rocky habitats, though (Moreno-Opo *et al*., 2011; Lardelli *et al*., 2022). Iberian birds are known to select ponds with relatively large water surfaces, shallow shores, low turbidity, developed shoreline vegetation, and a high diversity of fish and amphibian species (Moreno-Opo *et al*., 2011). The species is known to breed up to 850 m in Austria and 2000 m in South Africa (Elliot *et al*., 2020). The species is listed as Least Concern in the IUCN Red List with an unknown population trend (BirdLife International, 2017), and its Green Status Assessment suggests it as Moderately Depleted (Cano-Alonso, 2021). However, in Armenia, its conservation status is evaluated as Vulnerable according to criteria D1 (Aghasyan & Kalashian, 2010).

The first records of the species in the country were made by Satunin (1907), Leister & Sosnin (1942), Spangenberg (1951), and Dahl (1954), where the species is supposed to be breeding, although no evidence is provided.

The first confirmation of species breeding was made in 1995, when the active nest was determined in northeastern Armenia, and then reconfirmed in 1997 when the nest was found in North-western Armenia (Adamian & Klem, 1999). Then, in 2003, another pair was detected in northern Armenia, and another active nest was found. Later, in 2016, another nest was found in southern Armenia (Ananyan *et al*., 2016). However, the questioning of the local inhabitants implemented by Ananyan *et al.* (2016) showed that they knew the pair had been active in the area since 1995, having two more nests and sometimes shifting between them (in 2007 and 2009). Later, other breeding records were made in central Armenia, and some other pairs were localized. Considering the new data on the

species accumulated since 2009, when the species account was prepared for the Red Data Book (Aghasyan & Kalashian, 2010), it is time to re-evaluate its national conservation status and review the existing conservation measures.

Therefore, the primary purpose of the article is to re-assess the species' national conservation status, which includes detailing its modern distribution and abundance, computing its long-term and mid-term population trends, and assessing the possible threats and efficiency of the conservation measures. This information can contribute to the next assessment of the Black Stork's global conservation status, inform the single-species or multi-species action plans, and inform the regional conservation networks.

MATERIALS AND METHODS

Study area

Armenia is a relatively small (29,743 km^2), landlocked, mountainous country with elevations from 375 to 4090 m above sea level. Such a significant difference in elevations determines various climatic conditions and creates many different landscapes, including semi-desert, juniper woodland, deciduous forest, mountain steppe, and sub-alpine areas. The terrain varies from rugged, consisting of many deep canyons, cliffs, and rocky outcrops, to flat Ararat plain and mountain plateaus (Aghababyan *et al*., 2015).

Data collection

By the beginning of the National Bird Monitoring Program in 2023 (implemented by BirdLinks Armenia NGO), there were two known nests of the species in the country (Adamian & Klem, 1999). From 2003, we surveyed the territory of Armenia regularly, covering 328 (88%) out of 374 10×10 km squares, while 46 squares (12%) were not surveyed due to their proximity to the state border and administrative difficulties of accessibility. Within the counted squares, 57 (15%) were visited every year, 91 (24%) were visited at least every three years, and the rest, 180 (48%), were visited opportunistically at least once (Fig. 1).

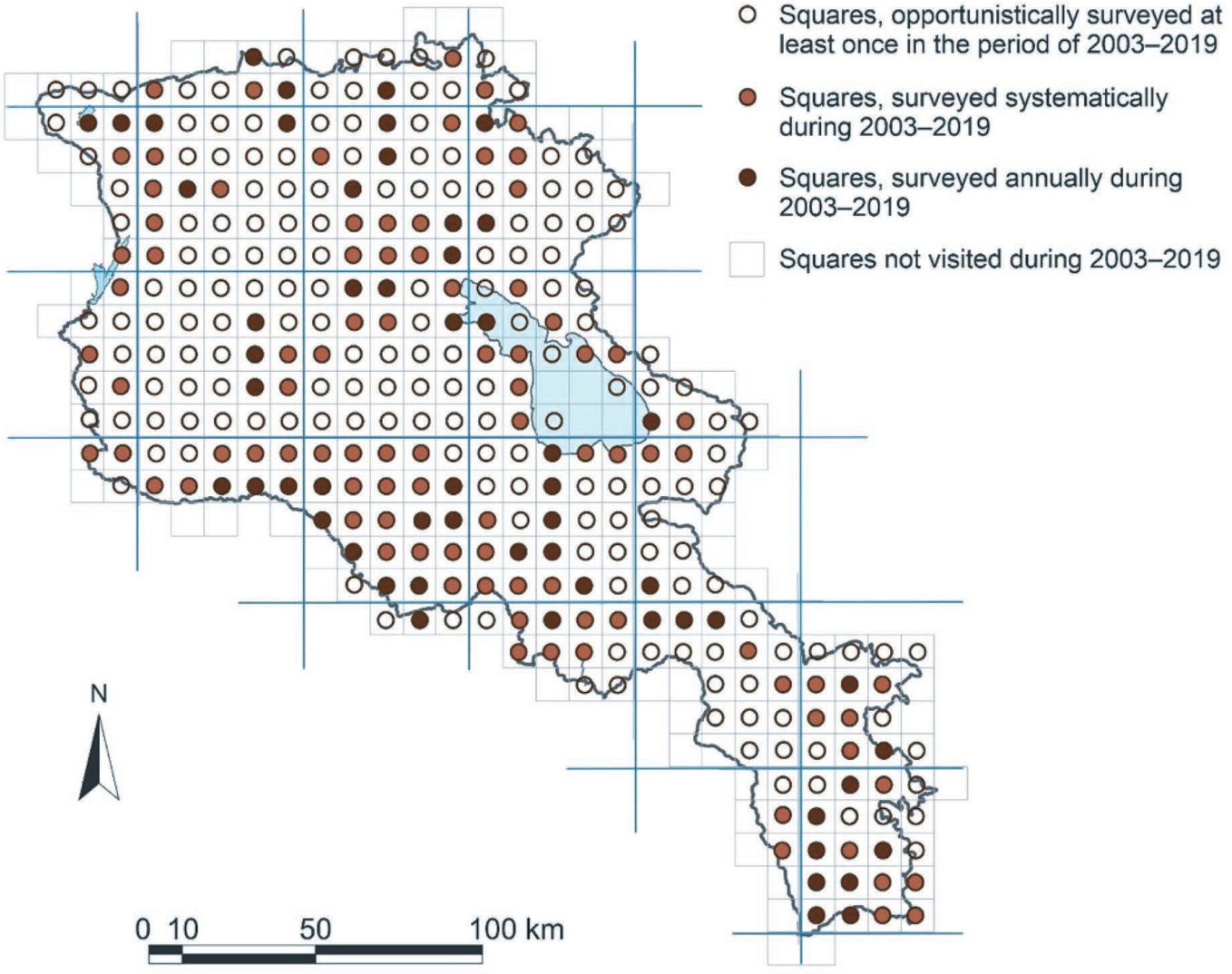

Fig. 1 – Study area. / Area di studio.

Monitoring of the species was implemented via a count of the breeding pairs through occupied nests (when it was possible to find the nest) or via localization of the breeding pair by its behavior (in cases when the efforts for determination of the nest could bring unnecessary disturbance) and was performed annually during May-June. Opportunistically, we visited the nests later in July-August to collect data on the number of fledglings. In addition, we have collected data on each nest's location, including the type of location (on a cliff in the niche, grotto, or cave; on a tree), height above the ground, and face of the slope. To understand some peculiarities of the species' feeding behavior, we have been making longer-term observations of the Black Storks at the water bodies from late May through August. The observations were generously assisted by over 50 volunteers of the Armenian Ornithological Society. During 2013-2017, the number of volunteer counters increased in response to fieldwork required for the European Breeding Bird Atlas 2 (Keller *et al*., 2020). During the Atlas fieldwork and beyond, these records were accumulated in the eBird Basic Dataset (2024) and Armenia.Observation.Org (2024) platforms.

To estimate the rate of possible illegal killing, we have conducted interviews with hunters and surveys of the main online and offline marketplaces where mounted bird specimens could be sold. Also, an interview with the State Inspectorate for Nature Protection and Mineral Resources was conducted to identify their potential involvement in poaching control. To estimate other threats, we tracked the environmental violations against Black Storks and wetland habitats with the help of the Armenian Ornithological Society through social networks.

Data analysis

The mapping is implemented using ArcGIS 10.0 software (ESRI, 2011). To visualize the species distribution, the breeding ranges were given as ca. 50,000 ha circles from the central point of a known or supposed nest site (Jiguet & Villarubias, 2004). Considering the species' sensitivity, the detailed spots of the nesting sites are not shown. In addition, the other observations in the breeding season, outside the 50,000 ha circles, are also shown. The area of species occupancy (AOO) and the extent of species occurrence (EOO) for the Black Stork were computed using the IUCN guidelines (IUCN Standards and Petitions Committee, 2024). To compute the AOO, we summed the areas of all the habitats where the Black Storks were observed during the breeding season. To compute the EOO, the rule of minimum convex polygons (the smallest polygon in which no internal angle exceeds 180° and which contains all the sites of occurrence) was applied to the species' AOO, excluding discontinuities and disjunctions within the overall distribution inside the borders of the country.

We used multi-year data series to calculate population trends and processed them using TRIM 3.0 software (Van Strien *et al*., 2004; Voříšek *et al*., 2008). The Collated Index was calculated using log-linear Poisson regression; then, the deviations were calculated and presented as a linear function, showing population growth or decline. For the analysis, we have considered each nest or localized pair as a site, as the survey areas were kept constant over time. We have used the time-effects module since we had data for all the years. The TRIM output parameters have been used to document the trend's direction and size based on the TRIM manual, which considers six possible options: strong increase (with an increase of more than 5% per year); moderate increase (significant increase but less than 5% per year); stable (when the most probable trends are less than 5% per year); uncertain (with no significant increase or decline); moderate decline (with decrease of less than 5% per year); and steep decline (with decrease of more than 5% per year). A statistically significant change was stated on the $p<0.05$ level; otherwise, the population was considered stable (Pannekoek & van Strien, 2005).

RESULTS

Distribution of the species and biological peculiarities in Armenia

In Armenia, the species was found breeding in the northern, central, and southern regions (Fig. 2). The nesting habitats vary from open woodlands with rocky outcrops to rocky canyons (Fig. 3) located in open grasslands.

The feeding habitat included marshes, riverbanks, ponds, and water reservoirs (Fig. 4), with a vegetated perimeter or a lack of shoreline vegetation. All known nests were located on the cliffs, 5 to 25 m above the ground (on average 16±3.7 m, n=5), in shallow niches of 1.6-2.2 m depth (on average 1.9±0.1 m, n=5), with the entrance width of 1.4-2.0 m (on average 1.6±0.1 m, n=5), and entrance height of 0.5-1.5 m (on average 1.0±0.2 m, n=5). The face of the cliff varied widely, and the nests were found at all major four faces. The elevation range of the nest sites varied from 1060 to 2160 m above sea level (on average 1560±160 m, n=8). The data is insufficient for computing the species' breeding success, but the successful production of three to five juveniles was observed. The AOO for the species is 764 km^2, and the EOO is 6977 km^2.

Population dynamics and threats

According to our last estimation in 2024, there are 7-9 breeding pairs in Armenia. The population trend demonstrates a moderate increase (additive = 0.0271±0.0134, multiplicative = 1.0275±0.0138, $p<0.05$), as shown in Fig. 5. The species' population shows an increase of 84% in 22 years, with an annual rate of 3.83%. The increase for the last ten years, though, was 24%.

Only one case was documented during the entire period in which the bird was injured by a possible shooting. The hunters admitted that they actually admire the species, knowing its rarity and value to Armenia. Two cases were documented when the bird was probably electrocuted.

During the period 2003-2024, the grassy marshes of the Shirak Plateau (where the pair #cn002 is located) were depleted by at least 60%, the grassy marshes of the Lori Plateau (pair #cn003) were depleted by at least 70%, the grassy marshes of the Sisian Plateau (pairs #cn004 and #cn005) by at least 30%, and the grassy marshes of the Aparan Plateau (pair #cn006) by at least 60%.

DISCUSSION AND CONCLUSIONS

Population trend, existing and potential threats

Two possible, not mutually exclusive, justifications exist for the observed species population increase. The first is related to Black Storks' secretive behavior and low detectability. The case with the pair #cn004 shows that the birds have been breeding at the site since at least 1995 but were found only in 2016 (Ananyan *et al*., 2016).

The second is related to the objective increase in the well-studied sites. Thus, Arai Ler Mountain or Mount Ara (pair #cn006) has been well studied since 2003 (except for 2006, 2013, and 2014), and thus, the pair found in 2019 was probably a new one. Similarly, the Marmarik River Gorge (pair #cn007) has been well studied since 1995; thus, the pair's finding in 2021 was new.

The increase of the species' breeding population in Armenia could be partly conditioned by the ongoing increase of western and eastern European populations, which started recovery after a long period of decline. Thus, the species disappeared from Belgium and parts of Germany in the late 19th century and from Denmark and Sweden in the 1950s (Boettcher-Streim, 1992), followed by a period of recovery in many European countries (BirdLife International, 2004). The increase was reported for Italy, Spain, Portugal, France, Austria, Belgium, and Poland (Dyrcz, 2010; Quaintenne, 2013; de Juana & Garcia, 2015; Lardelli *et al*., 2022). It could cause an increase in the number of immature birds, which start searching for new breeding areas and could colonize Armenia. Unfortunately, there is a lack of information on the species in neighboring Georgia, Azerbaijan, and Iran, although there is a piece of information about an increase in the species population in Türkiye (BirdLife International, 2004).

At the same time, some eastern European populations demonstrated a declining trend related to agricultural inten-

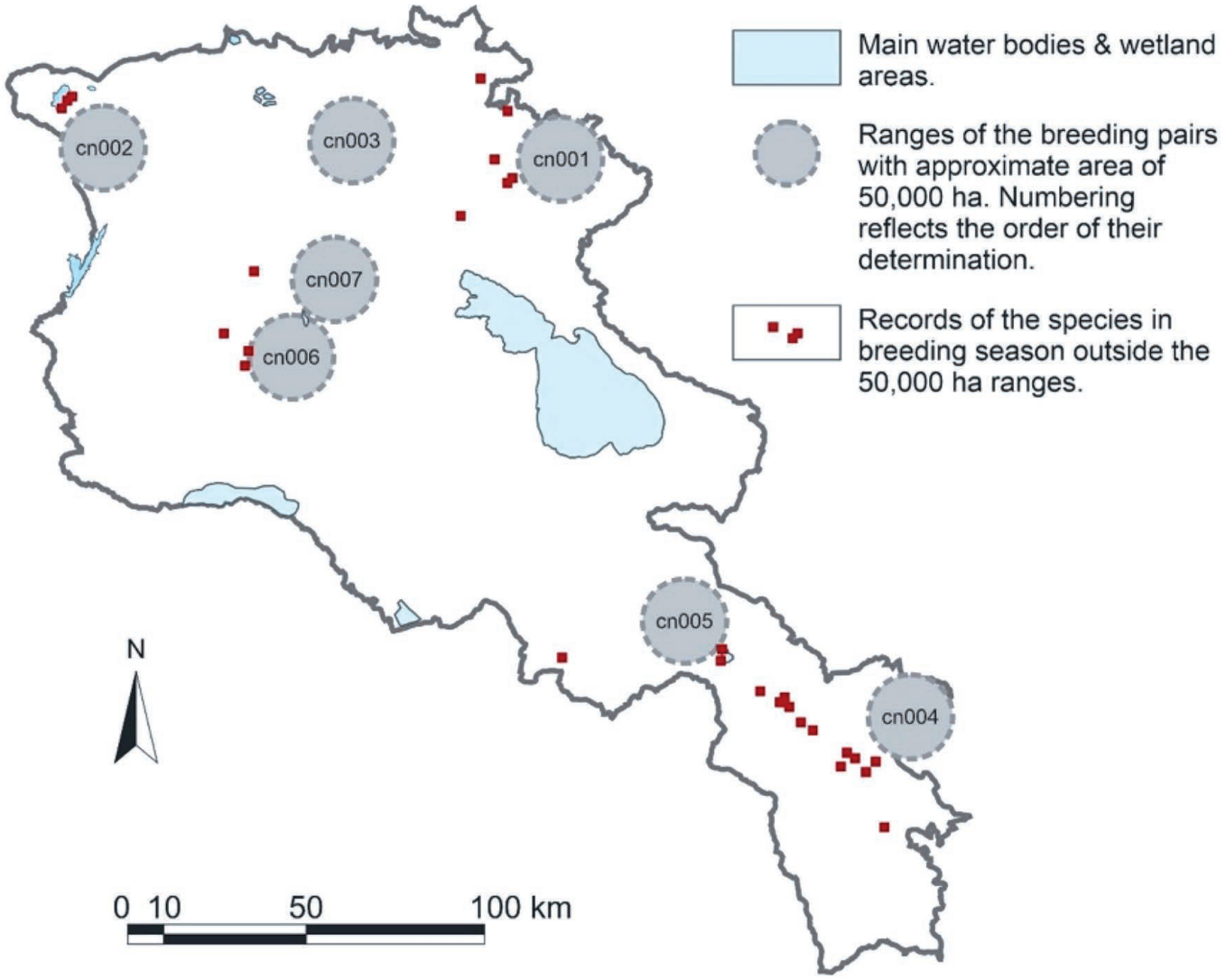

Fig. 2 – Breeding distribution of the Black Stork *Ciconia nigra* in Armenia. Grey circles indicate 50,000 ha ranges of the breeding pairs. Numbers inside the circles are the codes of breeding pairs put historically by the order of their determination. Red square dots indicate species records outside the 50,000 ha ranges in the breeding season. / Distribuzione riproduttiva della cicogna nera in Armenia. I cerchi grigi indicano i range di 50.000 ha delle coppie riproduttive. I numeri all'interno dei cerchi sono i codici delle coppie riproduttive inseriti storicamente in base all'ordine del loro rinvenimento. I quadrati rossi indicano i record di specie al di fuori dei range di 50.000 ha nella stagione riproduttiva.

sification and increased forestry activity (Janssen *et al*., 2004). For the Baltic States, climate change can also cause some habitat transformation, followed by a decline in the Black Storks' population (Treinys *et al*., 2008).

Among possible threats to the species, it can be stated that the degradation of grassy marshes in the mountain plateaus does not affect the species, and ponds, rivers, and especially water reservoirs seem to be more important for the foraging of the storks. Being a mountainous country, Armenia is relatively rich in water resources, having 87 dams totaling 1.4 billion m^3 of capacity. These dams were constructed mainly for irrigation purposes and thus are staying sustainable (Winston *et al*., 2015). All these dams contain a variety of fish, the most abundant ones include *Carassius gibelio*, *Capoeta capoeta*, *Alburnoides eichwaldii*, *Pseudorazbora parva*, and *Cyprinus carpio* (Pipoyan, 2012; Pipoyan *et al*., 2024). The fish are known to comprise most of the Black Storks' diet (Elliot *et al*., 2020), and therefore, the artificial water reservoirs seem to play a significant role in sustaining the species' population. Six out of seven breeding pairs have water reservoirs within the 50,000 ha of their home range, while the other pair has small lakes and three large rivers within the 50,000 ha. On the other hand, the country's rigorous terrain creates many rocky outcrops, cliffs, and canyons along the rivers, containing numerous caves, niches, and grottos that can serve as hidden nesting sites for the species. Therefore, it can be concluded that habitat degradation, reported earlier at the global scale (Hancock *et al*., 1992; del Hoyo *et al*., 1992; Diagana *et al*., 2006) and for Armenia (Balian *et al*., 2002) can hardly be considered a threat to the species in Armenia currently.

Another possible threat could be related to human disturbance and persecution. Black Storks are known to be secretive and sensitive to human disturbance (BirdLife International, 2015). Tourism in Armenia is developing rapidly (Armstat, 2023), resulting in the urbanization of the wild areas and an increase in outdoor activities, such as hiking, rock climbing, and jeep-touring, often accompanied by drone video shooting. Therefore, it is possible that the construction of the tourism infrastructure in conditions of a weak environmental impact assessment and non-careful outdoor activities disturb the birds during the breeding season, which can cause the abandonment of their nests (BirdLife International, 2015).

Fig. 3 – The breeding habitat of the Black Stork *Ciconia nigra* in the Akhuryan River gorge. Photo by Karen Aghababyan. / Habitat riproduttivo della cicogna nera nella gola del fiume Akhuryan. Foto di Karen Aghababyan.

Fig. 4 – The foraging habitat of the Black Stork *Ciconia nigra* in the Shamb Reservoir. Photo by Karen Aghababyan. / L'habitat di foraggiamento della cicogna nera nel bacino idrico di Shamb. Foto di Karen Aghababyan.

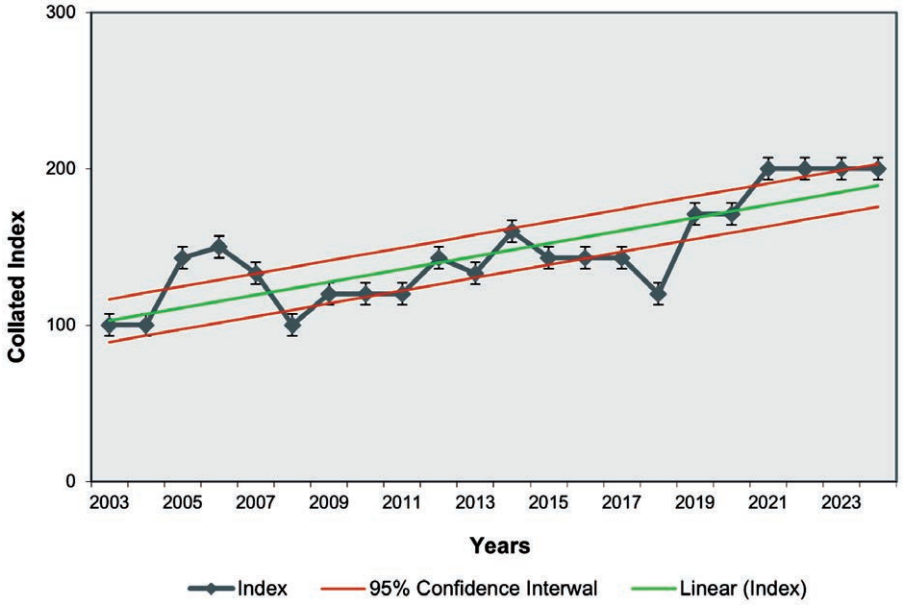

Fig. 5 – Population trend of the Black Stork *Ciconia nigra* in 2003-2024. / Andamento della popolazione della cicogna nera nel periodo 2003-2024.

At the same time, illegal killing does not seem to threaten the species in Armenia, unlike the previous reports for Southern Europe and tropical Asia (Hancock *et al*., 1992), and the one case of shooting the bird seems to be an exception. The general awareness of the hunters about the Black Storks and their positive attitude and perception towards the species also shows that. Therefore, the species is not threatened by direct persecution but could be potentially threatened by human disturbance in the breeding season.

The next possible threat is electrocution, for which there are surprisingly just two pieces of evidence. Considering the higher risk of collisions of the Black Storks with power lines and overhead cables reported by Hockey *et al*. (2005), it is possible, though, that the threat is underestimated, and during post-fledgling dispersion and migration, Black Storks face this threat on a bigger scale. Therefore, it is recommended to intensify the study of the possible collision and electrocution of Black Storks along with other soaring Raptors, Cranes, and Storks.

Conservation measures

The Black Stork is listed in the Red Book of the Animals of Armenia as Vulnerable, according to the criteria D1 (Aghasyan & Kalashyan, 2010), which means that the number of mature individuals is less than 1000 (IUCN Standards and Petitions Committee, 2024). With the current knowledge of the species, it can be stated that the Black Stork qualifies the criteria D1 for the category Critically Endangered (number of mature individuals <50). However, according to criteria B1 (EOO<2000 km^2) and B2 (AOO < 500 km^2), it qualifies for the category Vulnerable (IUCN Standards and Petitions Committee, 2024).

The species is included in Appendix II of the CITES and Resolution 6 of the Bern Convention. Currently, the nesting ranges of the species are covered only by Lake Arpi National Park (#cn002) and five candidate Emerald Sites (Fayvush *et al*. 2016), protected under the Bern Convention: Lake Arpi National Park site (#cn002), partly Debed Gorge site (#cn003), partly Arai Ler site (#cn006), Djermuk site (#cn005), and Khndzoresk site (#cn004).

Despite the increasing population trend, the species remains extremely vulnerable due to a very small number of breeding pairs, a growing factor of disturbance, and a lack of enforcement in the environmental impact assessment procedures.

To improve the state of the species in the country, it is suggested: i) to review the Emerald Network in Armenia, and evaluate a new site on Tsaghkunyats Mountains to cover the pair #cn007; ii) to revise the borders of existing several candidate Emerald Sites, such as Debed Gorge (to fully cover pair #cn003), Arai Ler (to fully cover pair #cn006), and Idjevan (to cover pair cn#001); iii) to apply for the official adoption of the candidate Emerald Sites and to develop management plans for them; iv) to secure proper Environmental Impact Assessment of constructions in the buffer zones of known nests of the Black Storks; and (v) to restrict the outdoor activities including drone video shooting in the buffer zone of the known nests in the breeding season.

The proposed conservation measures should be supported by continuous monitoring of the species with two purposes: i) to track its further population trend, and ii) to indicate the efficiency of the undertaken conservation measures.

CONTRIBUTIONS

Karen Aghababyan made a substantial contribution to the design of the study and article. Karen Aghababyan and Gurgen Khanamirian made substantial contributions to the interpretation of the results of the study. Astghik Tsaturyan and Karen Aghababyan made substantial contributions to the data analysis.

All three authors made substantial contributions to drafting the work, revising it, and finalizing the version to be published. All three authors agree to be accountable for all aspects of the work and to ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

The authors declare an absence of competing interests.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study is a part of the National Bird Monitoring in Armenia implemented by BirdLinks Armenia NGO since 2003. According to Armenian Environmental Legislation, wildlife monitoring does not require ethics approval.

AVAILABILITY OF DATA AND MATERIAL

The data is stored in the Database of National Bird Monitoring and is available upon request.

FUNDING

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