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ASSESSMENT OF ECOSYSTEM SERVICES PROVIDED BY WHITE STORK IN REPRESENTATIVE HABITATS FOR THE SPECIES IN BULGARIA

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Abstract

This paper aims to review and assess the potential ecosystem services (ESS) provided by the White Stork and its habitats in the village of Belozem. The village was described in 2005 by Green Balkans as the Bulgarian representative in the European Stork Villages Network. Gradually, stork population in the area of Belozem has increased, reaching about 60 pairs in 2023. The high number and concentration of birds provide good conditions for conducting representative ecological studies of the species and its habitats. Given that the species is characterized as farmland birds, it inhabits the following Ecosystem types - Cropland and Grassland (Agroecosystem), Sparsely vegetated land and Wetlands (Nature), as well as Rivers and lakes (Freshwater) as foraging habitats, and Urban type as a nesting site. The following key ESS provided by White Stork in the target area are identified - cultural and regulating ESS. Particularly diverse and associated with an annual stork festival, an information centre, the only ones in the country, a stork monument and park, etc. are Cultural ecosystem services provided by the species in the area of Belozem.

Key words*: Agroecosystem, Belozem, Ciconia ciconia, European Stork Villages Network*

INTRODUCTION

White stork (*Ciconia ciconia,* Linnaeus, 1758) is representative of the family Ciconiidae and of this taxon only 2 of totally 20 stork species inhabit Bulgaria (Gula et al., 2023). This bird species is well known by people and is widely distributed across Europe except the northernmost parts. Breeding population in Europe is estimated to be approximately 250,000 pairs (Chodkiewicz & Sikora, 2020) while in Bulgaria in the periods 2004-2005 and 2014 – 2015 respective numbers of occupied nests by the species were more than 4,800 (Petrov et al., 2007) and 5,800 (Cheshmedzhiev et al., 2016). These results from the International White stork census show a clear trend for an increase in the numbers of breeding storks in Bulgaria during this decade. One of the locations with the highest density of breeding pairs in the country is the village of Belozem situated in the central part of Southern Bulgaria in the Upper Thracian Plain. The village was nominated in 2005 by Green Balkans NGO as the Bulgarian representative in the European Stork Villages Network (ESVN) (Gradev et al., 2023). Over the years, the number of the White stork colony in the area has increased, reaching about 60 pairs in 2023 (Figure 1). The high number and concentration of birds provide good conditions for conducting representative ecological studies of the species and its habitats.

Figure 1. White stork foraging habitat in the Agroecosystem (original)

Given that the species is characterized as a typical representative of the group of farmland birds (Tobolka et al., 2012), Agroecosystems represent important habitats of the White stork as foraging grounds during the breeding

season, communal pre-migratory roost sites, migratory stopover sites, etc. At the same time, ecosystem services provided by the Agroecosystems are described as an important factor for local development and competition (Peneva, 2017).

The objective of this paper is to critically review and evaluate the potential ecosystem services (ESS) associated with the White Stork (*Ciconia ciconia*) and its habitats within the context of the village of Belozem.

MATERIALS AND METHODS

The White stork, that is in the focus of the current study, is listed as an endangered species classified as Vulnerable (VU) at national level in accordance with the Red Data Book of Bulgaria, developed in compliance to the IUCN criteria (Petrov et al., 2015). The study was conducted in the vicinity of the village of Belozem, Rakovski municipality. The municipality is situated in the Southern Bulgaria in the eastern part of the Pazardzhik-Plovdiv lowland of the Upper Thracian plain to the northeast of the regional centre - the city of Plovdiv. The study area is characterized with favourable soils and climatic conditions, as well as flat relief that provide excellent settings for the development of agriculture. There is sufficient potential of land and water resources, including abundant groundwater. Local water resources ensure full supply of the municipality's needs, including the well-developed rice farming (Geografika, 2014). Regarding biogeographic regions of Bulgaria, the territory is within the scope of the Mid-Bulgarian region and more specifically in the sub-region of the Upper Thracian plain. This region is dominated by relatively homogeneous flat relief and a significant part of the land is cultivated (Gruev & Kuzmanov, 1999), which suggests domination of Agroecosystems. On the south the lands of the village border with the Maritsa River, which is included in the European ecological network NATURA 2000 (MOEW, 2015). It is one of the largest rivers in terms of basin size, not only in Bulgaria, but also on the Balkan Peninsula, with its source in the Rila Mountain and flowing to the southeast across Bulgaria, Greece, and Türkiye and flowing into the Aegean Sea through a complex delta system. The river valley creates conditions for Mediterranean influence and that affects the climatic conditions in some parts of the subregion of the Upper Thracian plain. The river connects Belozem - Bulgarian representative in the ESVN with its Greek counterpart in the network - village of Poros (www.storkvillages.net), also lying along the Maritsa River in its lower valley, close to its delta where the river flows into the Aegean Sea. The two villages are situated hundreds of kilometers apart along the same river, and thus confirm its importance as a valuable habitat for the White storks at cross-border level. In the area of Belozem during the different years, depending on the crop rotation, several hundred hectares of rice fields are cultivated. For that purpose, there is a network of small streams and canals used for irrigation or drainage of the paddies together with a few micro reservoirs (Figure 2). All these represent Wetlands and Rivers, and Lakes Ecosystem types (Maes et al., 2018).

Figure 2. White stork habitat in Rivers and Lakes Ecosystem types (original)

Regarding the assessment of the ecosystem services provided by the White storks and their main habitats in the study area, an analysis based on the classification of MAES Ecosystem types (Maes et al., 2018) was performed. Assessment was made of all described Ecosystem types that are 12 in total - Urban; Cropland; Grassland; Forest and woodland; Heathland and shrub; Sparsely vegetated land; Wetlands; Rivers and lakes; Marine inlets and transitional waters; Coastal Shelf; Open ocean, distributed in 7 different pilots – Urban, Agroecosystem, Forest, Nature, Freshwater, Marine and Soil pilot.

Taking into account the geographical situation of the study area, two different pilots - Forest, and Marine - were excluded from the assessment due to unsuitability of the habitats or geographical isolation of the target area. In this regard, from a total of 12 Ecosystem types, only 7 (Figure 3) are amongst the potential habitats used by White storks in Belozem and these are within 5 different pilots (Figure 4). All these findings show significant variability in habitat use by the target species and opportunity for a wider scope of the provided Ecosystem services.

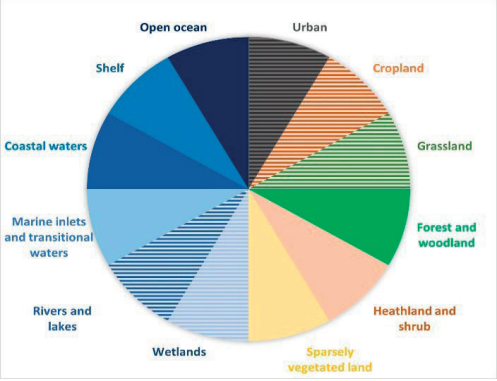

Figure 3. MAES Ecosystem types - dashed colours show ecosystem where the White stork is present

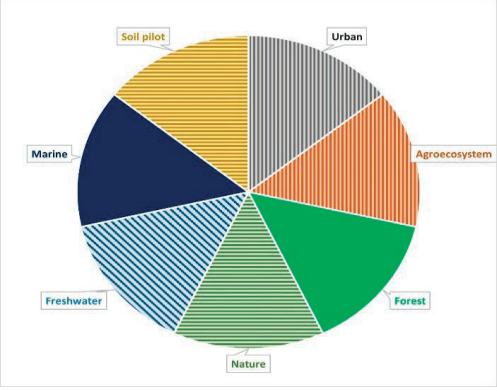

Figure 4. Pilots of MAES Ecosystem types - dashed colours show pilots where the White stork is present

RESULTS AND DISCUSSIONS

Regulating ecosystem services provided by the White storks in the area of Belozem

The White stork is described as an apex predator, with its main prey being certain species of voles, fish, amphibians, reptiles, etc. (Emmerson et al., 2016), found in diverse foraging habitats. Insects (Grasshoppers, Beetles, and Bush crickets) are listed as the main prey for non-breeding White storks in Bulgaria, which they capture mainly in different types of grasslands as a foraging habitat (Milchev et al., 2013). Other authors point to various orders of insects that dominate the diet of breeding White storks in farmland habitats in Poland. These are mainly representatives of the taxa Coleoptera, Orthoptera, and Hymenoptera (Mikicińska et al., 2024). Herbivorous insects, some of which belong to these orders, cause 18% loss of production in agroecosystems at a global level (Jankielsohn, 2018). Various bird species, defined as predators at the top of the food pyramid, such as the White stork (Emmerson et al., 2016) can also be described as natural pest controllers (Kirk et al., 1996). The authors distinguish "natural control" from "biological control", which is based on the additional introduction of various pathogen, parasite, or predator species negatively affecting insect pests in farmland. The regulating role that the White stork plays in ecosystem services is also the subject of research in Poland (Czajkowski et al., 2016; Dylewski, 2020). The most common prey found in food remains (pellets) around nests of these birds are insects, which are part of the diet of this predator, while the regulating influence on rodents is significantly lower. All of this supports the clearly expressed conclusion that the White storks are providing Regulating ecosystem services in agroecosystems, and the potential of this farmland bird species for biological control in agriculture by suppressing populations of different agricultural pests. Considering the high number of the population of these birds in the studied area - about 60 pairs, as well as the need for food resources of about 1.141 kg per day for each pair raising 2 chicks (Dylewski, 2020), the regulating effect concerning various pests in agroecosystems provided by the White storks in the area of Belozem is significant. From all the farmland bird species, the White stork is a good indicator for both environmental conditions and habitat diversity (Tobolka et al., 2012).

Cultural ecosystem services provided by White storks in the area of Belozem

In the Belozem region, various facilities and restored natural habitats contribute to the provision of ecosystem services, such as ecotourism, environmental education, conservation, and bird watching. A prominent facility in this area, serving both ecotourism and environmental education, is the Info-Center “Belozem - European Stork Village”. This center was established through a collaborative effort between the “Prosveta 1909” Community Center, the Belozem Village Hall, and the Rakovski Municipality, with support from the Green Balkans NGO.

The Info-Center features an exhibition that includes photographs, models, a diorama, informational boards, and other materials designed to educate visitors on various aspects of the White Stork and the European Stork Villages Network. A particular focus of the exhibition is placed on local White Storks, with data detailing the fluctuations in nest numbers, breeding success, and migration patterns to wintering grounds.

The Stork festival is a major event in the village, organized usually in the middle of May, since 2006. The event takes place within the "White Stork Park", which houses an observation tower and an information point, offering a wealth of informative materials regarding the White Stork and the "European Stork Villages" initiative. Local amateur artist groups (dancing, musical, literature) perform a cultural program along a local market, where farmers, artisans, and merchants, promote local production. Every year the festival gains more and more popularity, attracting over 5,000 visitors, contributing to ecotourism in the Belozem region.

The primary attraction for ecotourism in the Belozem region is undoubtedly the White Storks, which have formed there one of the largest breeding colonies in Europe. In recent years, more than half of the storks in the Belozem village colony have nested on the roof of the "Geo Milev" School. This stork colony plays a crucial role in environmental education, benefiting not only local students but also visitors to the region. The school every year organizes an international drawing competition “The Life of a White stork” where children from different countries participated. The competition aims to encourage children to perform creatively, to show individual ideas, and instill awareness of nature protection. To further enhance students' environmental education, “Geo Milev” School organizes a Festival of Fertility and Abundance in the Green Garden of the School.

The White stork has a special place in one of the unique Bulgarian traditions - wearing the “Martenitsa” - a combination of white and red threads used for decoration from the 1 March until the first sight of a White stork. On the first day of March, everyone gives gifts to their family, loved ones, friends, etc., which is usually hung or placed on the hand, on clothing, or in the house. Only after the return and observation of the first storks, the “Martenitsa” can be taken down and placed on a flowering tree or bush. The tradition is related to the arrival of spring and wishes for good health and fertility of farming.

In 2017, as part of a Green Balkans NGO project, a modern photo hide was constructed at the "Kisimovi Dupki" wetland to promote bird watching in the region. Annually, the site attracts nature enthusiasts, specialists, and renowned photographers from various European countries and beyond, who visit to observe and photograph rare species of birds, animals, and plants that inhabit the wetland.

The primary objective of the "Kisimovi Dupki" wetland is to foster nature conservation and promote the harmonious coexistence of humans and the environment. Activities at the site are focused on ecosystem conservation, the creation of conditions conducive to rich biodiversity, and the provision of opportunities for various forms of ecotourism. Visitors can engage in a range of activities, including bird watching, angling, wildlife photography, recreation, art and photo plein air, as well as educational, scientific, and research visits. The site also hosts organized events and supports a variety of nature conservation initiatives.

Conservation efforts of Green Balkans NGO in the area were not limited only to the protection of the birds in the area, but included also restoration and conservation of the White stork habitats. The majority of the farmlands in the Belozem region, which closely resemble natural habitats, consist of wet meadows.

Similar to rice fields, these meadows are flooded during specific periods of the year, providing a crucial foraging resource that supports a rich biodiversity. Wet meadows are common in the vicinity of Belozem village, where the high groundwater levels contribute to salination, resulting in the characteristic whitish coloration of the soil. This feature is reflected in the name of the village - Belozem, which translates to "white ground" in Bulgarian.

Lowland hay meadows are among the most biodiverse agricultural landscapes. These meadows correspond to habitat type 6510, as defined under Directive 92/43/EEC on the conservation of natural habitats and wild fauna and flora within the European Union, and are part of the NATURA 2000 ecological network. This type of open habitat is present in the Belozem village area and along the Maritza River, providing essential shelter for a variety of insects, mammals, and birds. The region is particularly notable for supporting feeding populations of White storks, herons, and various species of birds of prey.

The Maritsa River valley around Belozem village is part of the NATURA 2000 European ecological network. Two protected sites overlap here: Special Protection Area “Maritsa - Parvomay” (EU Birds Directive site) and Special Area of Conservation “Reka Maritsa” (EU Habitats Directive site). The conservation objects and objectives of the two sites encompass typical riparian forests, as well as rare and protected species, including birds, otters, bats, tortoises, terrapins, and other endangered reptiles and amphibians. These sites aim to preserve these critical habitats and species, ensuring their continued survival and ecological integrity (Figure 5).

Figure 5. White stork habitat in Cropland Ecosystem type (rice field) (original)

CONCLUSIONS

The assessment of Ecosystem services provided by the White stork in Belozem - the Bulgarian representative in the European Stork Villages Network - identifies two main categories of ecosystem services provided by this species and its main habitats in the area, which are half of the already described and known categories.

Regulating ecosystem services provided by the species are mainly expressed in suppressing various agricultural pests in the Agroecosystems, which are inhabited by the White stork as a typical representative of farmland birds.

Particularly diverse are the Cultural ecosystem services that we identified in the study area. These include Eco-tourism (birdwatching), Aesthetic value of cultural diversity, Spiritual and religious values, System of knowledge and educational value, Inspiration for culture, art and design, and others. We have identified a unique Cultural ecosystem service that is associated with White storks not only in the area of Belozem, but also in Bulgaria as a whole.

This is the tradition of taking down the Martenitsa and observing the first returning storks in the spring.

All this provides significant opportunities for sustainable development of Belozem based on the ecosystem services provided by the White storks.

This cultural tradition associated with the White stork has not been described at the level of Cultural ecosystem services. The economic connections and interrelationships of an emblematic species such as the White storks and the social and ecological aspects for local communities are also the subject of specialized studies (Czajkowski et al., 2016; Kronenberg et al., 2017; Dylewski, 2020).

From similar studies conducted in Bulgaria on the assessment of ecosystem services provided by another typical representative of farmland bird species, such as the Lesser kestrel (*Falco naumanni*) (Gradev et al., 2023a), it can be summarized that the two species provide the same ecosystem services - regulating and cultural ecosystem services, represented in

some common ecosystem types - Urban, Cropland, and Grassland.

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