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Past and Current Situation of Glossy Ibis *Plegadis falcinellus* in Romania

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ABSTRACT

According to historical records, in the early twentieth century the Glossy Ibis was a common species in all the main wetlands of southern and eastern part of Romania. Due to habitat degradation and loss throughout the Danube floodplain and its main tributaries the breeding population underwent a dramatic decline, some colonies disappeared while others suffered considerable numerical decrease. At that time, the Danube Delta was considered to be the main refuge for the species in Romania which registered a maximum of 12,000 pairs in 1977 followed by a sharp decline to about 6,000 in 1979 and 525 in 1983. In the 1984-1995 period the population increased to 3,340 pairs and varied between 2000 – 3000 breeding pairs during the next decade. Although all known Glossy Ibis colonies from Romania are located in protected areas and have a good conservation status, recent annual surveys show large fluctuations in breeding population size. Whereas historical fluctuations have been mostly attributed to habitat loss and degradation, present conditions indicate a much more complex cumulus of factors.

Introduction

In many parts of Europe large wetland areas have historically held a high diversity and abundance of colonial waterbirds (Brouwer 1954; Van Eerden *et al.* 1997). However, massive land reclamations and radical changes in land use caused most of these wetlands to vanish pre- and post- 1900. Significant parts of Romania's wetlands have been reclaimed for agricultural use and have thus reduced the surface area of natural wetlands throughout the twentieth century. The largest reclaimed areas were along the Danube Floodplain in the south and southeastern part of Romania. This situation led to a decrease in both potential feeding habitats and suitable breeding sites for Glossy Ibis *Plegadis falcinellus* and most colonial waterbird species (Paspaleva *et al.* 1985; Botzan *et al.* 1991; Munteanu 2005).

In all the lowland Danubian wetlands that are still present, including the Danube Delta, the water quality has suffered from increasing eutrophication, reducing the amount of isolated and mesotrophic freshwater lakes (Oosterberg *et al.* 2000). The mean annual discharge (c. 7,000 m^3/s) has remained relatively constant throughout the years. One of the direct consequences of the reservoir and dam construction on Danube and its tributaries was the decrease of the sediment load of Danube River in the last 50 years to more than 50%. At the same time, the construction of a dense network of canals was performed in the Danube Delta, which almost tripled the water discharge toward the interior of the delta plain (Oosterberg *et al.* 2000; Giosan *et al.* 2013). Polder construction for agriculture, in Danube Delta,

expanded until 1990 to over 950 km^2 (25% of the ca. 3,400 km^2 of the delta proper) but restoration of these polders has started and will eventually recover ca. 600 km^2 (Staras 2000; Schneider 2010).

The campaigns to "optimize the populations of fish-eating birds" that have been performed in the Danube Delta in the late 1970s and beginning of 1980s caused a high level of disturbance in mixed-species colonies that has led, in many cases, to nest abandonment during breeding and change of the colony location in the next year (Paspaleva *et al.* 1985).

In order to preserve the Danube Delta ecological values, its entire Romanian territory of the delta and the Black Sea lagoons has been assigned the status of an international Biosphere Reserve since 1990, covering some 5800 km^2. In the 1990s and the beginning of the 2000s, some other wetlands that persisted in the former Danube floodplain have been designated as protected areas (Natural Parks and Natural Protected Areas of National Importance).

Romania, as a member of the European Community since 2007, must meet the EU Bird Directive requirements. In this context all known Glossy Ibis colonies from Romania are in Special Protection Areas (SPAs). In order to comply with the country's obligation to warrant a sustainable and favourable conservation status for this qualifying bird species, both numerical developments and the factors responsible for their variation must be collected.

The Bird Directive does not explicitly ask for regular monitoring of qualifying bird species, so the obligation of delivering regular progress reports to the European Committee is fulfilled with the availability of regular and as comprehensive as possible surveys of the colonial birds.

Study area

Romania is located in a proportion of 97.4% in the Danube hydrographic basin. The Danube, after 2,860 km of which 1,075 km in Romania, discharges into the Black Sea in a characteristic delta area. The southern Romanian Plain, along the Danube River, along the Black Sea coast, Danube Delta and in the south-western part of the country recorded the highest values of the average annual temperature of over 11°C. In the extreme eastern part of the country, along Prut River the average annual temperature is over 10°C.

The annual mean precipitation of the Romanian lowlands varies widely between 650 mm/year and 300 mm/year, decreasing from west to east. Precipitation is well distributed over the seasons, with a maximum in May and June (Badea *et al.*1992; Posea *et al.* 2005).

Methods

In order to evaluate the past and current situation of the Glossy Ibis in Romania, the available literature, reports, unpublished studies and databases have been reviewed.

The spatial analysis of the sites and sizes of the bird colonies was carried out using GIS (Geographical Information System).

All colony sites were plotted as accurately as possible. For those colonies visited from the ground/water, the plotting procedure was based on GPS measurements, while the colonies located from the distance or whose location was communicated to us by others were plotted as well as possible. All these data are organised as a GIS database. The locations for the Danube Delta Biosphere Reserve colonies where the Glossy Ibis nested was updated yearly with the number of breeding pairs.

Recent annual average temperature layers have been used to determine the overlapping degree of certain temperatures (Worldclim) with Glossy Ibis breeding distribution in Romania. Ringing of Glossy Ibis in Romania was performed infrequently, as a bycatch in the mixed colonies and only with metal rings. As a consequence, mark-capture-recapture analyses to assess dispersal and vital rates of this species are not possible at the present time.

Results

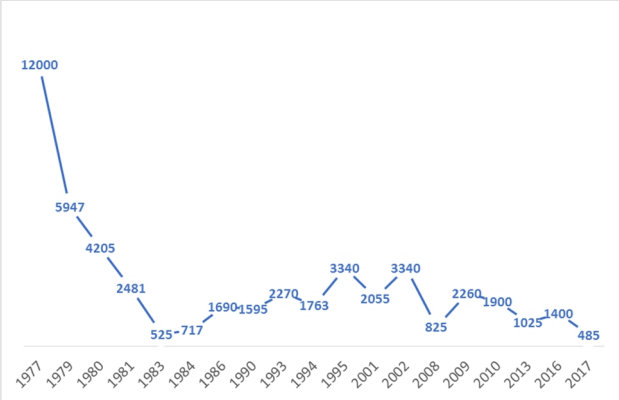
Abundance and distribution

Glossy Ibis was an abundant migratory and breeding species in all the extensive wetlands from southern and eastern part of Romania in the early twentieth century (Dombrowski 1912; Lintia 1955). Numerical evaluations for the entire country are missing from

that period. Due to habitat degradation and loss throughout the Danube floodplain and its main tributaries the breeding population underwent a dramatic decline, some colonies disappeared while others suffered considerable numerical decrease. At that time, the Danube Delta represented the main refuge for the species in the area that registered a maximum of 12,000 pairs in 1977 followed by a collapse to about 6,000 in 1979 and 525 until 1983. In the period 1984-1995 the population increased to 3,340 pairs and varied between 2,000 – 3,000 breeding pairs in the following decades (Marinov and Hulea1996; Platteeuw *et al.* 2004; Munteanu 2005, Onea 2015, CNDD 2015). Recent annual surveys show large fluctuations in breeding population size even if all known Glossy Ibis colonies from Romania are located in protected areas and have a good conservation status.

Regarding the distribution over the last 15 years, the species staged an apparent comeback in Romania with records of breeding in several locations where it had been absent for more than 50 or even 80 years (Nagy *et al.* 2007; Onea 2015). In the last decade (2008 -2017) a total of 8–10 Glossy Ibis colonies were located in the Danube Delta, holding an estimated 500 - 3000 breeding pairs. Estimated numerical development of Glossy Ibis breeding pairs in Romanian Danube Delta Biosphere reserve between 1977 and 2017 show a high fluctuation with a general descending trend (Marinov and Hulea1996; Platteeuw *et al.* 2004; Munteanu 2005; unpublished reports Danube Delta - National Institute for Research and Development) (Figure 1). However, the missing years from the presented figure (Figure 1) represent missing/ incomplete data for this species or data sets for which the right to publish is not available yet.

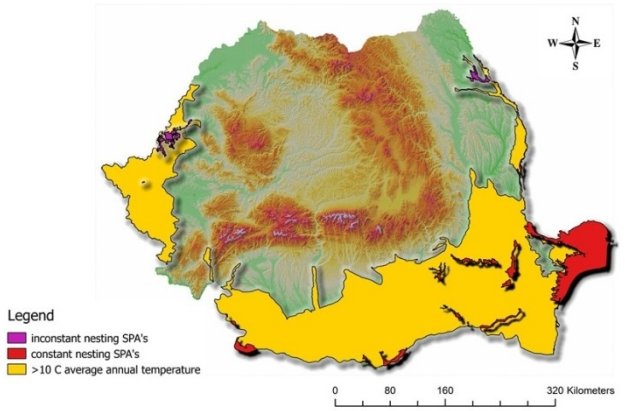
Figure 1. Estimated numerical development of Glossy Ibis breeding pairs in Romanian Danube Delta Biosphere reserve between 1977 and 2017



The Glossy Ibis colonies are relatively close together, most of them in the central, lake-rich part of the Danube Delta. Shifts of breeding locations for this species are frequent. Distances from an old site to a new site can vary from several hundred meters to more than 3 km. Some of these displacements might have been caused by disturbances, nesting failure, breeding and feeding site quality but other causes cannot be ruled out. The degree of individual exchange in the colonies is unknown yet.

The present distribution of the Glossy Ibis colonies in Romania is limited to areas with an annual mean temperature that exceeds 10°C (Figure 2).

Figure 2. Estimated Recent Glossy Ibis breeding distribution in correlation with SPA Network and >10°C average annual temperature incidence in Romania. Pink colour: inconstant nesting SPA's. Red: constant nesting SPA's. Orange: areas with an annual mean temperature that exceeds 10°C



Considering the estimates available in the last 10 years (unpublished reports Danube Delta - National Institute for Research and Development; Onea 2015; CNDD 2015), we consider that a minimum of 80% of the breeding pairs from Romania are found in the Danube Delta. In the last ten years, regular breeding of Glossy Ibis in Romania was recorded in 13 SPAs (Natura 2000 sites). In the other two SPAs, irregular breeding of between five and 15 pairs has been recorded (eionet).

Changes in global climate and the aspiration for sustainable wetland management are highlighting the requirement for improved understanding of the effects of the climate on the behaviour of the waterbird species. The species global distribution range associated with dependence on mixed-species heronries and both natural wetlands and wetland agroecosystems makes the Glossy Ibis a good potential candidate for an early warning system for an indication of overall wetland health. Considering the importance of wetlands for human society, data regarding the identification of patterns in Glossy Ibises movements through time and space and their numerical dynamics could be of value for a better understanding of the changes in wetlands health.

As an outcome of this adaptive behaviour, it is feasible that the observed changes in quality, surface and spatial distribution of remaining wetlands are representative for the numerical and spatial dynamics of the Glossy Ibis population.

If the distribution of the wetlands reflects the distribution of the Glossy Ibis and the Glossy Ibis distribution is related to the amount of precipitation and temperature, then we would expect the precipitation and temperature field to be reflected in the spatial distribution of the wetlands and Glossy Ibis. In a climate change scenario where the incidence of extreme hydrological and meteorological phenomena is higher, we predict that the Glossy Ibis distribution and numbers are likely to be affected. Changes in the spring and summer distribution caused by various environmental or anthropogenic factors are possible to lead to a change in the path taken during the migration in late summer and autumn, which could potentially affect the breeding distribution. Further investigation of this effect is therefore warranted.

Breeding

All regular breeding sites hold extensive wetlands with densely vegetated marshes, supporting large mixed-species heronries. Other species that are recorded nesting along the Glossy Ibis in Romania include Little Egret Egretta garzetta, Squacco Heron *Ardeola ralloides*, Black-crowned Night Heron *Nycticorax nycticorax*, Pygmy Cormorant *Microcarbo pygmeus*, Eurasian Spoonbill *Platalea leucorodia*, Great Cormorant *Phalacrocorax carbo sinensis,* Grey Heron *Ardea cinerea*, Great Egret *Ardea alba* and rarely Western Cattle Egret *Bubulcus ibis*. Most of the known colonies are in flooded stands of trees and/or bushes. These stands are found in floodplain forests and bushes in reed beds. In the floodplain forests all the Glossy Ibis nests are located in White Willow *Salix alba* and the Grey Willow *Salix cinerea* is the species preferred for the colonies located in bushes from the reed beds (Common Reed *Phragmites australis*). Only a few records indicate nesting on reeds in Romania (Lintia 1955; Ignat 2008; Onea 2015; C. Ion, pers. comm. 2018). Their nests are relatively small, the measurements of Glossy Ibis nests found in reed beds from Prut River flood plain show external diameter is 40–55 cm, internal

diameter 15–19 cm, height 18–30 cm, depth 4-7 cm (Ignat 2008). In Danube Delta, seven nests from two tree colonies had an external diameter of 28-50 cm and a depth of 4–8 cm (Danube Delta - National Institute for Research and Development). They tended to be grouped very close together and nests located in Grey Willow *Salix cinerea* are at 1–2.5 m above water level, while the colonies located in tree stands had nests at 2-5 m above water in the Danube Delta and 5-7 m above water in the colonies that are upstream along the Danube course due to the hydrological conditions. Usually, colonies in the Danube Delta tended to be rather large, hardly ever under 100 pairs.

Foraging and diet

The foraging habitats for this species in Romania are mainly represented by wet and moist grassland habitats, but are also found in open patches in the reed beds or among the trees of flood-plain forests and even on dense floating vegetation along lakes shores. Where rice fields are available and functional, they are used by the species. Early data about the Glossy Ibis food choice in Romania indicate small fish, molluscs and aquatic insects and specifically mention leeches and insects as most important in their diet with less fish (Dombrowski 1912). Later on, the food analyses carried out by (Kiss *et al.* 1978; J.B. Kiss unpubl.) on 33 bird stomachs revealed a total of 435 identifiable prey items, of which only 2% were attributable to fish. The vast majority of prey items consisted of insects (65%) and plants (20%). Molluscs (6%), amphibians (4%) and 'other' prey items (3%) made up the rest. Another 12 stomachs collected from 5 different points of the Danube Delta and south-eastern Muntenia (Danube Valley) show that the diet is composed mostly by invertebrates: insects, oligochaete, molluscs *Viviparus sp*., arachnids. Vertebrates have been represented by some amphibian species (*Triturus sp.* and *Rana sp*.). Insects are dominant representing 87.48% of the studied set of samples (Petrescu 1999). Even if the new environmental conditions induced by man-made wetlands connectivity favoured the fish productivity, the Glossy Ibis that is feeding mainly on small (semi) aquatic invertebrates, is likely to have suffered decreases caused by a degradation of this species' optimal habitats (Platteeuw *et al.* 2004). Therefore, further action should aim to assess the population genetic make-up and their relationships with other Glossy Ibis hotspots, in order to understand population trends, connectivity degree and migration rates.

Movement

The breeding birds of the Black Sea and the Balkans are migratory, wintering mostly in sub-Saharan Africa (del Hoyo *et al.* 1992). Glossy Ibis arrivals are first recorded in the first half of March but colonies start to be populated in mid-April. The main autumn migration for this species is in September but a few individuals may still be seen until early December in the wetlands of southern Romania.

Sampling issues

Regardless the specific aim of a study, the sampling plan plays an important role in the data collection for this species in Romania. Usually, the sampling design is a matter of proper questioning of the problem to increase the likelihood of achieving results (Ciorpac *et al.* 2017). Particularly in the Danube Delta, due to environmental factors, such as landscape, vegetation and water levels, and colony conformation, the Glossy Ibis sampling process is a complex and challenging task. Colony accessibility is a limiting factor in Glossy Ibis sampling, due to strong dependency on weather conditions, spatial-temporal dynamics and water level variation that can facilitate or block the access to colonies. Another milestone of the sampling process is regarding the individuals' accessibility, due to required resources, conservative and ethical issues. In some cases, even if the access to the colony is feasible, the sampling process could be impossible (in safe circumstances for sampler and birds) due to nest placement within the colony. Usually, the nests are located in trees at varying heights (less than 1 m–up to 7 m), becoming partially or completely inaccessible. In addition, across the Danube Delta, the Glossy Ibis are nesting in mixed colonies with other species, and the approach of the colony highlights several ethical limitations. The

sampling process should be done as quickly as possible to avoid jeopardizing the chicks' survival, by exposure to predators, since the researcher's presence in the colony will induce a temporary parental abandonment of nests. Therefore, due to all the reasons presented above, the optimal strategy for sampling Glossy Ibis in the Danube Delta is to use the least invasive sampling methods, such us feather and buccal swabs.

Both sampling methods had proved their efficiency for colonial waterbird species in a pilot study during the last year (Ciorpac *et al.* 2017). Feathers and buccal swabs sampling present the following advantages: it is suitable for fast sampling, decreases the amount of time spent in the colony, and is informative enough for population genetics studies.

Discussion

In Romania, the species is well established, particularly in the Danube Delta, but exhibits large fluctuations in population dynamics. Considering the colonies distribution over the last 15 years, the species registered an apparent comeback in Romania. The multiannual counts performed in the colonies from the Danube Delta show a high fluctuation in the breeding population, with a general descending trend. The colonies outside the delta are rather isolated and the marginal ones experience inconsistent breeding. If the historical numerical fluctuations have been considered to be mostly due to the habitat loss and degradation, present conditions indicate a much more complex set of factors.

All known Glossy Ibis colonies are in Natura 2000 sites and they already benefit from the full protection and management measures that are available for most of them and, presumably, will cover all of the sites in the near future.

We hypothesize that dispersal distributions within-colonies and among-colonies could create or already reflects genetic and demographic connectivity within different areas according to dispersal scale. This spatial dynamic more likely enables the Glossy Ibis to avoid poor feeding conditions during its breeding and cause it to search out optimal areas for reproduction and feeding.

More studies regarding the Glossy Ibis metapopulational dynamics are necessary in order to be able to identify patterns and to produce dispersal models for this species.

Further actions towards Glossy Ibis metapopulation conservation requires genetic diversity assessment to gain a better understand the metapopulation structure and gene flow. Moreover, use of the same molecular mitochondrial and nuclear markers across the International Research Network on Glossy Ibis will provide a worldwide overview of the genetic diversity and gene flow of the Glossy Ibis, creating a paradigm framework for studying colonial waterbirds cosmopolitan distribution.

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