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Publication of the IUCN SSC Stork, Ibis and Spoonbill Specialist Group

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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

***Editors-in-chief*: K.S. Gopi Sundar and Luis Santiago Cano Alonso**

***Guest Editor for Special Issue*: Simone Santoro**

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AIMS AND SCOPE
Stork, Ibis and Spoonbill Conservation (SISC) is a peer-reviewed publication of the IUCN SSC Stork, Ibis and Spoonbill Specialist Group. SISC publishes original content on the ecology and conservation of both wild and captive populations of SIS species worldwide, with the aim of disseminating information to assist in the management and conservation of SIS (including Shoebill) populations and their habitats worldwide. We invite anyone, including people who are not members of the SIS-SG, to submit manuscripts.
The views expressed in this publication are those of the authors and do not necessarily reflect those of IUCN, nor the IUCN SSC Stork, Ibis and Spoonbill Specialist Group.

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Welcome to Stork, Ibis and Spoonbill Conservation

Joan Paul RODRÍGUEZ

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It is a great honour to present this first issue of *SIS Conservation*, not only because of the importance of this fascinating group of birds, but for the accomplishment of one of our finest: the IUCN SSC Stork, Ibis and Spoonbill Specialist Group (SIS SG), created in 1981 and currently structured by 97 members from 5 continents.

This new journal is an encouraging and inspiring example for the IUCN Species Survival Commission (SSC) family. It is an accomplishment of collaborative commitment, leading to a unique peer-reviewed publication devoted to their subject of study, and entirely worked out by themselves – simply spectacular! It is in perfect alignment with SSC's species conservation cycle, targeting conservation action after assessment and planning, while firmly anchored on networking and communication. At the same time, the journal is a product of their internal strategic planning process that led SIS SG to set such a high communication goal standard. The accomplishment is even more impressive given that the group values communication as a key issue, opening the gates as well to a wide number of people that may not be members of SSC.

I want to especially congratulate Simone Santoro for the great editing effort of bringing together an entire monograph devoted to the extraordinary Glossy Ibis *Plegadis falcinellus*, posing exciting biological questions that may help improve the conservation of many other species that do not have such ecological plasticity. This publication compiles the knowledge of the species trough 25 papers written by 75 specialists, which is in itself an impressive achievement.

At SSC we are very proud and grateful for the leadership of K. S. Gopi Sundar and Luis Santiago Cano Alonso, excellent examples of what evidence-based, enthusiastic and collaborative co-leadership can achieve.

Long and successful life to *SIS Conservation*!

Jon Paul RODRÍGUEZ
Chair, IUCN Species Survival Commission

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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

Editorial: A New Publication Focussing on Storks, Ibis, Spoonbills and Shoebill

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Storks, Ibises and Spoonbills constitute 60 species, and have a pan-global distribution. The IUCN SSC's Storks, Ibis and Spoonbills Specialist Group (SIS-SG) therefore has a lot of ground to cover. In 2017, the charismatic Shoebill *Balaeniceps rex* was also included under the aegis of the SIS-SG, increasing our collective responsibility.

Thanks to the charisma of SIS species, there are many champions of SIS species worldwide, many outside of the SIS-SG membership. Interested coalitions have come together to help conserve populations and habitats of several endangered species including the Greater Adjutant Stork *Leptoptilos dubius*, Oriental White Stork *Ciconia boyciana*, Asian Crested Ibis *Nipponia nippon*, Northern Bald Ibis *Geronticus eremita*, and Black-faced Spoonbill *Platalea minor*. The behaviour of other, more common, SIS species has led to collaborations focussing on research, and these include species such as the Black Stork *Ciconia nigra* and the European Spoonbill *Platalea leucorodia*. Long-term investigations on various aspects of ecology and behaviour have been ongoing thanks to efforts of smaller groups of people, even individuals, giving us deep insights into the requirements of species such as the White Stork *Ciconia ciconia* and Straw-necked Ibis *Threskiornis spinicollis*.

Some SIS species like the Asian Woollyneck *Ciconia episcopus*, White Stork, Hadeda Ibis *Bostrychia hagedash*, Australian Ibis *Threskiornis moluccus* and Black-headed Ibis *Threskiornis melanocephalus* appear to have switched to less natural habitats. However, the long-term impacts of such a switch on their populations, ability to breed successfully, and their health are still poorly understood. While scientists and conservationists have documented such behavioural dexterity, we are still a long way from knowing if these species can endure the risks that come with getting used to areas dominated by humans and human activity. If they can, that is good news since human modified areas will continue to dominate the planet.

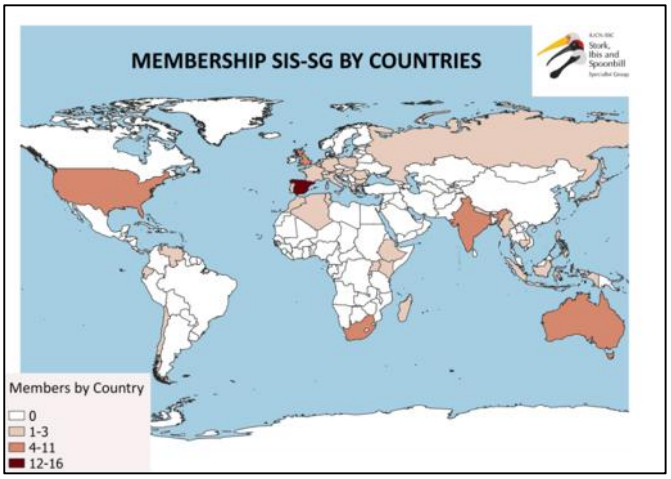
However, a large number of SIS species remain poorly studied, with little effort expended to decipher their needs and develop cogent conservation plans for their conservation. This lacuna is not trivial and needs to be overcome urgently given the rapidity with which we are losing forests, wetlands, and grasslands that several SIS species likely rely on. SIS species remain particularly poorly studied in South America and Africa, and attention to Asian species is steadily increasing, with most of the research and conservation effort focussed on species in Europe and North America. The membership of the SIS-SG is very similar to existing coverage of SIS species ecology (see Figure below), and we clearly need to do more to gain expertise from the various countries where SIS species occur.

The SIS-SG has had strong and effective leadership in the past, and like many other SGs, has endured several challenges along the way. The last publication of the SIS-SG was a newsletter that was completed in September 2003. After this effort, information on SIS species, and work by SG members, have been available in a scattered manner. We are pleased to start a new peer-reviewed publication managed by the

SIS-SG, with a new name, and one that is accessible online for free. Without sacrificing rigour, we aim to present scientific work documented in the now-familiar academic format, and also invite contributions that are less science-y. Named simply "SIS Conservation", or SISC for short, our intention with this publication is to showcase ongoing work and efforts, and to try and inspire new work, while making all of this easily available via our website for free. At the very least, we hope that having this publication will inspire people to write up information that they already have, and have not been able to publish anywhere else. We will attempt to focus equally on species that are globally threatened or endangered, and on species that are common. We hope to include in-depth investigations of questions relating to ecology and evolution, and also more popular-science writings and art that celebrate the quirks and beauty of these species. Another fond hope is that the SISC helps attract additional membership of people who are as fascinated as we are with SIS species everywhere. Anyone can submit manuscripts for publication in SISC and a membership in the SIS-SG is not a prerequisite.

Being part of the IUCN SSC family of Specialist Groups we are especially pleased to be starting this initiative during the IUCN quadrennium 2017-2020. The SSC has prioritized communication as a key priority area during this period. Towards this collective goal of improving communication, the SISC joins the SIS-SG's "Special Publications" series that we initiated in 2018 to help collate and make available key literature (e.g. conference abstracts) that traditionally have short shelf times, becoming difficult to access over time. SIS-SG Special Publications are also available on our website for free download. The first two Special Publications collate extensive information brought together during regularly organized meetings focussing on the Black Stork and the Eurasian Spoonbill. Articles contributing to these Special Publications cover extensive geographical areas, include an incredible array of subjects that provide an in-depth understanding of what each species does and needs, provide thoughtful discussions on how to reduce threats to the species, and celebrate the collective power of many individuals and institutions brought together by a shared passion for these species.In this regard, we are also pleased that the first issue of the SISC is a Special Issue, being a collection of papers by members of the newly formed International Glossy Ibis Network. For the first time, researchers from across the world provide updated information and knowledge of this species. The Glossy Ibis is one of the most common SIS species, and one of the very few today that is expanding its range worldwide. Thanks to the interest and leadership of SIS-SG member Dr. Simone Santoro, this new group was put together relatively rapidly and is already very active in sharing information related to the Glossy Ibis. For this first issue, Simone has worked with colleagues worldwide to collect and present fascinating work that enhances our understanding of this species enormously.

As with previous SIS-SG publications, this new avatar is also a shared one, and will be as successful as the members and SIS enthusiasts allow it to be. We invite anyone interested in SIS species to consider this publication as a forum for your work, for your thoughts, and to help highlight your successes and failures while working with SIS species. We are grateful to the members who have bravely volunteered to be Editors for this publication – enterprises such as this one requires time and patience, and we thank you for your interest. We are especially grateful to the many people who helped review the excellent submissions for the first issue of *Storks, Ibis and Spoonbill Conservation* and also the support from *Tour du Valat* which generously has provided the ISBN for this issue.



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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

Guest Editorial

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My first meeting with the Glossy Ibis was pretty much random. I moved from Rome (Italy) to Seville (Spain) looking for a PhD project. By chance, I heard that Drs. Jordi Figuerola and Andy J. Green (Estación Biológica de Doñana- Agencia Estatal Consejo Superior de Investigaciones Científicas, EBD – CSIC) just opened the application for a PhD project on the population dynamics of Glossy Ibis. They were looking for a motivated student – I definitively was! – with some experience in statistical modelling of population dynamics. That was a hit for me since a few years earlier I spent part of my Bachelor thesis in the field marking and monitoring a population of roe deers. By then, I started to feel a real fascination for capture-mark-recapture models. That PhD proposal was therefore perfect to me and I was really lucky to find myself involved in a thesis on the Glossy Ibis, a bird, that being said, I had never seen before.

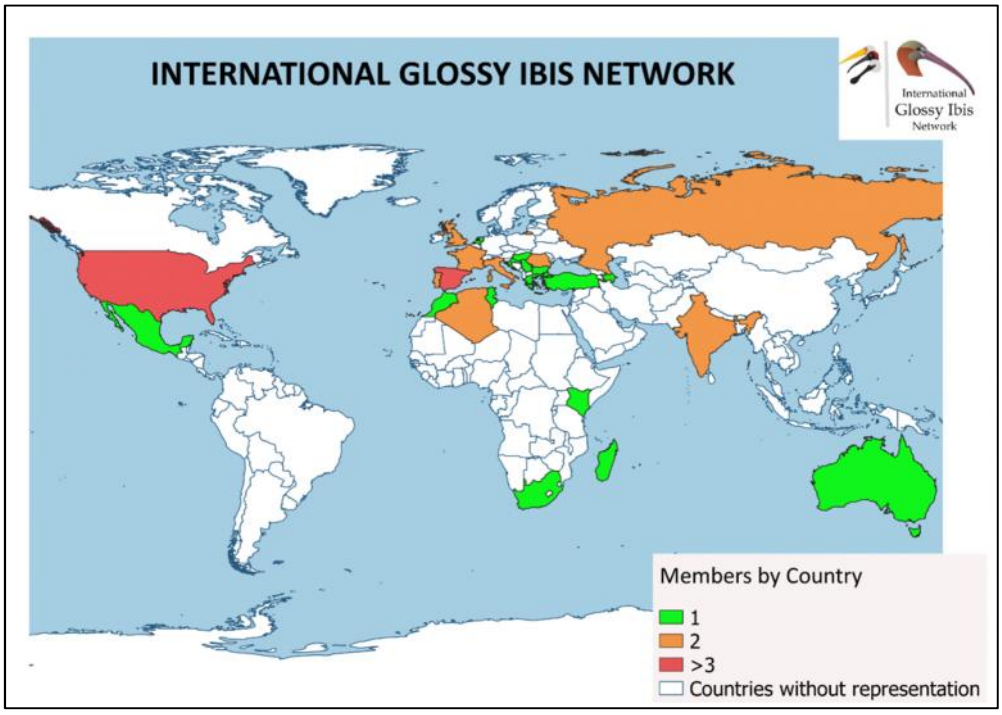
A few pairs of Glossy Ibis started to breed in Doñana, a spectacular wetland and ornithological sanctuary in South Spain, in 1996 after almost a century of local extinction. Researchers from the EBD started immediately a monitoring program (based on counts, ringing and visual resightings of marked birds) which gave rise to an impressive database that is still growing just like the wintering and breeding population of the species made up of more than 8,000 pairs nowadays. These data were crucial to shed light on quite a few aspects related to the increase of the local population and the consequent spread of the species across the Mediterranean Basin and Western Europe.

During my PhD I was thrilled by the ecological plasticity of this species, the speed at which it responds to adverse conditions (e.g. local droughts) and the impressive dispersal skills (e.g. 3-4 months old birds leaving Doñana and crossing the Atlantic Ocean to reach the Antilles). Still, although this is among the six most cosmopolitan landbird species in the world, with a distribution range covering five continents, we know very little about the processes that have determined such a lucky fate. Why has the Glossy Ibis not been attractive to researchers? The reason must be probably found in its reputation as a nomadic species, with a fluid dynamic based on some populations popping up here and there and others crashing and disappearing all of a sudden. These characteristics make the Glossy Ibis undoubtedly difficult to study but, at the same time, they also make it very emblematic of the complexity beyond population dynamics, especially in these times of global change. Why some species decline and others increase and spread? Why does a species increase here and decrease there? To be able to answer these questions we need to focus our effort not only on the endangered species but also on common and cosmopolitan species. Furthermore, we need to do that by adopting a holistic approach. This has been the main reason (and challenge) to move me and other people to organize a research network. By doing so, we expect to share information and gain an otherwise unachievable knowledge of its dynamic. Working towards synergic and enthusiastic networking, we finally organized the first international workshop on the Glossy Ibis in November 2017 hold at the Parque Nacional de Doñana. This workshop would have been impossible without the collaboration of the EBD (my deepest

gratitude goes to Dr Jordi Figuerola without whom the workshop would have not been possible) and the auspices of the Tour du Valat (thanks to Drs. Jocelyn Champagnon and Arnaud Béchet) and the IUCN SSC Stork Ibis and Spoonbill Specialist Group (SIS SG – thanks to Drs. Luis Santiago Cano and Gopi Sundar).

That was the seed of the International Glossy Ibis Network (IGIN) that nowadays recruits about 50 researchers and technicians from 25 countries (Figure 1). Some of them were already involved in monitoring programs of the species, some others have started more recently. Many of the IGIN members have worked in this special issue on the Glossy Ibis that I am pleased and honoured to announce as Guest Editor of SIS Cons, this brand-new publication born after the initiative of Drs. Luis Santiago Cano and Gopi Sundar, the tireless Co-chairs of SIS SG. I wish to acknowledge all the persons who have made this possible, thank you for tolerating my annoying insistence. It was worth the effort and I now feel really enthusiastic about the future of this research network that, no doubts, will surely unravel more secrets of this beautiful and captivating ibis.

Figure 1. Map of the International Glossy Ibis Network (IGIN)



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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

The Glossy Ibis *Plegadis falcinellus* in Azerbaijan

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ABSTRACT

Glossy Ibis *Plegadis falcinellus* is a nesting species in Azerbaijan. Nesting occurs in large mixed colonies with up to 11 species, including herons, ibises and cormorants. The research was conducted on all main nesting sites in Caspian Sea coast and on inland lakes and water reservoirs of Kur-Araz lowland. The present study estimates Glossy Ibis abundance between 1990-2006 in Azerbaijan to be between 10,000–15,000 individuals. This is about two times less than a previous estimate published for the 1990s which reported 12,500–18,000 pairs (25,000–36,000 individuals). However, the dynamics seemed to be heterogeneous among different Azerbaijan sites. As an example, the population declined in Aggol (about four-fold) and in Mahmudchala lakes (>30-fold), whereas it increased in Gyzylagach SNR and Sarisu lake (up to 6,000-8,000); from other areas the data were not precise enough to infer net changes in numbers. Although absent in the list of species permitted for hunting, the Glossy Ibis is not a protected species in Azerbaijan. No special Protected Areas are dedicated for Glossy Ibis but, notably, two National Parks (Aggol and Shirvan) and one State Nature Reserve (Gyzylagach) include > 63% of all of the breeding population in the country. Main threats for the Glossy Ibis are illegal hunting and fluctuation of water level, due to the presence of dams or water extraction effectuated in most nesting sites. To improve the conservation status of the Glossy Ibis in Azerbaijan I recommend to: (i) increase the effectiveness of plans against illegal hunting, (ii) strengthen conservation work in Special Protected Areas, and (iii) develop and maintain a regular monitoring program of the species especially consisting of spring–summer counts in all key sites.

Introduction

Glossy Ibis *Plegadis falcinellus* is a very common bird in Azerbaijan in certain habitats, namely the wetlands. Every big wetland (lake or just shallow water, sea gulf or sometimes water reservoir) in Azerbaijan hosts mixed colonies of *Ciconiiformes* and *Pelecaniformes* birds with up to seven species of herons: Black-crowned Night Heron *Nycticorax nycticorax*, Squacco Heron *Ardeola ralloides*, Western Cattle Egret *Bubulcus ibis*, Little Heron *Egretta garzetta*, Great Egret *Ardea alba*, Grey Heron *Ardea cinerea* and Purple Heron *Ardea purpurea*. These colonies also as a rule include two species of ibises: Eurasian Spoonbill *Platalea leucorodia* and Glossy Ibis, and two species of cormorants: Great Cormorant *Phalacrocorax carbo* and Pygmy Cormorant *Microcarbo pygmeus*. During the 20th

century, the Glossy Ibis has undergone a population decline in 1940s–1960s (in 1940s in Mahmudchala Lake, in 1960s in Gyzylagach State Nature Reserve) and, subsequently, a population increase in 1970–1980s (Patrikeev 2004).

Spring migration occurs from late March to Mid–May. Autumn migration occurs from Mid–August to earlier October but in some years extends through to November–December (Patrikeev 2004). Although sporadically observed in winter (Radde 1884; Vinogradov and Chernyavskaya 1965; Patrikeev 2004 -record in 1991-), the Glossy Ibis is not a regular wintering species in Azerbaijan (Tuayev 1975, our data).

Nest building occurs during April in reed and tamarisk growth or on trees if they are achievable (only Varvara water reservoir (w.r.). The diameter of nest is 280–350 mm, depth 40–60 mm (Grekov 1965; Mustafayev and Kazimov 1965a, b, 1966). Average egg measurement is 52.4 x 35.8 mm (Mustafayev and Kazimov 1966). Eggs laying is mostly in late April–early May (Grekov 1965; Vinogradov 1967; Tuayev 1975) but on Mahmudchala Lake, it was registered in late May–early June (Patrikeev 2004). The number of eggs per clutch is 4–6 but can sometimes be up to nine if two females lay eggs in the same nest (Vinogradov 1967). Incubation by both parents lasts 19–23, on average – 21.2 days and chicks remain in the nests for 30–32 days mainly in first days of June and leave the nest mainly in the end of June–beginning July (Tuayev 1975). In Gyzylagach State Nature Reserve (SNR) in the 1960s, 13% of eggs were lost and 7.5% of chicks (Mustafayev and Kazimov 1965a, b, 1966). Just within the 1960s there was a sharp decline of this species in this reserve. On average 3 fledglings per pair were counted in Aggol State Nature Reserve (now National Park) in 1960s (Vinogradov 1967; Vinogradov and Tcherniavskaya 1969). Research on diet shows that 47% of all stomachs contained Marsh Frog, 24% fishes and 23% insects (Vasilyev 1975), mainly dragonfly larvae (Tuayev 1975).

Study Area

In Azerbaijan, there are many lakes with shallow water (1–5 m depth) and coastal areas where water is warm and it is covered by reed growth (*Phragmites communis*). They tend to not freeze during the winter (or do for only a very short time). Reed beds are a main component of plant community in these shallow waters especially during the breeding period when the majority of birds use them for nesting and nest building, shelter and, in some cases, even for feeding.

Colonial species like the Glossy Ibis are commonly observed nesting together in big mixed-species colonies of *Ciconiiformes* and *Pelecaniformes* (herons, ibises and cormorants). Their nests are often distributed in two–three floors in reeds or bushes of Tamarisk (*Tamarix ramosissima* and *T. meyeri*). These colonies may host up to several thousand nests (in Gyzylagach SNR – several tens of thousands of nests).

Most inland lakes are supplied with water from channels of the Kura River (Lakes Jandar and Hajigabul) or from channels of the Mingachevir reservoir located on Kura River (Lakes Aggol, Sarisu and Bozgobu). Two inland lakes are Ramsar sites: Gyzylagach SNR and Aggol National Park (NP).

In Azerbaijan, the Glossy Ibis counts proceed mainly by two macro-areas (details may be found in Sultanov *et. al*. 2000; Sultanov *et al.* 2008): the Caspian Sea coast and the Kura–Araz lowland.

Caspian Sea coast

Lake Agzibhir is 12 Km from Shabran (former Divichi) city in the direction of the Caspian Sea. The inflow and outflow of this coastal lagoon (1,600 – 2,200 ha, maximum depth – two meters) is mediated, respectively, by three rivers and one river which ends in the Caspian Sea; Kura River Delta, eight–10 km from Neftechala city. The area is about 30,000 ha. The wetland includes main and secondary branches of the river Kura with dense reed beds, many small dams connecting small islands and one major island. The straight-line distance (MD hereon) is about 20 Km in the Southeast direction; Gyzylagach SNR, 30 km from Lankaran city by the asphalt road (South-east Azerbaijan). This vast area (88,360 ha) is among the most important places both in Europe and in all of Western Palearctic for wintering and nesting waterbirds. It consists of four main parts: 1) open water of the Great Kyzylagach Gulf (area 40,000 ha,

MD 29 Km, width 24 Km, maximal depth 3.5 m), Little Kyzylagach Gulf (16,000 ha, MD 16.7 Km, width 6.5 Km, maximal depth 2.5 m); 2) a maritime belt of reed beds is in Great Kyzylagach Gulf (width 2–2.5 Km) especially along the western and northern beach at about 200 m from them; 3) different shallow waters with reed beds and 4) semidesert plots on remaining territory of reserve. The Great Kyzylagach Gulf plays a major role for the Southern Caspian Sea region as a place with a concentration and growth of newly–hatched, economically-valuable species of fish, specifically in Lake Flamingo in Shirvan NP, with an area of about 2,000 – 4,000 ha (now decreasing). This lake was formed as a result of overflow of water from Shirvan Spillway Canal. The water level fluctuates. Reed beds are very developed and water is very shallow (often less than 0.5 m).

Kura–Araz lowland

Lake Aggol, 20 km from Agjabedi city with an area of about 10,000 ha (in the past only 4,500 ha). The lake is located at Mil steppe in Karabakh with a MD (west – east) of 25 km and a width of 1.4 – 5 km. The depth is 1.2 – 3.5 m, and in the coastal strip is 0.1 – 0.5 m. 75% of the area is covered with vegetation (basically reed beds). In the lake there are several islands of 2 – 10 ha, richly covered by vegetation. This site is especially important for wintering and breeding of many threatened waterbird species. Varvara water reservoir, created in 1956, covers an area of 2,140 ha near Mingachevir city with a water depth of 0.5 – 18 m. The reed beds are extensive and the reservoir is surrounded by shallow waters separated from it by a dam and narrow strips of land. This place is used for nesting and wintering by many rare and threatened species of birds (in summer large mixed breeding colonies of *Ciconiiformes* and *Pelecaniformes*); Lake Sarisu, an area of 11,000 ha in the Imishli, Kurdamir and Sabirhabad districts. This is one of the largest wetlands in Azerbaijan. More than half of the territory is covered by reed beds providing ideal conditions for nesting of a very large number of birds. Lake Mahmudchala is one of the largest wetlands (about 7,000 ha) in a flat part of Azerbaijan with an unstable water level located between Salyan and Bilasuvar cities. Owing to very developed reed beds, this is one of the most important wintering and nesting site of rare and hunted species of birds. Lake Bozgob is located between the Aggyol and Sarisu lakes. This lake which is important for wintering and breeding of birds, receives water from Lake Aggyol and different collectors and canals. Reed beds are very developed. The oil fields near Bozgobu and the oil ponds are significant threats to this ecosystem. Lake Hajigabul covers 904 ha (with fishponds and neighbouring shallow waters – more than 2,500 ha) and is located between Hajigabul and Shirvan cities. This lake initially appeared as a gulf of the Caspian Sea and subsequently remained isolated from it, being supported by periodic overflows of the river Kure. Unlike the majority of other lakes of Azerbaijan, the reed vegetation is not abundant here although it is in the neighbouring shallow water and fishponds. The depth of this lake, important for temporary rest of migratory birds during migration, does not exceed 5 m.

Methods

Outside of the breeding colonies, direct bird counts were taken from road surveys. Inside of the breeding colonies, the number of birds was estimated by direct counts of adult birds and nests on randomly selected squares with subsequent extrapolation on the full area where breeding colonies were present. Binoculars and telescopes were used to identify the species. The data used for this study comes from surveys performed in the period between 1990 and 2006 from several areas located within the Caspian Sea coast and the Kura–Araz lowland.

Results

The following numbers of birds were estimated by direct counts in the two macro-areas (Figure 1).

Caspian Sea coast

Lake Agzibir (Divichi Lagoon) ≥ 85 individuals were counted in 1998 (Sultanov and Agayeva 2003). Kura River Delta – in June 1996 in a mixed colony with about 1,100 nests, 50 nests of Glossy Ibis (≤ 5% of total); in Gyzylagach SNR in 1950s there were

between 50,000 pairs (Grekov 1965) and 150,000 individuals (Dunin 1960), their number decreased to ≥ 3,000 pairs in 1980s and ≥ 1,800 in 2006. In Lake Flamingo in Shirvan NP – no information about the number of breeding birds because the colony was inaccessible. M.V. Patrikeev registered two individuals on the 21 May 1990 (Patrikeev 1991b).

Figure 1. Nesting sites of Glossy Ibis in Azerbaijan in the last two decades: 1-Aggol NP; 2-Lake Mahmudchala; 3-Varvara w.r.; 4-Lake Sarisu; 5-Shallow waters near the Lake Hajigabul; 6-Lake Bozgobu; 7-Gyzylagach SNR: 8-Kura Delta; 9-Divhichi Liman (Lake Agzibhir); 10-Shirvan NP, Lake Flamingo. Big red circles 500 – 4500 individuals; small red circles ≤ 500 individuals

Kura–Araz lowland

More than 8,000 pairs were observed on Lake Aggol in 1988–1990 (Patrikeev 2004), according to data collected by A.F. Jabbarova (2006) in the first half of July 2004. 4,230 individual (23.5% of total) Glossy Ibis were registered in a mixed colony of 18,000 individuals. 50 – 60 pairs on Varvara water reservoir were counted in 1980 – 1990 (Sultanov and Agayeva 2003; Patrikeev 2004). In April 2006, only 20 individuals of Glossy Ibis were observed in two mixed colonies of about 900 individuals. Lake Sarisu had ≥ 100 pairs in 1990 (Patrikeev 2004), ≥ 130 individuals (Sultanov and Agayeva 2003) in 1998 and 953 individuals in 2000 (pers. obs.). Lake Mahmudchala, where this species disappeared in the 1950s and then returned in 1980s had 5,500 – 6,000 pairs counted in 1990 (Patrikeev 1991a). According to our data for 1998, 250 individuals (10% of the total number of birds in the mixed breeding colony) were counted with 63 individuals outside the colony on shallow waters of the lake (Sultanov *et al.* 1998; Sultanov and Agayeva 2003). Also, some colonies with Glossy Ibises have been observed in Lake Bozgobu and in shallow waters near the Lake Hajigabul (20 individuals were registered in the end of May 1998, pers. obs.) where, due to inaccessibility of shallow waters, exact data about the number of breeding birds does not exist.

Table 1. Distribution and number of Glossy Ibis in Azerbaijan according to our data. Ind.: Individuals

Site			**Trend**	**% in mixed breeding colony**
	Min.	**Max.**		
1. Aggol National Park	4,230 ind. in 2004	8,000 pairs in 1990s	↓	24%
2. Lake Mahmudchala	313 ind. (1998) 932 ind. (2000)	6,000 pairs (1990)	↓	12%–34%
3. Varvara Water Reservoir	20 ind. (2006)	60 pairs (1990)	↓	12% (1998)
4. Lake Sarisu	>100 pp 1900s	953 ind. 2000	↑	9–31%
5. Shallow waters near the Lake Hajigabul	20 ind. 1998	?	↓	28%
6. Lake Bozgobu	Regular in breeding season	?	?	?
7. Gyzylagach SNR	50 pairs in 1960s	>3,000 pairs in 1990s, >1,800 in 2006	Fluctuation	14.5%
8. Kura Delta	50 nests in 1996		?	?

Site			Trend	% in mixed breeding colony
	Min.	Max.		
9.Divhichi Liman (Lake Agzibhir)	85 ind. in 1998		?	?
10.Shirvan NP, Lake Flaming	2 ind. in 1990		?	?
Total	**2,574 pairs**	**>17,536 pairs**		

Discussion

According to current data we estimate general numbers of Glossy Ibis in Azerbaijan for the research period spanning 1990-2006 as 10–15 thousand individuals. This is about 2 times less than the estimate made by M.V. Patrikeev for the 1990s which was 12,500–18,000 pairs. This takes into account the decrease of in the numbers in Aggol (about 4 times) and Mahmudchala lakes (which decreased more than 30 times), the increase in the number in Gyzylagach SNR and Sarisu lake (up to 6,000-8,000 individuals together) and no precise data from Divichi lagoon, Shirvan NP and Kura river Delta (where we can propose important numbers of this species).

There may be some competition between Glossy Ibis and Spoonbill that exists, as the presence of one species is often accompanied by the absence or important decrease in number of the other species. For example, in lake Sarisu, 130 Glossy Ibises and 0 Spoonbills were recorded in 1998, 22 Glossy Ibises and 67 Spoonbills were recorded in 1999, and 953 Glossy Ibises and 1 Spoonbill in 2000. In Lake Mahmudchala, 313 Glossy Ibises and 8 Spoonbills were counted in 1998, and in Varvara water reservoir 123 Glossy Ibises and 0 Spoonbills were recorded in 1998. A similar pattern has been observed with the Grey Heron if the presence of Glossy Ibis is consistent (> 100 individuals).

Conservation and economic importance

The Glossy Ibis is not a protected species in Azerbaijan although it is absent in the list of species permitted for hunting. No special Protected Areas are dedicated to the Glossy Ibis; however, two National Parks (Aggol and Shirvan) and one State Nature Reserve (Gyzylagach) include more than 63% of all breeding population. No specific actions for the conservation of the species have ever been planned or implemented.

Main threats for the Glossy Ibis are illegal hunting (up to 50% of pairs lose one partner as a result of hunting) (Litvinova 1986) and fluctuations of water level. This is due to the presence of dams or water extraction effectuated in most lakes (for example, Mahmudchala lake) that can totally destroy all mixed breeding colony.

Gaps and recommendations for future

Unfortunately, there is no detailed information about numbers of breeding birds in lakes Flamingo (Shirvan NP), Agzibir, Bozgobu, Sarisu, and Hajigabul. Similarly, there is no knowledge about the effect of lead shots, which represents a well-known cause of poisoning in waterfowls (Scheuhammer and Norris 1996), and about the interaction with fishers as it is known they can disturb breeding colonies and even be responsible of illegal hunting of this and other bird species. To improve the conservation of the Glossy Ibis in Azerbaijan I recommend the following actions to be taken:

1) Increase of effectiveness of fighting illegal hunting.
2) Strengthening conservation work in Special Protected Areas
3) Regular spring–summer counts on all key sites.

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IUCN SSC Stork, Ibis and Spoonbill Specialist Group

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Past and Present: The Glossy Ibis *Plegadis falcinellus* in Tunisia

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ABSTRACT

This work aims to clarify the current breeding status of the Glossy Ibis and describe the recent population dynamics of the species in Tunisia. We have used bibliographic data from 25 ornithologists and personal observations made during our long-term monitoring of the Tunisian wetlands. The Glossy Ibis was always observed in the winter (56.74% of observations) and before (8.61%) and after (28.78%) the breeding period. The majority of these observations (43.41%) were from southern Tunisia. The lowest percentage was recorded during the breeding period (5.85%) principally in Lebna dam at Cap-Bon (north-east Tunisia) where the breeding of the species on Tunisian territory was demonstrated for the first time in 2008. Another nesting case with 4 breeding pairs was recorded in June 2014 at Ichkeul Lake in northern Tunisia. Currently, the nesting populations of Glossy Ibis appear unstable at both breeding sites. In 2017, for the first time in the last three decades, there was no mixed heronry in the Ichkeul National Park and, therefore, no Glossy Ibis nesting. On the other hand, in Lebna the number of breeders continued to decrease year-to-year until just one couple was recorded in 2017. The current situation of the breeding populations in Tunisia is serious and requires urgent action by conservation stakeholders. It is therefore necessary to start an adequate conservation plan to safeguard the protection of the species in Tunisia. We suggest that more effort should be devoted to limit anthropic disturbances, especially during the breeding season, and to properly manage the recently-built dams around the Ichkeul Lake in order to guarantee sufficient levels of water for wading birds nesting.

Introduction

The Glossy Ibis *Plegadis falcinellus* is recognized as a widely distributed landbird species (Newton 2003). Due to its great dispersal capability it was recently able to colonize the New World by individuals who crossed the Atlantic (Santoro *et al*. 2013). Its current reproduction zone is vast and scattered, ranging from southern Europe, Africa and Madagascar to Central and South Asia, Philippines, New Guinea and Australia. It also breeds along the Atlantic coast of North America and in Islands from the Caribbean Sea (Matheu and del Hoyo 1992).

In the Western Mediterranean, Glossy Ibis recolonized the southern part of Italy (Brichetti 1986)

and Sardinia (Grussu 1987) during the 1980s. After a long absence and as a consequence of wetland management in Doñana National Park, the species recolonized Ebro delta and other Iberian sites since 1994 and increase
d in population from 8 in 1996 to 4048 in 2008 (log population size+1) (Figuerola *et al.* 2004; Santoro *et al.* 2010). Likewise, according to Kayser *et al.* (2006; 2009) Glossy Ibis populations continued to increase in number and size until the first recolonization in the Camargue in southern France.

In North Africa, Glossy Ibis had nested commonly in Morocco and Algeria from at least the 19th century (Heim de Balzac and Mayaud 1962; Thévenot *et al.* 2003). Subsequently, nesting recording had halted for almost a century only to begin again with new recordings of reproduction at the mouth of the Massa Wadi in 1994 (Rousseau 1994), in the palm grove of Marrakech, Morocco in the 1980s (Barreau and Bergier 2001;Thévenot *et al.* 2003) and recently in Smir marshes in northern Morocco (Amezian *et al.* 2012). In Algeria, Glossy Ibis started to breed again, first at Lake Tonga (Belhadj *et al.* 2007) and later at Lake Fetzara, Lake Tonga, Dakhla, and Chatt (Boucheker *et al.* 2009). The species has also bred recently in the Boussedra wetland in northeastern Algeria (Boudraa *et al.* 2015).

In Tunisia, the Glossy Ibis has always been observed in double passing (pre and postnuptial) and in the winter around Tunisian wetlands with the postnuptial passage being the most prominent (Isenmann *et al.* 2005). This bird had only ever been known as a wintering species (De Balzac and Mayaud 1962; Etchecopar and Hue 1964; Mayaud 1982). However, the species had bred for the first recorded time at the fresh water reservoir at Lebna dam near Cap-Bon (Ouni *et al.* 2009; Nefla *et al.* 2012). Also, another case of nesting with 4 breeding pairs was observed in June 2014 within the mixed heronry of Ichkeul National Park in northern part of Tunisia (Nefla *et al.* 2014).

Except for this bit of data and our personal observations and against the scarcity of information, no information has come to either reinforce our knowledge about the Glossy Ibis or investigate the sustainability of its establishment and nesting on Tunisian territory. These tasks seem indispensable and obligatory for making suitable decisions for conservation measures in order to carry out the necessary action plans to preserve and protect the species in Tunisia. This work aims to clarify the new breeding status of the Glossy Ibis and to retrace its history by describing the past and the current situation of the species in Tunisia.

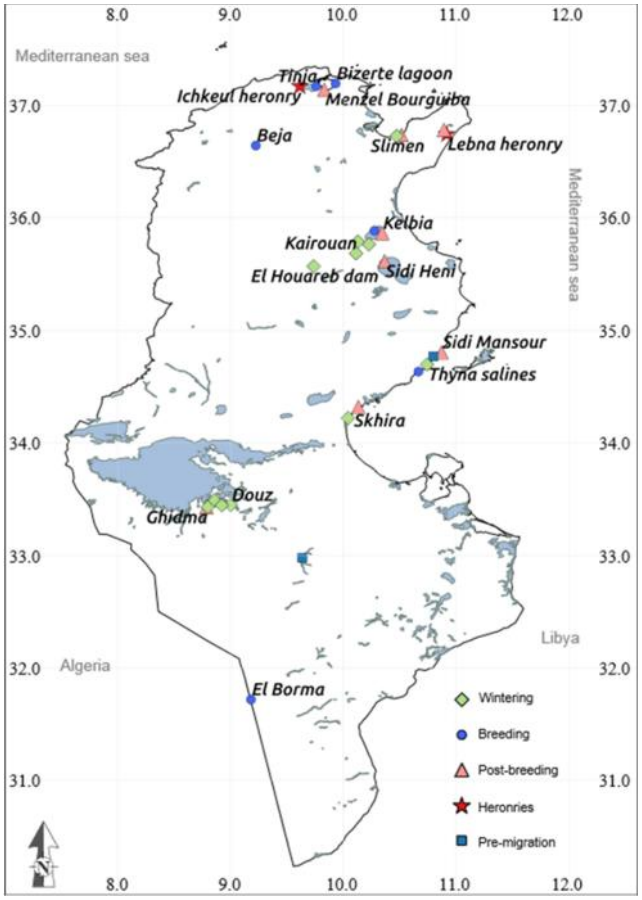
Study Area

The study concerned the Tunisian territory. Tunisia has an area of 164,150 km^2. It extends from north to south (750 km) over seven degrees of latitude (N 37° 20’ – N 30° 16’) and four degrees of longitude (E 7° 50’ – E 11° 30’) from west to east (400 km). All Tunisian IBAs (Important Birds Areas) cover 12,529 km^2, which represents about 13.1% of the national territory. Among these IBAs, 46 wetlands are distinguished, including the lagoon of the Ichkeul National Park and the Lebna dam reservoir, where the species has exclusively nested in Tunisia (Figure 1).

Methods

The development of this work was based on bibliographic data, our own observations (A. Nefla, pers. obs., 2008 to 2017) as well as the valuable observations of R. Ouni (from1987 to 2008) of surveying Tunisian wetlands and waterbirds including Glossy Ibis. In fact, bibliographic data used herein were collected from several observations made by 25 ornithologists and cover four phenological periods: Wintering (November-February), Pre-breeding passage (March-April), Breeding (May-July), and Post-breeding (August-October) (Appendix).

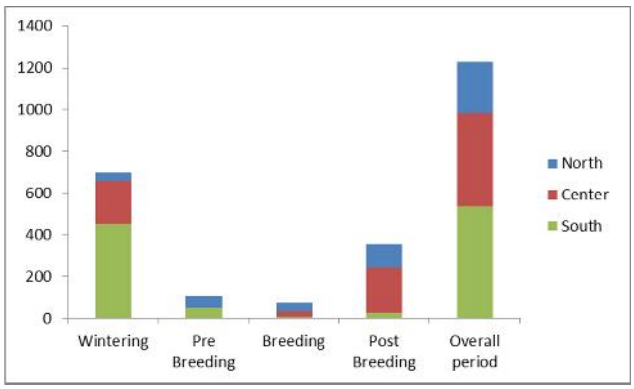
Figure 1.Map of Tunisia showing main recording sites and both nesting areas of Glossy Ibis in Tunisia during the four phonological periods (Wintering in green diamonds, Pre-Breeding in blue squares, Breeding in blue circles, and Post Breeding in pink triangles). Stars indicate Heronries



Results

The Glossy Ibis is always observed in the winter (56.74% of all observations) and during double passing (pre (8.61%) and postnuptial) with the postnuptial passage being the most prominent (28.78%). The majority of these observations are mentioned in southern Tunisia with 43.41% followed by recordings in central (36.66%) and northern (19.92%) parts of the country (Figure 2).

Figure 2. Numbers of Glossy Ibis specimens (Y axis) recorded over periods and geographic zones (X axis)



The Lowest percentage is recorded during the breeding period (5.85%) principally, in Lebna dam at Cap-Bon. Since the suspected breeding attempt in 1990 at the edge of a heronry at Kelbia/Sousse (Gaultier and Essetti in Isenmann *et al.* 2005) the nesting of the species on Tunisian territory is now proven for the first time in 2008 at Lebna in Cap Bon (Ouni *et al.* 2009; Nefla *et al.* 2012). Another nesting case with 4 pairs is observed in June 2014 at Ichkeul Lake (Nefla *et al.* 2014) (Table 1).

The only study that focused on reproduction of the Tunisian Glossy Ibis populations is conducted by Nefla *et al.* (2012). Currently the nesting populations of Glossy Ibis appear clearly unstable at both breeding sites. Indeed, at Ichkeul National Park the mixed heronry did not settle in 2017 as had not happened during last three decades, and the Glossy Ibis did not nest. However, the number of breeders continued strangely decreasing in Lebna from a one year to other until just a single couple was observed in 2017 (Table 1).

Table 1. Numbers of Glossy Ibis breeding pairs in the two mixed heronries from 2008 to 2017

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Lebna dam	8	18	3	3	2	3	3	2	2	1
Ichkeul N. Park	0	0	0	0	0	0	4	4	2	0

Discussion

Because of its vulnerability and conservation value, the Glossy Ibis is considered to be one of the most ecologically remarkable species, representing one of the six most widely distributed landbird species (Newton 2003). Glossy Ibis has always been regarded as wintering species in Tunisia which is why the majority of recordings of the species were done in the winter. However, breeding is first recorded at Lebna dam in Cap Bon in 2008, when nests are found in late Spring in a heronry, containing also Western Cattle Egret *Bubulcus ibis*, Squacco Heron *Ardeolaralloides* and Little Egret *Egrettagarzetta*. Since then the species became one of the Tunisian nesting birds. The reproductive performance recorded in recent studies indicates some environmental changes that promoted its installation. According to Nefla *et al.* 2012 the average clutch size over three years is 3.44 ± 0.73 eggs (N = 29 nests). Hatching success is 83%, with 2.86 ± 1.18 SD eggs hatched/nest and 2.65 ± 1.17 SD hatchlings/nest surviving until the age of 10 to 12 days. Also, egg mortality is 17% during the incubation phase and chick mortality is 7.2%. Currently, the situation of the breeding populations in Tunisia is serious and requires urgent action by conservation stakeholders by limiting illegal access and disturbances caused by fishermen and livestock near the heronry. Additionally, regular water releases from the six dams surrounding the Ichkeul lagoon should be scheduled. Thus, the number of breeding pairs has continuously decreased since the first nesting case. Tunisian wetlands are facing large challenges more than at any time in the past. The majority of sites are currently under threat from various sources such as drainage, urbanism and most likely from the prolonged drought that is considered to be the principal cause of instability, irregularity of reproduction, spatial dispersion and the decline of the species in Tunisian territory (Santoro *et al.* 2013). In fact, according toNefla *et al.* (2012), low levels of water in the Lebna dam open passages allowsentrance of predators and children of locals, causing huge disturbances to reach the bird nests and cause considerable loss in the number of nests, eggs and nestlings.

Future work

According to Underhill*et al.* (1999), ring recoveries point to nomadic movements of the Glossy Ibis. Due to the considerable tendency of their numbers to vary and their erratic occurrence, Glossy Ibis are not an easy species to monitor using regular waterbird counts (Taylor*et al.* 1999). We still don't know if any of the subjects occurring in Tunisia during any one of four phonological seasons conserved their migrant status or became residents.

In addition, determining eco-biological requirements for the sustainable establishment of breeding populations of Glossy Ibis in the Tunisian territory appear essential more than at any time in the past. Therefore, we propose to:

Investigate the effects of landscape and anthropic actions on the spatial and temporal distribution of Glossy Ibis;

Examine the effect of ecological factors, particularly parasite occurrence and pollutant bioaccumulation, on the reproductive success of the species;

Shed light on the influence of the availability and behaviour of prey in the feeding habits of the species, and

Carry out ringing missions in order to follow the dispersion of the Tunisian breeding population and to determine its origin.

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APPENDIX

References used in the study for each period

Wintering (November-February)	**Pre-breeding passage (March-April)**	**Breeding (May-July)**	**Post-breeding passage (August-October)**
HM, CM, OI, SP, VJ, BM, PC, CF, AH, MmL, DB, ML, OR, GTO, NA, DH, DA, AM	VG, KG, YP, FM, KY, SH, OR, GTO, NA	GTO, EI, GT, OR, NA, JB, DH, DA	MP, KY, AH, SM, GT, OR, GTO, NA, DA

AH: Azafzaf, H. in Isenmann et al. 2005; AM: Abdelli M.. pers. obs; BM: Bailo M. in Isenmann et al. 2005; CF: Christensen, F. in Isenmann et al. 2005; CMCezajkowski M. in Isenmann et al. 2005; DADabbar A.,pers. obs; DB Delpart B. in Isenmann et al. 2005; DH: H. Dlensi pers. obs ; EI Essetti I. in Isenmann et al. 2005; FM: Fay M. in Isenmann et al. 2005; GT : Gaultier T. in Isenmann et al. 2005; GTO: Group of Tunisian Ornithologists, pers. obs.; HM: Hemprich M. in Isenmann et al. 2005; JB: Jmaa B.,pers. obs.; KG: Knötzsch G. in Isenmann et al. 2005; KY: Kayser Y. in Isenmann et al. 2005; ML: Müller L. in Isenmann et al. 2005; MmL: Maumary L. in Isenmann et al. 2005; MP: Meininger P. in Isenmann et al. 2005; NA: Nefla A., pers. obs; OI: Olsen I. in Isenmann et al.2005; OR Ouni R., pers. obs.; PC: Parnell C. in Isenmann et al. 2005; SH: Spiekman et al. 1993; SM: Smart M. in Isenmann et al. 2005; SP: Svensson P. in Isenmann et al. 2005; VG:Vaillant G. in Isenmann et al. 2005; VJ: Van der Winden J. in Isenmann et al. 2005: YP: Yésou P. in Isenmann et al. 2005.

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The Breeding and Wintering of Glossy Ibis *Plegadis falcinellus* in Sardinia (Italy)

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ABSTRACT

Located in the centre of the western Mediterranean, the Island of Sardinia hosts a limited number of Glossy Ibises Plegadis falcinellus that are regularly spotted during migration and wintering but rarely during the breeding season. The first record of wintering ibises dates back to the 1982-1983 winter in the Gulf of Cagliari (south of the island). During the following years, the presence of wintering Glossy Ibises was regularly recorded with a maximum of 35 individuals. The first breeding record was documented in 1985 with five to six pairs in a mixed heronry, with Little Egret *Egretta garzetta* as the most abundant species, in the Stagno di Molentargius (Gulf of Cagliari). In the period between 1985 and 1993, the breeding of the Glossy Ibis has been regular but in low numbers in this site with a maximum of 12 pairs. Nonetheless, in the period between 1994–2013, the breeding has been occasional and away from this area with only one or two pairs. Finally, in recent years (2014–2018), the species has bred only in the Gulf of Oristano where it is apparently becoming a regular breeder in two sites (Arborea and Cabras) with a total population of maximum six to nine pairs. All of the breeding events took place within previously established colonies and, as it is common in the species, there are no records of monospecific colonies of Glossy Ibis in Sardinia

Introduction

Historically, in Sardinia the Glossy Ibis *Plegadis falcinellus* was considered as migratory and wintering species (Cara 1842; Lepori 1882; Arrigoni degli Oddi 1929). But the claims regarding the wintering, with no other evidence in the rest of Italy, was considered doubtful by other authoritative researchers (Salvadori 1864; Martorelli 1960). The first wintering records were ascertained in 1982 with a group of nine individuals in the Gulf of Cagliari. In 1985, in the same area in a mixed heronry 5-6 breeding pairs were discovered, representing the first breeding record of the Glossy Ibis in Sardinia (Grussu 1987). Subsequently the species was recorded as a regular migrant, regular wintering and irregular breeding species on the island (Grussu *et al.* 2000; Grussu 2001; 2003; Grussu and Sardinian Ornithological Group, pers. obs.). In this note I summarize and update the available data on the species in Sardinia, with particular attention to breeding and wintering status. If not expressly indicated, all the data shown are of the Author (i.e. pers. obs.).

Study Area

Set in the centre of the western Mediterranean, N 38° 51'-41° 15', E 8° 08'- 9° 50', Sardinia is about 200 km from Italy and North Africa (shortest straight distances), 400 Km from France and 500 Km from

the Iberian Peninsula. With an area of 24,088 square kilometres, it is the second largest island in the Mediterranean. Swamps and lagoons are frequent close to the coasts, especially in the south and in the Gulf of Oristano (West Sardinia), covering a total area of about 12,000 ha. The differing salt content of their waters, depending principally upon the waters flowing in from the streams and on sea water, gives rise to composite environments and causes the different distribution of botany and animal species. Overall the climate can be defined as warm-temperate and two-seasonal, with a succession of a warm dry period (summer) and a wet cold one (winter) separated by two intermediate seasons (autumn and spring). The average temperature in January is 10°C on the south west coasts and 6°C in the highest mountain areas of the interior (~1,800 m a.s.l.). Annual average rainfall is 500 mm on the southern coasts and 900 mm in the highest mountain areas of the interior, with historical peaks of 2,500-2,700 mm (Arrigoni 1968). The coasts and the south of the island are drier than the rest of the island owing to scarce rainfall, the long dry summer and the type of geological substratum.

Methods

Since the early 1980s the presence of the Glossy Ibis in Sardinia has been carefully monitored with each siting of the species being recorded and located on the map of the island. During the winter and the migration, the contingents, the habitats used by the species for feeding and the night roost were monitored. During the breeding period all the suitable areas were checked regularly to identify any breeding pairs and to evaluate the present population. Whenever possible, the breeding parameters, associated species and habitats used were detected for breeding pairs. In the period 1985-1993, a total of 30 nests were monitored with weekly checks in the Stagno di Molentargius (Gulf of Cagliari), analysing the measurements of eggs and nests, their position in the colonies and the reproductive success. I have measured the Glossy Ibis eggs using a Vernier caliber 0-150 mm with a 0.05 mm resolution. Further data on the parameters of reproduction were found, usually at a distance, in the area of the Sulcis and the Gulf of Oristano where the species was recorded as an irregular breeder in the period between 1998 and 2018.

Results

Wintering

The first wintering assessments, recorded in the winter 1982-83 in the Gulf of Cagliari, in the south of the island, was the first one to be regularly documented in Italy and in the whole Europe (Grussu 1987). Indeed, Cramp and Simmons (1977) highlighted the winter presence of the species in the South of Spain; but this record was referred to the occasional presence of one bird (A. R. Johnson, pers. comm. 1986). After these first regular winter presence, the wintering of the Glossy Ibis was found regularly during all winters on the island until today (Grussu 2001; Grussu and GOS 2017) with small groups in:
(i) the Gulf of Cagliari - regular in the 1982-2002 period and occasional (only one bird in winter 2012-2013) in the period 2003-2017 -,
(ii) the Gulf of Oristano (West of the island) - present almost every year since 2001 and onward - and,
(iii) occasionally elsewhere (e.g. Alghero/ North-West coast, 2013 year).

The maximum population size ever recorded has been 35 individuals (in 2005 and 2014) usually gathered in a single group, more rarely scattered (Figure 1). During the non-breeding season, the habitat utilized by the species is that of permanent or temporary coastal freshwaters wetlands, even with high organic pollution (swamps, lagoons, river mouths, irrigation channels and waste water of domestic or domestic activities) and rich in emerging vegetation with prevalence of *Phragmites australis*, *Juncus sp., Typha latifolia, Typha angustifolia* and *Carex sp.*.

Breeding

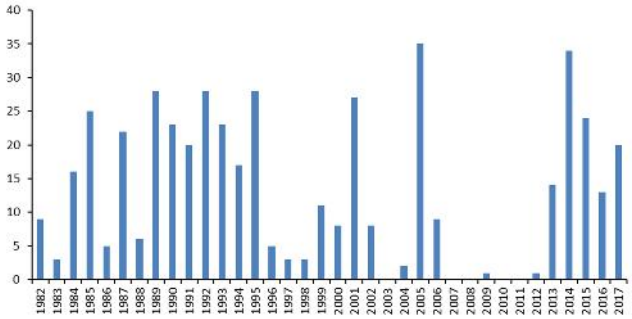
In the Gulf of Cagliari, after the uninterrupted presence of little groups during the non-breeding season since 1982, in 1985 the first breeding record of the species was recorded in the Stagno di

Molentargius. Five-six pairs were observed breeding in a mixed heronry with Little Egret *Egretta garzetta* (about 110 pairs), Western Cattle Egret *Bubulcus ibis* (one-two pairs, first breeding record in the whole Italy) and Squacco Heron *Ardeola ralloides* (two pairs, first breeding record in Sardinia) (Grussu and Secci 1985; Grussu 1987). In this site, the presence of Glossy Ibis breeding pairs was confirmed annually until 1993 with a variable number of pairs (three-twelve). Then, due anthropic disturbances, the population of the mixed-species colony moved to another site a few kilometres away, but the Glossy Ibis, despite being present during the breeding season and in the winter, has never been recorded as a breeding species in the Gulf of Cagliari (Grussu 1994;1998; pers. obs.). In 1998, one-two pairs bred in the Sulcis area (South - West Sardinia) in the inland barrage of Cixerri/ Siliqua; breeding took place in a mixed heronry with Black-crowned Night Heron *Nyctycorax nycticorax*, Little Egret, Western Cattle Egret and the Squacco Heron (Grussu 2000, pers. obs.).

After this last record, two breeding pairs were discovered in 2003 in a heronry of Little Egret and Western Cattle Egret in the Stagno di s'Ena Arrubia/ Arborea, in the Gulf of Oristano (Grussu 2003). The breeding on this site probably repeated again in 2014 with one-two pairs and certainly in 2017 and 2018 with five-seven pairs every year, always in association with the Little Egret and the Western Cattle Egret (pers. obs; G. Pinna, pers. comm.). Also, in the Gulf of Oristano the breeding was recorded in 2016 (at least two-three pairs) and probably also in 2017 and 2018 (some pairs) in a monospecific heronry of Purple Heron *Ardea purpurea* in the Stagno di Cabras.

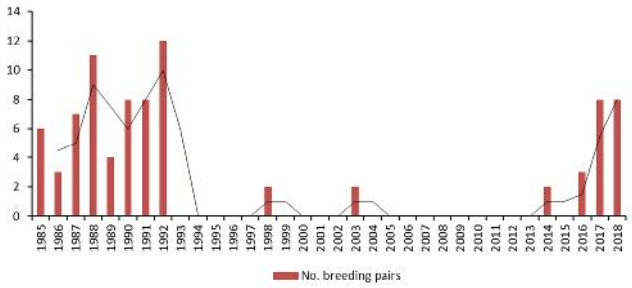
In summary, for the first nine years (1985-1993) the population (three-twelve pairs) remained localized in the first breeding site (Stagno di Molentargius, Gulf of Cagliari - South Sardinia). After the abandonment of the colony and until the 2014 year, the breeding was found only occasional and away from this area: in the Gulf of Oristano and in the Sulcis area (respectively South-West and West Sardinia).

Figure 1. Winter population size (maximum number of birds in the whole island in each winter) of Glossy Ibis in Sardinia, up to 2017. X axis shows year and Y number of Glossy Ibises



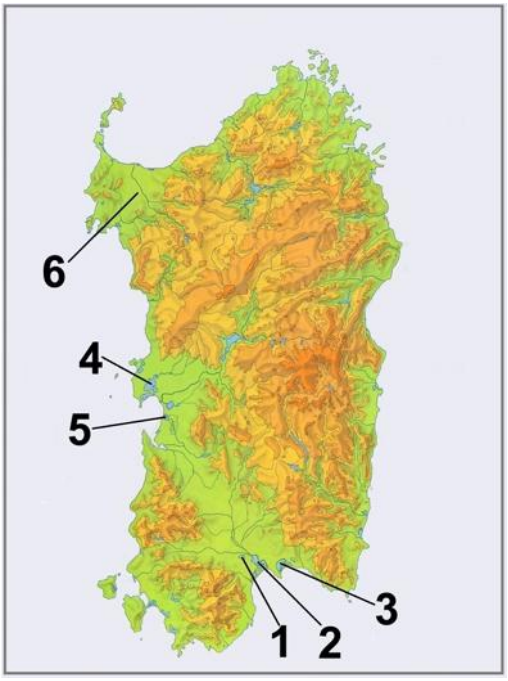
After 2014, the Glossy Ibis has been observed breeding only in the Gulf of Oristano where it is apparently becoming a regular breeder in some sites. In the period between 1985-2018 the breeding of the Glossy Ibis in Sardinia occurred 15 times with a maximum population of 12 pairs (1992); for nine years the breeding has been recorded in the Gulf of Cagliari, for five years in the Gulf of Oristano and one time in the south-eastern part of the Island (Figures 2, 3). All the breeding events took place within pre-existing heronries and there are no records of monospecific colonies of Glossy Ibis in Sardinia.

Figure 2. Breeding population size (maximum number of pairs in Y axis) of Glossy Ibis in Sardinia up to 2018 year. X axis shows year



Habitat

Figure 3. -Breeding and wintering wetlands of Glossy Ibis in Sardinia. Gulf of Cagliari: 1-Basin of Cixerri (breeding), 2-Stagno di Cagliari (wintering), 3-Stagno di Molentargius (breeding and wintering). Gulf of Oristano: 4-Stagno di Cabras (breeding and wintering), 5-Stagno di s'Ena Arrubia (breeding and wintering). North West coast: 6-Alghero area (wintering)



In the Stagno di Molentargius the breeding (1985-1993 period) occurred in a wetland of about 1,400 ha located in an urban context in the Gulf of Cagliari (South Sardinia). The heronry was located in an area with high organic pollution, with the nests built on the Common Reed *Phragmites australis* of 1-4 m height. The Stagno di Cabras is a lagoon of about 2,200 ha in the Sinis area, in the northern part of the Gulf of Oristano (West Sardinia). The breeding of the Glossy Ibis on this site (period 2016-2018) occurred on groups of Common Reed of 1-4 m height. The Stagno di s'Ena Arrubia (190 ha) is a lagoon in the central part of the Gulf of Oristano. The breeding conditions on this site (2003, 2014, 2017 and 2018) are extraordinary as the nests are built directly on the ground or on the vegetation, an islet covered with low shrubs of Salicornia *Halocnemum strobilaceum* and other *halophilous* vegetation.

Instead, in the Sulcis area, the breeding (1998) was discovered in the internal artificial basin of Cixerri, with the nests built on a semi-submerged forest of Eucalyptus *Eucalyptus sp.,* 10-15 m high.

Breeding parameters

In Sardinia, the first eggs were found in the third week of April (earlier date 21 April 1987); but they usually occur between mid to late May or the first days of June. The latest record corresponds to mid - June. However, on June 19th 1992, in the Gulf of Cagliari a nest was found still under construction, but unfortunately, it was not possible to verify the egg laying and/ or the breeding success (Grussu 1987, pers. obs.). In this heronry, groups of nests of Glossy Ibis (up to five together), were often built close together and egg laying was synchronized (Grussu 1987; 1994, pers. obs.).

In a total of 30 nests monitored in the Stagno di Molentargius, I recorded the following measurements:

(i) maximum diameter 28-50 cm,
(ii) internal cup diameter 15-29 cm,
(iii) depth cup 1.5-10.5 cm,
(iv) nest thickness 11-62 cm,
(v) distance of upper edge from the water 14-210 cm.

Although the nests are usually not in contact with water, in 1988 I found a nest built directly leaning on the water.

The size of brood is usually three-four (one-five) eggs, laid at 24 h intervals.

Out of a total of 37 complete broods controlled, 80% of these (n = 30) had 3-4 eggs and the rest of the broods with 2 or 5 eggs, with only one nest of a brood with single egg. Out of a total of 47 eggs checked in the Stagno di Molentargius (1985-1992) I recorded the following measurements:

(i) maximum diameter 53.0 (46.1-58.3, ± 2.48 SD) mm,
(ii) minimum diameter 37.2 (32.4-40.0, ± 1.77 SD) mm.

An accurate study on the reproduction has been made in the period between 1985-1992 in the colony of the Stagno di Molentargius. In a total of 15 nests of

which I have followed the whole reproductive cycle (egg laying, hatching and growth of juveniles), I was able to record the following parameters:
(i) eggs laid: 56 (average clutch size of 3.7/nest, ± 0.79 SD),
(ii) hatched eggs: 53 (hatching success of 94.6%, average brood size 3.53 pullus / nest, ± 0.74 SD),
(iii) juveniles reared 49 (survived success of 92.4%, average of 3.2 young / nest, ± 1.22 SD).
The egg mortality was 5.35% during the incubation phase, and chick mortality was of 7.54%. I verified the breeding success of 23 nests in total and I noticed a productivity of 3.0 juveniles / pair.

Discussion

Sardinia hosts a regular migrant and wintering population and irregular breeding population of the Glossy Ibis. Despite the limited population recorded during the winter period (max 35 individuals) and breeding (max 12 pairs in one site), this is an important percentage of the population of this species in the whole of Italy (Volponi 2019). The breeding of the species in Sardinia is also important for the whole Glossy Ibis population of the central Mediterranean where recently the breeding has only been recorded in Sicily (2-4 pairs in the early years of the century) (Corso 2005), in Tunisia (max 18 pairs, period 2008-2017) (Nefla 2019) and in Algeria (Nedjah *et al.* 2019). Of these records, only breeding in Algeria has been regular in the last few years and it involves an important number of pairs (up to 400 pairs in 2016 and an average of 250 pairs in the period 2013-2017; Nedjah *et al.* 2019). In Sardinia, the first historical breeding population, that of the Stagno di Molentargius, became extinct in 1993 due to heavy anthropic disturbances consequent to the realization of the Regional Natural Park. This caused the destruction of the whole heronry (hosting 700 pairs of three species of Ardeidae), which was at that time the most important in Sardinia. The sites recently utilized for the breeding of the Glossy Ibis in the Gulf of Cagliari and in the Gulf of Oristano are under legal protection and that of Stagno di Molentargius is within a Natural Regional Park. In both areas there are many mixed heronries which potentially attract Glossy Ibis breeding pairs. However, these areas are threatened by anthropogenic disturbance (fishing, hunting), fire of vegetation, water regime changes, etc. It is essential to encourage the regular breeding and therefore increase the still small population of the species for the protection of the Glossy Ibis in Sardinia. This aim can be achieved only by designing specific interventions of protection of the heronries by limiting the anthropic disturbance, restoring the in-situ habitats and by starting appropriate environmental management programs.

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The Glossy Ibis in Greece

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ABSTRACT

The Glossy Ibis *Plegadis falcinellus* is a well-known bird species in Greece since antiquity as evidenced by many ancient texts. In recent times, the species was initially confirmed nesting in 1960, in a colony consisting of approximately 1,000 pairs at Evros Delta, northeastern Greece and a few years later at three more wetlands. Its nesting population in Greece has been surveyed since 1985. Until 1990 it was recorded in at least three colonies with its nesting population presenting a negative trend ranging from 71 to 45 pairs. After 2003 its nesting population started increasing gradually reaching 639 pairs in 2017. During the same period its geographical nesting range expanded in eight colonies mostly in northern and western Greece. Glossy Ibis nests in reed beds, trees and bushes, in mixed colonies with ardeids, Great and Pygmy Cormorants (*Phalacrocorax carbo* and *Microcarbo pygmaeus*) and European Spoonbills *Platalea leucorodia*. Their colonies are situated at lakeshores, river deltas and freshwater marshes that are located in large, protected wetlands. Water pollution, as well as, degradation of wet meadows in certain wetlands are considered to be the main threats for the species. The recently recorded increase of the nesting population can probably be related to better surveillance and organized attempts for wetland management that takes place in Greece during the last decade, at least.

Introduction

The first known report of Glossy Ibis *Plegadis falcinellus* was written by the great Greek philosopher and zoologist Aristotle (384-322 BC). In his work "*Historia animalium*" (History of animals) he refers to two Ibises' species, black and white (presumably Glossy and African Sacred Ibis *Threskiornis aethiopicus*, respectively). Ibises were also known by the historian Herodotus (484-425 BC) who describes the "Black Ibis" and the Sacred Ibis, mentioning their presence in Egypt. Pausanias (110-180 AC), a Greek

geographer, also refers to Ibises in his work "*Arkadika*" describing the myth of Hercules and the Stymfalian birds (6th labour of Hercules according the myth) that took place at Stymphalis Lake in Peloponnese, southern Greece (see also Pollard 1977).

In more recent times, the Glossy Ibis was first confirmed breeding in Greece in 1960 when a colony of at least 2000 birds was found at Evros Delta (northeastern Greece). A few years later, three smaller colonies were found, two in northern Greece (Ismaris and Kerkini lakes with approximately 40 and 10 nests, respectively) and one in western Greece (Amvrakikos Gulf with approximately 150 nests). The total nesting population during the 1960s was estimated at 1,500-1,840 pairs (Handrinos and Akriotis 1997; del Hoyo *et al.* 1997). During the 1970s at least one more colony was established at Prespa Lakes (northwestern Greece). The total nesting population during 1971-1973 was estimated to be more than 1500 pairs in four colonies (at least 1100 pairs at Evros Delta and 400 pairs at Kerkini Lake, Handrinos and Akriotis 1997). In the late 1980s, more systematic research on heron and cormorant colonies was carried out in Greece. The distribution and the population of the nesting herons and of the associated colonial species is now much better understood. However, the Glossy Ibis is considered poorly studied in Greece since no specific research on the species has been carried out so far, apart from monitoring nesting populations and nesting site distribution.

The species is protected according to the EU Bird Directive and it is included in the "Red Data Book of animals in Greece" as "Critically endangered" (Legakis and Maragou 2009).

The aim of this article is to describe the current status of the Glossy Ibis in Greece, as well as the 1985-2017 trend of its breeding population.

Methods

The information included in the present article was obtained both from literature (for Amvrakikos Gulf up to 1990 and for Prespa Lakes) and from our direct or indirect counts of nests and estimates of the number of nesting pairs. The main heronries with Glossy Ibises have been systematically monitored (Kerkini Lake: yearly since 1988, Axios Delta: every 2-3 years, however, there are no data for the period 1991-2002, Prasoudi islet: yearly since 2011). The first national survey of heron colonies in Greece was carried out in 2003 and it was repeated in 2009 and 2014. In 2017, only the Glossy Ibis nesting population was monitored.

Survey of colonies

All wetlands that could potentially host heronries were visited during the breeding season (from late April until early June). When a colony was found, the following data were collected: a) the geographic location (coordinates) of the colony, b) the type of vegetation and the tree species that hosted the nests, and c) the number of active nests for each species (Yfantis and Kazantzidis 2004; Kazantzidis *et al.* 2013). In two cases (Volvi Lake and Axios Delta) the nesting population of Glossy Ibis could only be roughly estimated from the number of adult birds recorded at the feeding grounds around the colony, during May or June. We assumed that a single bird in the feeding grounds represented a nesting pair, and that the other member of the pair was incubating.

The nest abundance of each species was recorded during the chick rearing period of most nesting pairs (late May and early June, Kazantzidis *et al.* 2013). Usually, we counted the active nests from outside the colony, either from the ground or from boats or from high observation towers, using binoculars and telescopes. In the cases that the colony was inaccessible, e.g. located in a reedbed, we estimated the number of nests by tallying the birds departing for the feeding grounds. Starting before dawn, we counted the exiting birds for approximately one hour (Fasola *et al.* 2011; Kazantzidis *et al.* 2013). We assumed that two birds correspond to one nest. In certain mixed colonies with Glossy Ibises (Kerkini Lake, Axios Delta and Prasoudi islet) we counted all the active nests of each species entering the colonies in the morning (6 – 9 am).

Results

Population

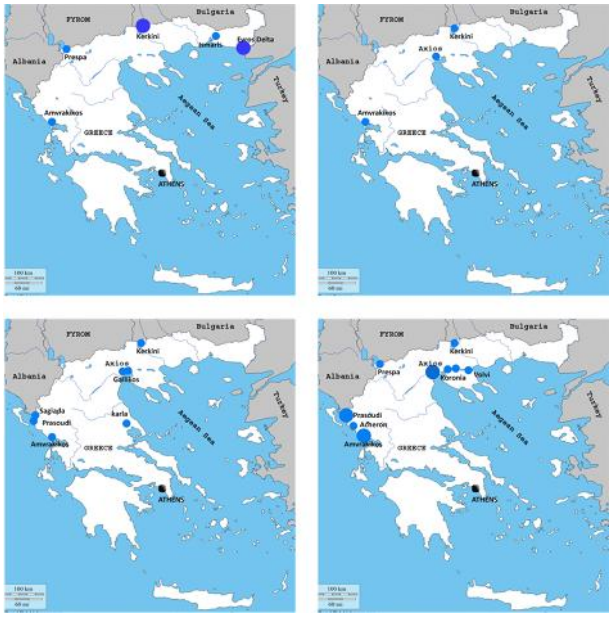
The situation of the colonies with Glossy Ibises during the 1980s, changed dramatically compared to the situation during the 1960s and the 1970s (Figure 1). Three colonies collapsed (Evros Delta, Ismaris and Prespa lakes) and a new one was established (Axios Delta). The breeding population of the species shrunk to barely 45-71 nests (Table 1). There are no data available for the 1990s regarding the total breeding population of the species.

In 2003, at least 95 nests of Glossy Ibis were counted in four colonies (Table 1, Figure 1). Six years later (2009), three more colonies were recorded and the number of nests increased to 116. In 2014 three colonies collapsed and three new colonies were established and the number of nests almost tripled reaching 373, the largest colonies being in western Greece (Table 1). During 2017, the number of nests had almost doubled from the previous count to 639 in eight colonies (one colony collapsed while two new colonies were established in northern Greece, Table 1, Figure 1).

Table 1 - Number of Glossy Ibises' pairs/nests in colonies recorded during the period 1985-2017 in Greece. (?: probably nesting, +: nesting with unknown population). * The count was carried out in 2016

Wetland/Year	1985-1986	1988	1989	1990	2003	2009	2014	2017
Kerkini Lake	60	10	14	15	5	4	41	45
Volvi Lake							16	11
Koronia Lake east								7
Koronia Lake west								8
Gallikos Delta					13	5		
Axios Delta	?	51	50	30		37	51	190
Acherontas River							5	
Sagiada marshes						4		
Prasoudi islet					22	15	120	191
Amvrakikos Gulf	+	+	+	+	55	43	135	187*
Karla Reservoir						8		
Prespa Lake							5	+
Total # of nests	**71**	**>61**	**>64**	**>45**	**95**	**116**	**373**	**639**

Figure 1. Distribution of colonies with Glossy Ibises in Greece (blue dots) during the 1960s and 1970s (upper left), 1980s (upper right), 2003-2009 (lower left) and 2014-2017 (lower right). Big dots: >120 nests of Glossy Ibis, small dots: <120 nests of Glossy Ibis



The distribution of colonies

Glossy Ibis, overall, have been recorded nesting in at least 14 sites (colonies) in 11 wetlands in Greece (all mentioned in Tables 1 and 2 and two more sites that were recorded in the 1960s, namely Evros Delta and Ismaris Lake). The distribution of Glossy Ibises' colonies was associated to the distribution of the largest wetlands and they were recorded mostly in eastern, northern and western Greece.

Characteristics of the breeding areas

The wetland types where the colonies were located are identified as: a) freshwater lakes, including two reservoirs; Kerkini and Karla, b) river deltas and c) river banks or marshes created along river banks (Table 2). In 2017 five out of eight colonies were around lakes. These colonies were small (7-45 nests of Glossy Ibis), totalling 71 nests (11% of the 2017 nesting population of Glossy Ibis in Greece). Two of the largest colonies were located in river deltas with 381 nests (60% of the total nesting population of Glossy Ibis in 2017, Table 2). At least two colonies

(one in 2017) were located along river banks. The three largest colonies in 2017 (88.9% of the breeding population in 2017) were in river deltas and on river banks. At least 66.7% of the breeding population in 2017 (in five colonies) nested in areas with rice fields (Table 2). All wetlands where the species was recorded nesting are protected areas (National Parks or Special Protected Ares).

Table 2. Characteristics of the wetlands with Glossy Ibises colonies in Greece. "Vegetation" refers to the vegetation type where the nests of Glossy Ibises were situated. "Rice fields" indicates the presence of rice fields around the colony that serves as feeding habitat for Glossy Ibises (Y=present). "% (2014)" indicates the percentage of Glossy Ibises' nests to the total number of nests of all nesting species in each colony in 2014

Wetland/Year	Wetland type	Vegetation	Ricefields	% (2014)
Kerkini Lake	Lake	Trees	Y	0.5
Volvi Lake	Lake	Reedbeds/Trees	-	1.7
Koronia Lake east	Lake	Reedbeds/Trees	-	
Koronia Lake west	Lake	Reedbeds/Trees	-	
Gallikos Delta	River/Marsh	Trees	Y	
Axios Delta	Delta	Trees	Y	5.8
Acherontas River	River	Trees	-	
Sagiada marshes	Marsh	Trees	Y	

Characteristics of the colonies

Glossy Ibis always nested in mixed colonies, with Ardeids, European Spoonbill *Platalea leucorodia*, Great Cormorant *Phalacrocorax carbo sinensis* and Pygmy Cormorant *Microcarbo pygmeus*. The number of other species associated with the Glossy Ibis ranged from 2 to 9 (mean 5.6 ± 2.1 SD species per colony not including the Glossy Ibis). Glossy Ibis nested always in colonies with Little Egret *Egretta garzetta* and in 81.3% of the cases with Squacco Heron *Ardeola ralloides*, Black-crowned Night Heron *Nycticorax nycticorax* and European Spoonbill (75.0%).

Glossy Ibis nests were placed on a) trees, mostly willows *Salix* spp., Tamarisks *Tamarix* spp. and Alder *Alnus glutinosa*, in five colonies with 235 nests or 36.8% of the nesting population in 2017; b) reed beds of *Phragmites australis*, two colonies with at least 187 nests or 29.3%; c) bushes of several plant species including wild olive trees *Olea* spp. (Prasoudi islet) and Tamarisks (Koronia Lake), three colonies with 191 nests or 29.9% of the population; d) mixed vegetation with reedbeds, trees and/or bush: three colonies at Koronia and Volvi Lakes with 26 nests or 4.0% (Table 2).

The proportion of Glossy Ibis nests on the total number of nests in mixed colonies ranged from 0.5% (Kerkini Lake) to 26.6% (Prasoudi islet, Table 2) in 2014.

Wintering and migrant population

Glossy Ibises overwinter in Greece only rarely (two birds at Kerkini Lake during winter 2017-2018). They are very common during spring migration with large flocks of 1000 birds recorded in coastal areas of western and eastern Greece (Handrinos and Akriotis 1997). On the other hand, Glossy Ibis is absent or very rare during the autumn migration period.

Threats

Since no systematic research has been conducted on the Glossy Ibis in Greece, we can only assume that pollution and marshland drainage threatened the wetlands in Greece during the 1980s and the 1990s (Tsiouris and Gerakis 1991; Zalidis and Mantzavelas 1994), probably affected many waterbird species including the Glossy Ibis.

Discussion

The period between 1960-2017 can be divided in 3 sub-periods. The first one, during the 1960s and 1970s, with high numbers of nesting Glossy Ibises. A second one in the 1980s and 1990s, when the nesting population almost collapsed (BirdLife International/European Bird Census Council 2000). Afterwards (after 2003), the nesting population recovered with a gradual range expansion.

During the 1960s and 1970s, the species was distributed mostly (75-100% of the breeding population) in northeastern Greece. During the 1980s the species abandoned the northeastern region and

established colonies in northern Greece (90-100% of the breeding population) and in western Greece (approximately 10%). In 2014 and 2017 the majority (60%) of the breeding population was recorded in western Greece and the rest in northern Greece. So, there is a gradual shift in the nesting population from northeastern Greece to northern and subsequently to western Greece.

The largest heron colonies are distributed in ecosystems with high diversity of feeding habitats e.g. deltaic ecosystems with freshwater marshes, saltmarshes and coastal area. Rice fields provide excellent feeding opportunities, and support the presence of several heronries that include Glossy Ibises (Kazantzidis *et al.* 2013; Mpoukas *et al.* 2017).

The absence of Glossy Ibises during the autumn migration agrees with the fact that the birds nesting at the northern coasts of the Black Sea migrate to western Africa crossing the northern Balkans to the Adriatic and Italy avoiding Greece (Schogolev 1996). Similar movements (loop migration) have been recorded for many shorebird species in Greece (Kazantzidis *et al.* 2009).

According to recoveries in Greece of birds ringed abroad, it seems that, the majority of Glossy Ibises come from Ukraine. However, the number of recovered birds is very small (four) (Akriotis and Handrinos 2004).

The increase of the nesting population of Glossy Ibis in Greece coincided with the restoration of certain wetlands and the establishment of management authorities at the main protected areas and National Parks including all areas with large heron colonies with Glossy Ibis. The legal protection framework and the proper management that resulted in the reduction of disturbance and illegal activities have provided the appropriate conditions for the population of Glossy Ibis to increase. Similar increases were recorded in some (but not all) conspecifics e.g. European Spoonbill, Great and Pygmy Cormorant, Squacco Heron etc. There are two examples related to the impact of restoration of Greek wetlands on birds: Karla Lake (Thessaly) and Koronia Lake (central Macedonia). Karla Lake was drained in the 1960s, and has been partially restored recently (Zalidis *et al.* 2004). Following the restoration of the lake, many waterbirds started nesting including herons, cormorants, pelicans and Glossy Ibises (2009). Koronia Lake was heavily polluted and drained during the 1990s due to water mismanagement. In 2015, following the outset of the restoration works, two heron colonies have been established where Glossy Ibises also nested.

Acknowledgements

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The Past, Present, and Future of Glossy Ibis in Australia

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ABSTRACT

The Glossy Ibis is one of three ibis species native to Australia. It is found throughout Australia utilising freshwater inland wetlands and sheltered marine habitats. The conservation status of the Glossy Ibis is Secure at the Australian federal level, and in each state other than Victoria where it is listed as Vulnerable. Observational data is relatively poor, and records of breeding are sparse. Similarly, there has been very limited targeted research on this species in Australia. With breeding primarily recorded in the Murray Darling Basin, Australia's most developed drainage basin, the future of Glossy Ibis is intricately linked with the management of wetlands and the impacts imposed by water resource development.

Introduction

Australia has three native species of ibis, the Straw-necked Ibis *Threskiornis spinicollis*, the Australian White Ibis *Threskiornis molluca* and the Glossy Ibis *Plegadis falcinellus*. The Glossy Ibis is the smallest of the three species with a body length 55-65 cm, wingspan 80-95 cm and weight ~500 g (Marchant and Higgins 1990).

In Australia, Glossy Ibis inhabit temporary freshwater inland wetlands and occasionally wet grasslands and sheltered marine habitats. Unlike Europe, where Glossy Ibis utilise artificial wetlands (Toral *et al.* 2012), Australian Glossy Ibis infrequently use artificial wetlands and impoundments (Marchant and Higgins 1990). They forage in shallow water over soft substrate or on grassy or muddy verges of wetlands, preferring those with a variety of water depths (Marchant and Higgins 1990; Taylor and Taylor 2015). Taylor and Shultz (2010) found that rice crops were important feeding areas during November and December in south-eastern Australia.

Glossy Ibis are a colonially nesting species, nesting in mixed species colonies with other ibis and spoonbills in inundated wetlands during October – March. Colonies are typically tens to hundreds of birds with the largest recorded single colony of 4000 nests in the Lachlan wetlands in 1984 (Marchant and Higgins 1990).

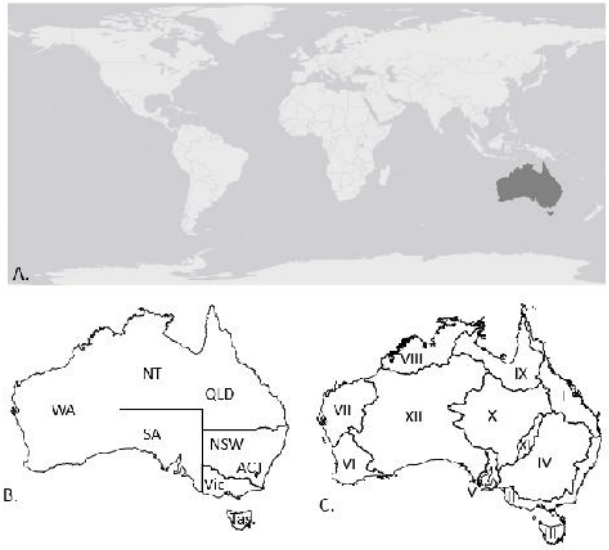
The conservation status of the Glossy Ibis is Secure at the Australian federal level, and in each state other than Victoria where it is listed as Vulnerable.

Study Area

Australia is an island continent and the world's sixth largest country by total area (7,692,024 km^2) (Figure 1A). Australia is divided into six states and two territories (Figure 1B) and twelve drainage basins (Figure 1C). It has over 33 million ha of wetlands (33,266,245 ha) including floodplains and swamps (55%), lakes (31%), estuarine wetlands (10%) and river and creeks (4%) (Bino *et al.* 2016). Australia

has identified 851 wetlands of national significance (DIWA 2001), and 64 Ramsar wetlands (Ramsar 2018), 27 of which have been nominated for their waterbird values (Criterion 5 and 6).

Figure 1. A) Map of the world with Australia highlighted in dark grey (source: Esri 2016), B) Australian states and territories, NSW – New South Wales, QLD – Queensland, Vic – Victoria, TAS – Tasmania, NT – Northern Territory, WA – Western Australia SA – South Australia, ACT – Australian Capital Territory, C) Australian river basins. I – North-east coast, II – South-east coast, III – Tasmania, IV – Murray Darling Basin, V – South Australian gulf, VI – South-west coast, VII – Indian Ocean, VIII – Timor Sea, X – Lake Eyre, XI – Buloo-Bancannia, XII – Western Plateau



Methods

A review of existing scientific literature, grey literature, historical records and databases was undertaken. Databases including the Global Biodiversity Information Facility (GBIF), Atlas of Living Australia (ALA), Aerial Survey of Waterbirds in Eastern Australia (EAWS), colonial waterbird breeding database (Brandis 2010) and the Australian Bird and Bat Banding Scheme (ABBBS).

One of the key contemporary data sources for Glossy Ibis in eastern Australia is the Aerial Survey of Waterbirds in Eastern Australia (EAWS). The EAWS is one of the spatially largest and longest running wildlife surveys in Australia and the world (Kingsford and Porter 2009). It was initiated in 1983 the by Commonwealth Scientific and Industrial Research Organisation (CSIRO) to assess the impact of hunting on wildfowl. The survey now focuses on censusing ~60 species of waterbirds and wetland condition. Data collected by the EAWS is used to track population trends for waterbird species and to measure the impacts of water resource development and water management policy. Surveys are conducted in October each year (1983-ongoing) and follow a fixed transect design with repeated counts of wetlands each year (Kingsford and Porter 2009).

Reproductive success data was collected during standard colony monitoring with fortnightly repeated visits to marked nests (Brandis *et al.* 2011). At each colony a sample of nest sites were randomly selected. Each nest site was numbered, and the geographic location recorded using a GPS. For each labelled nest the number of eggs or chicks was recorded. Glossy Ibis abundance was estimated at each colony site and nest establishment was monitored throughout the breeding periods. Phenology of breeding by identified by tracking egg and chick development using survey data. Mean clutch size for each colony.

Hatching rates were calculated for each colony. Data were categorised into three groups: egg, chick and nest. Success was determined for periods between surveys. For example, if at the end of each time period between surveys the nest contained eggs or chicks it was scored 1, if neither then 0. Data were further analysed based upon date of first survey of that site. All survey sites were initially sampled at egg stage. We used date of first survey as a surrogate for laying period.

Access to and around the colony sites was by small motorised boat or canoe. Monitoring of individual nests was done by a person standing in the water recording individual nest contents. Water quality and water depth were also recorded.

Results

A review of the scientific literature (Web of Science) found 64 peer reviewed publications, eight of which were Australian led publications with only two specifically on Glossy Ibis (Taylor and Taylor 2015,

Lowe 1983) and six including Glossy Ibis as part of a larger waterbird group (Morton *et al.* 1993; Kingsford and Johnson 1998; Kingsford and Auld 2005; Taylor and Shultz 2010; Brandis *et al.* 2011; Arthur *et al.* 2012).

The Global Biodiversity Information Facility reports 255,985 Glossy Ibis records (1798-2017). 10% of these records are from Australia (26,239).

The Past

Australia's indigenous people continue to have a relationship with Glossy Ibis ("Birndu"). Aboriginal people in the Northern Territory (Figure 1B) note that they observe Glossy Ibis in large flocks in the build up to the wet season and on the floodplains during the wet season. Glossy Ibis, straw-necked ibis and Australian white ibis are a source of food for aboriginal people (Mace, L. pers. comm.).

Glossy Ibis had been observed and recorded in Australia by European colonists. Initial records refer to foraging and roost sites in north-western Australia. The first record of breeding of Glossy Ibis was 1899, the three nests observed in the Lachlan district of New South Wales (Bailey 1934). In the following thirty years only three records of Glossy Ibis breeding were recorded, all within the Murray-Darling Basin (Figure 1C).

The Present

The Atlas of Living Australia has 29,130 observational records for Glossy Ibis (1770-2017) (ALA 2017) (Figure 2). This is in contrast to records for straw-necked ibis (N =215,106) and Australian white ibis (N =264,920) for the same time period.

Abundance and breeding data collected by the EAWS show low numbers of Glossy Ibis in any one year (mediaN =1000) with years with larger abundances coinciding with breeding years. Reasons for this may include the congregation of birds at survey sites for breeding during wet years when wetlands were inundated (Figure 3).

Figure 2. Glossy Ibis observations (N =26,130) in Australia 1770 – 2017 (source: Atlas of Living Australia)

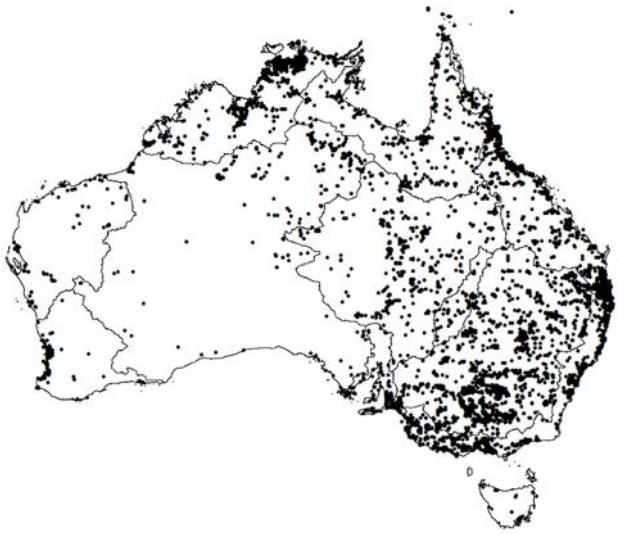
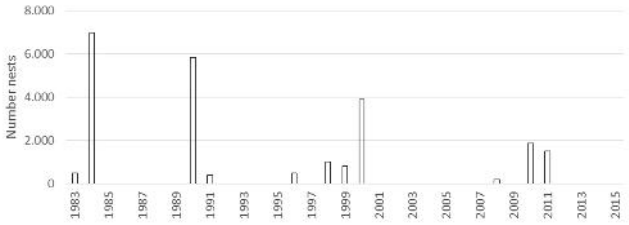
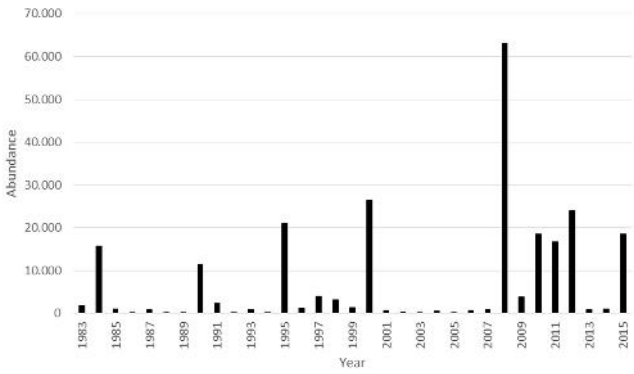


Figure 3. A) Total Glossy Ibis nest counts (1983-2015) and B) total abundance in eastern Australia (source: EAWS 2017). X axis shows year

A



B



Banding

There have been very few Glossy Ibis banded in Australia, 1,522 birds were banded with uniquely numbered metal bands between1960-2014. There have been no reported resightings and two recorded recoveries of deceased birds (1987, 2014) (ABBBS 2018). Australia does not currently have any colour banding programs for Glossy Ibis.

Breeding

Glossy Ibis have been recorded breeding in eastern, northern and western Australia, with the Murray Darling Basin being the stronghold (Figures 1C and 3). Glossy Ibis breed in mixed species colonies with other species of ibis, spoonbill, egrets and herons (Marchant and Higgins 1990, Brandis 2010). They nest in emergent vegetation (e.g. reeds, shrubs, trees) in inundated freshwater wetlands.

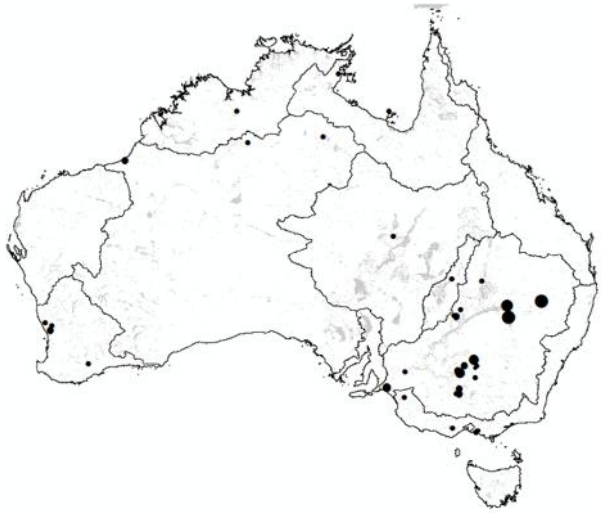
There have been four comprehensive studies that have measured reproductive success (Lowe 1983; Brandis 2010, 2012, 2017) (Table 1). Mean clutch sizes varied from 1.98 – 4.23 and nest success rates from 63 – 93%. Colonies with deeper water ~70-80 cm, had greater success rates that colonies with shallow water (<50cm) (Brandis *et al.* 2011; Brandis 2017). This was because shallower water allowed access to ground-based predators such as pigs and foxes which can cause significant mass mortality.

Table 1. Glossy Ibis breeding data, including sample size, mean clutch size (± SD) and nest success

Site	Year	Number nests monitored	Mean clutch size	Nest success rate
Lowbidgee wetlands[a]	1981	64	3.06 (0.41)	88%
Narran Lakes[b]	2008	13	1.98 (0.32)	63%
Lowbidgee wetlands[c]	2010	43 30 13	3.7 (0.96) 3.47 (0.77) 4.23 (0.96)	93%
Macquarie Marshes[d]	2016	95	2.9	69%

[a]Lowe 1983; [b]Brandis et al. 2011a; [c]Brandis et al. 2011b; [d]Brandis 2017.

Figure 4. Records of breeding colonies for Glossy Ibis in Australia. Circle scaled with reference to the number of colonies recorded at the wetland (1-9), grey shading shows wetland areas, boundaries represent river basins (See Figure 1C)



The Future

Australia's wetlands are under are under pressure from numerous threats including agriculture, urbanisation, pollution, water resource development and the building of dams. It is estimated that more than 50% of Australian wetlands have been lost in the past 230 years since European settlement, to a range of land uses, water regulation and drainage (Finlayson and Rea 1999). The large scale and wide spread loss of wetlands has contributed to the long-term declines in waterbird populations. The EAWS surveys have shown a continued decline in Australia's waterbirds.

Wetland types most used by Glossy Ibis, vegetated floodplain wetlands and swamps are most under threat from water resource development, including damming of rivers resulting in altered flow and flooding regimes. This often means that floods are smaller, irregular and aseasonal. Reduced river flows and flooding to wetlands during the right time of year reduce the opportunities for breeding by colonial wading birds (Brandis *et al.* in review).

Due to the types of wetlands that colonial wading birds, including Glossy Ibis, use for breeding i.e. temporary freshwater floodplain wetlands, breeding tends to be opportunistic rather than seasonal. For colonial wading birds to reproduce successfully,

flooding is required for a minimum of five to six months (140-168 days) (Leslie 2001; Briggs and Thornton 1998, Brandis *et al.* 2011). Breeding habitat suitability is determined by a number of factors including; flow volume, duration of inundation, seasonal timing of flows, nesting habitat availability, and sufficient food resources. Area of inundation and water depth at wetlands where colonial waterbirds breed is primarily determined by total flow volume (Kingsford and Thomas 1995; Ren *et al.* 2009). For many species of colonial wading birds (e.g. ibis, spoonbills, egrets, herons), nests need to be surrounded by water (Carrick 1962; Bancroft 2002). If flow volumes are not sufficiently large to provide long term nesting habitat, breeding may be initiated but reproductive success compromised (Leslie 2001; Frederick 2009). Reductions in flow can drop water levels, reducing the duration of flooding and triggering desertion by adult birds with high chick mortality, particularly in ibis (McCosker 1996; Scott 1997; Kingsford 1998; Brandis *et al.* 2011).

Due to the specific water requirements needed for successful breeding, Australia's ibis species have developed a breeding strategy that includes a short breeding cycle. The Glossy Ibis is the fastest of the three ibis species with a total nesting period of ~46 days (incubation and chick rearing) with a further 21 days of post-fledging care. Straw-necked ibis and Australian white ibis take ~47 days (+14 days post-fledgling care) and ~61 days (+21 days post-fledgling care) respectively (Brandis and Bino 2016). This allows these species to respond quickly and raise chicks in a short-time period to take advantage of suitable conditions when they occur.

The future for Glossy Ibis in Australia is intricately tied to the future of Australian wetlands. The Murray-Darling Basin, the key breeding area for ibis (Figure 3), is the most intensively water managed area of Australia and subsequently many wetlands have been impacted. To alleviate some impacts Australia has a water management tool known as environmental flows. Environmental flows are a portion of the total water held in dams allocated solely for the environment and achieving environmental outcomes. For example, the delivery of environmental water to many wetland sites in the Murray Darling Basin identify straw-necked ibis as a target species. In practice, this means that management targets are set to achieve or support breeding by straw-necked ibis. The delivery of water to achieve these targets also benefits Glossy Ibis. With a shorter nesting period than straw-necked ibis, Glossy Ibis can benefit from water management plans targeting straw-necked ibis.

Discussion

There has been limited research on Glossy Ibis in Australia resulting in a scarcity of data and knowledge gaps including population and sub-population movements within and outside of Australia, comprehensive breeding ecology and basic life history knowledge. Glossy Ibis have not been identified as a species of concern or particular research interest by state or federal governments, so it is unlikely that this situation will change in the near future. However, Glossy Ibis will continue to be monitored in conjunction with other wading bird species as part of EAWS and colony monitoring programs.

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Ecology and Conservation of Glossy Ibis in Algeria: Synthesis and Perspectives

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ABSTRACT

A review of ongoing projects focusing on the Glossy Ibis Plegadis falcinellus and carried out by the *Laboratoire de Conservation des Zones Humides* since 2002 is presented. A brief description of these projects (population counts, breeding ecology, foraging behaviour, niche partitioning, diet, dispersal, morphometric sexing, parasitology and conservation) and constraints hindering these efforts are provided and discussed. These projects have benefitted from a fruitful collaboration with Doñana Biological Station and it is expected that the recently created International Glossy Ibis Network may facilitate further collaboration that will ultimately help the conservation of the species across its breeding range.

Introduction

After an eclipse which lasted over a century, the Glossy Ibis *Plegadis falcinellus* has staged a remarkable return to Algeria (Belhadj et al. 2007; Boucheker et al. 2009), the rest of North Africa (Amezian et al. 2012; Nefla et al. 2012) and Western Europe (Brichetti 1986; Grussu 1987; Figuerola et al. 2004; Kayser et al. 2006) as a breeding species. The species is now mainly located in northeastern Algeria: The El Kala wetlands complex and environs in Eastern Numidia (Samraoui and Samraoui 2008) and Lake Fetzara and the Guerbes-Senhadja wetlands complex in Western Numidia (Samraoui and de Bélair 1997).

The Algerian population, like its counterparts across southern Europe (Santoro et al. 2010, 2013, 2016) is undergoing a rapid growth and is expanding. However, the reasons why the Glossy Ibis disappeared in the last century from its former haunts in the Western Mediterranean are still unclear although anthropogenic pressures involving loss of habitats and persecution are likely candidates (Santoro et al. 2010; Samraoui et al. 2011).

There is also no indication how it managed to stage a spectacular come-back. The unexpected return of the species offers a stimulating but formidable challenge to ornithologists to uncover the ecological determinants behind such a population upswing. At the turn of the 21st century and in the early stages of the recolonization process, the Laboratoire de Recherche des Zones Humides, University of Annaba, now known as the Laboratoire de Conservation des Zones Humides, University of Guelma, set up a long-term research project to investigate the population dynamics of the species. As early as 2008, the project benefitted from a close and fruitful collaboration with the laboratory of Dr. Jordi

Figuerola (Doñana Biological Station, Spain).

Study Area

Northeastern Algeria houses a large spectrum of wetlands (freshwater lakes, ponds, brackish marshes, lagoons and temporary pools) that owe their origin to a combination of climatological and lithological factors. The climate is humid to sub-humid whereas the landscape is made up of low-relief plains contrasting with numerous hills and mountains.

The El Kala National Park (PNEK) includes two freshwater lakes, Lake Tonga and Lake Oubeira, and a lagoon, Lake Mellah, which are all protected by the Ramsar Convention (Samraoui and Samraoui 2008). Further west, but still in Eastern Numidia, lay the vast Mekhada Marsh (15,000 ha). More wetlands are present in Western Numidia which houses Lake Fetzara, another vast brackish marsh, and the Guerbes-Senhadja wetlands complex (Samraoui and de Bélair 1997).

Figure 1. Location of the ringing stations of Glossy Ibis in Numidia (black circles), northeast Algeria (2008-2017)

Results: Ongoing projects

A brief description of current projects is provided as preliminary results of our research on the Glossy Ibis, highlighting progress but also constraints:

1. Population counts: Despite the difficulties (lack of manpower and resources to monitor such a vast region) we attempted to monitor population growth by means of winter and breeding pair counts. Although the species can also be found at El Goléa, in the Sahara, we only carry out regular surveys in Numidia, northeastern Algeria (Figure 1). For logistic reasons, surveys at El Goléa are irregularly undertaken. Preliminary analyses indicate a rapid population growth of the Glossy Ibis in northeastern Algeria.

Breeding ecology

In Numidia, the Glossy Ibis breeds in mixed heron colonies together with Purple Heron *Ardea purpurea*, Grey Heron *Ardea cinerea*, Western Cattle Egret *Ardea ibis*, Little Egret *Egretta garzetta*, Squacco Heron *Ardeola ralloides*, and Black-crowned Night Heron *Nycticorax nycticorax*. The reproductive ecology of the Glossy Ibis was studied between 2002 and 2012 (Boucheker *et al.* 2009). Egg-laying occurs from mid-April to the end of June. Mean clutch size for three combined years (2004, 2005 and 2007) was 3.7 ± 0.7 eggs (N = 49) (Boucheker *et al.* 2009). The study of the reproductive ecology of the Glossy Ibis was discontinued after it was found that breeding pairs exhibit extreme shyness (similar to Purple Heron *Ardea purpurea*) towards human intrusion. In a mixed heron breeding colony where competition for nest material is high, Glossy Ibis are the last to return to their nests, spending considerable time flying over the colony well after pairs of other species have resumed their incubation. Although the species appears to be extremely sensitive to human disturbance, it manages to breed in peri-urban sites like Chatt and Boussedra.

3. Foraging behaviour: A comparative study of the foraging behaviour of herons and ibis was undertaken in parallel with a study of their diet.

4. Niche partitioning: An investigation of nest-site selection and resource partitioning between Glossy Ibis and herons was carried out suggesting a high degree of overlap. However, the resource utilization suggests a pattern of resource segregation by coexisting nesting herons and ibis based on the timing of reproduction, nest height, prey types, prey size and foraging microhabitats (Samraoui *et al.* 2012; in prep.).

5. Diet: A study of the chicks' diet was carried out in the years 2004, 2005 and 2007. The analysis indicated that the diet was dominated by vertebrates (the frog *Rana saharica*) and invertebrates (dragonfly larvae, water beetles, and freshwater snails).

6. Dispersal: Starting in 2008, a ringing program was initiated with rings provided by the Doñana Biological Station. This program, still ongoing, has been running uninterrupted over the last ten years (2008-2017) and a total of 1027 chicks have been ringed (Table 1). A monitoring program of ringed birds has been active throughout this period providing data that shed light on dispersal of native and foreign birds.

Table 1. Number of Darvic rings fitted to Glossy Ibis chicks between 2008 and 2017 in northeastern Algeria

Year/Sites	Chatt	Dakhla	Fetzara	Tonga	Boussedra	Estah	Total
2008	41	0	26	4	0	0	71
2009	0	58	0	0	0	0	58
2010	96	0	156	0	0	0	252
2011	0	55	0	0	0	0	55
2012	0	103	9	0	0	0	112
2013	74	0	0	0	0	0	74
2014	0	61	0	0	0	0	61
2015	0	66	42	0	0	0	108
2016	9	0	0	0	115	29	153
2017	83	0	0	0	0	0	83
Total	303	343	233	4	115	29	1027

7. Morphometric sexing: We have relied on molecular techniques carried out at the Doñana Biological Station to sex ringed chicks. However, these methods are time-consuming and costly (Childress *et al.* 2005). Two Discriminant Function Analyses (DFA) were developed for Glossy Ibis chicks born in Doñana (Figuerola *et al.* 2006) indicating substantial predictive value for tarsus length (or tarsus width) and, to a lesser extent, wing length. However, the validity of these two functions outside of Spain has not yet been verified. We have initiated a project to (1) identify which morphometric covariates help to predict the sex of Glossy Ibis chicks, (2) ascertain whether there is geographical variation in the morphology of Glossy Ibis, and (3) evaluate different classification methods that best achieve the first two objectives.

8. Parasitology: In order to explore the impact of parasites on population dynamics and survival, we investigated the taxonomical diversity and spatial distribution of ectoparasites of Glossy Ibis chicks. The following chewing lice (*Phthiraptera: Amblycera, Ischnocera*) were recorded: *Plegadiphilus plegadis, Colpocephalum leptopygos, Ardeicola rhaphidius* and *Ibidoecus bisignatus*. In addition, one tick, *Ixodes ricinus* was also recorded (Touati *et al.* 2015).

9. Conservation: Although the species is formally protected, its future is far from secure as its habitats are under severe anthropogenic pressures. An unexpected side-effect of the ringing program was the discovery that the Glossy Ibis is a victim of illegal hunting. Many rings were recovered from poachers and one of the rings was even handed out with an incrusted shotgun pellet. The identification of current pressures as well as a good understanding of the species' ecological requirements and population dynamics at the metapopulation level will undoubtedly help to develop efficient management tools.

Conclusions

This was a concise review of ongoing and published research being carried out at the *Laboratoire de Conservation des Zones Humides*, University of Guelma in collaboration with the Doñana Biological Station. Conservation has much to gain from the study of a species that had exhibited a dramatic reversal in its population growth. However, the species still faces increasing anthropogenic pressures over much of its North African range where its habitats are shrinking. It is expected that global warming will exacerbate this looming threat as drought becomes more frequent. The species has shown fast responses to past environmental changes (Santoro *et al.* 2016) and it may prove a fitting biological model to monitor how species may respond to current global changes. Another constraint is the lack of funding that limits severely both the quality and the range of research that can be carried out. This is where a vigorous International and well-established Glossy Ibis Network can mitigate such drawbacks and offers new avenues of fruitful collaboration.

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Glossy Ibis *Plegadis falcinellus* in Serbia and Neighbouring Balkan Countries

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ABSTRACT

This paper discusses the distribution and population of Glossy Ibis in Serbia and neighbouring countries in the Balkan Peninsula: Bosnia and Herzegovina, Montenegro and North Macedonia. Literature and unpublished data have been used, especially the information concerning breeding of this species in the above referenced countries. The last cases of breeding, as well as the last date of appearance of individuals have been also stressed, and the dynamics of the breeding population in Serbia for the period between 1963-2017 has been presented. Temporal and spatial dynamics of the breeding population, population trends, threats and executed active conservation measures were analysed.

Introduction

This paper discusses the distribution and population of the Glossy Ibis in Serbia and neighbouring countries in the Balkan Peninsula: Bosnia and Herzegovina, Montenegro and North Macedonia. Literature and unpublished data have been used, especially concerning the information related to breeding of this species within these countries. The last cases of breeding, as well as the last data of appearance of individuals have been also stressed, and for Serbia, breeding dynamics for the period between 1963 and2017 are presented. Temporal and spatial dynamics of the breeding population, population trends, threats and executed active conservation measures were analysed.

Study Area

Study area covers four Balkan countries: Serbia, Bosnia and Herzegovina, Montenegro and North Macedonia. Their total area is 179,015 km^2. Suitable habitats for Glossy Ibis breeding and migration exist in each of them. In recent times these habitats are predominantly located in the north Pannonian part of Serbia (Vojvodina Province), north Bosnia (Posavina Region), south Herzegovina (Neretva River Basin), south Montenegro (Skadar Lake, Ulcinj and Tivat Regions) as well as in south North Macedonia (Ohrid and Prespa Lakes, Pelagonia Valley, Lower Vardar River Valley).

Methods

Published literature, unpublished data from the authors and their contributors, as well as the data from museums and other collections have been used in this overview. For the purpose of developing the survey, we reviewed all available literature and unpublished accessible reports, personal observations and/or communication. Where appropriate, the last cases of breeding, single cases of breeding or the last observations were reported. The paper summarizes temporal and spatial breeding population dynamics in particular countries, trends, threats and protection measures implemented so far.

Results

Serbia

First published observation of Glossy Ibis comes from the late 17th century and originates from Danube region in Vojvodina (Vasić and Džukić 1977). Reports were numerous during the 19th and the first half of 20th century, especially along the Sava River, in Obedska Bara and Zasavica (Šćiban *et al.* 2015). According to Landbeck (1843), in first half of 19th century, it was a common nesting species, mainly in wetlands along the Sava River, mostly within the vicinity of Obedska Bara, where around 1,000 pairs bred. Lobenstein (1840) reported a large colony on the island near Belgrade. The maximal estimated numbers on Obedska Bara was 4,500 pairs in 1869, however the species no longer used that site for breeding at the beginning of 1960s (Puzović 1998). In the following decades, until the 1910s, Glossy Ibis was observed at several locations throughout Vojvodina, while breeding was recorded in the vicinity of Titel, Novi Sad, Kovin, Opovo, in Pančevački Rit near Besni Fok, Zemun and Fenečka Bara (Schenk 1918; Šćiban *et al.* 2015). At the beginning of the 20th century, the species was exceptionally numerous along the Sava River in particular, until it gradually disappeared during following decades (Matvejev 1950; Puzović *et al.* 1999). A large colony existed in Interwar period in Novosadski Rit (20-600 pairs; large fluctuation, Marčetić 1955). Known breeding sites in Serbia south of the Sava and Danube were in the Negotinska Krajina region in East Serbia (Rašković 1905), at Makiš near Belgrade - large flocks in 1900 (Rajzer 1904), Krupačko Blato near Pirot - 25 pairs in 1947 (Matvejev 1950) and in Zasavica (max. 250 pairs, Dombrowski 1895). Dombrowski (1891) mentioned that in 1890 a certain number was recorded in Kumanački Rit (Braničevo Region), however he failed to establish whether it nested.

In the second half of the 20th century the Glossy Ibis has become a scarce and irregular breeder in Banat and Bačka (near Uzdin in 1951, in Carska Bara 1950-1960s, near Čurug, 1943) and in Obedska Bara (Antal *et al.* 1971; Pelle *et al.* 1977; Garovnikov 2006; Šoti and Dimitrijević 1974; Ham 1975). Marčetić (1955, 1957) mentioned large fluctuations in the numbers from year to year in mid-20th century. There were no breeding records in Serbia between 1963 and 1985, except the period between 1963-65 and 1969, when one or two pairs bred in Carska Bara. After that, one pair has bred in 1986 in Dubovački Rit for the first time. The only periodical breeding site between 1986 and 2002 in Serbia was Dubovački Rit, wetland complex on the Danube in South Banat. Another nesting site in 1998 was Jazovo Fishpond in northern Banat, where this species has nested only once (four pairs). An increase in the number of pairs was recorded starting from 1996. In the period between 2003 and 2007 number of pairs fluctuated between 2 and 5, and Sutjeska Fishpond was identified as a new breeding site (Ham 2007).

Table 1. Estimated number of breeding pairs of Glossy Ibis in Serbia between 1963 and 2017

Year/Period	Breeding site	Number of breeding pairsin Serbia
1963-1965	Carska Bara: 1-2	1-2
1966-1968		0
1969	Carska Bara: 1	1
1970-1985		0
1986	Dubovački Rit: 1	1
1987-1989		0
1990	Dubovački Rit: 3	3
1991	Dubovački Rit: 5	5
1992-1995		0
1996-1997	Dubovački Rit: 5-11	5-11
1998	Jazovo Fishpond: 4; Dubovački Rit: 3-5	7-9
1999-2002	Dubovački Rit: 0-1?	0-1
2003	Potamišje: 2-4; Dubovački Rit: 0-1?	2-5
2004	Jazovo Fishpond: 0-1; Potamišje: 2-3	2-4
2005	Potamišje: 2-5	2-5
2006	Potamišje - Sutjeska Fishpond: 3	3
2007	Potamišje - Slatina: 2-6	2-6
2008	Potamišje - Slatina: 2-5, Sutjeska Fishpond: 6; Dubovački Rit: 2-5	10-16
2009	Potamišje - Slatina: 10-12	10-12
2010	Potamišje - Slatina: 15-20	15-20
2011	Potamišje - Slatina: 7-10	7-10
2012	Potamišje - Slatina: 9-10; Bečej Fishpond: 0-1	9-11
2013	Potamišje - Slatina (Jer): 4; Dubovački Rit: 5	9
2014-2015		0
2016	Potamišje - Slatina: 1; Obedska Bara: 4	5
2017	Potamišje - Slatina: 4; Obedska Bara: 4	8

During the period between 2008 and 2013 it was a rare breeder only in Vojvodina Province, in only one or two colonies annually. It bred in Dubovački Rit and on Sutjeska Fishpond at the beginning of that period (Ham *et al.* 2008). At the same time, Glossy

Ibis started to breed in a floodplain along the river Tamiš (Szymanski *et al.* 2007; Ham 2007; Ham and Tucakov 2010; Tucakov 2011, 2013) and continues to do so up to today, with exception of 2013 and maybe 2015. However, in 2013 a colony in Dubovački Rit was recolonized and after that again vacated. It possibly bred on Bečej Fishpond in 2012, (Balog and Šćiban 2012). In 2016-2017, breeding colonies in Serbia existed only at Obedska Bara and along the Tamiš.

Glossy Ibis has CR (Critically Endangered) breeding population status in Serbia (Tucakov and Puzović 2018). Short-term (2000-2013) and long term (1980-2013) trends are fluctuating. According to Puzović *et al.* (2015), non-breeding population status in Serbia is EN (Endangered). Migrating populations were estimated at less than 250 mature individuals in the last three generations (20 years).

Non-breeding period: outside of the breeding season the Glossy Ibis was occasionally recorded at lakes, ponds, wet pastures and rivers throughout Serbia, even on karst poljes of Pešter Plateau, above 1,150 m a. s. l. (12 individuals on 11 April 2012; 1 individual on 23 August 2015; 10 individuals on 1 May 2016; 26 individuals on 31 July 2016; 10 individuals on 10 August 2016; 19 individuals on 15 August 2016 and 2 individuals on 30 April 2018 (Vučković 2012; Puzović et al., 2019), and Vlasina Plateau, above 1,200 m a. s. l. (1 individual on 9 April 2006; 2 individuals on 16 April 2006; Kulić 2009).

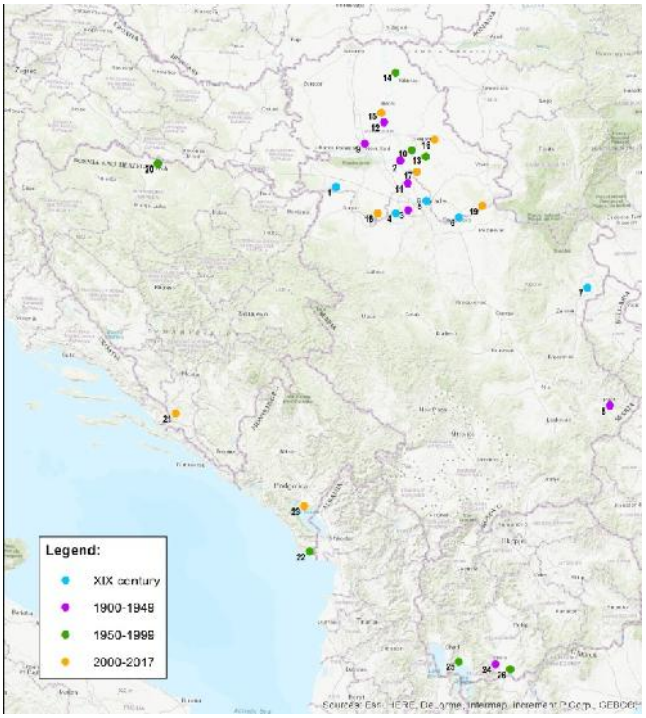
Habitats used by this species in Serbia include: pastures, natural grasslands, inland wetlands, and water bodies. It prefers spacious, shallow marshes, ponds, fishponds, mud banks and wet meadows. Occasionally it appears at wastewater treatment pools of sugar factories and livestock farms. Outside of the breeding season, Glossy Ibis occupies shallow muddy water of ponds, rivers, reservoirs and fishponds (Tucakov and Puzović 2018).

There are numbers of threats in Serbia that affect this species periodically or permanently. Some of them include: disappearance of appropriate nesting and feeding areas due to draining of marshes and other wetland habitats; regulation of rivers and decrease in the size of flooding zones, as well as large-scale land development with the goal of obtaining new arable land; demise of carp fishponds with extensive production leading to a decrease in food base; overgrowth of open aquatic habitats with thick tree and shrub vegetation due to changes in water level or land use; burning of reed beds and other aquatic vegetation in breeding areas during the reproductive period; poaching for taxidermy or as accidental kills, as well as disturbance to birds in nesting and foraging areas and establishment of poplar and willow plantations in open wet meadows important for foraging (Tucakov and Puzović, 2018)

Depending on the number and distribution of colonies in a particular year, sometimes the entire population is breeding within the protected areas (for example in 2016 in Deliblatska Peščara and Obedska Bara, both Special Nature Reserves), while in other years all pairs are outside of protected areas (Tamiš Floodplain, Bečej Fishpond, Fishpond near Jazovo). Tamiš Floodplain is already proposed for protection as Potamišje Protected Landscape. Most (90%) of areas where this species occasionally breeds, or is recorded during migration and dispersal, are in Important Bird Areas, situated within the ecological network and Emerald Network (Tucakov and Puzović 2018).

There are several proposed and implemented conservation measures: conservation of wetlands which are necessary for reproduction and open wetlands for foraging; regular mowing of vegetation on wet meadows and periodical removal of vegetation from shallow ponds; banning of any forestation of open wetlands with poplar and willow plantations, especially in important areas such as Tamiš and Sava river floodplains; supporting semi-intensive production on carp fishponds; careful planning of hunting of aquatic birds and suppressing poaching, particularly on fishponds and other habitats used in migration period; decreasing disturbances to birds in breeding sites, through managing visitations to protected and other areas; prevention of any burning of emergent and shrub vegetation at breeding sites in reproductive period.

Figure 1. Confirmed breeding sites of Glossy Ibis in Serbia, Bosnia and Herzegovina, Montenegro and FYR of Macedonia.



Legend: 1. Zasavica, 2. Titelski Rit, 3. Makiški Rit, 4. Fenečka Bara, 5. Dunav island near Belgrade, 6. Kovinski Rit, 7. Negotinsko Blato, 8. Krupačko Blato, 9. Novosadski Rit, 10. Carska Bara, 11. Besni Fok, 12. Čuruški Rit, 13. Uzdinski Rit, 14. Jazovo Fishpond, 15. Bečej Fishpond, 16. Sutjeska Fishpond, 17. Opovo-Baranda (Slatina), 18. Obedska Bara, 19. Dubovački Rit, 20. Bardača Fishpond, 21. Hutovo Blato, 22. Bojna Delta, 23. Skadar Lake, 24. Bitolj Field, 25. Prespa Lake, 26. Pelagonia Plain.

Bosnia and Herzegovina

There are several historical records throughout the country, mainly during migration. The first breeding record was noticed in 1972 at Bardača Fishpond (Obratil 1972/73; 1983). It bred there until 1980, when it disappeared due to habitat destruction (Dalmatin *et al.* 2013). A breeding record was noted again in 2013 in Hutovo Blato near Neretva River, in a mixed colony with herons and cormorants. Maximum counted number of birds in colony was 141, with about 80-100 young fledging birds in July (Dalmatin *et al.* 2013). It was regularly observed during migration. No winter records exist.

Montenegro

According to Saveljić and Jovićević (2015), Glossy Ibis has regularly occurred as a breeding species and has been reported during migration in Montengro. No winter records exist. In the period between 2000 and 2002 only 1-2 pairs were breeding, and a population decline of 30-50% was assessed (Puzovic *et al.* 2003). In Plavnica near Skadar Lake, a total of 118 birds were observed on 8 April 1965 (Ivanović 1970). The species regularly breeds only on Skadar Lake (Vizi 2007). Bojana Delta in Ulcinj region (Puzović 2002) is a former breeding site. Breeding populations in this country were estimated at 5-10 pairs (Environmental Agency Montenegro 2013).

North Macedonia

According to Velevski *et al.* (2010) in a period between 2002 and 2011 there were no breeding records. Several data from Skopje Valley have existed formerly, mainly during migration, with no breeding records (Karaman 1949). One breeding record exists from 1940: four eggs were conserved in museum collections from Bitolj Field (Studene Vode locality) and in total there were 24 museum specimens of Glossy Ibis in collections of tree museums: 15 in Struga, seven in Skopje, and two in Belgrade (Vasić *et al.* 2016). According to Velevski and Vasić (2017) it bred for the last time possibly between 1957 and 1959 in former Crna Reka River marshes, Pelagonia Plain and/or Lake Prespa (in 1966).

Ringing and recoveries

In total, 13 chicks of Glossy Ibis have been ringed in former Yugoslavia (except Slovenia), from 1910 to 1992, but without any recoveries (Radović *et al.* 1993a, b). Several individuals have been ringed in Obedska Bara and in other parts of Vojvodina at the beginning of the 20th century. Between 1912 and 1933 there were 68 recoveries from ringing individuals, mainly in Vojvodina (Stanković in litt. 2017). Kralj *et al.* (2013) mentioned that an additional four individuals were ringed (in total 17) in Croatia after that period, with three recoveries of young birds ringed in Serbia (Vojvodina) and Hungary, but

without other data on the time and place of ringing and recoveries. According to the Data Base of Belgrade Center for Animal Marking (Stanković et al., 2018), 21 Glossy Ibis chicks were ringed in Vojvodina from 1993 to 2017, all in the period between 2010 and 2013 in Tamiš floodplain, by Ištvan Ham. There have been no recoveries until now. One adult was observed in the colony of Dubovački Rit on 15 June 2013 with a white plastic ring from Spain, on the left leg, originated from the FAO colony located in Doñana in 2011. (Figuerola, pers. comm. 2017). There is no information about ringing individuals of Glossy Ibis in other countries in Central Balkans.

Discussion

There were 12-15 colonies of Glossy Ibis in Serbia in 19th[h] century, with 7,000-10,000 breeding pairs. In the first half of 20[th] century there were 10-11 colonies with 3,000-3,500 breeding pairs, while in the beginning of the second half of 20th[h] century there were only 3-4 colonies with a maximum of 30-50 breeding pairs. In the last two years there were only few small colonies, with no more than 5-8 pairs.

"Return of the Ibis" project was been implemented within Obedska Bara beginning in 1992. During the first 25 years, about 220 ha of suitable foraging habitat were restored and maintained and water levels were improved, and after more than 60 years of absence four breeding pairs of Glossy Ibis were recorded at Obedska Bara in 2016 and 2017 (Puzović *et al*. 2016; Puzović 2017).

Populations of Glossy Ibis in Serbia, with thousands of pairs in 19th century and in the first half of the 20th century has suffered drastic reductions in the second half of the 20th century, when there were a considerable number of years without the presence of breeding pairs recorded. Since 1986 slow recovery has been observed, with fluctuations in numbers. Conditions in places of reproduction are important for the beginning of breeding and breeding success, but there is certainly a significant contribution from other populations in countries where the number is growing. This was confirmed by the observation of a Glossy Ibis that was hatched in NP Doñana in 2011, and found breeding in Dubovački Rit in 2013.

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The Settlement of Glossy Ibis in France

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ABSTRACT

The Glossy Ibis *Plegadis falcinellus* was very rarely breeding in France until its settlement in Camargue in 2006, in a colony of ardeids. From then, the number of breeding pairs increased exponentially to reach 2,087 breeding pairs in 2017 distributed over ten colonies mainly in Camargue but also in others sites over the French Mediterranean coast. In parallel, breeding attempts occurred regularly in other regions, with some successes in Loire Atlantic on the Atlantic coast. Here we present some preliminary results on the ringing programme of chicks conducted in Camargue since 2006 and on the diet of the breeding birds. Finally, we discuss factors that influence the settlement of new colonies.

Introduction

Until recently, the Glossy Ibis *Plegadis falcinellus* rarely bred in France. During the 19th century, there was only one reported case: in 1844 in the Camargue, in the Rhône Delta in southern France (Dubois and Yésou 1992). Hugues (1937) and Mayaud (1938) reported that the species bred occasionally in the Camargue during the early 20th century. The first verifiable breeding events occurred in 1961 in Dombes (Chabert and Reymonet 1966) and in 1988 in Aude (Heinzel and Martinoles 1988; Figure 1). In five of eight years between 1991 and 1998, up to four Glossy Ibis pairs bred in the Camargue. In three of these years, some chicks successfully fledged (Pineau *et al*. 1992; Kayser *et al*. 1996; Dietrich *et al*. 1999). The two adult pairs breeding in 1995 were reared in captivity before release (Kayser *et al*. 2006). The origin of the birds breeding in the other years is not known and a captive origin cannot be discounted. After this period, there was no evidence of breeding in France for eight years (1999–2006). Nevertheless, the number of Glossy Ibises increased over this period in the Camargue, especially in the breeding period (Kayser and Cohez 2006). During that period, groups of dozens of individuals were seen, some ringed in Spain.

In this article, we documented the attempts and successes of settlement of Glossy Ibis in France

between 2006 and 2017, with a special focus on the research activities performed in Camargue.

Methods

We first presented information available on the number of breeding pairs for each region where attempts occurred between 2006 and 2017. The data were collected from the literature complemented by personal observations from regional experts or the authors themselves. Because Glossy Ibis in France was still rare during this period, detection of breeding Glossy Ibis was generally performed first by bird watchers and status of breeding occurs during annual census of breeding ardeids.

Since 2006, a Glossy Ibis ringing programme was launched by Tour du Valat in Camargue to provide insights into the migratory routes, survival, dispersal, and recruitment. Ringing operations occur two to four times a year on unfledged chicks captured in the nests in the Scamandre colony. Chicks were weighed, their tarsus was measured and they were fitted a PVC ring with unique code on one tibia and a metal ring on the other tibia. PVC rings allowed individual observations from a distance up to 300m. Resightings were realised by observers and the information transmitted to the authors.

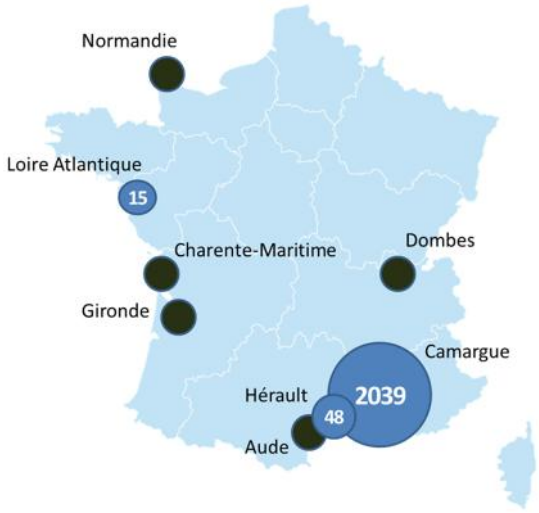
Thirty-four diet samples were collected from chick regurgitates during ringing operations in the Camargue in May 2010 and 2011. Regurgitates were stored individually in plastic bags and conserved in -20°C fridge before analysis. Animal items were sorted using binocular microscope and identified to the species whenever possible. They were then dried to assess the contribution in mass of each species to the diet.

Results

Camargue

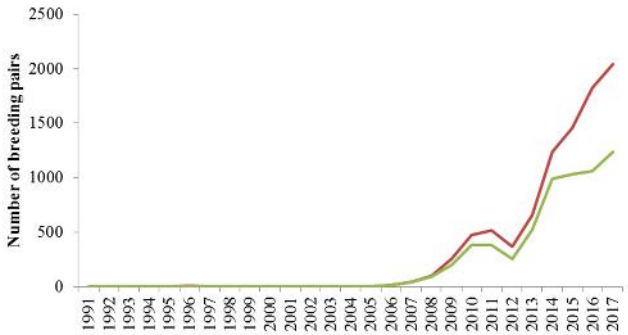
In 2006, 14 Glossy Ibis pairs settled in the Scamandre Natural Regional Reserve, Western Camargue. They raised 45 chicks to the fledgling state (Kayser *et al.* 2006).

Figure 1. Distribution of Glossy Ibis breeding sites in France. Numbers of breeding pairs in 2017 are indicated. Breeding attempts that occurred recently or in the past are presented as black circles



Since 2006, the breeding population of Glossy Ibis increased exponentially at Scamandre, reaching 1,236 pairs in 2017 (Figure 2).

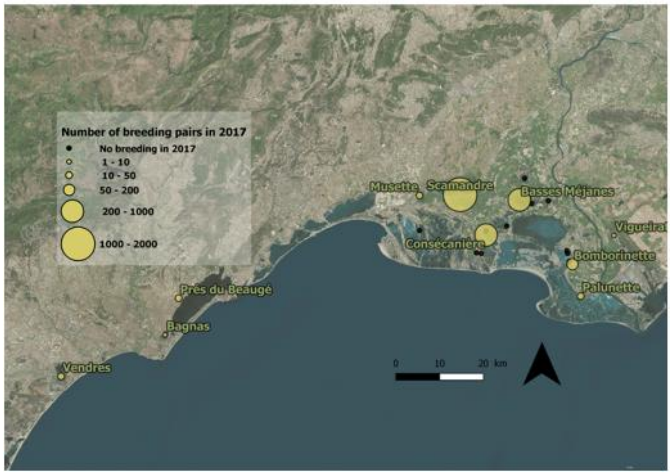
Figure 2. Evolution of the total number of breeding pairs along the French Mediterranean coast (in red) with a focus on the Scamandre colony (in green)



The Scamandre Natural Regional Reserve is a 220 ha area of reedbeds, riparian woods and open marshes. The Glossy Ibis nests and breeds in a 3 ha patch of French Tamarisk *Tamarix gallica* trees within a seasonally flooded marsh. Heron species breed alongside the Glossy Ibis (in decreasing order of abundance: Western Cattle Egret *Bubulcus ibis*, Little Egrets *Egretta garzetta*, Black-crowned Night Herons *Nycticorax nycticorax*, Squacco Herons *Ardeola ralloides*, Grey Herons *Ardea cinerea* and

exceptionally some Great Egrets *Ardea alba*). Since 2005, the total number of breeding pairs (Glossy Ibis and herons combined) has fluctuated between 3,000 and 9,000 individuals. Thus, Scamandre supports the largest mixed heron colony in France and one of the largest in Europe (Gauthier-Clerc *et al.* 2006).
The Scamandre colony was the sole breeding site for Glossy Ibis in France in 2006 and 2007 and it remains the main breeding site today, with 59% of the French population in 2017. From 2008 onwards, the number of Glossy Ibis colonies along the French Mediterranean coast increased steadily. In 2017, there were 10 colonies in the area: seven in the Camargue and three in the Hérault department (Figure 3).

Figure 3. Distribution of Glossy Ibis colonies along the French Mediterranean coast in 2017

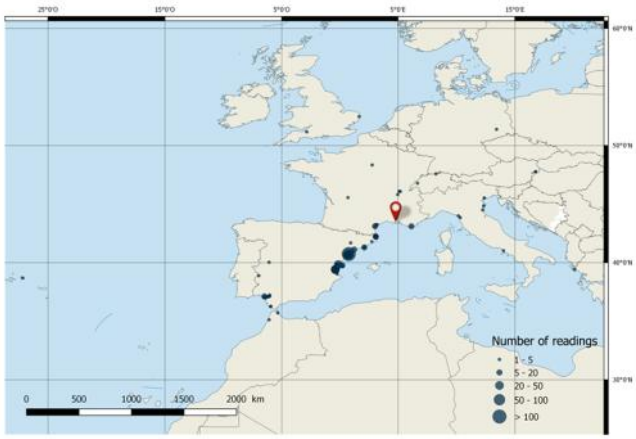


Thanks to ringing operations that occur annually in Spain (this issue) it is known that Spanish-born birds contributed substantially to the population increase along the French Mediterranean coast. We saw 53 different birds born and marked in Doñana at the colony of Scamandre between 2010 and 2017, 28 birds from Delta del Ebro, one individual from Albufera marshes in Valencia and one from Ravenna in Italy. At the Scamandre colony, Spanish-born birds represent on average 21.5% of all resightings during the breeding season, including local birds from the Camargue (range 12% in 2017- 47.2% in 2009).

Dispersion

3,462 different chicks were ringed in the Scamandre colony. It leads to 1249 resightings of 724 individuals outside Camargue. Resightings distributed over Europe mainly in Spain (93%) and 3 resightings occurred in Morocco (Figure 4).

Figure 4. Resightings of Glossy Ibis ringed as chicks at Scamandre colony (red pin), Camargue, Southern France from 2006 until 2017. This map does not include resightings that occurred in the Camargue



Diet of chicks

Regurgitates were dominated by the Red Swamp Crayfish *Procambarus clarkii* which was present in 28 of the 34 samples and represented 73% (± 24 SD) of the dry weight of those samples. Odonata and water beetles (*Dytiscidae*) were both found in 68% of the samples, and fishes in 41% of the samples. Other items included (in order of importance) water bugs (*Nepomorpha*), crustaceans (*Triops cancriformis*), orthopteran species, small mammals and frogs. The Red Swamp Crayfish is also abundant in Doñana, southwest Spain but contrary to the Camargue, it appears not to contribute to Glossy Ibis diet there during the breeding season (Macías *et al*., 2004; Tablado *et al.*, 2010). In the Ebro delta, Crayfishs also accounted for less than 6% of the diet of the chicks (Bertolero and Navarro, 2018).

Hérault

The three sites in Hérault (Vendres, Bagnas, and Prés du Beaugé, Figure 3) are situated along the French Mediterranean coast, but they are ecologically and hydrologically distinct from the Camargue. The first site occupied in Hérault was located on Etang de Vendres with two pairs breeding in 2013. This increased to 20 breeding pairs in 2017 (D. Clément, pers. comm.). The two other sites (Prés du Beaugé and Bagnas) are adjacent to the Etang de Thau and were first active in 2017 with 20 and 8 pairs respectively. Similar to the Camargue sites, Glossy Ibis breeds on tamarisks in mixed colonies of Little Egrets, Western Cattle Egrets, Grey Herons and, sometimes, Black-crowned Night Herons. Marked Glossy Ibises have not been resighted at these sites, but birds born in the Camargue probably formed the source of those colonies.

Loire-Atlantique

At the Grand-Lieu lake, Glossy Ibis was observed irregularly in 1994, 1995 (transport of materials by birds certifying a nest attempt), 1996, 1999, 2000, 2001 and then annually from 2005 onwards. The first breeding success occurred in 2011 with a production of four Glossy Ibis fledglings from a mixed colony of 708 pairs of herons, 87 African Sacred Ibises *Threskiornis aethiopicus* and seven Eurasian Spoonbills *Platalea leucorodia* (Marion and Marion 2011; Reeber 2011). No nesting occurred between 2012 and 2014, although 15 adult Glossy Ibis were observed at the site in 2014 (Reeber 2016). In 2015, eight Glossy Ibis pairs bred in a mixed colony (not the same birds as those breeding in 2011 and 2012), six of these pairs bred in May (L. Marion and P. Marion, pers. obs. 2015) while two bred in July (Reeber 2016). The same colony was occupied by an estimation of 9 to 11 breeding pairs in May 2016. In 2017, 15 nests were found, in three distinct mixed colonies (Reeber 2018).
17 chicks were ringed in 2015 and 2016. Two of them were sighted within two months, at a maximum distance of 110 km from the ringing site. A small number of individuals remains in winter in the coastal swamps close to the lake (up to 55 individuals at Bourgneuf-en-Retz in 2015-2017, M. Maillard, pers. comm.).

Normandie

It is possible that one Glossy Ibis pair bred in 2014 in a mixed colony of herons (Grey Heron, Little Egret, Western Cattle Egret, Great Egret) that also includes one pair of Eurasian Spoonbills. The colony was in a willow plantation of a flooded peat bog near Baupte (Purenne 2016). The nest was not located, and Glossy Ibis has not been observed at the site since.

Charente-Maritime

One pair successfully bred in a mixed colony of herons and Eurasian spoonbills in marshes near Brouage in 2014 (M. Caupenne and L. Jomat, pers. comm. 2014).

Gironde

To date, there is no evidence of successful breeding, but breeding attempts in 2014 and 2016 have been reported (F. Cazaban, pers. comm. 2016).

Dombes

Since 2000, the number of Glossy Ibises in Dombes has increased up to 14 birds (some ringed in Spain and the Camargue) observed in March and April 2012. One bird was seen in a mixed-heron colony in spring 2012, two other individuals settled for one year, and more settled in 2016 and 2017. Nevertheless, no evidence of breeding exists in Dombes since 1961.

Discussion

The Glossy Ibis is now well settled in France and, the population is growing exponentially. The growing population of Glossy Ibis in the Camargue is consistent with the increase in breeding pairs in Doñana, Southern Spain and many local resightings support the hypothesised link between the populations. Besides the role of the Doñana population, the Camargue population has increased thanks to high local recruitment and high breeding

success. Indeed, some individuals were seen breeding when just one year old and other individuals were seen breeding successfully two times during the same breeding season (Kayser *et al*. 2009). Also, the Ebro delta population likely contributed. It has increased exponentially like the Camargue population, although the magnitude of the increase has been smaller: the Ebro delta population contained fewer than 300 breeding pairs in 2015 (this issue). Finally, we cannot discount exchanges from Eastern Europe where no recent ringing programme exists, excepting a few birds in Italy.

The year 2014 seems to be a year with high breeding attempts in new sites (Normandie, Charentes-Maritime, Gironde but also in the United Kingdom). It is believed that drier conditions in southern Spain may have pushed young birds further north this year, as in 1999 and 2005 (Santoro *et al*. 2013). These one-off attempts did not lead to colonization of the sites. Nevertheless, due to the Glossy Ibis's adaptability to forage on variable local resources (for instance invasive crayfish in the Camargue) and the increase of the breeding pairs in Southern Europe, it is predicted that new colonies will appear soon in France, as well as in the United Kingdom and the Netherlands (Boele and Winden 2012).

Factors that influence the settlement of new colonies are still unknown. Studies are currently underway to identify the extrinsic (climatic variables, habitat, social facilitation from other species) as well as intrinsic (individual characteristics) factors that influence the success of the settlement of Glossy Ibis colonies and the dispersion of individuals.

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SIS CONSERVATION 1 (2019) 56–59

SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

Breeding Status of the Glossy Ibis *Plegadis falcinellus* in Bulgaria

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ABSTRACT

Data about the spatial distribution, numbers and dynamics of the breeding pairs of the Glossy Ibis *Plegadis falcinellus* in Bulgaria during the period 1890-2017 are provided. Currently the species breeds in Bulgaria mainly along the Danube River and in the central part of the Bulgarian Black Sea Coast. Two colonies exist along the Danube River: at Srebarna Lake (with 20-175 pairs) and Kalimok Marsh (with 0-150 pairs). A single colony exists along the Black Sea Coast at Poda Reserve near Burgas (4-11 pairs). In inland Bulgaria single pairs bred in certain years at two small wetlands: Trud Fishponds and Konush Reservoir.

Introduction

The Glossy Ibis *Plegadis falcinellus* is a species of Least Concern category, though its global population is decreasing (BirdLife International 2018). This trend is very obvious in countries with limited numbers of wetlands such as Bulgaria where the species is included in the National Red Data Book as Critically Endangered (Michev *et al.* 2011). Information about the Glossy Ibis in Bulgaria is scattered in various publications (Michev 1985; Simeonov *et al.* 1990; Kovachev *et al.* 2007; Michev *et al.* 2011) and there is no publication on the current breeding population situation. The aim of the paper is to present the past and current state of the Glossy Ibis on the base of all available information.

Study Area

The entire territory of Bulgaria was studied in 2012-2017 by BSPB – BirdLife Bulgaria for the purposes of the European Breeding Birds Atlas. Special attention was paid to the sites with known Glossy Ibis breeding in addition to the long-term monitoring of the birds at some sites, especially along the Danube River and the Black Sea coast.

Methods

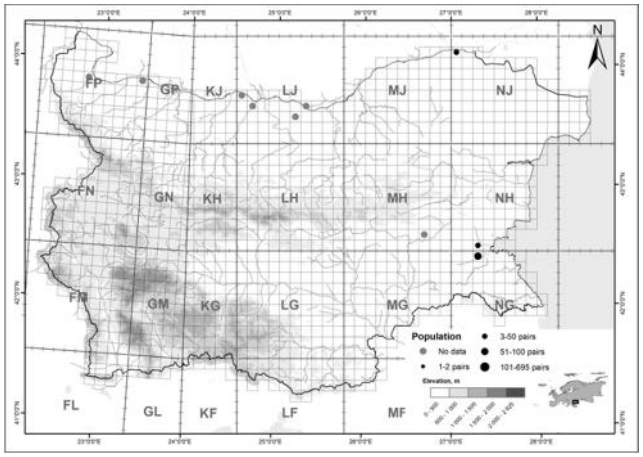
Multiple visits were paid to the sites where breeding was suspected and whenever possible breeding status was clarified, and birds were counted. At some traditional breeding sites, the colonies were subject to monitoring (from twice per month for Poda Reserve, N 42°27'01.62", E 27°27'14.88" during the period 2010-2017 to two-three times per breeding season for sites such as Belene Island, N 43°40'25.98", E 25°13'39.16" and Srebarna Reserve, N 44°06'50.97", E 27°04'04.97"). Numerous single records from different observers all over the country were used to complete the information. In cases where approximate figures were published, (e.g. 18-20 pairs) the bigger one was used for the graphs.

Results

Spatial distribution and numbers

During the period between 1890-1950 the Glossy Ibis breed along the Danube River, at Burgas Wetlands and probably in some of the big inland marshes, such as Straldzha Marsh (Michev 1985; Simeonov *et al.* 1990; Kovachev *et al.* 2007, Figure 1).

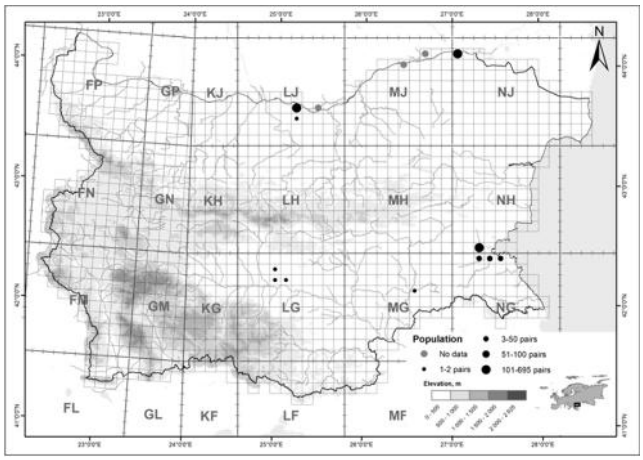
Figure 1. Breeding localities and size of the colonies (black circles) of the Glossy Ibis in Bulgaria during 1890-1950



Scarce data about the numbers of the breeding pairs does not allow for a rough assessment of the population size, but it most probably has been (at least in some years) in the hundreds of pairs at each of the main localities.

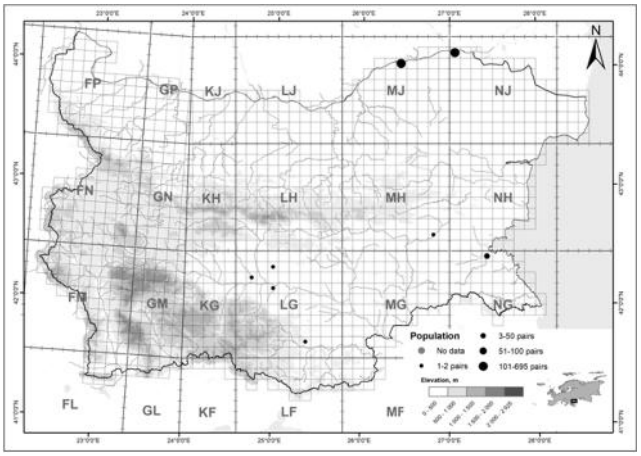
The population faced significant reduction after the mass drainage of the marshes during the first half of 20th Century and in the period between 1951-1999 when most of the colonies disappeared. Several breeding localities survived along the Danube River, where up to 695 pairs have been recorded at Belene Island and up to 500 pairs at Srebarna Reserve. A population of up to about 200 pairs remains also at the Burgas Wetlands. It is well known that the species numbers are subject to significant fluctuations (Michev 1985; Simeonov *et al.* 1990) and years with no breeding pairs occur in all main localities at both Danube and Burgas regions during this period. Inland colonies disappeared with the drainage of the big marshes, but the creation of a few thousand micro-dams enhanced appearances of some heronries and incidental breeding of single pairs of Glossy Ibis in some of the locations (Michev 1985; Simeonov *et al.* 1990; Kovachev *et al.* 2007, Figure 2). During this period some of the breeding colonies went extinct (at Mandra Lake – since 1969, at Burgas Lake – since 1986, at Uzungeren Bay – since 1986), though part of the pairs moved to neighbouring sites and established new smaller colonies (about 30 pairs at Poda Reserve – since 1986).

Figure 2. Breeding localities and size of the colonies (black circles) of the Glossy Ibis in Bulgaria during 1951-1999



During the present period (2000-2017) at the same two main areas (the Danube River and Burgas Wetlands) three main breeding localities of the species remained: at Srebarna Lake (up to 175 pairs) and Kalimok Marsh (up to 150 pairs) along the Danube River, and at Poda Reserve (up to 27 pairs) in Burgas area. Accidental breeding of single pairs in different years occured at five other sites (Figure 3).

Figure 3. Breeding localities and size of the colonies (black circles) of the Glossy Ibis in Bulgaria during 2000-2017



Dynamics of the breeding numbers

During the last five years (2013-2017) between nine (2017) and 291 (2015) pairs of Glossy Ibis have bred in Bulgaria. At around 1990 the national breeding population was estimated to have 100-700 breeding pairs (Simeonov *et al.* 1990), around 1995 – 200-300 pairs (Kostadinova, 1997), 50-150 in 1995-2005 (Kovachev *et al.* 2007).

In spite of the inconsistent data, it is clear that during the period between 1960-2016 in both main breeding areas (the Danube River and Burgas Wetlands) the numbers of the breeding pairs decreased (Figure 4a and 4b and Figure 5a and 5b). Along the Danube the numbers of the breeding pairs fluctuated significantly which can be observed also during the period after 2010. The numbers of pairs at Burgas Wetlands appeared more stabilised, although some fluctuations exist there, too.

Figure 4a. Dynamics of the breeding numbers of the Glossy Ibis along the Bulgarian part of the Danube River during 1960-1995

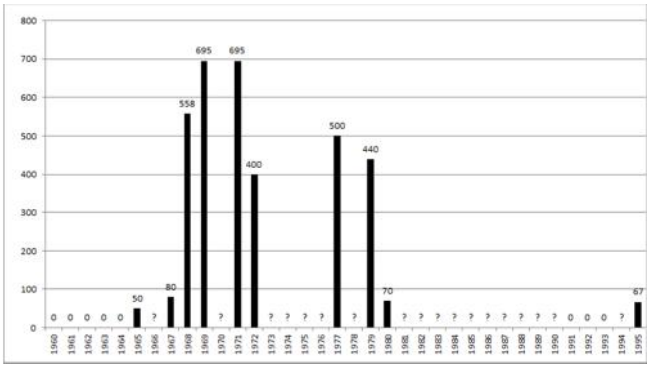


Figure 4b. Dynamics of the breeding numbers of the Glossy Ibis along the Bulgarian part of the Danube River during 1996-2017

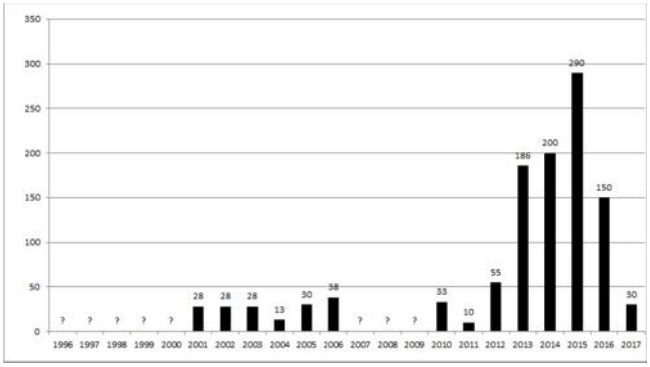


Figure 5a. Dynamics of the breeding numbers of the Glossy Ibis at Burgas Wetlands during 1960-1995

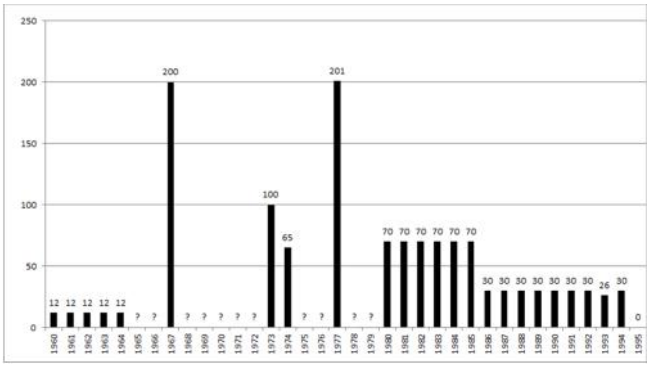
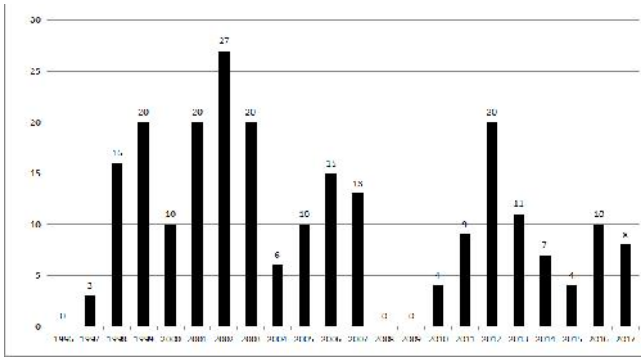


Figure 5b. Dynamics of the breeding numbers of the Glossy Ibis at Burgas Wetlands during 1996-2017



Discussion

Currently the Glossy Ibis breeds in Bulgaria mainly along the Danube River and the Poda Reserve (part of the Burgas Wetlands) in the central part of the Bulgarian Black Sea Coast. During the period between 2013-2017 two colonies existed along the Danube River: at Srebarna Lake (with 20-175 pairs) and Kalimok Marsh (with 0-150 pairs). During the breeding period Glossy Ibises were observed feeding at the marshes of Belene Island, but these are birds, breeding in a colony on the Romanian Bank of the river (S. Cheshmedzhiev, pers. comm. 2018). Along the Black Sea the Glossy Ibis breeds regularly in the mixed colony of herons, egrets, Eurasian Spoonbill *Platalea leucorodia* and Pygmy Cormorant *Microcarbo pygmaeus* at Poda Reserve with 4-11 pairs during the above-mentioned period. During the same period in inland Bulgaria single pairs bred at two small wetlands: Trud Fishponds (2014-2017) and Konush Reservoir (2014).

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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

Status Assessment and Population Trends of the Glossy Ibis *Plegadis falcinellus* in Madagascar between 1993 and 2016

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ABSTRACT

The Glossy Ibis *Plegadis falcinellus*, listed as a Least Concern species in the IUCN Red List is a cosmopolitan species present in all continents except Antarctica. The Madagascar population is sedentary and represented by the nominate subspecies *P.f.falcinellus*. Changes in the population of this species were investigated over the last 23 years through literature reviews, field monitoring and surveys undertaken from 1993 to 2016. A total of 232 wetland locations were visited all around Madagascar and Glossy Ibis were recorded in only 58 of the surveyed localities. A higher concentration was recorded in the western parts of the country mostly inside the system of protected areas. In the central and eastern parts of Madagascar, birds were rarely seen or were even absent. We estimate that the current population of the species is between 8,500 to 11,000 birds in Madagascar. Using a loglinear analysis, the overall population trends showed a moderate increase during the study period between 1993 to 2016. The main threats to the Glossy Ibis in Madagascar are habitat destruction and human disturbances at all breeding and foraging habitats. Actions are needed to understand the bioecological needs of the birds to reinforce conservation action at all sites where Glossy Ibis have been recorded.

Introduction

The Glossy Ibis *Plegadis falcinellus* is a cosmopolitan species distributed in Europe, Asia, Oceania, North and South American and Africa where it is found in a variety of wetlands habitats (Hagemeijer and Blair 1997; Young 2003). The species is represented in Madagascar by nominate subspecies *P.f.falcinellus* (Langrand 1990; Delany and Scoot 2002). Glossy Ibis is listed as a Least Concern species in the IUCN Red List according to the global population which is estimated at 230,000-2,220,000 individuals, and it is classified as a migratory species under the Agreement on the Conservation of African-Eurasia Migratory Waterbirds (IUCN 2012; UNEP/CMS 2014). The global population seems to be decreasing but this decline is not believed to be sufficiently rapid enough to approach the thresholds for a Vulnerable classification (IUCN 2012; Birdlife International 2018). In Africa, the population is estimated to be around 40,000 to 75,000 individuals (Wetlands International 2006). In Madagascar, the first record documented was in 19th century by Milne-Edwards and Grandidier between 1879 – 1885, but the species was considered to be common all around the country during the 1930s (Safford and Hawkins 2013). The population remains low, evaluated at less than 5,000

individuals (Delany and Scoot 2002). One of the major threats of the species is the wetlands habitat degradation, mainly destruction of breeding and foraging habitats. This article introduces the current population of the species in Madagascar and its trend during the last 23 years (1993 – 2016).

Study Area

The study area consisted of Madagascar wetlands. We considered and tried to cover all wetlands types such as lakes, marshes, and rivers and especially any location previously known to harbour nesting Glossy Ibis. In addition, transformed wetlands were considered in the study and included rice fields, artificial lakes and ponds, and agricultural channels. All habitat information was recorded on data sheets and included: coordinates, wetland type, vegetation type and cover, wetland use and threats.

Methods

The Glossy Ibis population was evaluated through technical assessments of information from waterbird census data, literature reviews and expert observations collected during field visits. Waterbird censuses have been conducted in Madagascar by non-governmental institutional staff, field managers and volunteers since 1993. During the censuses, all bird species were recorded using International Waterbird Census methods (Perennou 1991) but in the present study, only information related to the Glossy Ibis were used for analysis. Field censuses usually started about sunrise and continued until 10:00 – 11:00 h and as needed from 16:00 h to dusk at roosting sites. All information was entered into a database: site name, georeferenced locality, habitat type, recorded threats, visit date and number of recorded birds. For predicting the population distribution of the Glossy Ibis, the REBIOMA data portal was used based on available habitat types (REBIOMA 2016). This portal predicts the species' distribution based on its presence/absence from all existing data and environmental variables (temperatures, precipitations, etc.) and then, the actual distribution was mapped using ArcGIS. For population trends analysis, the log-linear Poisson regression analysis was used to impute any missing count data from 1993 to 2016 dataset using Trends and Indices for Monitoring data (TRIM) software (Statistic Netherlands version 3.54) (Pannekoek and van Strien 2001). Considering 1993 as the starting year, zero count was considered and sites with less than five data counted were not used for analysis.

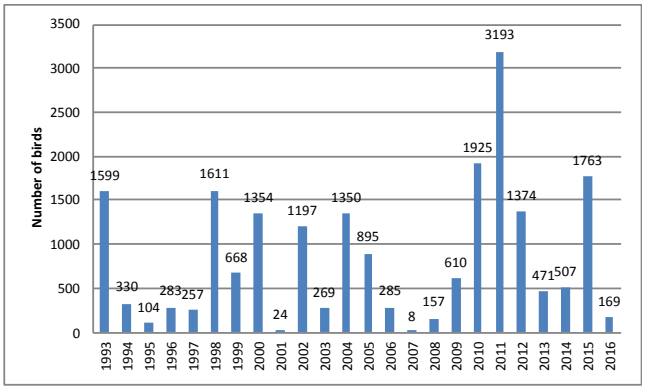
Results

Numbers and distribution of occurrence sites

During the survey from 1993 to 2016, a total of 232 wetlands localities where visited in Madagascar. Only, 58 localities (25% of surveyed area) were recorded with Glossy Ibis. These localities were dispatched inside 19 wetland sites of which nine were protected area sites, nine sites were without legal statute and one Ramsar site. The species occurred throughout the country except the middle east and some parts of the high plateau. Greater numbers were seen in the western and central parts of the island with higher concentrations recorded inside five protected areas including the Mahavavy Kinkony Wetland Complex (with 1,763 individual birds in 2015), the Alaotra Lake (896 birds in 2000), the Ankarafantsika National Park (838 birds in 2011), the Manambolomaty complex (801 birds in 2004) and the Mandrozo Andranovaobe wetlands (504 birds in 2011). Particular attention was given to sites outside of protected areas which host important concentrations of the species such as Bemamba Lake (1,265 birds in 1993) and Loza River (500 birds in 2004), both located along the western part of the country. Except at Alaotra Lake, the biggest lake in Madagascar, few birds were recorded in the high plateau and the eastern part of Madagascar. No birds were seen both at Itasy Lake (S 19° 04' 14'', E 46° 46' 17''), one of the important lakes in the high plateau and Torotorofotsy wetland (S 18° 51' 04", E 48° 21' 30"), the largest marsh area in central eastern part of the country. No ringed birds were seen during the census period. Glossy Ibis were seen in all types of wetland habitats with shallow and fresh water such as lakes, river shores with aquatic vegetation, marshes, floodplains and rice fields. Birds were never seen on saltwater coastal areas such as mangroves and

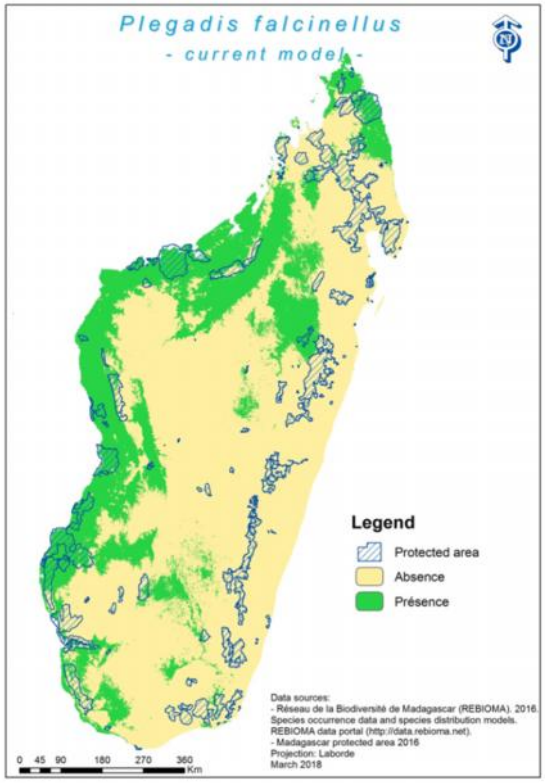
estuaries. The number of birds surveyed in Madagascar from 1993 to 2016 is summarized in Figure 1.

Figure 1. Number of individual Glossy Ibis birds (Y-Axis) surveyed in Madagascar from 1993 to 2016. All sites were not surveyed in all years



Based on this information, most of the current distribution and population of the species, representing about 70% of recorded birds is located in the western part of Madagascar with most of them being included inside the protected area system (Figure 2).

Figure 2. Current distribution of the Glossy Ibis in Madagascar using data from 23 years (1993-2016)



Estimate and trends of populations

In making population estimates and identifying trends, most of the censused population of Glossy Ibis occurred in the Western part of Madagascar. Taking maximum values recorded at each site during the visit period from 1993 to 2016, a total of 8,706 birds were recorded in all of the 19 sites (58 localities). We assumed that 80% of important wetlands were visited and censused (data in appendix 1). Our analysis showed that a maximum estimation of 10,882 birds were probably present in Madagascar. Using TRIM software, a log-linear Poisson regression analysis, our study confirmed that a moderate Glossy Ibis population increase ($p<0.05$) occurred in Madagascar during the last 20 years.

Species threats

The main threats to the Glossy Ibis recorded at the 19 sites are mainly habitat degradation, disturbance of breeding and foraging habitats by human

overexploitation of wetlands due to conversion of marshes and lake shores to agricultural land and infrastructure settlement. The collection of eggs and fledgling birds exists but the impact was not evaluated, in the case of the two known nesting sites at Ravelobe Lake (National Park of Ankarafantsika) and Kinkony Lake (Protected Area of Mahavavy Kinkony Wetland Complex).

Discussion

The actual population of Glossy Ibis is estimated to be between 8,500 to 11,000 birds in Madagascar which is higher than the 5,000 birds previously estimated in 2002 by Delany and Scoot (2002). The species is considered to be a migratory, nomadic bird (del Hoyo and al 1992). However, the absence of banded birds during the census period indicates that no movement occurred from the Africa-Asian population to Madagascar. The Malagasy sub-population referred as *P.f.falcinellus* is probably an isolated sub-population but further investigation is needed to clarify this situation. The bird frequents all types of wetland habitats with shallow and freshwater. They were seen foraging in high numbers (more than 10 birds) in rice fields. The species was not seen in mangroves and estuaries with saltwater. Even if the global population in Africa is decreasing according to Wetlands International (2006), our results spanning 23 years (1993 to 2016) show a moderate increase in the Glossy Ibis population. The reason is probably because a high concentration of birds (> 80%) were recorded inside the protected area system, where wetland habitat use is more regulated than areas without legal statute. All known nesting sites are located inside the protected area. This is important to maintain the population of the species in adequate numbers. However, research action is needed to better identify the bioecological needs of the birds and its movements within the country to understand the unequal population distribution in Madagascar and also to reinforce conservation action.

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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

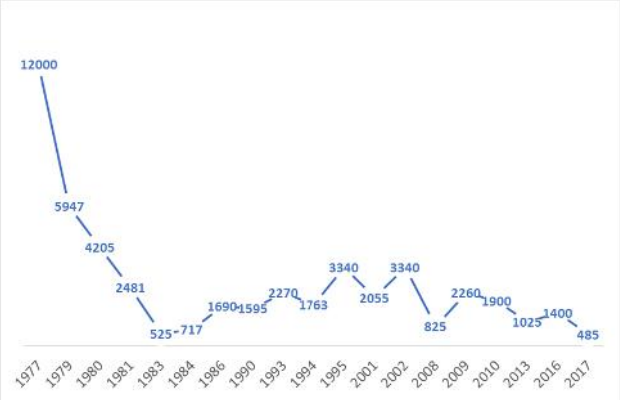
Abundance and distribution

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.

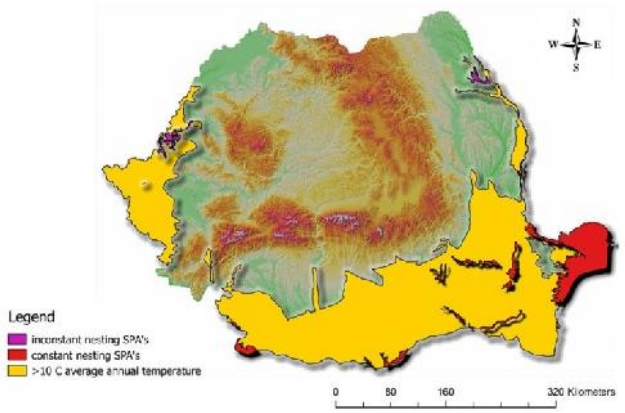
Figure 1. Estimated numerical development of Glossy Ibis breeding pairs in Romanian Danube Delta Biosphere reserve between 1977 and 2017



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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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

The Captive Glossy Ibis *Plegadis falcinellus* Population and *Ex Situ* Conservation Opportunities

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ABSTRACT

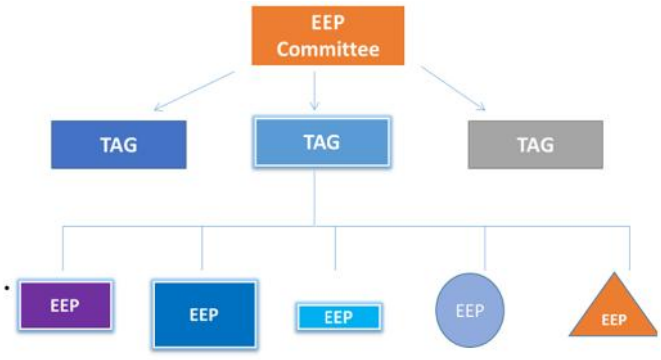
Although Glossy Ibis *Plegadis falcinellus* are found in zoos throughout the world, most (421, including 135 males, 150 females and 136 of unknown gender) are held in 44 European Association of Zoos and Aquaria (EAZA) zoos. Taxon Advisory Groups (TAGs) have been established for all animal groups that are housed in EAZA zoos. These TAGs acts as link between in situ and ex situ efforts, and work to improve conservation and research contributions as well as captive welfare and husbandry of the species under their umbrella. One of the main tasks of TAGs is to develop Regional Collection Plans (RCPs) that define the reasons for having captive population of the selected species and the ex situ management level that the species require. The Glossy Ibis has been designated the management category Monitor by Person in the RCP developed by the Ciconiiformes and Phoenicopteriformes TAG, which includes all of the taxa traditionally included in the order Ciconiiformes. The EAZA Glossy Ibis population has been steadily growing for the last 20 years, and overall larger groups have had better breeding success than smaller groups. Some management issues currently being tackled are mentioned in this paper. The One Plan Approach requires that animals in zoos and aquariums have a conservation role that benefits wild counterparts. This approach extends beyond ex situ breeding programs by linking researchers in zoological facilities with scientists and conservationists working directly with wild populations. Through their support of in situ projects, research, conservation education, capacity building, advocacy, lobbying and fund raising, many members of EAZA are active in the conservation of habitats and entire ecosystems.

Introduction

Modern zoos and aquariums aim to connect people to the natural world, with the mission of conserving the world's biodiversity and stopping species extinction through increasing understanding and appreciation of wildlife. To achieve their goals in conservation of wildlife and natural environments, zoos use field engagement, environmental education, public awareness and advocacy, breeding programs, fundraising, research collaborations and partnerships (Mellor *et al.* 2015). By enabling authentic emotional personal experiences with animals under managed care, zoos can influence attitudes toward the

environment and stimulate public engagement in conservation. Zoos are organized in associations on national and/or regional as well as a global level. The European Association of Zoos and Aquaria (EAZA) includes 370 member institutions in 44 countries in Europe and the Middle East (EAZA 2018a) and is the largest regional zoo organization. Some of the zoo regions have established Taxon Advisory Groups (TAGs) which focus on specific groups of animals. The approximately 40 EAZA TAGs are responsible for developing best practice husbandry guidelines and also for acting as a link between in situ and ex situ activities. The TAGs help zoos to get involved with and support in situ efforts through contributions ranging from financial, logistic, and educational to research. An important TAG task is to develop a Regional Collection Plan (RCP) in which species selection is based on many factors in a "One Plan Approach" that considers both in situ and ex situ conservation needs and strategies. A new breeding program structure is currently being introduced in which all breeding programs are in the same category but each one will be tailored to its specific needs (Figure 1). The TAGs also identify people to run the breeding programs and the TAGs oversee these. There are currently more than 400 EAZA population management programs (EAZA 2018b).

Figure 1. New population management structure (Holst, 2017). EEP Committee - European Endangered species Programmes Committee, TAG – Taxon Advisory Groups, EEP - European Endangered species Programmes



Despite recently widely accepted taxonomic revision of the order *Ciconiiformes* (e.g. Matheu *et al.*, 2018), the *Ciconiiformes* and *Phoenicopteriformes* TAGs in the different regions include all of the families traditionally included in the *Ciconiiformes*, including the *Threskiornithidae*, because of similarities in management needs.

Although categorized as 'Least concern' on the IUCN Global Red List (BirdLife International 2018) the Glossy ibis *Plegadis falcinellus* has a high educational value, and because it has a cosmopolitan distribution it is suitable for most geographically themed exhibits - for example it can feature in an Australian wetland exhibit as well as one with a Caribbean or European theme. While this ibis is relatively numerous in zoos, its zoo population is still deemed small and fragmented enough to need loose management to ensure that the population is sustainable. The Glossy Ibis is assigned to one of four (now being phased out) EAZA management categories in the current EAZA *Ciconiiformes* and *Phoenicopteriformes* TAG RCP.

The category, Monitor by Person, requires that a designated person regularly assesses the genetic and demographic health of the zoo population to identify management issues that need a regional scale approach, and can interact with holders to improve their management on the individual zoo scale, with the goal of having a healthy, viable population.

Study area

Data on Glossy Ibises held in zoos world-wide are included, however, special emphasis is put on specimens within the EAZA region.

Methods

Data are taken from the globally used Zoological Information Management Software (ZIMS) database available through the organization Species 360. This database includes millions of records on more than 22,000 species and ten million individual animals, and enables real-time management of institutional and animal records.

Dietary data for Glossy Ibises in EAZA zoos were collected by M. Damjanović in 2013 in a survey sent to EAZA zoos. A total of 40 surveys were sent and 26 responses were received; two zoos no longer held the ibises and 24 submitted data.

Results

As of March 2018, 525 Glossy Ibises are held in 73 institutions in five regions of the world (Species 360 2018). Most are found in Europe, where 434 specimens are reported in 48 institutions (Table 1). Of these, 92.2% are in 40 EAZA institutions, with the remainder held in non-EAZA institutions.

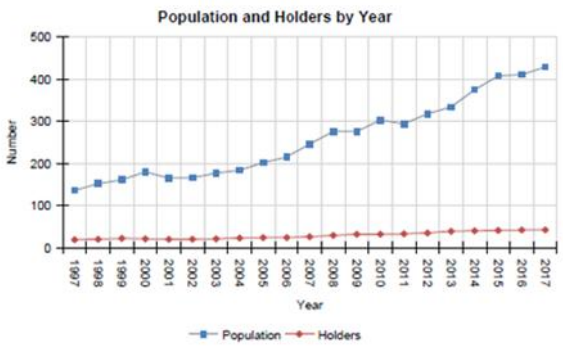
Table 1. Glossy Ibis in Zoos by Geographical Region, *: unknown gender

Region	No of institutions	Male	Female	Other*
Africa	2	1	3	0
Asia	10	59	27	1
Australia	12	47	34	27
Europe	48	141	156	137
North America	1	1	0	0

Additionally four Middle Eastern zoos included in the Asia region are EAZA members, thus Glossy Ibises are held in 44 EAZA institutions, with a total number of 421 (135 males, 150 females and 136 of unknown gender). This constitutes 60.3% of all institutions reporting to Species 360 that hold Glossy Ibises globally and 80.2% of the specimens.

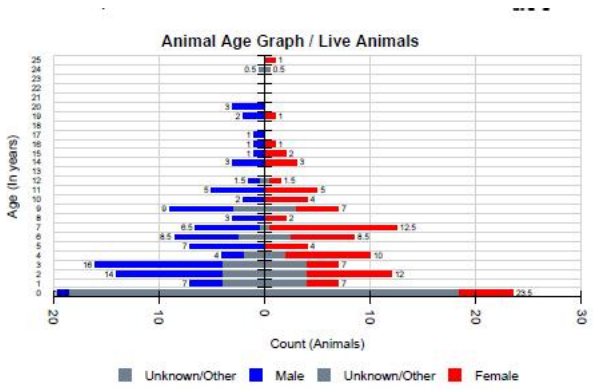
The EAZA Glossy Ibis population has been steadily growing for the last 20 years, as has the number of zoos holding them (Figure 2). Nonetheless, 19 (43.2%) of the 44 EAZA institutions hold less than 6 specimens, including six (13.6%) that hold single specimens (Species 360 2018).

Figure 2. EAZA Glossy ibis Population and Holder by Year



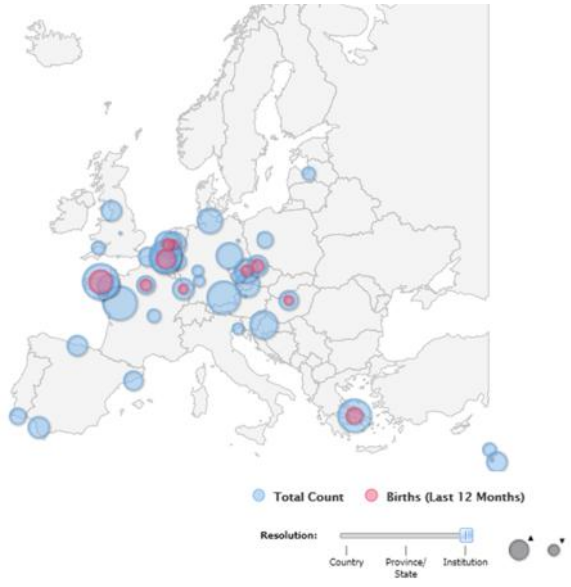
The smallest group to breed in EAZA zoos in 2017 was 4 (1 male and 3 females), and the mean group size was 13.0 (± 7.1 SD) for breeding groups. This is larger than the mean size of all groups: 8.6 (± 7.2 SD). Most (345 of 421; 82.0%) Glossy Ibises in EAZA zoos are of breeding age, i.e. one year of age (Davis *et al.* 2000) or more (Figure 3).

Figure 3. Age pyramid of Glossy Ibis in EAZA Zoos (09/2017)



Breeding occurred in 14 of the 44 EAZA zoos in 2017, producing 59 offspring (Figure 4).

Figure 4. Glossy ibis in EAZA zoos (09/2017)



The gender is not known for almost one-third (32.3%) of the individuals in EAZA zoos, but the sex ratio is almost even (1.0:1.1) among birds of known gender.

A total of 14 items were reported to be included in

diets of Glossy Ibises in EAZA zoos in the 2013 survey (Table 2).

Table 2. Food Items Offered in EAZA Zoos (Damjanović 2016)

Food items offered in zoos	No of zoos
Saltwater fish, whole or chopped	17
Beef meet or heart, ground or chopped	10
Ibis/flamingo pellets	10
Freshwater fish whole or chopped	9
Chicken, adult, ground	5
Other bird diets	4
Carrots	4
Egg, boiled	4
Rice, boiled	4
Crickets, mealworms, earthworms	4
Chicken, one-day-old	3
Dog pellets	3
Shrimp	2
Cat food	1

Discussion

The Glossy Ibis is well established in EAZA zoos and clearly many zoos wish to continue with this species, despite the fact that it is not threatened globally. A common goal of RCPs is to have sustainable populations of the species included. For many ibises, this requires improvement of breeding success.

While wild Glossy Ibis colonies are variable in size, but often number in the thousands (del Hoyo *et al.* 1992), limited space in zoos means group sizes are often small. While breeding may occur in very small groups, e.g. four individuals in 2017, breeding groups tend to be larger than groups generally, and group size is felt to be a factor in achieving good breeding success. The minimum recommended group size is 6 (3 pairs); however zoos are encouraged to hold groups of 10 (5 pairs) or more specimens. If zoos with few birds are unable to increase the group size, they are asked to consider sending the birds to another zoo that can house them in a larger group.

Having an unequal sex ratio can of course also influence breeding success (Matheu *et al.* 2018), and it is unfortunate that gender has not been determined for almost one-third of the Glossy Ibises in EAZA zoos. The TAG promotes determination of gender of all individuals but currently no widely-embraced method for ibises exists. DNA-analysis based on PCR-methodology is reliable and reasonably non-invasive if feathers are used, but is relatively expensive and zoos are often reluctant to invest in this for colonial species held in substantial numbers. Figuerola *et al.* (2006) determined sex of Glossy Ibis chicks with high accuracy using tarsus width and wing length, but zoo staff are often reluctant to disturb nests during the breeding season. Data for Glossy Ibises included in Hancock *et al.* (1992) suggest that culmen length of adults may be an easily measured, low-cost and reliable indicator of gender, as it is for some *Eudocimus* ibises (Babbitt and Frederick 2007; Herring *et al.* 2008). However it is possible that captive individuals originating from different geographic locations have different bill lengths and it is also not known at what age this technique would become reliable, hence zoos are being asked to measure culmens of Glossy Ibises of known sex, and age and origin as possible, to assess how widely the technique can be applied.

An important TAG goal is to elevate the standards of animal care of species under its umbrella by continuously identifying important issues relating to animal welfare; consequently optimization of diets is a goal. Results of the survey on the Glossy Ibis diets showed that diets vary considerably among zoos in the types of food and amounts offered, as well as how food is prepared. Diet items most frequently fed are meat i.e. beef, saltwater fish Sprat *Spattus sprattus*, Smelt Osmeridae, Anchovy *Engraulidae*, Pilchard Clupeidae, whitebait, Capelin *Mallotus villosus*, herring *Clupeidae*, Pollack *Pollachius pollachius*, hake *Merlucciidae, Phycidae*, freshwater fish (Prussian Carp *Carassius gibelio*, common roach *Rutilus rutilus*, Common Cream *Abramis brama*, Smelt Osmeridae, Crucian Carp Carassius carassius, and also ibis or flamingo pellets. Some plant based items such as carrots and rice are also regularly added. Diet items reported differ substantially from the diet of wild breeding Glossy Ibises in Doñana, Spain which mostly consists of aquatic beetles (*Coleoptera*) and dragonfly (*Odonata*) larvae (Macias *et al.* 2004). However Toral *et al.* (2012) and Acosta

et al. (1996) both found that Glossy Ibises feed on waste rice grains during the nonbreeding season. Food preparation is also variable: some items are offered whole (e.g. small fish), but others are offered ground or chopped (e.g. beef) and some are even boiled (eggs, rice). More study is required to identify whether any specific zoo diet, and preparation method, is better than others.

Conservation of biodiversity is core to the EAZA mission (EAZA 2018d) and it embraces the One Plan Approach, developed by the Conservation Planning Specialist Group (CPSG) to species conservation. This entails the development of management strategies and conservation actions by all responsible parties for all populations of a species, whether inside or outside their natural range (CPSG 2018). External experts can help the TAG to identify species under its remit that would benefit most from captive breeding in the One Plan Approach context, and should be included in the future RCP. These experts can help to establish potential roles, goals and form of the programs and their feasibility. Colleagues from the Glossy Ibis Working Group/ IUCN SSC Stork, Ibis and Spoonbill Specialist Group could provide valuable help and critical thinking in topics ranging from population management, social structure and behaviour, gender identification, diet and nutrition to data collection protocols.

Vice versa, zoo populations may also be useful in solving field research questions in a wide range of disciplines and in development of management techniques, ranging from physiological studies to testing tracking equipment and methods. For example, during the International Glossy Ibis Network meeting in 2017 it was agreed that many members of this network will send feather (or blood) samples to the Estación Biológica de Doñana for genetic analyses to study gene flow, and consequently samples are currently being collected from EAZA zoos. Relevant examples of how captive flamingos have or can contribute to field work are provided in King (2008; 2017). A few of these include feeding trials carried out with captive flamingos at Basle Zoo to help predict impact of wetland degradation on Greater Flamingos *Phoenicopterus roseus* (Deville *et al.* 2013). Captive Greater Flamingos were the source of feathers, uropygial secretions and behavioural observations in an interesting study on the use of uropygial secretions as make-up in this species (Amat *et al.* 2010). Captive flamingos have featured in studies of filter-feeding structures and mechanisms (Beckman 2006; Jenkins 1957; Zweers *et al.* 1995). Testing of expensive tagging equipment and techniques can easily be accomplished with captive birds: captive flamingos were used to test transmitters for lesser flamingos in Africa and for Andean flamingos in South America (B.Hughes, F. Arengo, *pers. comms*).

The TAG can also help in addressing other conservation management issues, for example it is suspected that escaped or released captive specimens have joined the Glossy Ibis populations in France and Spain, (J. Champagnon, *pers. comm.* 2017), ahypothesis that the TAG can investigate and help to clarify. However, Glossy Ibises are also held by private breeders, and these birds constitute a potential source that would be much more difficult to identify.

Zoos have an enormous conservation potential that can benefit many animals and their habitats, including Glossy Ibis. Nearly 140 million visits are made to EAZA member institutions yearly (EAZA 2018c) providing a broad platform for support of in situ projects and research, especially through conservation education. There are also huge opportunities for capacity building, advocacy, lobbying and fund raising as well. Zoos and in situ conservationists need not only to work together to protect animals, but also to engage the public of their communities to take the lead in demanding action from authorities, governments, corporations and themselves so that together we can reduce the stress on endangered species and their habitats (EAZA 2018b).

Conclusion

The EAZA Ciconiiformes and Phoenicopteriformes TAG strives for high welfare standards for the animals under its remit, and to optimize the education, conservation and research contribution of these animals and the zoos that hold them. The fact that the Glossy Ibis is reasonably common in EAZA zoos means that it can play a significant role in achieving these goals. The first International Workshop on Glossy ibis helped to build

relationships for future collaboration and information sharing in order to strengthen and complement effective decisions for Glossy Ibis populations both in situ and ex situ, in line with the One-plan Approach.

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IUCN SSC Stork, Ibis and Spoonbill Specialist Group

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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

Status of the Glossy ibis *Plegadis falcinellus* Breeding and Wintering in Portugal

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ABSTRACT

This work intends to present the current status the Glossy Ibis *Plegadis falcinellus* in Portugal, resulting from surveying and monitoring efforts during both breeding and wintering seasons over the last 10 years. The wintering population of Glossy Ibis has increased considerably since the end of the 20th century in Portugal. The number of birds in winter has increased at a very rapid with only 1-7 individuals being recorded in 2005 and 8,320 birds recorded wintering in Portugal in 2015. The first recorded nesting occurred in 2005 in Paul do Boquilobo Natural Reserve. Currently, the breeding population is estimated between 600 and 700 breeding pairs. The breeding colonies are so far established in the vicinity of or within rice fields. This fact limits the species' potential expansion and settlement. Half of the nesting population is found in the colonies located in the Tagus river basin. Controls and recoveries of ringed birds show that the wintering population is mostly composed of individuals from Spain and France, which potentially indicates the continuation of the European population expansion. The continued increase could potentially result in conflicts with rice cultivation.

Introduction

The present work intends to present the current status the Glossy Ibis *Plegadis falcinelus* in Portugal, resulting from surveying and monitoring efforts during both the breeding and wintering season over the last 10 years.

During the twentieth century the species was extinct as breeders in diverse places in Europe, mainly due to the destruction and degradation of habitat and hunting pressure (Tucker and Heath 1994).

Until the recent past, a large number of individuals of the species was known to have wintered in the countries of North Africa, and Moreau (1972) estimates that a majority belongs to the Palearctic population. On the other hand, Bernis (1969) is of the opinion that most of the individuals observed in the Iberian Peninsula must come from the colonies of the Danube River in central Europe and Italy.

Historically, the species is referred to as common in the Alentejo region by Felix Capelo, in "*Aves de Portugal*" (1932), but after that, until the 1990s it was a rare species to observe in Portugal. However, since 1994, there has been a substantial increase in records of individuals, initially mostly in the Algarve. In the last decade it has been observed more frequently throughout Portugal, mainly in the estuaries of the Tejo and Sado rivers, but in also in almost all coastal wetlands and even inland, on the center and south

regions of the country and in very significant numbers.

This increase in observations is a consequence of both, the increase in the number of observers and the recent increase in the populations of the species in Europe (Costa 1993). The Santo André Lagoon is one of the places besides the great estuaries, where the species was observed at the beginning of its expansion, throughout the national territory, mainly during the period of migratory passage (Costa 1993), but also during the winter.

Its presence and population evolution in Portugal cannot be separated from its distribution in Spain, given its proximity, either by the existence of some colonies in some places of southwest Spain or in northwest Africa, along the Mediterranean basin, especially in the marshes of the Guadalquivir (Bernis 1969). This situation is reinforced by the fact that there are no records of nesting in the last century in Portugal.

The Glossy Ibis is a recent breeding species in Portugal, following a very significant increase in the wintering population during the last decade, having settled as breeders only six years ago. The first breeding records were in colonies on wetlands in the center of the country, at the Mondego, Tejo and Sado basins and also at Alentejo rivers, with the largest breeding colonies being currently located in the Tagus and Sado basins. The Glossy ibis breeds in mixed colonies where other Ardeidae are also present and does not yet present relevant numbers when compared to those species.

Methods

Study Area

The study area covers the entire continental territory of Portugal, although the known occurrence areas of the species, are particularly relevant in the southern half of the country, where its presence as wintering and/or nesting is more significant.

The field surveys and subsequent presentation of the results are organized in accordance to Portuguese river basins, considering the distribution of the species and the location of the respective breeding colonies and refuges.

Winter season

Winter counts are carried out under the National Program for the Monitoring of Winter Waterfowl (PNMAAI) in January, coordinated by the ICNF/CEMPA and take place every year in the most important wetlands for these species, in particular estuaries, dams, and reservoirs.

Counts are usually performed by a set of volunteer-professional staff (ICNF), mostly from points located at the edge of wetlands. In large estuarine wetlands, counts are also made from a boat and along a pre-defined transect during high tide. In winter, each wetland area is visited in January, preferably in a period of seven days selected in order to promote simultaneous surveys between the various wetlands, while avoiding hunting days. In the case of estuarine areas, counts are carried out during the highest tides of the month and during the high tide period.

Whenever possible the quantification of the number of birds is performed by direct counting. In the case of large flocks or when in flight, the numbers are an estimation of groups with n birds (Bibbly *et al.* 1992).

Breeding season

The method used to inventory the breeding population was the nest count method (Franzeb 1977).

For the identification of the location of the colonies, where the species nests together with ardeids, known colonies were visited and others where their presence and possible nesting were known.

Each breeding colony was visited two times during the breeding season while trying to maximize the level nesting evidence. The abundance quantification method was carried out in the form of direct censuses according to the characteristics of the species, by quantifying the number of breeding pairs. Most cases are in the smaller colonies.

When this method was not possible to employ, in the large colonies, censuses were made by estimations based on sampling and extrapolation.

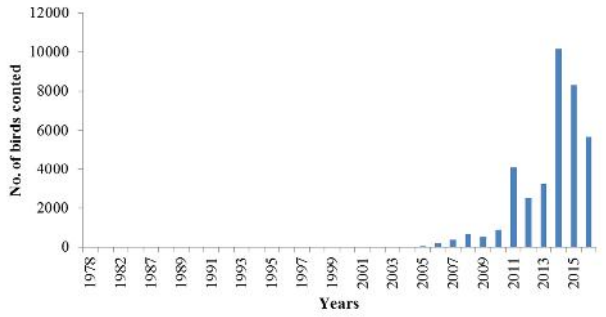
For ease of presentation, the smaller river basins were encompassed with those adjacent to them, or with larger basins, forming larger sets which are named

according to the Portuguese Environment Agency (APA 2017).

Results

The wintering population of Glossy Ibis in Portugal has increased considerably since the end of the 20th century. The number of birds in winter has increased at a very rapid rate since 2005, when only 1-7 birds had been recorded, whilst 43 were recorded in that year (Figure 1).

Figure 1. Variation on wintering population of Glossy ibis in mainland of Portugal



In 2006 a new record count of 191 was attained and only nine years later (2015) 8,320 birds were wintering in Portugal. In 2016, the winter numbers decrease substantially, likely due to the severe drought that began the previous year. During winter the species is present in 21 of the 80 wetlands covered by the winter surveys, occupying mainly coastal areas and rice fields.

The first recorded nesting occurred in 2005 in Paul do Boquilobo Natural Reserve, followed by another record, in 2006 in a small island on the Tagus basin. Since 2012 breeding has been recorded each year. The breeding population was estimated in 2016 at between 600 and 700 breeding pairs, (Table 1) following a trend of growth, and has grown rapidly since the last census (Encarnação 2014).

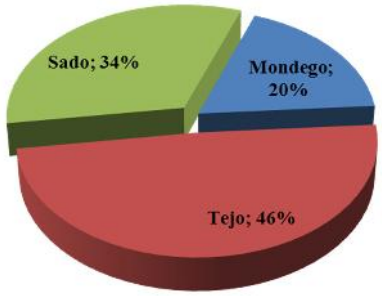
Table 1. Distribution of breeding pairs by colonies

River basins/colonies	No. Pairs 2014	No. Pairs 2016
Mondego river		
Paul do Taipal	85 - 90	120 - 150
Tejo river		
Paul do Boquilobo	200 - 210	150 - 200
Escaropim	40 - 44	125 - 150
Póvoa	0	45 - 50
Sado river		
Sacholinha	120 - 150	150 - 190
Murta	0	12 - 14
Santo André - Covinha	2	50 - 60
Pizão	0	2 - 3

The species is currently breeding at 8 different sites, mainly in the river basins of Mondego, Tejo and Sado, as well as in one coastal lagoon of Alentejo and in a small dam near of Beja (Figure 2). Half of the nesting population is found in the colonies located in the Tagus river basin (Figure 3). In all cases breeding is mixed with herons and spoonbills.

Figure 2. Map of Portugal, its main hydrographic basins and geographical location of Glossy Ibis breeding colonies (red spots)

Figure 3. Distribution of breeding pairs by river basin



Discussion

During the winter, the Glossy Ibis is observed in several wetland areas, all of which encompass rice fields thus suggesting its dependent on this habitat, where they may find abundant food mainly consisting of Red Swamp Crayfish *Procambarus clarkii* from Louisiana. Likewise, the breeding colonies are so far established in the vicinity or within areas of rice fields. This fact, limits the species' potential expansion and settlement as a breeding bird to very specific regions.

On the other hand, controls and recoveries of ringed birds show that the wintering population is mostly composed of individuals originating from Spain and France, which potentially indicates the continuation of the European population expansion (CEMPA, not published data). Many of the wintering birds may become established as breeders, if they find food availability and favourable habitat.

The continued increase in population could potentially result in conflicts with rice cultivation. Although the largest numbers occur during the winter, when there should be no conflict as rice-paddies have no agricultural activity at that time, this is no longer the case during spring and summer. Given its current association with rice fields the continued growth of the breeding population might potentially be regulated by agricultural practices limiting the species access to rice-fields.

Finally, given the rapid population growth during both, winter and breeding seasons, it will be vital to continue monitoring the species numbers and its movements. Therefore, marking individuals born in the Portuguese colonies is a priority, which together with the observations of individuals marked in other countries will allow a better understanding of population dynamics.

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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

Glossy Ibis *Plegadis falcinellus* in South Africa, Lesotho and Swaziland

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ABSTRACT

This paper first reviews the historical literature on the Glossy Ibis *Plegadis falcinellus* in the southern African bird literature, focusing on three countries: South Africa, Lesotho and Swaziland. Secondly, it extends the comparison of the species distributions in these three countries as revealed by the First and Second Southern African Bird Atlas Projects.*

*Keywords and Abstract have been written by the editors.

Introduction

In the southern African bird literature, the Glossy Ibis *Plegadis falcinellus* does not have a single full-length paper devoted to any aspect of its biology; there are only a series of "short notes", and species accounts in field guides, atlases and reviews of groups of species (Barnes 2005). The longest paper published to date which focuses on this species only is a comparison of the distributions as revealed by the First and Second Southern African Bird Atlas Projects (Underhill *et al.* 2016).

This paper extends and expands that comparison. The geographical limitations are South Africa, Lesotho and Swaziland. It makes use of two sections. The first reviews what was understood about the status of the Glossy Ibis during the 19th and 20th centuries and consists of a literature review. The second section considers the information related to the distribution of the species from the bird atlas projects. Note that in this paper the seasons are austral: summer refers broadly to the period October–March, and winter to the period April–September.

The historical status of the Glossy Ibis in southern Africa up to the 1980s

The early books on southern African birds described the Glossy Ibis (Figure 1) as a migrant to the region from the Palearctic with most records being made in summer. For example, in the first fieldguide Leonard Gill described the Glossy Ibis as "an irregular migrant to South Africa from Southern Europe and Asia" (Gill 1936). Austin Roberts (1940) wrote: "*It is a rare migrant to South Africa from the Northern Hemisphere*." But several decades earlier, at the start of the 20th century, Stark and Sclater (1906) were more cautious and simply noted: "*The Glossy Ibis is not known to breed in South Africa*". It is completely unknown if "Palaearctic migrant" was the real status of the species in the region until the first half of the 20th century, or whether breeding had simply been

overlooked.

Breeding was first recorded in southern Africa in September 1950, when 10 nests were found at spring in Gauteng in a heronry, containing also nests of Western Cattle Egret *Bubulcus ibis*, Black-crowned Night Herons *Nycticorax nicticorax*, Purple Herons *Ardea purpurea* and African Sacred Ibis *Threskiornis aethiopicus* (Anon 1951; Tarboton 1968; Tarboton *et al.* 1987). The way in which this event was reported in 1951 is remarkably matter-of-fact. This contrasts strongly with the hype surrounding the first discovery of breeding by species considered to be Palearctic migrants to South Africa. For example, White Storks Ciconia ciconia were first reported as breeding in 1941 (Roberts 1941a) and this was treated as a milestone event in African ornithology (e.g. Roberts 1941b, 1942; Broekhuysen 1942; Priest 1942), as was the discovery of breeding Leach's Storm Petrels Oceanodroma leucorhoa in 1995 (Whittington and Dyer 1995; Whittington 1996; Underhill 1998; Whittington *et al.* 2001; Underhill *et al.* 2002). The lack of enthusiasm associated with the discovery of breeding of Glossy Ibis in South Africa in 1951 suggests that breeding had been long-suspected, and was at last finally proven. The species was by then already known to breed on the Kafue Flats and Barotse Plain in Zambia (Anon 1951). The first recorded breeding attempts in the Western Cape were made in 1955 (not successful) at Rondevlei Bird Sanctuary, Cape Peninsula) and then in 1967 (successful) at the farm Kersefontein, in the Hopefield district, along the Berg River (Middlemiss 1955; Hartley *et al.* 1968).

It breeds colonially, often a minor species in a large heronry, and so its breeding is generally hard to detect. For example, Ernest Middlemiss (1995), the professional ornithologist at Rondevlei Bird Sanctuary, wrote "*I never saw the two Glossy Ibises [myself] during the 39 days they were known to be present. [The first observation was made by] a carpenter building a shore observation tower who reported that he had seen two strange, dark birds with long, curved beaks flying over the water*." This breeding occurrence was discovered more by accident than by design. Likewise, the description of the breeding event at Springs in Gauteng indicates that it took some detective work to find the nests on the third visit "*about 20 yards from the edge of the reeds*" and they "*could only be reached after wading through water and mud waist deep and knee deep respectively*" (Anon 1951). It seems plausible that the idea hinted at by Stark and Sclater (1906), that there was a breeding population, but it had simply not yet been discovered, is the appropriate status for the Glossy Ibis in southern Africa in the first half of the 20th century.

In the decade before fieldwork for the First Southern African Bird Atlas started in 1987, a series of regional atlases were published, and most contained a succinct account of the status of each species in the region. These paint a valuable picture of the abundance and distribution of the Glossy Ibis in the late 1970s and early 1980s. The remainder of this paragraph quotes the key points in each of these species accounts. In describing status of the Glossy Ibis in the area south and west of the Olifants and Breede Rivers of the Western Cape, Hockey *et al.* (1989) wrote: "*Uncommon resident and summer visitor, breeding September to February. Although uncommon, both numbers and range are increasing.*" They attributed this increase to the construction of artificial waterbodies, such as farm dams and sewage works. In KwaZulu-Natal, Cyrus and Robson (1980) wrote: "*Encountered, often in flocks, on the edges of open stretches of water on the littoral plain and, to a lesser extent, inland vleis, dams and sewage farms*." Their distribution map showed most records were from the north-eastern section of the province, adjacent to Swaziland and southern Mozambique, and showed no clear pattern of seasonality. In Swaziland (where fieldwork for the atlas was 1985–1991), Parker (1994) wrote: "*An uncommon summer visitor to all regions, encountered in small flocks of up to 10 birds*". For the Transvaal (now roughly the provinces of Gauteng, Limpopo, Mpumalanga and North West), Tarboton *et al.* (1987) wrote (summarizing fieldwork from 1960–1986, but mainly 1983–1985): "*Occurs widely but sparsely in all regions, but most common on the Highveld*" and "*The 80% decline in numbers in winter is assumed to be the result of a seasonal movement to the tropics.*" In the Free State (1983–1986), the range and status of the Glossy Ibis was described by Earlé and Grobler (1987) as "*Uncommon to fairly common in specific localities.*

Can probably be expected everywhere as it is expanding its range." Their seasonal maps show that records were mostly made in summer. At the eastern end of the Eastern Cape, in the former Transkei, Quickelberge (1989) noted: "*The only record is a bird shot by Gould at Matetiele at the turn of the century*" (i.e. around 1900). In Barnes (2005) it is stated that the Glossy Ibis does not occur in Lesotho, quoting Osborne and Tigar (1990). This is an error; Osborne and Tigar (1990) knew of four records since 1970, but did not observe the species themselves while they were doing the bird atlas of Lesotho.

The status of all bird species in southern Africa (defined as Africa south of the Kunene and Zambezi Rivers) is provided in the 1980 checklist of the Southern African Ornithological Society (S.A.O.S. List Committee 1980). For the Glossy Ibis, List Committee wrote: "*Recorded breeding locally south-western Cape, Zululand, Transvaal, Botswana and northern Namibia (Ovamboland), and occurs in small numbers elsewhere. Status uncertain, but Palaearctic migrants also conceivably reach South Africa*."

That essentially summaries the perceived status of the Glossy Ibis at the time the first bird atlas started. It had been an enigmatic species for the previous eight decades.

Methods and Results

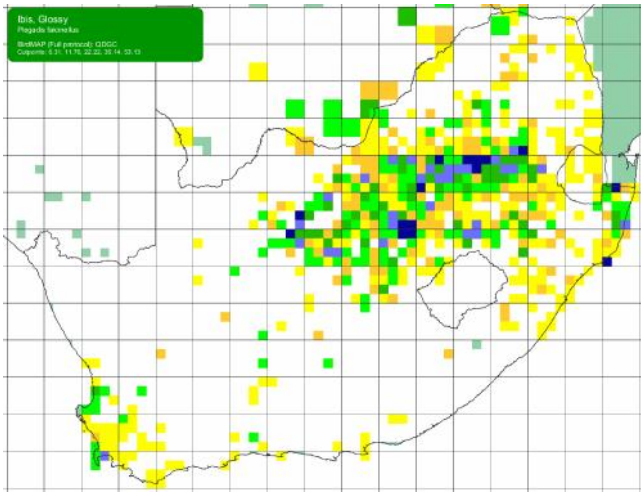
The definitive status of the Glossy Ibis in southern Africa: bird atlas insights

SABAP1 distribution

The First Southern African Bird Atlas Project (SABAP1) used a 15-minute grid, generating what are known in the region as quarter degree grid cells (there are actually 16 of these per degree cell), and they have sides of about 27 km (Harrison *et al.* 1997; Harrison and Underhill 1997). Fieldwork for SABAP1 was mainly in the period 1987–1991, but the project included data from compatible projects for smaller regions from 1980 onwards, and can be viewed as generating a snapshot of overall bird distributions in the 1980s. The SABAP1 distribution map shows that the bulk of the distribution in South Africa was in the Grassland Biome which covers much of central South Africa (Harrison and Underhill 1997) (Figure 1).

The grid cells in Figure 1 with the dark blue shading indicate the core of the range of Glossy Ibis during SABAP1; the main centres of abundance are on the eastern Witwatersrand, Gauteng where many of the wetlands are artificial, a by-product of gold-mining, and in the panveld around the towns of Welkom and Virginia, in the Free State; where the mining industry of the Free State Goldfields pumps freshwater to the surface, supplementing the pans and creating artificial wetlands. The core of the distribution in Gauteng lies precisely in the region where breeding was first recorded in 1950.

Figure 1. SABAP1 distribution map for the Glossy Ibis in South Africa, Lesotho and Swaziland, and a quarter degree grid scale, downloaded 3 April 2018. The species was not reported in grid cells shaded white. The species was recorded in grid cells shown in colour, with shades based on reporting rate ranges: yellow 0–5.7%, orange 5.7–11.7%, light green 11.7–22.2%, dark green 22.2–34.6%, light blue 34.6–53.5% and dark blue 53.5–100%. These cutpoints were determined by SABAP2 calculations, see Figure 2. There were no checklists for grid cells shaded turquoise



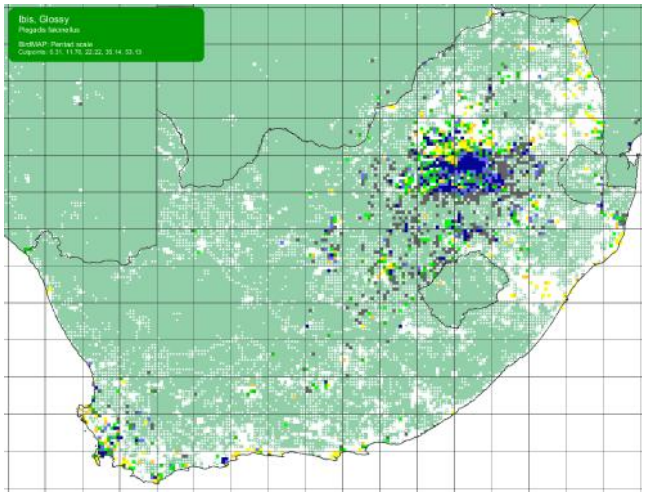
SABAP2 distribution

The Second Southern African Bird Atlas Project (SABAP2) uses a five-minute grid, generating grid cells known as pentads (Underhill 2016). It started in 2007 and is ongoing. The two atlas projects are about

two decades apart. There are nine SABAP2 pentads per quarter degree grid cell, as used by SABAP1, so the distribution maps are produced on a finer scale.

The interpretation of the pentad-scale distribution maps derived from SABAP2 data is fully described by Underhill and Brooks (2016a). In brief, reporting rates are shown in colour for pentads with four or more checklists – white: not reported, probably absent; and then six colours ranging from yellow, low reporting rates, to dark blue, high reporting rates, arranged so that the number of pentads in each of these six colours is an even as possible). For pentads with fewer than four checklists, grey indicates presence, and a small white dot indicates not reported, possibly absent. Pentads without data are shaded turquoise.

Figure 2. SABAP2 distribution map for the Glossy Ibis, on pentad scale, downloaded 3 April 2018. The detailed interpretation of this map is provided by Underhill and Brooks (2016a). Pentads with four or more checklists are shaded white if the species was not recorded, or in colour, with shades based on reporting rate ranges: yellow 0–6.3%, orange 6.3–11.8%, light green 11.8–22.2%, dark green 22.2–35.1%, light blue 35.1–53.1% and dark blue 53.1–100%. These cutpoints were determined in such a way that the number of pentads shaded each colour are as equal as feasible with integer arithmetic. In pentads shaded grey or with white dots, there are one, two or three full protocol checklists, or there are ad hoc lists, or incidental records. In pentads shaded grey, the species was recorded as present; in pentads with white dots the species has not been recorded. If a pentad has four or more checklists, and the species has been recorded on an ad hoc checklist or as an incidental recorded, it is shaded yellow, indicating that the species has a small reporting rate



The overall impression of the SABAP2 distribution map for the Glossy Ibis (Figure 2) is that the distribution is fragmented compared to SABAP1 (Figure 1); this is a false conclusion, and is a consequence of the change of size of grid cells between the two projects. Glossy Ibis, being a waterbird, is restricted to pentads containing wetlands. On the pentad scale, the SABAP2 distribution map (Figure 2) shows that the core of the range of the Glossy Ibis remains in southeastern Gauteng, in the one-degree grid cell having S 26° and E 28° in its northwestern corner. Many of the pentads in this degree cell are shaded dark blue, indicating a

reporting rate exceeding 53.23% and those shaded light blue have a reporting rate between 35.29% and 53.25% (Figure 2). From this core region, the distribution extends mainly westward and eastward across the grasslands of the Free State and Mpumalanga, with another focal point in the Senekal-Bethlehem-Harrismith district of the southeastern Free State. With declining output from the Free State Goldfields, the Glossy Ibis hotspot around Welkom seems to have dissipated. Elsewhere in South Africa, Lesotho and Swaziland there are centres of abundance in northwestern KwaZulu-Natal and in the Western Cape, on the Cape Flats near Cape Town, on the West Coast along the Berg River estuary and at Verlorenvlei, and near the estuary of the Gouritz River at the western end of the Garden Route. Elsewhere there is scattering of records, where Glossy Ibises have been observed in many pentads, presumably mainly at wetlands (Figure 2).

Seasonal distribution maps, based on the SABAP2 data, show a striking difference between summer and winter (austral seasons) (Figures 3 and 4). The distribution in summer, defined as the four months from November to February, is similar to the overall distribution of Figure 2, except that the core parts of the range are now highlighted. The distribution in winter (Figure 4), defined as May to August, is sparse in relation to the summer distribution of Figure 3. There is clearly not a total migration of Glossy Ibises from South Africa, but especially there is a large winter emigration of birds from the core of the range in Gauteng. Night time temperatures in Gauteng are often below 0°C in the winter months. The subtropical coastal plain of KwaZulu-Natal is warm in winter, but there is not a hint of suggestion of increased reporting rates there, so Glossy Ibises from Gauteng do not migrate westwards to the coastal plain, either here, or farther north in southern or central Mozambique (Figure 2, Parker 1999; 2005).

Figure 3. Summer SABAP2 distribution map for the Glossy Ibis, on pentad scale, downloaded 3 April 2018. The austral summer was defined as the months November, December, January and February. The interpretation is the same as in Figure 2, and uses the same cutpoints as used in Figure 2. Pentads shaded white, or in colour, had four or more checklists in these midsummer months

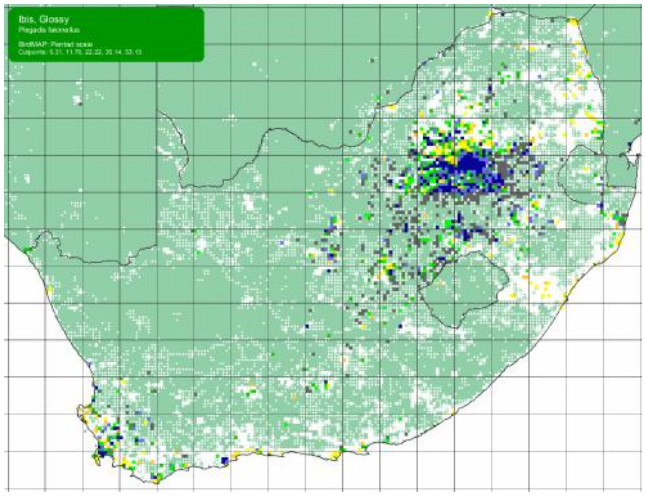
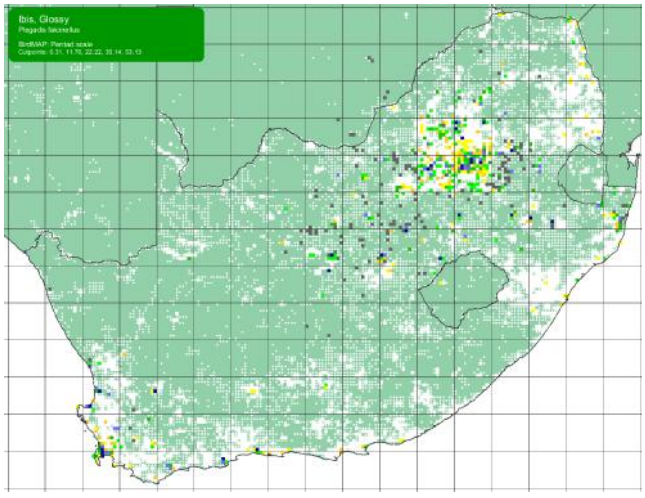


Figure 4. Winter SABAP2 distribution map for the Glossy Ibis, on pentad scale, downloaded 3 April 2018. The austral winter was defined as the months May, June, July and August. The interpretation is the same as in Figure 2, and uses the same cutpoints as used in Figure 2. Pentads shaded white, or in colour, had four or more checklists in these midwinter months



There is one ring recovery from Gauteng northwards to Zambia; a nestling ringed in Benoni in November

1970 was recovered in the Senanga District of Zambia (S 15° 39', E 23° 02') in August 1973. 1,300 km north of the ringing site (Underhill *et al.* 1999; Safring ring 710061). This recovery was made in the vast Barotse/Zambezi floodplain, so it is feasible that the non-breeding destination of South African Glossy Ibis lies here and on the floodplain of the Kafue Flats (Dowsett *et al.* 2008). However, Dowsett *et al.* (2008) provide no hint of a suggestion that there might be an influx of Glossy Ibis in the austral winter, but they do state that flocks, numbering hundreds and thousands have been observed at various sites, and that "these are suggestive of long-distance movements". Thus the huge Zambian wetlands are likely to prove the non-breeding grounds of the Glossy Ibis which move out of South Africa during the austral winter.

Range change between SABAP1 and SABAP2

The interpretation of the range-change maps showing how distributions have changed between SABAP1 and SABAP2 has been described by Underhill and Brooks (2016b). The key quantifies in the comparison are the reporting rates for quarter degree grid cells calculated for SABAP1 and SABAP2. The SABAP2 reporting rate is computing by combining all the checklists for the nine pentad with the quarter degree grid cell. In Figure 5, the Underhill and Brooks (2016b) approach was used to classify the quarter degree grid cells into six categories of increase and decrease. The relative increases and decreases are estimated by applying the Griffioen transformation to the SABAP1 and SABAP2 reporting rates (Underhill and Brooks 2016b). The quantitative estimate of proportional change involves an assumption that, in pentads where Glossy Ibis occurs, they are randomly distributed across the landscape, i.e. they are not clustered or in flocks. For the Glossy Ibis, this is not true, so the quantitative estimates of relative change suggested by the Griffioen transformation need to be treated cautiously; and they are regarded qualitatively here.

Results are shown in Figure 5 for only the 779 quarter degree grid cells for which there are four or more checklists for both SABAP1 and SABAP2 and in which Glossy Ibis occurred in either SABAP1 or SABAP2 (Table 1). In other words, grid cells in which Glossy Ibis did not occur in either project are not included in this analysis.

Figure 5. Range-change map between SABAP1 and SABAP2 for the Glossy Ibis, downloaded 3 April 2018. Each quarter degree grid cell shown in colour received at least four checklists in both SABAP1 and SABAP2. All these grid cells had Glossy Ibis recorded in them either in SABAP1 or in SABAP2 or in both. Red, orange and yellow represent quarter-degree grid cells with very large, large, and small relative decreases and blue, dark green and light green represent grid cells with very large, large and small relative increases. A count of the number of grid cells in each category is provided in Table 1. Fuller information on the interpretation of this range-change map is provided in Underhill and Brooks (2016b)

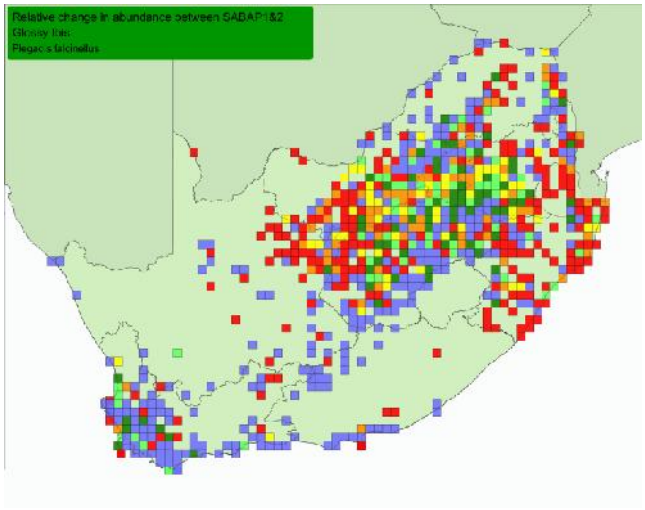


Table 1. Range-change summary for the Glossy Ibis between SABAP1 and SABAP2. The table provides a count of the number of quarter degree grid cells of each colour in Figure 5. Also shown are the same summaries when the analysis is restricted to grid cells with at least 30 checklists for both SABAP1 and SABAP2

Status	Four checklists for both SABAP1 & SABAP2		30 checklists for both SABAP1 & SABAP2	
	Count	%	Count	%
Red (very large decrease)	217	28	107	24
Orange (large decrease)	70	9	46	10
Yellow (small decrease)	54	7	35	8
Light green (small increase)	62	8	50	11
Dark green (large increase)	71	9	45	10
Blue (very large increase)	305	39	167	37
Total	**779**	**100**	**431**	**100**

Of these 779 quarter degree grid cells, the numbers of grid cells shaded blue (very large increase) and dark green (large increase) are 305 (39%) and 71 (9%) respectively. At the other end of the scale 217 (28%) grid cells are red (very large decrease), and 70 (9%) are orange (large decrease). The groups of blue grid cells suggesting very large increases extend across the Western Cape, along the Eastern Cape coastal strip, and along an axis running from Beaufort West in the Western Cape, just west of Lesotho to Volksrust in the Free State. There is also an axis of blue running from Rustenburg in North West to Polokwane in Limpopo. Over the central highveld, in the grassland biome around Gauteng, greens, yellow and orange grid cells predominate, suggesting that populations are fairly stable in this region. There are large groups of red cells over much of KwaZulu-Natal. It needs to be borne in mind that some of the increases and decreases are off a low base (see Figure 1). Apart from in the Western Cape, the patterns of increases and decreases are complex. In the Western Cape, the comment of Hockey *et al.* (1987) almost certainly remains true: "*both numbers and range are increasing*."

Repeating the quantitative count of Figure 2 and Table 1 using grid cells with 30 or more checklists in both SABAP1 and SABAP2, the sampling error is considerably smaller than with four checklists for both projects, but there are now only 431 grid cells which meet this criterion (Table 1). In this restricted analysis, 34% of grid cells show large or very large decreases and 47% show large or very large increases. The two sets of results are similar.

Discussion

Overall, the conclusion has to be that the Glossy Ibis has increased in both range and abundance over the Western Cape in the two-decade period between SABAP1 and SABAP2. Its fortunes appear to be mixed over the remainder of South Africa, with some clear regions of increase, some regions of stability and some clear regions of decrease. The atlas database does not provide reasons for the changes, it only highlights the patterns, which then need further and more detailed investigation.

The Glossy Ibis is not an easy species to monitor using regular waterbird counts. It is erratic in occurrence at particular wetlands, and numbers tend to vary considerably (Taylor *et al.* 1999). Ring recoveries also point to nomadic movements (Underhill *et al.* 1999).

This is clearly an interesting and enigmatic species, and poorly studied in southern Africa. Genetic analyses would probably reveal whether the species did indeed only start breeding in South Africa in the middle of the 20th century. We still do not know if any of the Glossy Ibis currently occurring in South Africa are migrants from Eurasia, but this does seem doubtful. This is a species for which tracking devices would generate fascinating data. We have little preconceived ideas of what such a study would reveal. The only safe prediction is that, given the species is nomadic, the devices would show patterns of movement. But we do not know the extent to which this movement, in individual birds, is on scales of tens of kilometres, hundreds of kilometres or thousands of kilometres. Given that this species is a partial migrant, this is likely to be highly variable at the individual level.

Acknowledgements

This paper is celebrates the contributions of thousands of citizen scientists to the databases of the first and second bird atlas projects in southern Africa (SABAP1 and SABAP2).

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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

Historical and Current Status of Glossy Ibis *Plegadis falcinellus* in Turkey

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ABSTRACT

The aim of this study is to provide the first comprehensive synthesis of past and present information available on the distribution and population status of breeding and wintering Glossy Ibis *Plegadis falcinellus* in Turkey. The Gloss Ibis used to be a widespread breeding species in the central and western part of Turkey. Approximately 2,500-2,795 pairs were breeding over at least 16-24 sites during 1950s and 1960s. During this period, Meriç Delta, Manyas Lake and the Amik Lake were holding the largest breeding populations and the total number of known breeding population reached up to 2,000 pairs in just these three sites. In the 2000s, the whole breeding population in Turkey was estimated to be between 500 and 1,000 pairs only. Currently, the species is breeding regularly in eight and irregularly in five wetlands. The current breeding population is estimated to be between 282-421 pairs. The species may also irregularly breed in another 8 different wetlands. Wetland drainages, water pollution, habitat alterations mainly due to cutting the willow trees *Salix alba* and reedbed fires are additional reasons for the dramatic decreases observed. The species used to be only a breeder before 2004 in the region. However, after 2004 the species started to expand their length of stay and 2005 onwards they started to overwinter as well and became a resident species. Establishment of monitoring and conservation programs is recommended.

Introduction

Glossy Ibis *Plegadis falcinellus* is one of the least known species in Turkey since there is no specific published study and or report on its population and distribution. Therefore, the existing information is very limited and it can only be obtained by investigating published historical site-based faunistic studies and observations by ornithologists made between 1950s and 2000s. These existing studies are mainly focusing on other breeding waterbird populations and scarcely include quantitative information on abundance and distribution of Glossy Ibises.

An important step needed to conserve Glossy Ibises is to synthesize all the available information. The aim of this study is therefore to provide the first comprehensive review of past and present quantitative baseline information on the distribution and population status of breeding and wintering Glossy Ibises in Turkey.

Methods

Study Area

Turkey is a transcontinental country that lies between Europe and spans about 780,000 km². Turkey lies in the temperate climate zone with an average precipitation of 643 mm, ranging from 250 to 2,500 mm in the country (DSI 2015). The elevation of the country increases from the west to the east. Mountain ranges stretch along the north and south coasts. The highest amounts of precipitation are seen along these mountain ranges. Being at the junction of the Arabian, Eurasian and African continental plates, Anatolian peninsula of Turkey is known to have started to evolve from the Parathehis Sea, during the Oligocene epoch and land formation and sedimentary deposition has continued up to the modern-era (Sengör and Yilmaz 1981). The formation of a land from the bottom of a sea has led to a very large number of wetlands and aquatic diversity (Kılıç and Eken 2004; Eken *et al.* 2006).

Breeding population

All published and unpublished information about the breeding populations of Glossy Ibises in Turkey during the 20th and early 21th century was collected by the authors. It includes the following references: Aharoni (1930); Meinertzhagen (1935); Coiffait (1955); Koßwig (1956); Kumorloeve (1963; 1964; 1970); Lehmann (1971; 1974); Renkhoff (1972; 1973); Vauk (1973); Martins (1989); Husband and Kasparek (1984); Dijksen and Kasparek (1985), Kasparek (1985; 1988; 1992); Ertan *et al.* (1989); Kılıç and Kasparek (1990); Turan (1990); Kirwan (1993); Hustings and Van Dijk (1994); Ertan (1996); Yarar and Magnin (1997); Karauz *et al.* (2007), Kılıç and Eken (2004), OST (1968-1969), Anonim (1973-85), Anonim (2008-2019), Gürpınar (1973, 1975, 1977), DHKD (1990). The breeding information collected from the literature is given with related source of information.

Based on our observations, Glossy Ibises are frequently breeding in mixed colonies with some other waterbirds, especially Grey Herons *Ardea cinerea*, Great Egrets *Ardea alba*, Little Egrets *Egretta garzetta*, Eurasian Spoonbills *Platalea leucorodia*, and Great Cormorants *Phalacrocorax carbo*, therefore we also searched the available information of the breeding status of these species in Turkey. Besides the literature review we also investigated the distributions and sizes of wetland habitats throughout Turkey (Ataol and Onmuş, in pub. 2018), in which Glossy Ibises prefer breeding. Some of those investigated sites were treated as possible breeding sites for Glossy Ibises as well and included in the distribution list.

Recent monitoring

We surveyed some of the known breeding sites and collected data on breeding numbers during the breeding seasons between 2016 and 2018. In some of the sites, we censused the number of occupied nests and provided our own data. Since Glossy Ibises frequently prefer to breed in mixed colonies with other species as mentioned, sometimes it was very difficult to carry out a direct census due to large number of different breeding waterbirds in vicinity. In addition, inaccessibility of some of the breeding grounds also prevented us from to applying a direct census. If any of these two constraints were met, we provided breeding population estimations based on the number of observed Glossy Ibises in or around suitable breeding habitats. The breeding information collected from our field surveys is given with “this study” statement..

The data concerning the breeding population in the Manyas Lake includes both data from the literature and our various field surveys between 2012 and 2018. We also provided information about the breeding biology of the species, and specific factors threatening the breeding populations.

Wintering and migration populations

The data on the wintering population were obtained from mid-winter waterbird Census Surveys between 1990 and 2017 (Dijksen *et al.* 1990; DHKD 1992; 1993; Yarar *et al.* 1996; Aydemir *et al.* 1999; Kurt *et al.* 2002; Çağlayan *et al.* 2005; Suseven *et al.* 2006; Onmuş 2007; Akarsu and Balkız 2010; Erciyas and Isfendiyaroğlu 2012; Orman 2015).

The available records of Gloss Ibises submitted by different observers to Kusbank (https://ebird.org/turkey/home) were also used. These data were first verified and then used in conjunction with the data on the wintering population to evaluate changes in the distribution and migration of Glossy Ibises.

Results

Breeding Population

The Glossy Ibis used to be a widespread breeding species in the central and western part of Turkey in the past. During 1950s and 1960s, approximately 2,500-2,795 pairs were breeding in at least in 16-24 different sites (Table 1). Among these sites, seven of them were regular breeding sites and five of them were irregular breeding sites. Besides the confirmed sites, we also identified 21 different sites where various Ardeidae, Threskiornithidae and Phalacrocoracidae species were breeding in the 1950s and 1960s. Among them, eight different sites were selected as sites where the Glossy Ibis may have bred at least irregularly. During that period, Meriç Delta, Manyas Lake and the Amik Lake had the largest breeding population and the total known breeding population was reaching up to 2,000 pairs in just these three sites. Kılıç and Eken (2004) stated without giving any specific source of information that the estimated population of Glossy Ibises in Turkey were between 500 and 1,000 pairs at the beginning of 2000s.

Table 1. Summary of the current and historical breeding populations of Glossy Ibis in Turkey (2012-2017)

Year of Estimation	Breeding Pairs
1950s – 1960s	2,500 – 2,795
2000s	500 – 1,000
2012–2017	281 – 410

Currently, there are only eight active breeding colonies: Manyas Lake, Marmara Lake, Işıklı Lake, Uluabat Lake, Göksu Delta, Meriç Delta, Eber Lake and Nallıhan Bird Paradise (*S. Ekşioğlu, pers. obs 2019*). Besides these, the species may also breed in Kızılırmak Delta, Yeşilırmak Delta and Sultan Marshes as well. Breeding of one pair was recorded in 2015 in Nallıhan Bird Paradise where there was no previous breeding documented. A summary of the historical (1950s and 2000s) and the current (2012-2017) breeding populations of Glossy Ibises in Turkey are given in Table 2 and Table 3, respectively. The distribution of confirmed and possible breeding populations of Glossy Ibises in Turkey is given in Figure 1.

Manyas Lake is an important breeding area for Glossy Ibises. The first breeding record in Lake Manyas dates back to 1959, although large flocks of ibises had been observed long before. The first breeding ibises were recorded on the Kabak and Kazak Islands located in the south of the lake. Due to the construction of an embankment and a regulator at the outlet of the lake, the breeding islands, 3,200 ha swamps, wetland meadows, mud plains and shallow coastal belts to the south of the lake were completely destroyed. Subsequently, breeding waterbird colonies including Glossy Ibises began to use the 52 ha Sığırcı Creek Delta located at the northeast of the lake and this area was declared as a National Park (NP) in 1959. However, artificial water level increases in Manyas Lake have caused many Willow trees *Salix alba* to die. To compensate those negative changes NPs planted willow trees in the national park area. The NP area became suitable for the nesting of colonially breeding waterbirds during 1970s and the area was closed to human activities, enabling the breeding populations to increase. However, the number of colonially breeding waterbird species started to decrease during 1985s as a result of fluctuating water levels and an increase in pollution. Due to observed decreases in breeding waterbirds, a 128-ha site next to the 52 ha Sığırcı Delta NP was also included in the NP area in 1998 and completely closed to human activities. Waterbird colonies then began to use this area since 2004 and the number of breeding Glossy Ibises has increased (Karauz *et a*l. 2007). However, highly eutrophic status of the lake, large fluctuations of water level due to changes in rainfall regime and increased water demand for agriculture are serious threats for all the colonially breeding waterbirds in Manyas Lake. Detailed information on the changes in the breeding population

of Glossy Ibises in the Manyas Lake is given in Table 4.

Table 2. Detailed information of the historical breeding population of Glossy Ibis in Turkey. D: Delta; L: Lake; M: Marshes; Dm.: Dam; B.P.: Bird Paradise; Stat.: Status; Freq.: Frequency; Breeding Status; C: confirmed; P: possible. Breeding Frequency; Regular: R; Irregular: I; Disappeared: Ds. *: wetlands drained and/or significantly reduced in size due to extensive irrigation projects for agriculture (Disappeared).

Site name	Breeding Stat./Freq.	Historical Breeding Population		Source of information
		Pair	Year	
Meriç D.	C / R	800	1950s-1960s	Ertan et al 1989; Yarar&Magnin 1997
Manyas L.	C / R	750	1950s-1960s	Ertan et al 1989;
Marmara L.	C / R	30	1970s-1980s	This study
Uluabat L.	C / R	20	1970s-1980s	Ertan et al 1989;
Göksu D.	C / R	10	1970s-1980s	Yarar&Magnin 1997
Eber L.	C / R	100	1970s-1980s	Ertan et al 1989;
Işıklı L.	C / R	30	1970s-1980s	Ertan et al 1989; Yarar&Magnin 1997
Yeşilırmak D.	C / R	10	1950s-1960s	Kılıç & Eken 2004
Kocaçay D.	C / R	40	1970s-1980s	Yarar&Magnin 1997
Sultan M.	C / R	200	1950s-1960s	Ertan et al 1989;
Ereğli M.	C / R	50	1997	Ertan et al 1989;
Akşehir L.	C / R	20	1990	Ertan et al 1989; Yarar&Magnin 1997
Hotamış M.	C / Ds	75	1997	Ertan et al 1989; Yarar&Magnin 1997
Karamık M.	C / Ds	20	1990	Ertan et al 1989; Yarar&Magnin 1997
Amik L.	C / Ds	500	1930s-1960s	Kumerloeve 1964, 1970
Nallıhan B.P.	C / I	0	2000-2010s	This study
Kucuk Menderes D.	C / I	10-20	1980s	Ertan et al 1989
İznik L.	C-P / I	10-15	1970s-1980s	Ertan et al 1989
Kızılırmak D.	P / I	0-50	1970s-1980s	This study
Eğirdir L.	P / I	0-10	1970s-1980s	This study
Balıkdamı M.	P / I	0-5	1970s-1980s	This study
Sarıyar Dm.	P / I	0-5	1970s-1980s	This study
Seyfe L.	P / I	0-5	1970s-1980s	This study
Beyşehir L.	P / I	0-20	1970s-1980s	This study
Bafa L.	P / I	0-10	1970s-1980s	Ertan et al 1989; Yarar& Magnin 1997

Table 3. Detailed information of the cuurent breeding population of Glossy Ibis in Turkey. D: Delta; L: Lake; M: Marshes; Dm. Dam; B.P.: Bird Paradise; Breeding Status; C: confirmed; P: possible. Breeding Frequency; Regular: R; Irregular: I; Disappeared: Ds. *: wetlands drained and/or significantly reduced in size due to extensive irrigation projects for agriculture.

Site name	Breeding Stat./Freq.	Current Breeding Population			Source of information
		Min-Max Pair		Year	
Meriç D.	C / R	100	100	1997	Yarar & Magnin1997
Manyas L.	C / R	30	50	2016-2017	This study
Marmara L.	C / R	20	30	2011	This study
Uluabat L.	C / R	14	20	1997	Kılıç & Eken 2004
Göksu D.	C / R	10	10	1997	Kılıç & Eken 2004
Eber L.	C / R	50	60	2014	This study
Işıklı L.	C / R	20	30	2016	This study
Yeşilırmak D.	C / R	7	10	1997 (*)	Kılıç & Eken 2004
Kocaçay D.	C / I	0	10	2009-2016	This study
Sultan M.	C / I	0	10	1994 (*)	Kılıç & Eken 2004
Ereğli M.	C / I	0	5	2000-2004 (*)	Kılıç & Eken 2004
Nallhan B.P.	C / I	1	1	2015	Ekşioğlu, per. obs, 2019
Kucuk Menderes D.	C / I	0	0	2012-2017	This study
İznik L.	P / I	0	10	2014-2016	This study
Kızılırmak D.	P / I	30	40	2012-2016	This study
Eğirdir L.	P / I	0	10	2014-2016	This study
Balıkdamı	P / I	0	5	2012-2014	This study
Sarıyar Dm.	P / I	0	5	2012-2014	This study
Seyfe L.	P / I	0	5	2012-2016	This study
Beyşehir L.	P / I	0	10	2012-2014	This study
Bafa L.	P / I	0	10	2012-2016	This study

Figure 1. Current and historical breeding distributions of breeding Glossy Ibises in Turkey.

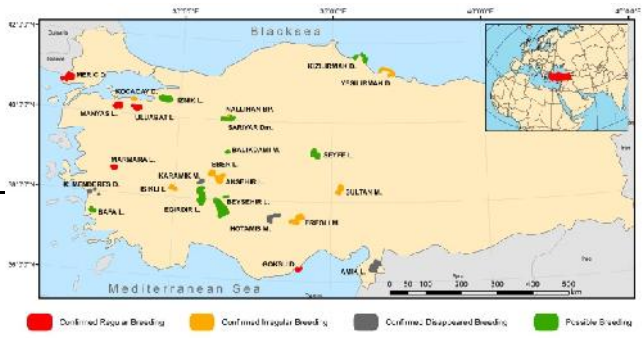


Table 4. Detailed information on the changes in the breeding population of Glossy Ibises in the Manyas Lake

Pair	Year	Source of Information
25	1966	DHKD; 1990
105	1967	DHKD, 1990
300	1968	OST, 1968-69
69	1973	T.Gürpınar, pers.com, 2007
91	1974	T.Gürpınar, pers.com, 2007
450	1975	T.Gürpınar, pers.com,2007
450	1977	T.Gürpınar, pers.com, 2007
404	1978	Anonim, 1973-85
379	1979	Anonim, 1973-85
730	1980	Anonim, 1973-85
572	1981	Anonim, 1973-85
740	1982	Anonim, 1973-85
701	1983	Anonim, 1973-85
700	1984	Anonim, 1973-85
40	1985	Anonim, 1973-85
10	1995	Karauz et al, 2007
8	2000	Karauz et al, 2007
5	2001	Karauz et al, 2007
30	2002	Karauz et al, 2007
34	2003	Karauz et al, 2007
9	2004	Karauz et al, 2007
26	2006	Karauz et al, 2007
10	2007	S.Karauz
61	2008	Anonim, 2008-2019
262	2009	Anonim, 2008-2019
115	2010	S. Ekşioğlu; Anonim, 2008-2019.
25	2011	S. Ekşioğlu; Anonim, 2008-2019.
25-35	2012	S. Ekşioğlu; Anonim, 2008-2019.
39	2014	L. Sınav; Anonim, 2008-2019.
50	2017	O.Onmuş

Our data showed that the breeding population of Glossy Ibises decreased steadily in Turkey. The observed decrease has started as a result of wetland drainage activities after the 1940s and 1950s and this decrease probably continued into the 1970s or 1980s. Wetland drying activities in Turkey first started as a result of laws enacted to combat malaria and have been continued in order to gain new farmland. Subsequently, with the operation of the dams and the consequent increase in the irrigated areas, the amount of water in the wetlands decreased, and intense wetland losses occurred, especially in closed basins (Ataol and Onmus, in pub. 2018). Wetland drainage has caused many waterbirds breeding populations to decrease (Onmus *et al.* 2011). Currently wetland drainages are prohibited according to the law in Turkey, but many wetlands are still in danger as a result of the changes observed in hydrological regimes in basins due to the construction of new dams and ponds, excessive water usage for irrigation and for human activities (Eken *et al.* 2006). Thus, water level changes in wetlands and direct human intervention on these natural wetland habitats are still a serious problem for many breeding waterbirds in Turkey (Gul *et al.* 2013).

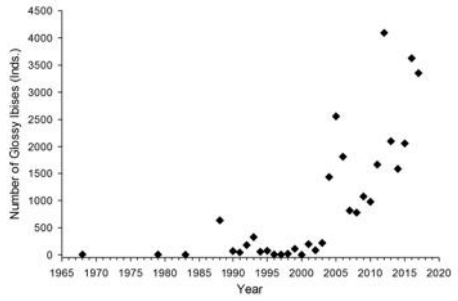
Breeding Biology

According to our observations in the field, the species prefers mainly to breed on Willow trees in its entire breeding range in Turkey. But they also breed on the ground in dense reedbeds which have stable water levels where there are no human activities and/or predation risk made by chackals, stray dogs, foxes and wild boars. Species tend to regularly visit their possible breeding location and spend a lot of time (two or four weeks in Manyas Lake before laying eggs) in or in the vicinity with the aim of checking the nest site security and appropriateness. They seem to be more sensitive to disturbances and/or predation than other similar species. During the onset of the breeding season, human activities and/or possible predators (mainly mammals) may easily change their breeding decision. Due to this behaviour, the species was observed to breed later than other similar species in the large breeding colony of the Manyas Lake.
Wetland drainage, water pollution, habitat alterations mainly due to cutting the Willow trees and reedbed fires, have caused a dramatic decrease and fluctuation in all *Ardeidae* and *Threskiornithidae* species in their entire breeding populations in Turkey (Gul *et al.* 2013).

Wintering and migration populations

A total of 1,823 different observations made between 1968 and 2017 were found in Kusbank data. These data were corresponding to 29,989 individuals. The total number of Glossy Ibis individuals observed in a single migration flock between 1968 and 2004 shows a stable trend with approximately 200 and 300 individuals per year in spring prebreeding migration. Since 2005, however, the number of migrating Glossy Ibis started to increase and reached up to 3,200 individuals (Figure 2).

Figure 2. The number of migrating Glossy Ibises in Turkey



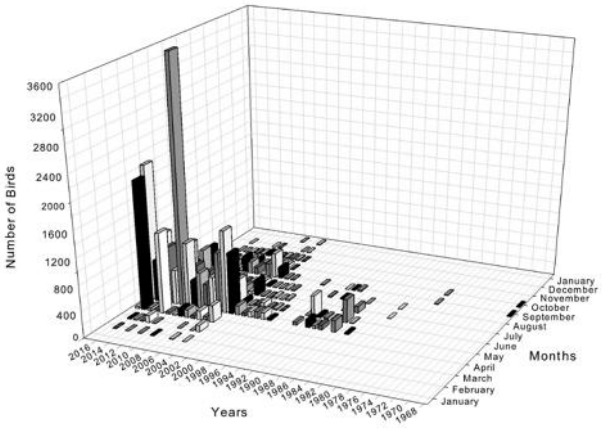
During migration season, the Glossy Ibis was observed throughout the Central and Western Anatolia. The largest prebreeding migration flocks so far has been observed in Kızılırmak Delta (3,200 Ind/per single migrating flock), Goksu Delta (2,500), Eber Lake (1,536), Meriç Delta (1,200), and Sultan Marshes (600). The observed change in the total number of Glossy Ibis individuals observed during prebreeding period between 1968 and 2017 in Turkey. This observed increase may either represent a real increase in the total number of migrating birds and/or it may represent a bias due to the increased number of observers in Turkey. More research is needed to reveal the real reason.

Total number of Glossy Ibises observed in a month in different wetlands between 1968 and 2016 are given in Figure 3. The Glossy Ibis used to be summer migrant species (i.e., observed during prebreeding period- spring migration, during breeding and post breeding period-autumn migration) between 1968 and 2004. However, after 2004 a small number of individuals started to enlarge their duration of stay during autumn and Glossy Ibises started to overwinter in small numbers in 2005, and then they became a resident species in Turkey afterwards.

Discussion

Glossy Ibis breeding population underwent a large decline during the second half of the 20th century in Turkey. The current breeding population size of Glossy Ibises in Turkey makes the species very susceptible to the risks of local extinctions, because many anthropogenic activities in wetlands in Turkey today also results indirectly in habitat degradation of the breeding waterbirds (Onmus and Sıkı 2013). Currently, we observed no direct disturbances to neither Glossy Ibises nor to the other breeding *Ardeide* or *Threskiornithidae* species. However, indirect disturbances are probably the main threat for the species and occurs by local people exploiting existing wetland products such as fishing, reedbed cutting, and hunting. The other important threat is the existing unfavourable conditions of many wetlands that experienced dramatic hydrological regimes changes both over years and over the weeks during the breeding period. Although direct wetland drying operations have long been discontinued in Turkey, the amount of water reaching wetlands has steadily decreased since the 1990s due to a steady increase in the number of dams and excessive irrigation demand for crops, especially with the increase in underground water withdrawal in closed basins (Ataol and Onmus in pub 2018). In coastal wetlands possible predation by yellow legged gulls may pose a threat (personnel observation).

Figure 3. The observed change of Glossy Ibises from a summering species into a wintering species in Turkey. Glossy Ibises used to be a summer migratory species but at the beginning of 2004's they duration of stay started to increase and they started also to overwinter in Turkey



In contrary to the observed decrease in the breeding population, the migratory population is increasing. The formation of a wintering population is thought to be the result of the global climate warming. Global climate change has already been proven to have

changed the distribution of many bird species in Turkey (Abolafya *et al.* 2013).

This study is the only study made so far on Glossy Ibises in Turkey, but there is a lot of information still missing. There is no established Species Action Plan for Glossy Ibises in Turkey. The establishment of monitoring and conservation programs is recommended. A ban of wetland destruction and rehabilitation of the key wetlands used by the species to breed is urgently needed.

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IUCN SSC Stork, Ibis and Spoonbill Specialist Group

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Twenty Two Years of Monitoring of the Glossy Ibis *Plegadis falcinellus* in Doñana

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ABSTRACT

The breeding of Glossy Ibis *Plegadis falcinellus* in Doñana has been documented between 1774 and the beginning of the 20th century, when it became extinct as regular breeder. Doñana was the last wetland where the species has bred in Spain. These ibises recolonized the Iberian Peninsula in 1973 (Albufera of Valencia) as a breeder, and in 1996 started to breed in the Ebro Delta and Doñana. Since then, the Glossy Ibis has expanded in Spain and other western Europe countries after the remarkable increase of the population in Doñana where it nests in the natural marshes. In these natural marshes there are four main breeding areas (usually with more than one thousand couples), five secondary areas (which have never reached one thousand couples), and three areas used sporadically. The breeding population has been growing, except for the dry years, from seven couples in 1996 to more than one thousand in 2004, more than seven thousand in 2011 and more than ten thousand in 2017. The total number of birds ringed until 2017 is 17,565, the 97.44% of all Glossy Ibises ringed in Spain. The total number of resightings reported is 29,199, the 99% of all the resightings of Glossy Ibises ringed in Spain. Many of these resightings proceed from European countries, North Africa, and even a few of them are from America. The Glossy Ibis is frequently observed in the area also during the non-reproductive season. Our winter censuses of the species in the Natural Area of Doñana and in the nearby rice fields are carried out in January. The resulting data show a clear growing trend and confirm that Doñana is the most important wintering area of the species in Spain.

Introduction

The Glossy Ibis *Plegadis falcinellus* is a cosmopolitan species with a worldwide but quite fragmented distribution (BirdLife International 2018). It is well known that this species bred in Doñana in the period between 1774 and the beginning of the 20th century, when it became extinct as a regular breeder (Valverde 1960). This was the last wetland where the specie bred in Spain (Díaz *et al.* 1996). Subsequently, there were three isolated breeding cases in the 1930s, 1940s and 1950s that also occurred in Doñana (Valverde 1960; Castroviejo 1993).

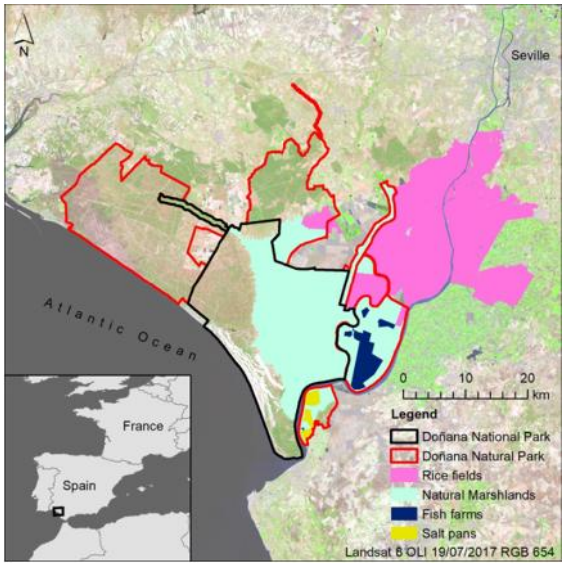
After decades of absence, in 1993 the species recolonized the Iberian Peninsula (Albufera de Valencia, Spain) as breeders (Dies *et al.* 1997), and later in 1996 started to breed in the Ebro Delta (Martínez-Vilalta 1996) and Doñana (Máñez and

Garrido 1996). Since that year, the Glossy Ibis has been expanding in Spain, especially in Doñana area, where it nests in the natural marshes (Máñez *et al.* 2009). The Glossy Ibis is frequently observed in the area also during the non-breeding season (Santoro *et al.* 2013) when it feeds mostly in rice fields and natural marshes, provided they are flooded (Toral *et al.* 2012).

Study Area

Doñana Natural Space (DNS) is a vast protected area in SW Spain covering about 122,990 ha, including the Doñana National Park and the Doñana Natural Park. Wetlands in this area are composed of natural and restored marshes (c. 31,690 ha), saltpans (c. 1,230 ha), fishponds (c. 3,214 ha) and rice fields (c. 2,076 ha). In the rest of Guadalquivir Marshes, were Doñana is located, about 34,000 ha of marshes have been transformed into rice fields (Figure 1). This area is particularly well known for its wintering waterbirds (Rendón *et al.* 2008), and also it is extremely important for breeding of colonial waterbirds such as *Ciconiformes* species (Ramo *et al.* 2013).

Figure 1. Map of Doñana Natural Space (Doñana National Park and Doñana Natural Park) and the nearby marsh transformed into rice fields. The four main environmental units are indicated: natural marshlands, fish farms, salt pans and rice fields



Methods

Estimating the number of breeding pairs

Visual estimation from vantage points: In colonies located at the periphery of natural marshes, pairs were estimated from a distance by telescope in order to minimize disturbances. For example, the José Antonio Valverde Visitor Centre roof provides excellent views of the colony of "Lucio de las Casas", where the species started to breed in Doñana in 1996 after decades of local extinction (Mañez and Garrido 1996; Santoro *et al.* 2010) and still is one of the main colonies of Glossy Ibist at Doñana.

Counts of nests on horseback or on foot by one or several observers: the methodology used to monitor the colonies inside the natural Doñana marshes consists of the systematic control of the whole marshland surface, mainly carried out on horseback. When each breeding nucleus is located, the nests are surveyed either on horseback or on foot and, if possible, through the simultaneous assistance of several observers. When the number of nests is a priori presumed to be very large, the number of pairs is estimated according to the number of adults leaving the colony.

Identification and visual count of nests by photointerpretation on the orthomosaic made by multirotor Unmanned Airborne Vehicles (Díaz-Delgado *et al.* 2017): the colony is controlled in order to make the flight when all or most couples are incubating. The subsequent photointerpretation of the orthomosaic is based on simple eye identification of the nests with incubating birds, and their automatic counting.

Ringing and data collection

In the early years when there were just a few breeding pairs, entrances to the colony were done just after the first hatching events as to attain an exhaustive control of all the nests (Máñez *et al.* 2009). Subsequently, the number of nests increased significantly (Máñez *et al.* 2009; Santoro *et al.* 2013, 2016). It was then decided not to enter the colonies until the chicks were large enough to ring and measure and to collect biological samples.

The ringing in one of the Glossy Ibis colonies at

Doñana typically requires the support of between 15 and 40 field assistants. Before starting the field-work, all of the participants are instructed on details of the field-work which consists of a coordinated surrounding of the big chicks, their manual capture and transportation to a neighbouring location where they are marked and measured. If many chicks are captured at the same time, they are placed in individual cardboard boxes in which they are quiet. Next, chicks are ringed, body traits (e.g. weight and body lengths) measured, and blood samples are taken for molecular sexing and identification of pathogens for research projects.

If the colony is in the middle of the flooded marshes, a smaller number of chicks is surrounded and captured, since it is not possible to use individual cardboard boxes. Then, most of the chicks are ringed and released immediately, except for a few that are also measured and sampled while the others are ringed.

Results

There are three kinds of colonies according to the number of breeding pairs and the occupancy: main colonies, secondary colonies and sporadically colonies (Figure 2).

Figure 2. Location of the Glossy Ibis colonies in Doñana. Main colonies: 1 FAO; 2 Juncabalejo; 3 Chujarro; 4 Caño Guadiamar Natural Park. Secondary colonies: 5 Caño Guadiamar National Park; 6 Marisma de Hinojos; 7 Marismas del Rocío; 8 Lucio del Cangrejo Grande; 9 Laguna del Tarelo. Sporadically colonies: 10 Lucio de Marilópez Grande; 11 Lucio de Los Ánsares; 12 Vado Don Simón; 13 Brazo del Este

Main colonies

Lucio de las Casas of the FAO: The "Lucios de la FAO" represent a system of three interconnected ponds covering a total surface area of c. 50 ha and flooded by direct precipitation and groundwater pumped from the underlying aquifer (Santoro *et al.* 2010).

The Glossy Ibis started to breed in 1996 in Doñana in the "Lucio de las Casas" of the FAO (Máñez and Garrido 1996). In that year, seven pairs bred successfully in the dense vegetation of *Typha spp.* after the previous installation of a colony of Purple Heron *Ardea purpurea* and Squacco Heron *Ardeola ralloides*. Since then, it also nests on *Tamarix spp*. in this area. Moreover, the Glossy Ibis has nested every breeding season except in dry years and in 2017, with a maximum of 2,400 breeding pairs in 2010. It was practically the only colony of the species until 2003.

Juncabalejo: A *Phagmites australis* area that has been fenced to protect it from cattle and predators. Glossy Ibises have nested in ten breeding seasons, with a maximum of about 6,000 pairs in 2015.

Chujarro: A *Phagmites australis* area recently fenced to limit disturbance of nesting birds. Glossy Ibises have bred here in two years: in 2017 about 3,181 pairs were estimated.
Caño Guadiamar Natural Park: A 7.6 km long fluvial marsh with many *Tamarix spp.* specimens on the banks. The colony has been occupied in four breeding seasons, with a maximum of about 2,885 pairs in 2017.

Secondary colonies

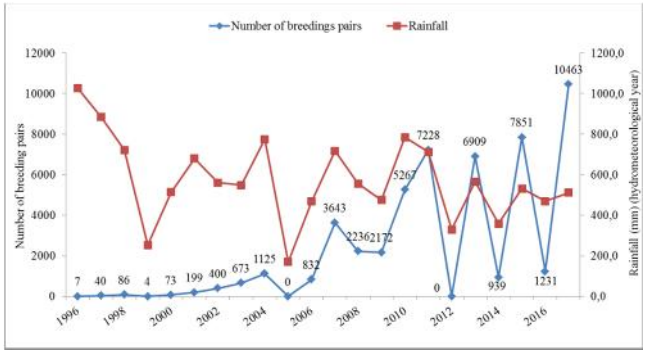
There are several colonies that have never exceeded 1,000 breeding pairs.

Caño Guadiamar National Park: The same fluvial marsh that we have previously referred to, but inside the limits of the National Park, downstream. Here there are no *Tamarix spp.* and the Glossy Ibis nests on yearly *Cyperaceae* plants in wet years.
Marisma de Hinojos: It is formed by several colonies in annual *Cyperaceae*. It is rarely used by Glossy ibis to breed which occurs especially in wet years.
Marismas del Rocío: A new colony installed in 2016 on *Tamarix spp.*, next to the village of El Rocío.
Lucio del Cangrejo Grande: Also a new colony installed in 2015 on *Phagmites australis* and *Tamarix spp*.
Laguna del Tarelo: A colony outside the natural marshes, installed on *Tamarix spp.* in an island of a small lagoon.

Sporadically colonies

The "lucios" of Marilópez Grande and Los Ánsares are two large marsh depressions formed by areas without helophytic vegetation, and other areas with *Schoenoplectus litoralis*. The Glossy Ibis has been observed breeding here only twice for each of these ponds.
In the Tamarix wood near the ford of Don Simon, a heronry is installed regularly from 2005. There, the Glossy Ibis has been observed breeding in 2016 with about thirty pairs.
A strong drought prevented the settlement of the species in the Lucio de las Casas of the FAO in 1999 (Figure 3). At that time, the majority of the population was detected in Brazo del Este Natural Site, on the left bank of the Guadalquivir River (Figure 2). Four pairs attempted to breed late in the season in a purple heron colony. However, this breeding attempt, the single in this protected natural space, turned out to be rather unsuccessful, since three of the nests were lost before hatching, and only in one of them, three chicks managed to fledge.

Figure 3. Number of breeding pairs and the total rainfall per hydrometeorological year (Blue line: Breeding Pairs; Red line: Rainfall)



Evolution of the breeding population of Glossy Ibis

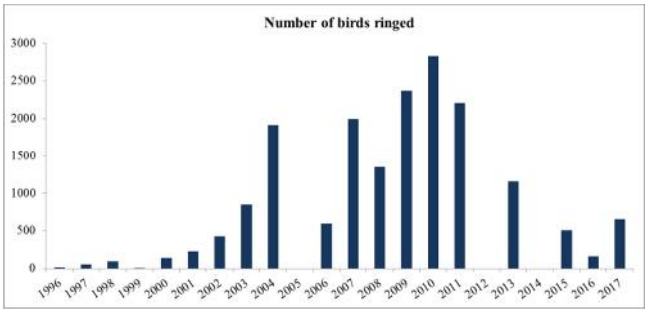
The colony installed in the "Lucio de las Casas" of the FAO grew from 7 pairs in 1996 to 40 the following year. In 1998, the nesting population in FAO doubled, and for the first time they tried to nest in a different site, specifically in a purple heron colony located in the Caño de Guadiamar, in a *Schoenoplectus litoralis* area. Two late nests were located, but none of them were successful. The year 1999 was very dry and only four pairs were installed for the first and only time in the Brazo del Este (colony number 13 in Figure 2). In 2000 the species was observed breeding again in the "Lucio de las Casas" and, since then, a continuous increase in the number of breeding pairs was observed until 2004. In addition, that year new colonies were formed and it was the first time that the number of Glossy Ibises exceeded the threshold of 1,000 breeding pairs. Since then, the population has continued growing remarkably, except in dry years (Figure 3). A similar trend can be observed in both parameters, rainfall for each hydrometeorological year and annual number of breeding pairs. In 2017, the maximum number of

Glossy Ibises ever recorded in Doñana has been reached with more than 10,000 breeding pairs.

Number of chicks ringed in Doñana and distribution of resightings by countries

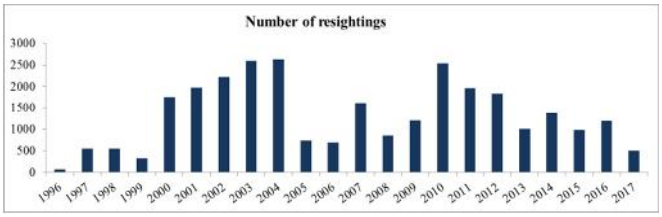
The number of ringed chicks for each breeding season is shown in Figure 4. At the present time, the total number of birds ringed over the last 22 years is 17,565. This number represents 97.44% of all Glossy Ibis ringed in Spain (N = 18,025).

Figure 4. Number of chicks ringed per breeding season



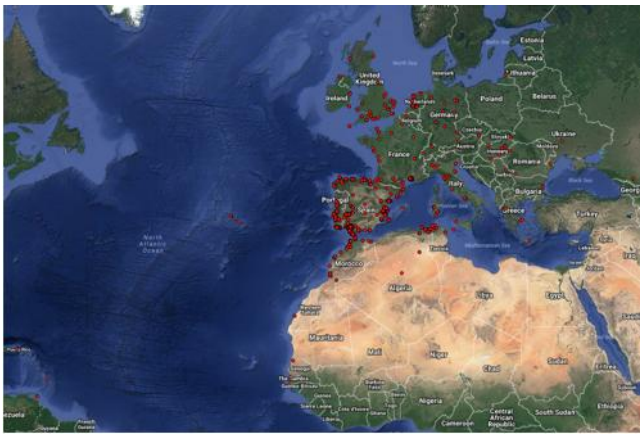
The annual number of resightings of chicks ringed in Doñana is shown in Figure 5. At this time, the total number of resightings reported is 29,199. This number represents 99% of all the resightings of Glossy Ibis ringed in Spain (N = 29,495).

Figure 5. Annual number of resightings of chicks ringed in Doñana



The ringed specimens have been observed in a large number of European countries, and also in North Africa, and even in America. The Figure 6 represents the countries and localities where the resightings of the Doñana ringed chicks have been made. The more noteworthy reports are from the Caribbean, Azores Islands, North African Atlantic coast until Gambia, Sahara Desert, Greece, Russia, Ukraine, Lithuania, the United Kingdom and Ireland.

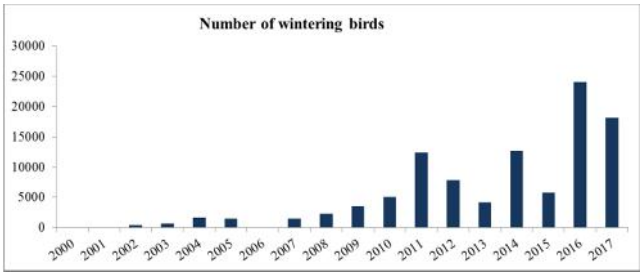
Figure 6. Countries and localities where the resightings of the Doñana ringed chicks (red circles)



Evolution of the wintering population of Glossy Ibis

We also carried out winter censuses of the species in the Doñana Natural Space and the nearby rice fields (Figure 1) in the month of January. The data show a clear increasing trend (Figure 7).

Figure 7. Number of wintering Glossy Ibis per hydrometeorological year



Until 2010, Doñana was the most important wintering area of the species in Spain (Máñez *et al.* 2012). The up-to-date data presented in this paper seem to confirm this assertion even more strongly.

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Héctor Garrido and Fernando Ibáñez (old teammates) worked with us during the first years of monitoring. Ricardo Díaz-Delgado (Remote Sensing & GIS Laboratory -LAST-, Doñana Biological Station) flew the UAV and he made the orthomosaic of the

obtained images. David Aragonés and Isabel Afán (Remote Sensing & GIS Laboratory -LAST-, Doñana Biological Station) designed the maps, and Carlos Moreno (Doñana Biological Station Ringing Office) provided us the information of ringing and sightings of chicks ringed in Doñana. A large number of volunteers have collaborated in the ringing activities and reported observations of ringed Glossy ibis in Doñana. Thanks to the different administrations of the Parks that, throughout these years, have enabled the work in Doñana. Waterbird surveys have been funded through a contract with Environment and Water Agency (AMAYA), of the Regional Environment Authority of Andalusia.

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SIS CONSERVATION 1 (2019) 104–109

SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

Status of Glossy Ibis *Plegadis falcinellus* in the Ebro Delta (Catalonia)

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ABSTRACT

In this paper we summarize the current status of the Glossy Ibis *Plegadis falcinellus* in the Ebro delta based on the information obtained from specific and non-specific bird monitoring programs developed by the Ebro Delta Natural Park's technical team. It was quite a rare species until 1990s. The first data included in the International Waterbird Census of mid-January was of one bird in 1988 and, from this year, the wintering population has grown almost exponentially. Currently counts fluctuate between 3,500 and 4,000 birds, with a maximum of nearly 6,600 birds recorded in the winter of 2017/2018. The Glossy Ibis feeds mainly in the rice paddies, particularly when they are flooded with fresh water and nearly the entire wintering population is concentrated in just a few groups. Roosting sites are located in some coastal lagoons, mainly in salt and reed marshes. The first record of a breeder was obtained in 1996 (four pairs). Since that year, growth in the breeding population has been strong and in 2014 there were 214 pairs. Until 2014 there were five breeding sites. In 1996 a special ringing programme featuring the use of plastic bands that incorporated engraved unique codes began. Of 236 chicks banded during the 1996-2017 period, 108 (45.8%) have been observed one or more times. The overall number of resightings amounted to 432, with an average of four resightings per individual (range: 1-35). 90% of resightings occurred in Spain and in the south of France, although observations were distributed among seven countries, all of which are in Europe. We took into consideration some methodological difficulties of the counting of this gregarious species, both in the winter and breeding population. We analyse succinctly its vulnerability to some agricultural changes, particularly the surface flooded decrease in rice paddies in winter.

Introduction

Until 1990s, the Glossy Ibis *Plegadis falcinellus* was quite a rare species that was sighted on a rather irregular basis in the Ebro delta. It is, however, currently present throughout the year, albeit with major monthly fluctuations. According to Wetlands International, the population of the Ebro delta is part of the Black and Mediterranean Sea/West Africa subpopulation and exceeds the threshold of 1% of the population in all periods (breeding, migration and wintering) of its life cycle.

Given this species' interest from a conservation perspective, the Ebro Delta Natural Park's technical team included it in the bird monitoring programme, adapting the monitoring methodology and frequency

to its abundance and phenological cycle. This article provides a summary of the main data obtained from monitoring.

Study Area

The Ebro delta, which covers an area of some 320 km^2, is one of the major wetlands in the Mediterranean basin. It includes coastal lagoons, shallow-water bays, beaches, dunes and freshwater marshes, brackish waters and salt flats. Nonetheless, because of the major agricultural changes that took place from the late nineteenth to the early twentieth centuries, many of the natural habitats were replaced by rice paddies, which currently occupy over 65% of the zone. This area is internationally significant because of the large number of aquatic birds: more than 30,000 pairs of more than 40 species regularly breed there (particularly coastal and marine species) and over 310,000 birds of about 100 species use the Ebro delta as a wintering zone (Curcó and Bigas 2018). The area's numerous and very diverse economic activities include agriculture (particularly rice cultivation), hunting, fishing, shell fishing, tourism, salt harvesting and livestock ranching. Some legal frameworks have been established with a view to conserving the biodiversity: Natural Park (1983), SPA (1988), Ramsar wetland (1993) and Biosphere Reserve (2013).

Methods

Breeding population

The methods for counting the Glossy Ibis breeding population in the Ebro delta have evolved over time and have been adapted, particularly, to its abundance and distribution. In the initial years (1996-2009), when only a few pairs bred, the count methodology involved prior detection from outside of colonies (mixed colonies were always formed with herons) and subsequent confirmation of breeding by visiting all nests. As the breeding population grew, this methodology became cumbersome, given that the colonies were hard to access (with a significant increase in effort) and the presence of many other species, particularly herons, which increased disturbance during the count within the colony. From 2010 onwards, the census methodology therefore changed. Counts now involve aerial photography synchronised with the census of colonial *Ardeidae*, carried out only every 4 years. The counts in the colonies located in open vegetation habitats (salt and reed marshes) are very easy, since the nests are quite exposed and the black coloration of the adults while incubating differs without any complication from other species (Purple Heron *Ardea purpurea*, Grey Heron *A. cinerea*, Western Cattle Egret *Bubulcus ibis*, Great Egret *Ardea alba*, Little Egret *Egretta garzetta*, Black-crowned Night Heron *Nycticorax nycticorax* or Squacco Heron *Ardeola ralloides*). In contrast, in Tamarix woodlands, where vegetation cover is much higher and nests can be arranged at different levels, this method is not as suitable and, in these cases, the counts are carried from the ground, avoiding a long stay in the colony.

Wintering population

The Glossy Ibis features on the list of species that are counted each year since 1972 during the International Waterbird Census (IWC) of mid-January. The count is based on the sum of the partial daytime counts recorded in the different sectors that form the Ebro delta (13 rice paddy sectors and 12 natural habitat sectors, including the Ebro River, the coastal lagoons, the bays and the marshes). The count in all sectors is performed, on average, in 15 days (asynchronous method). When the winter population of Glossy Ibis was small (1972-2014), sources of error were negligible, but as the population grew, the probability of double counts or false zeros increased. This is particularly significant, given the high level of gregariousness and considerable mobility of this species in the rice paddy sectors. In order to minimise these sources of error, recent years (2015-2016) have seen the use of other methods such as synchronous counting or, in other words, the performance of a swift specific census by surveying all the sectors in a day. Evening census methods have also been tested (2015-2016) given that this species forms large roosts in the evening.

Monitoring of other aspects

The movement patterns of the Glossy Ibis in the Ebro delta have been studied by means of two methodologies: fortnightly censuses of aquatic birds in the main wetlands and the programme of ringing birds with special bands. The fortnightly censuses of aquatic birds are part of the Natural Park bird monitoring programme and this species was only included from 2000 to 2006, the period covering the initial years of colonisation of the Ebro delta.

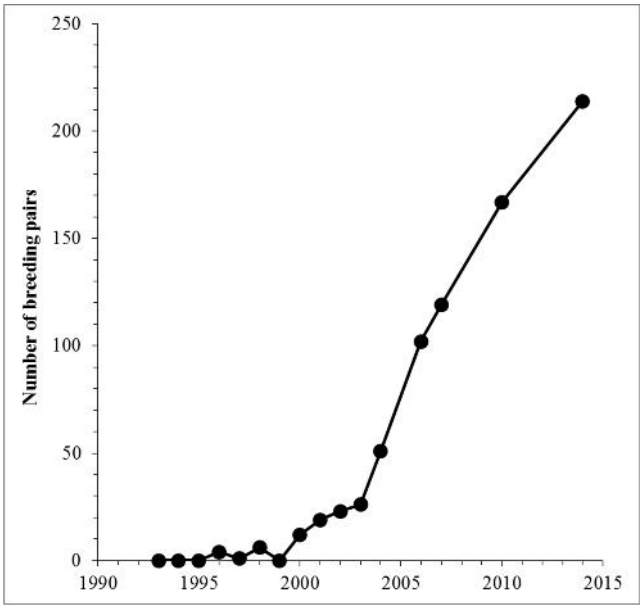
In 1996 a special ringing programme began which featured the use of plastic bands that incorporated engraved unique codes, supplied by and coordinated with the Doñana Biological Station (Spain). Banding and observations data management is performed by means of an Access program that was developed by the team from La Tour du Valat (France). These data not only provide information about the species' migratory patterns, but also help to reveal other essential aspects associated with conservation: demography, degree of interrelation with other populations, etc. During the 1996-2017 period, 236 chicks were banded with these special bands.

Results

Breeding population

The first records on breeding in the Ebro delta were obtained in 1996 (Martinez Vilalta 1996), a year in which 4 pairs settled on Illa de Buda. Since that year, growth in the breeding population has been exponential and in 2014 there were 214 pairs (Figure 1). The breeding population in the Ebro delta appears to fluctuate less than those of the Guadalquivir river wetlands, probably because the area covered by the flooded rice paddies is more stable (Máñez and Rendón-Martos). Depending on the year, the Ebro delta hosts between two and 36% of the population in Spain. Until 2014 there were five breeding sites, which correspond to three coastal lagoons (Illa de Buda, Encanyissada and Canal Vell) and are always located in areas of reed swamps, halophilous salt marshes and tamarisk woods and associated with *Ardeidae* colonies.

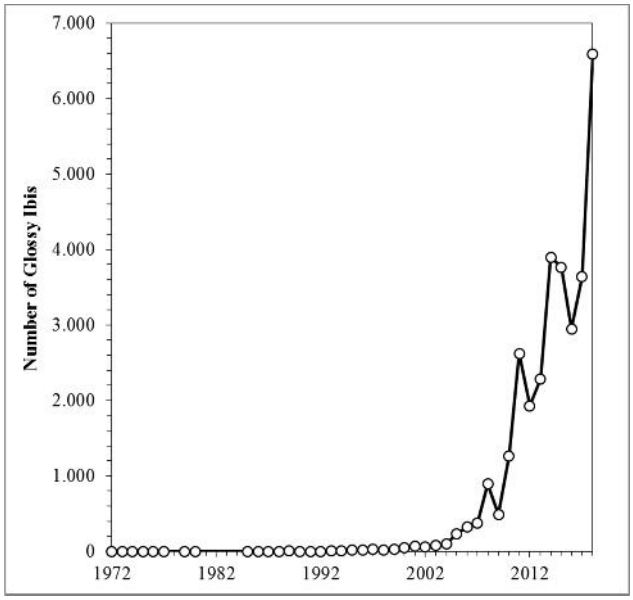
Figure 1. Evolution of the breeding population of Glossy Ibis in the Ebro delta (Years in X axis)



Wintering population

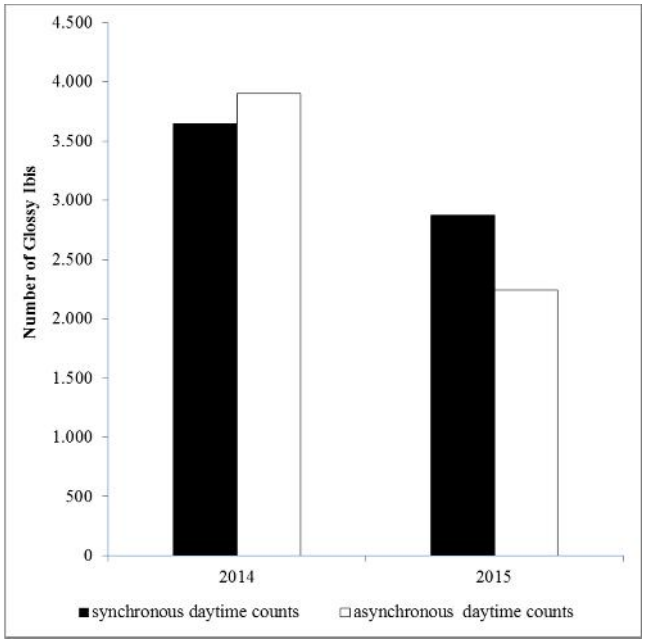
The first count performed as part of the International Waterbird Census (IWC) of mid-January took place in 1988, when 1 bird was counted. Since that year growth in the wintering population has been exponential (Figure 2) and it currently fluctuates between 3,500 and 4,000 birds (Curcó and Bigas 2018), with a maximum of nearly 6,600 birds in the winter of 2017/2018. In recent years, the winter population in the Ebro delta has accounted for between 20 and 25% of the population in Spain (Gonzáles and Pérez-Aranda 2011).

Figure 2. Evolution of the winter population of Glossy Ibis in the Ebro delta (Years in X axis)



In the Ebro delta, the Glossy Ibis feeds mainly in the rice paddies, particularly when they are flooded with fresh water (Curcó and Bigas 2018). Nearly the entire wintering population is concentrated in just a few groups, which move erratically in search of areas of food. In the evening, the concentrations are even larger and they form sizeable roosts in some coastal lagoons, particularly Els Calaixos de Buda and L'Encanyissada. After several trials, we have determined that the method of counting at the roosts is rather complicated, because prior to entering the roost they circle it often and, moreover, visibility is very poor. Roost wintering censuses, widely used for other highly gregarious species such as the Great Cormorant *Phalacrocorax carbo*, the Western Marsh Harrier *Circus aeruginosus* and some *Ardeidae* (Little Egret, Western Cattle Egret and Black-crowned Night Heron), seems to be unsuitable for the Glossy Ibis. The comparison between the synchronous and asynchronous count methods are still not very conclusive although in one of the 2 years during which they have been tested there were differences of over 20% (Figure 3, Curcó and Bigas 2018). The synchronous count is probably the most accurate method for the Glossy Ibis wintering census. This method, used for years for the wintering counts of the Greater Flamingo *Phoenicopterus roseus* in the Ebro delta, assumes, however, an increase in effort compared to asynchronous method.

Figure 3. Comparison of the methods for counting the Glossy Ibis in the winter census of aquatic birds in the Ebro delta (International Waterbird Census Data)



Monitoring of other aspects

Fortnightly censuses of aquatic birds (2000-2006) reveal population minimums during the breeding season (June-July) and maximum values during post-breeding migratory movement and winter (Figure 4).

Figure 4. Monthly variations in the population of Glossy Ibis in the Ebro delta (2000-2006)

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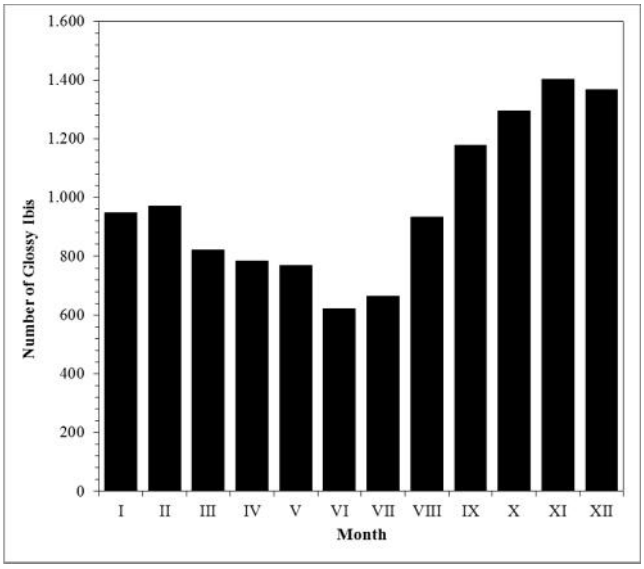
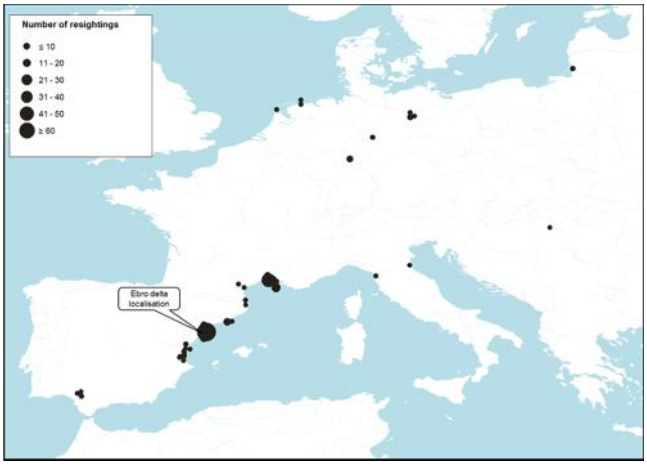


Of 236 chicks banded during the 1996-2017 period, 108 (45.8%) have been observed one or more times. The overall number of resightings amounted to 432, with an average of four resightings per individual and a range of between one and 35 resightings. Although observations were distributed among 7 countries, all of which are in Europe, 90% of resightings occurred in Spain and in the south of France (Figure 5). There were no observations in the north of Africa

Figure 5. Map of distribution of resightings of Glossy Ibis chicks banded with special tags in the Ebro delta



Discussion

In recent decades, the Glossy Ibis, like other species (e.g. Great Egret, Mediterranean gull *Ichthyaetus melanocephalus*), has been experiencing a process of expansion, from East to West, in the Western Palaearctic (Bekhuis *et al.* 1997; Ławicki 2014). In the Ebro delta, colonisation took place in the nineteen-eighties, first as a migratory and wintering species and, from the 1996, as a breeding population. In this process, population increases in the Ebro delta have been very significant and virtually exponential, and account for between 20 and 25% of the wintering population (1991-2015), and between 2 and 36% of the breeding population (1993-2015) in Spain.

The success of this colonisation is probably due to good adaptation resulting from use of the flooded rice paddies as feeding zones and to the existence of ideal and sufficiently isolated and peaceful breeding sites in natural habitats (reed swamps, halophilous salt marshes and tamarisk woods). Winter flooding of rice paddies is a practice that was promoted as an agri-environment measure in the Common Agricultural Policy (CAP) between the late nineteen-nineties and 2014. However, in the new Rural Development Programme (2014-2020) of Catalonia, flooding is no longer encouraged and the area of flooded rice paddies has decreased from about 20,000 to 3,400-8.900 ha in 2016-2017. High winter dependence of the Glossy Ibis on flooded rice paddies as feeding habitat represents a significant threat, which also affects many other species of aquatic birds.

The Apple Snail *Pomacea insularum* is a mollusc that is native to freshwater areas in South America and has invaded many countries with a tropical or temperate climate. It features among the “100 of the World’s Worst Invasive Alien Species” (Lowe *et al.* 2000) and since 2009 has invaded the Ebro delta and become an agricultural pest in the rice paddies. In 2010 a programme was initiated to fight the Apple Snail and has entailed winter management of the rice paddies (drying, forced salinization of the paddies and of agricultural channels) and the use of saponins. SEO/BirdLife has also recently initiated a study on the role of the Glossy Ibis in controlling this exotic species, based on analysis of stable isotope ratios as biomarkers of diet. The results, albeit in a very early

stage, are very promising.

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IUCN SSC Stork, Ibis and Spoonbill Specialist Group

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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

The Current Status of the Glossy Ibis in Italy with an Update on Distribution and Population Trend

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ABSTRACT

This paper reviews the status of the Glossy Ibis *Plegadis falcinellus* in Italy reporting updated information on the distribution and numbers of the breeding and wintering population. In Italy, until the last five-ten years, this ibis species was considered a regular migrant, an irregular and localized breeder, and a rare and uncommon wintering species. Breeding was historically known in some heronries located in northern Italy and a few other sites irregularly occupied in Apulia and Sardinia. During migrations, single individuals and small flocks were more frequent and regular in April and September. These data contrast with the information from the 19th and early 20th centuries when the Glossy Ibis were observed throughout entire Italian peninsula and up to thousands of individuals were recorded in Sicily in the spring and several hundreds of breeding pairs were recorded in Piedmont. A slow but significant change in the distribution and number of Glossy Ibises has been recorded from about the year 2010 when Glossy Ibises have been seen during the whole year and across the whole country, a larger number of wintering birds have been reported, and the breeding population has increased in number, spreading into new areas. From recoveries of colour-ringed ibises, changes in population size and distribution observed in Italy could be linked to the expansion of the new increasing population in Western Europe. Because of its pivotal position at the centre of the Mediterranean basin, Italy can play a significant role as a bridge between western and eastern populations, contributing to the conservation of the Glossy Ibis along the African-Eurasian Waterbird Agreement (AEWA) flyway.

Introduction

In Italy, for a long time, the Glossy Ibis *Plegadis falcinellus* has been considered a regular migrant, an irregular and localised breeder, and a rare and uncommon wintering species (Brichetti 1983; 1992). Breeding was historically known in some heronries located in northern Italy (Piedmont and Emilia-Romagna) and a few other sites irregularly occupied by a few pairs in Apulia and Sardinia. During migrations, single individuals and small flocks were more frequent and regular in April and September, with higher numbers recorded in southeastern Italy and Sicily in spring and in the Po Plain and along the Tyrrhenian coast in autumn. Far in the past, up to thousands of individuals were recorded in Sicily in April (Doderlein 1869) but, although with lower numbers, the entire Italian peninsula saw movements of Glossy Ibises, probably because of its central geographical position in the Mediterranean, between

the past stronghold of the species in eastern Europe and the former USSR and the winter quarters located in Africa (Cramp and Simmons 1977). As reported in other European countries (Bauer and Glutz von Blotzheim 1966; Matvejev and Vasic 1973), winter records have been sporadic and very rare until recently, with only seven reports between 1871-1977 (Brichetti 1983). Since the 1980s, and especially in the last five-ten years, several changes in phenology, distribution and size of the breeding and the wintering population have been recorded. New breeding sites have been occupied and observations of single individuals or flocks up to 50 birds have become increasingly common both outside the historic distribution range and in winter. In Italy no monitoring program has ever been devoted to the Glossy Ibis and this has led to a lack of continuous data available on this species. Furtermore, information is often scattered among different sources, making retrieval difficult. In this paper, the status of the Glossy Ibis in Italy is updated, describing the recent changes in phenology, distribution and population trend. Recoveries of Glossy Ibises ringed in Italy and abroad are also analysed, linking the observed population changes to the movements and the immigrations of Glossy Ibises born in the rapidly growing colonies established in southern Spain and Camargue (France) (Ramo *et al.* 2013; Thibault *et al.* 2014).

Methods

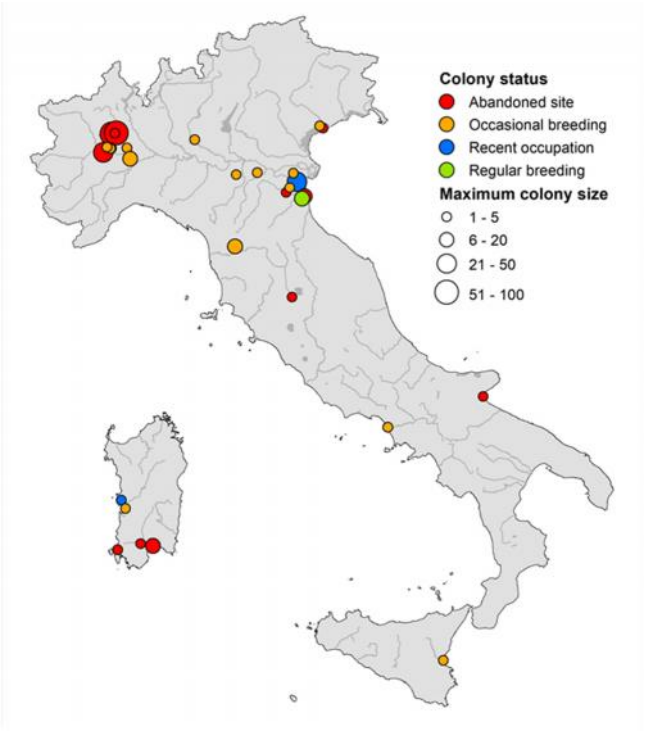
The national and local ornithological literature was reviewed and reports, ornithological blogs and websites, birdwatcher's e-lists and forums were accessed looking for historical (from the early 1900s onwards) and new data on the distribution and numbers of breeding and wintering Glossy Ibises. All information was checked, with old data revised and new data collected from different sources ammended to delete double observations, or data that could refer to the same birds if reported in the same localities, nearby areas or within the same period of time. All verified data was entered into a geo-database for analysis. Information on Glossy Ibises breeding in the Po Delta and most data on ringed birds come from the field work carried out by the Author's team since the early 1990s on colonial waterbird ecology (Costa *et al.* 2009; Passarella and Volponi 2009). Other data on Glossy Ibises ringed and recovered in the period from 1925 to 2017 have been provided by the Italian ringing scheme based at the ISPRA in Ozzano Emilia (Bologna).

Results

Breeding distribution and trend

Earliest data on Glossy Ibis colonies date back to the 15th and 19th centuries, when breeding was reported in mixed heronries located in the municipalities of Malalbergo (Bologna) and Argenta (Ferrara) (Brichetti 1983; 1992). In mid 1916-17, several hundreds of breeding pairs were recorded in Piedmont but, due to persecution, colonies disappeared by 1927 (Brichetti 1992). Later on, breeding was reported only at Verrua Savoia (Torino) in 1959-1964 and, from 1970 at Daunia Risi (Foggia) and Punte Alberete (Ravenna). The latter colony, located in the southern Po Delta, is the only breeding site regularly occupied almost every season for almost 50 years (Brichetti and Fracasso 2003; Costa *et al.* 2009, Volponi and Emiliani unpubl. data). From 1980 to 2009 occasional breeding was also reported for southern Sardinia, Sicily, Tuscany, the Lagoon of Venice and a few localities in the eastern Po Plain (Figure 1).

Figure 1. Map of breeding sites reported since early 1900s to now. The actual status and the maximum number of nests recorded at each site are also reported. In abandoned sites breeding has never been reported in the last twenty years or more up to now, or the habitat changed becoming unsuitable for the reproduction of Glossy Ibises. In occasional breeding sites, Glossy Ibises have bred in one or more seasons, even non-consecutive, since the year 2000 onwards. Regularly breeding refers to the colony of Punte Alberete, while in recent occupied sites Glossy Ibis are known to breed only since 2015

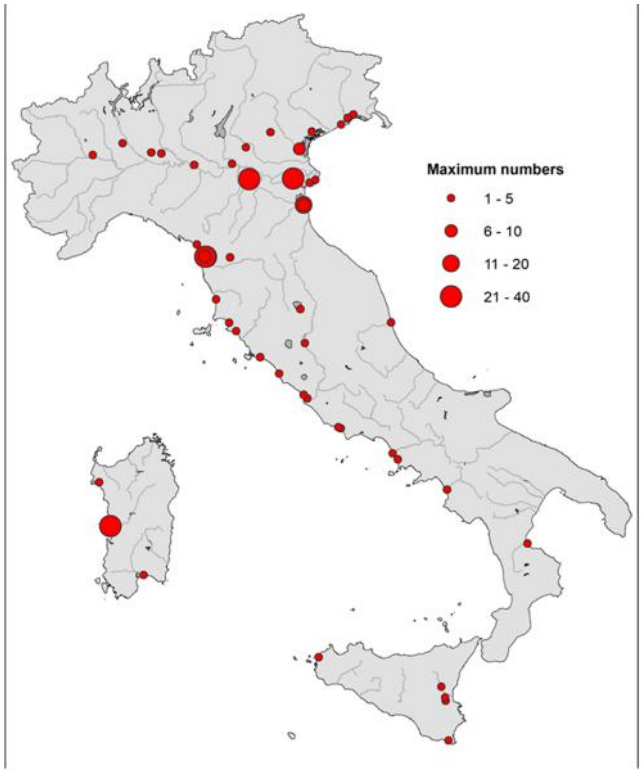


In these three decades, Glossy Ibises were known to breed in about 15 sites, most of them irregularly occupied by single pairs or small groups of birds (1-12 nests), which bred for just one or a few consecutive seasons. From 2010 onwards, things started to change. Breeding was reported from 17 mixed heronries, mostly located in the Po Plain (plus two in Tuscan inland, coastal Campania and western Sardinia) with colony sizes ranging from 1 to 30-40 nests. Nowadays, the overall population is growing, but it is still small compared to the rapidly expanding populations in Portugal, Spain, France and Algeria. Lack of a coordinated and exhaustive census does not facilitate the drawing of a complete trend line, but available data allows for an estimate of the Italian population in 0-24 breeding pairs (bp) in the 1960s, 0-18 bp in the 1970-2000s and 10-50 bp in the years from 2010 to 2016 (Brichetti and Fracasso 2003; Grussu 2019; Volponi this paper).

Wintering

Winter observations of Glossy Ibises had always been very rare until the early 1980s, when small groups of 9-25 birds had been observed in the lagoons near Cagliari (southern Sardinia) (Grussu 1987; Brichetti 1992). During the 1990s and the 2000s small groups of wintering birds have been regularly reported in Sardinia, Sicily, and in a few other sites in continental Italy (Serra *et al.* 1997; Baccetti *et al.* 2002). In January 1992-1995, 13-28 Glossy Ibises were counted in 1-5 localities. Numbers remained low in the following fifteen winters (3-20 Glossy Ibises reported 2-4 localities) with the exception of two peaks recorded in January 2005 and 2006. In midwinter 2006-2010, more than 90% of the average numbers of Glossy Ibises have been seen in only four localities (one located in north continental Italy). On average, in 2001-2010, 20-50 Glossy Ibises per winter have been reported during the mid-January International Waterbird Counts (IWC), with a maximum of 62 Glossy Ibises recorded in five sites in January 2005 (Zenatello *et al.* 2014). Overall, Glossy Ibises were more regular and numerous in Sardinia, Sicily and central-southern Italy, where, however, no site has been constantly and continuously used for more than a few consecutive winters. Less than 20 Glossy Ibises have been recorded in the winters of 2008-2013, but since then the trend has continued to be positive and in January 2016 and 2017 about 90 birds have been counted in a dozen of sites. In recent years, Glossy Ibises have been regularly observed in the wetlands of Sardinia, Sicily, Tyrrhenian Sea coast, Po Plain, the coastal lagoons of the northern Adriatic Sea and some large wetlands in central Italy (Figure 2).

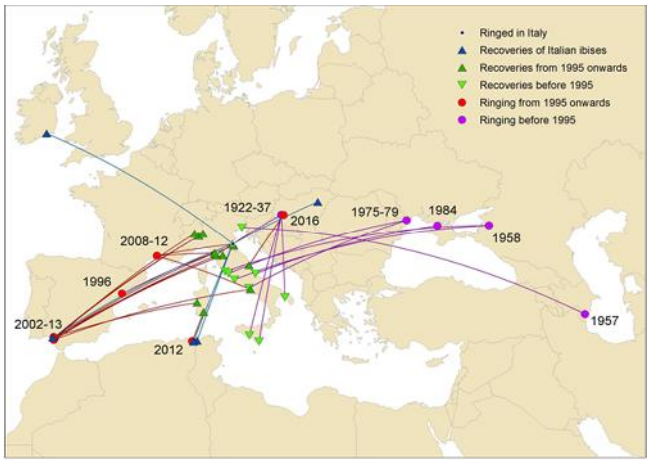
Figure 2. Map of Glossy Ibis observations reported in winters 2010-2017. Only data recorded in the period of November-February are shown. Duplicate data and observations that could refer to the same individual or flock have not been considered here. In winter, distribution of Glossy Ibises is clearly associated with wetland availability. Glossy Ibises are more common in freshwater wetlands along the river Po and its tributaries in the Po Plain as well as in coastal lagoons of the northern Adriatic Sea and Sardinia. They also occur at river mouths along the Tyrrhenian coast and in few inland freshwater wetlands of central Italy



Origin and movement

Recoveries of marked Glossy Ibises were very rare until 2005, when the first observation of a colour-ringed bird was recorded. From 1925 to 1984, only ten Glossy Ibises ringed at the nest in colonies located in the Kis-Balaton (Hungary), the Dniestr Delta (Ukraine), the mouth of the River Beisug (Russia), the Gulf of Perekop (Krimea) and the Kura Delta (Azerbaijan) were reported to the Italian Ringing Centre. All these Glossy Ibises had been shot along the Italian coasts during spring or autumn migrations (Brichetti 1983; Spina and Volponi 2009). No marked ibis was then reported until late December 1996, when a bird born in the Ebro Delta (Spain) was seen in the southern Po Delta. From 2005 to March 2017 twelve Glossy Ibises wearing colour rings have been spotted. Except one born in the Kis-Balaton, all of them have been ringed in the new colonies established in the Coto Doñana, the Ebro Delta, the Camargue and Dakhla (northern Algeria) (Figure 3).

Figure 3. Recoveries of Glossy Ibises ringed in Italy and recorded abroad, and vice versa, reported from 1924 to March 2017. For the 26 Glossy Ibises ringed outside Italy, the ringing year or interval of years are shown close to each ringing locality. From 1982 to 2017, 97 Glossy Ibises were ringed in Italy, and six of them were observed 36 times abroad. For each bird, however, only the first recovery is shown here



Recoveries of five nestlings ringed in Italy in 2008-2011 show a similar pattern of movements across southern Spain, eastern Europe and North Africa, while an observation carried out in Ireland in December 2016 confirms the nomadic behaviour of some individuals as already reported by Cramp and Simmons (1977) and more recently by Mañez *et al.* (2019).

Discussion

From historical and recent data the core breeding area of the Italian Glossy Ibises extends over the river Po plain, from the main rice fields area of Piedmont and Lombardy to the semi-natural freshwater wetlands in the Po Delta and the lagoon of Venice. Single pairs or small groups established in Sardinia, Sicily and southern continental Italy, bred only for one or few

seasons, which is typical of birds nesting at the border of their main breeding range and for this species known to shift nesting sites quickly (Hancock *et al.* 1992). In Italy Glossy Ibises have always bred in mixed heronries, mostly with herons (*Ardea cinerea, Ardeola ralloides, Nyctycorax nyctycorax*) and egrets (*Ardea alba, Ardea ibis, Egretta garzetta*), but also with Eurasian spoonbills *Platalea leucorodia* and cormorants (*Phalacorcorax carbo, Microcarbo pygmeus*). Finding the few and well-hidden nests of the Glossy Ibis in mixed colonies has always proved difficult and it is possible that some breeding events have not been reported, also considering the irregular breeding and low number of pairs involved in most of the nesting attempts. Thus, both colony distribution and population size may have been, to some extent, under-estimated. However, the Italian population has always been very small and only over the last three to five years has shown a slight positive trend. A similar positive trend has affected distribution and number of Glossy Ibises seen during the whole year. Nowadays, the observations of Glossy Ibises in winter, during post-breeding dispersal and migrations are becoming more frequent than ever in the last century, especially in the eastern Po Plain and along the Tyrrhenian and the northern Adriatic coasts. Regular wintering occurs now in north-eastern Italy, in wetlands along the Tyrrhenian coast, in Sicily and Sardinia, while in the Po Delta the Glossy ibis is becoming a resident bird.

In the past, factors limiting the breeding population were wetland transformation, direct persecution and killing of adults and nestlings for consumption (Moltoni 1936). Although protected since 1977, the illegal killing of Glossy Ibises and other waterbirds still occurs in some breeding areas and in hot spots used in autumn and winter (e.g. Campania, Puglia, Po Delta). Illegal shooting may have been one of the causes of the low number of ibises wintering in Italy until a few years ago, considering that most of their wintering sites coincide with the areas with the highest waterfowl hunting pressure. Habitat degradation (e.g. salinization of the water table in coastal freshwater wetlands), loss of foraging areas and prey (e.g. water pollution, transition from wet to dry rice cultivation, introduction of alien species) can limit population growth and the expansion of the Glossy Ibis range in Italy. On the contrary, positive factors are the overabundant general availability of the Red swamp crawfish (*Procambarus clarkii*), the increased winter survival due to milder winters and the recruitment from rapidly expanding colonies in Spain, Camargue and northern Algeria. In some areas (e.g. northwestern Po Plain and the Po Delta), Glossy Ibises and African Sacred Ibises *Threskiornis aethiopicus* breed, roost and forage in close association, but, at least for now, there are no elements suggesting any negative impact of the larger exotic species on the autochthonous ibis.

In the last century and until today, recruitment from Glossy Ibises born in Italy was low and likely not sufficient to support a viable population without a constant immigration of new breeders. Recoveries of ringed birds show that Glossy Ibises historically observed in Italy were linked to populations distributed from Hungary to the Black Sea and the Caspian Sea. During the 20th century and even today, these eastern populations have remained stable or have declined (Cramp and Simmons 1977), so the flux of potential immigrants was not enough to promote the growth of the Italian population. Therefore, the recent increase of Glossy Ibis numbers observed throughout the year in Italy could be the consequence of the dramatic population growth occurring in the colonies of southwestern Europe (Santoro *et al.* 2010; Kaiser *et al.* 2014). Italy lies at the centre of the Mediterranean Sea, where Glossy Ibises from Spain and Camargue can meet and mix with individuals flying from the Balkans, the Black Sea and the Caspian Sea towards the wintering quarters located in North and sub-Saharan Africa. Italy can thus play a significant role as a bridge between western and eastern populations, contributing to the conservation of the Glossy Ibis along the African-Eurasian Waterbird Agreement (AEWA) flyway.

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The Changing Status of the Glossy Ibis *Plegadis falcinellus* in Britain

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ABSTRACT

Numbers of Glossy Ibis recorded in Britain have increased dramatically since the mid-2000s, mirroring the increase in their breeding population in southwest Europe, especially in Doñana (south Spain). Despite the increasing number of records in Britain, there are still only small numbers of Glossy Ibis present in spring and, so far, only two nesting attempts. The majority of Glossy Ibises recorded in Britain arrive in autumn, with re-sightings of colour-ringed birds indicating that most arrive during their first year. Our results indicate that, regardless of any common trend, larger numbers of Glossy Ibis tend to be recorded in Britain in years when smaller numbers have bred in Doñana. A higher proportion of Glossy Ibises then tend to be present in Britain in spring compared to the previous autumn, when temperatures are higher during the winter in between. In short, our results suggest that Glossy Ibis is more likely to breed in Britain when poor conditions for breeding in Doñana are followed by mild winters in Britain. Although we expect Glossy Ibis to begin breeding regularly in Britain eventually, there are probably very few wetlands in Britain large enough to support breeding colonies of significant size.

Introduction

Until the early decades of the twentieth century, Glossy Ibis *Plegadis falcinellus* was a fairly regular visitor to Britain, with 340 accepted records prior to 1950 (http://www.rbbp.org.uk/). The number of records then declined, probably mirroring the decline in their breeding population in southeast Europe (e.g. Doroşencu *et al.* 2019; Puzović *et al.* 2019), their main breeding population in the region at that time. Glossy Ibis became a very rare visitor to Britain until the early 2000s, albeit with two long-staying individuals present in Kent during the period between 1975 and 1992 (Brown and Grice 2005). Major arrivals of Glossy Ibises into Britain took place in the autumns of 1986 and 2002 (http://www.rbbp.org.uk/), after which numbers recorded in Britain have shown an upward trend, which we quantify and report on in the Results.

The 1986 arrival took place before the re-establishment of regular breeding by Glossy Ibis in southwest Europe in 1993 (Santoro *et al.* 2010; Vera *et al.* 2019), but the subsequent increase in numbers of sightings in Britain has coincided with a period of growth in their breeding population in the Iberian Peninsula and south France. In these areas, the breeding populations have shown a remarkable increase, especially in Doñana (south Spain) which nowadays hosts the main breeding and wintering populations of Glossy Ibis in Europe (e.g. Santoro *et*

al. 2016; Mañez *et al.* 2019; Champagnon *et al.* 2019).

It remains to be seen whether Glossy Ibis might start breeding regularly in Britain. Two breeding attempts have already occurred. The first took place in 2014, and involved a pair of birds displaying at RSPB Frampton Marsh in Lincolnshire in eastern England, one of which then built a nest platform (Holling *et al.* 2016). Then in 2016 a pair summered at RSPB Ham Wall in Somerset in southwest England, and built a nest platform in the old nest of a Eurasian Coot *Fulica atra*. Ham Wall forms part of a large (ca 1,200 ha) complex of wetlands in Somerset known as the Avalon Marshes. A limiting factor for the breeding of the Glossy Ibis in Britain could be the ability of juveniles to survive the winter and remain in the area until they can breed. We are not aware of any information regarding the effect of winter conditions on the probability of ibises remaining in Britain from autumn to spring.

In this study we aim to (i) describe the changing status of Glossy Ibis in Britain by reporting the variation in the yearly and monthly frequency of sightings and their spatial distribution; (ii) test whether numbers of Glossy Ibis recorded in Britain are explained by the dynamics of their breeding population in Doñana; and (iii) evaluate whether numbers of Glossy Ibis in Britain in spring relative to autumn might be negatively affected by winter conditions.

Methods

Description and comparison of numbers in Britain and Doñana

First, we summarised long-term (1950-2016) changes in the status of Glossy Ibis in Britain using numbers of accepted records of Glossy Ibis in Britain each year. Before 1 January 2013 records of Glossy Ibis were collated by the British Birds Rarities Committee (BBRC) (https://www.bbrc.org.uk/), the official adjudicator of rare bird records in Britain. After this date, Glossy Ibis ceased to be classified as a rare bird, which meant that records of them ceased to be assessed by the BBRC. Subsequent records have instead been assessed by county record committees, and collated to produce an annual report on scarce migrant birds in Britain (e.g. White and Kehoe 2017). Both systems of assessing and collating records list the location, and first and last dates, of each record. This information is used to estimate the numbers of newly arrived Glossy Ibises each year. Most apparently recently arrived flocks of Glossy Ibises in Britain have broken into smaller groups and dispersed within a few days. Based on this, and on observations of colour-ringed Glossy Ibises in Britain, the BBRC and scarce migrants reports presume that most subsequent records are of individuals from these dispersed flocks (e.g. Hudson *et al.* 2010, 2011). Hence the figures produced by the BBRC and scarce migrants reports will tend to under-estimate numbers of Glossy Ibis arriving in Britain, rather than double-count birds.

The numbers of Glossy Ibis pairs in Doñana, their most important breeding site in western Europe, have been collected since 1996 by the Monitoring Team of Natural Processes of the Biological Station of Doñana (see Mañez *et al.* 2019 for details on visual count methodology). For each population (Doñana breeding pairs and British records), we performed a Poisson GLM (glm function in R, R Core Team 2017) to assess the linear trend of their annual numbers in the period 1996–2016. Given that we were interested in estimating the two populations' trends if both of them had started in 1996, we added a zero to each data set for 1995, and for each series we ran a model without intercept to make the two coefficients comparable.

Then we investigated whether variation in the number of records of Glossy Ibis recorded in Britain each year was explained by variation in the breeding population in Doñana (see Mañez *et al.* 2019). The analysis of the two time-series cross-correlation was performed using Autobox (Version 6.0, Automatic Forecasting Systems Inc., Hatboro, Pennsylvania, USA). This software implements an automatic algorithm capable of detecting, estimating and adjusting for the presence of (i) outliers (shift-levels or pulses), (ii) autocorrelation and (iii) non-stationarity in the auto-regressive integrated moving-average (ARIMA) model. The number of annual records in Britain was set up as the dependent variable, and the annual number of breeding pairs in Doñana as the independent variable. Since most

apparently recently arrived ibises in Britain are first year birds, we defined the model as to allow only immediate (no lagged) effects. The results of this analysis indicate whether variation in numbers of ibises breeding in Doñana explains variation in numbers recorded in Britain during the same year, net of any common trend between the two series.

Monthly frequency and spatial distribution

We investigated changes in the monthly abundance and spatial distribution of Glossy Ibis in Britain since the start of recent influxes in 2002. To do this, we calculated the number of Glossy Ibis 'bird-site-days' per month. For each accepted record, we multiplied the number of ibises recorded at a site by the number of days between the first and last date they were recorded there. To investigate changes in the abundance of ibises, we then summed the number of ibis 'bird-site-days' in each month, and divided this by the total number of days in the month. This provided an estimate of the mean number of Glossy Ibises present in Britain per day during each month. We investigated the geographical distribution of ibises by summing the number of ibis 'bird-site-days' in each bird recording area in Britain.

Winter conditions and numbers of ibises present in spring compared to the previous autumn

We also investigated the relationship between the abundance of Glossy Ibises in Britain in spring compared to in the previous autumn, and the mean temperature of the winter in between. We ran a Spearman correlation test (cor.test function in R) between the (i) ratio of 'bird-site-days' in April and May and 'bird-site-days' during the previous September and October and the (ii) mean UK temperature anomaly during December to February inclusive. Temperature data were from the UK Met Office (https://www.metoffice.gov.uk/climate/uk/summaries/anomalygraphs). For this analysis we only used data collated in the period 2009-2015, since very few ibises were present in Britain in autumn and/or spring before then.

Results and Discussion

Description and comparison of numbers in Britain and Doñana

After the long period between 1950 and 1986 when the species was almost absent in Britain, numbers of Glossy Ibis recorded in Britain have increased dramatically, particularly since 1996 when the Doñana colony became established (Figures 1 and 2). The Doñana yearly rate of increase has been 1.92 times greater than that in Britain (on the log-scale, Doñana: $\beta = 0.427$, SE = 0.00027, $p < 0.001$; Britain: $\beta = 0.222$, SE = 0.00209, $p < 0.001$). This is not surprising, given that the growth rate in Doñana is determined by the population's high breeding productivity (Santoro *et al.* 2016), whereas the population in Britain comprises birds that have dispersed from other areas.

Figure 1. Numbers of accepted records of Glossy ibis in Britain between 1950 and 2016

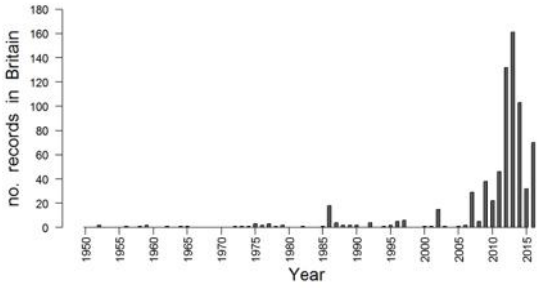
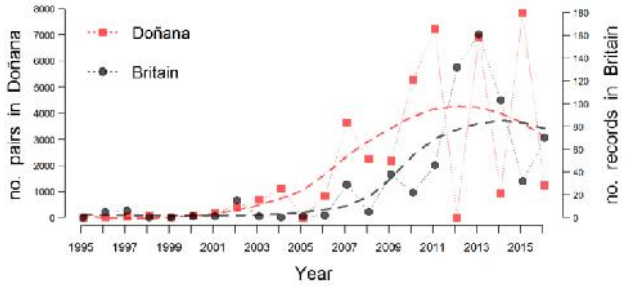


Figure 2. – Numbers of breeding pairs of Glossy Ibis in Doñana and numbers of accepted records of Glossy Ibis in Britain during the period 1996 – 2016. Red squares and dashed line indicate, respectively, the number of breeding pairs in Doñana and the relative smoothed trend. Black circles and dashed line the number of accepted records in Britain and the relative smoothed trend



According to the final model selected by Autobox, which accounted for the statistically significant causes of non-stationarity (autoregressive factor AR1, coeff. = 0.9, E = 0.103, p < 0.001; pulse at time 17, coeff. =37.5, SE = 17.3, p = 0.044; pulse at time 18, coeff. = 99.9, SE = 16.4, p < 0.001), the number of ibises recorded in Britain was negatively affected by the dynamics of the population in Doñana (Intercept = 0.709, SE = 5.36, p = 0.203; slope = - 0.00581, SE = 0.00163, p = 0.002). This indicates that, regardless of any common trend, in years when there are smaller numbers of breeding pairs in Doñana, larger numbers tend to be recorded in Britain. This might be because poor conditions for breeding in Doñana also tend to result in higher rates of dispersal of birds towards other areas such as Britain after the breeding season. A previous study (Santoro *et al.* 2013) demonstrated that when breeding in Doñana was prevented by dry years, the probability of dispersal towards other regions increased between 2.5 and 4 times depending on the individual's previous fidelity in the area.

Furthermore, the immediate effect (in the same year) of the Doñana dynamics on numbers of ibises recorded in Britain, is supported by the evidence that most ibises arrive in Britain during their first year. Of the 135 Glossy Ibises thought to have arrived in Britain in autumn during 2009-16 (i.e. since the large increase in numbers of records), 62 were juveniles, four were adults, with the age of the remaining 69 not reported. Evidence that the majority of Glossy Ibises arriving in Britain are first year birds is further supported by the results of colour ringing. There have, so far, been sightings of 33 colour-ringed Glossy Ibises in Britain, of which 30 were ringed as nestlings in Doñana in southwest Spain, and three as nestlings in the Petite Camargue in the south of France. The majority of these individuals have been recorded in Britain during their first year (21 out of 30 birds ringed in Doñana; all three of the birds ringed in the Petite Camargue). Many of these birds have dispersed quickly from their breeding areas, with eight of the colour-ringed Glossy Ibises having been recorded in Britain within three months of being ringed as nestlings in Doñana.

Monthly frequency and spatial distribution

The peak of records of the species in Britain tends to be in autumn, but this pattern has not been consistent over time (see Figure 3). The majority of assumed arrivals of Glossy Ibises in Britain have been in coastal counties of southwest and southeast England. Both of these regions are also favoured by Glossy Ibises during the rest of the year (Figure 4).

Figure 3. Mean numbers of Glossy Ibises recorded in Britain since the start of recent influxes in 2002

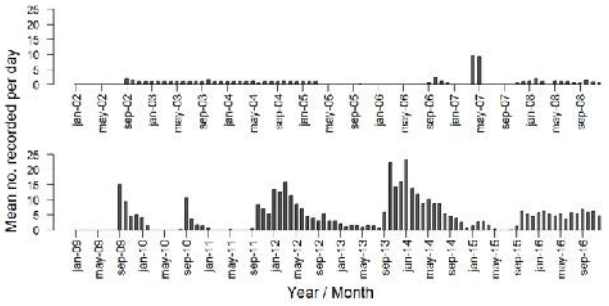
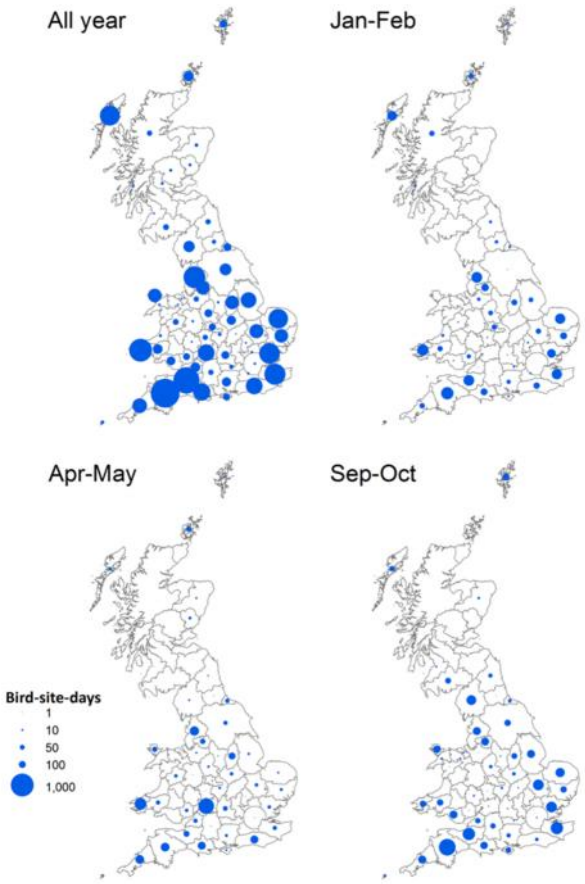


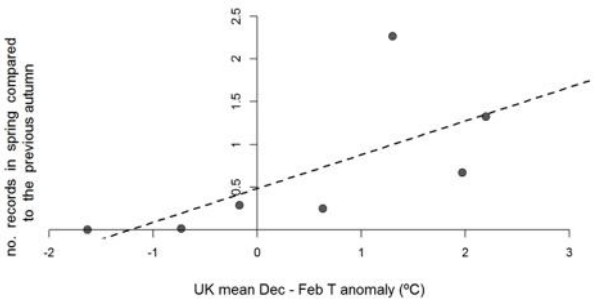
Figure 4. The abundance of Glossy Ibis in different bird recording areas in Britain between 2002 and 2016



Winter conditions and numbers of ibises present in spring compared to the previous autumn

Because the majority of Glossy Ibises arriving in Britain are first year birds, most would have to survive at least one winter in Britain before breeding. There has been considerable variation in the abundance of Glossy Ibises in Britain in spring, compared to in the previous autumn (Figure 5).

Figure 5. The relationship between the abundance of Glossy Ibises in Britain in spring compared to the previous autumn, and the mean UK temperature anomaly during the winter in between. Temperature is expressed as the mean difference from the 1961-90 average, with negative values in the x-axis indicating that the winter was colder than the 1961-90 average. The dashed line indicates the regression line of the ratio between spring and previous autumn records on the temperature anomaly



This variation appears to be largely related to the severity of the winter, with a higher proportion of birds being present in spring compared to in the previous autumn, when temperatures are higher during the winter in between (Spearman correlation coeff. = 0.86, p = 0.024). There is no evidence that Glossy Ibises show a more southerly, or south-westerly, distribution in Britain in winter than during the rest of the year (Figure 4). This is perhaps surprising, given the milder winter temperatures in southwest England compared to further north and east in Britain.

Our results therefore suggest that Glossy Ibises are more likely to breed in Britain when poor conditions for breeding in Doñana result in birds dispersing north in autumn, and these are followed by mild conditions in Britain that enable birds to remain there through the winter. However, it is unclear whether Britain could support significant-sized breeding colonies of Glossy Ibis, even as the climate continues to warm. In particular, there are probably very few wetlands in Britain large enough to support significant-sized breeding colonies of colonial waterbirds (Ausden *et al.* 2014). The most likely area in Britain for Glossy Ibis to begin regularly breeding is probably the Avalon Marshes. This large complex of wetlands is in southwest England, a region with a

large number of records of Glossy Ibis, and there has already been one nesting attempt in the Avalon Marshes, as described earlier. The Avalon Marshes is playing an important role in the colonisation of Britain by several other southerly-distributed waterbird species (Ausden *et al.* 2014; Hughes 2018).

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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

Glossy Ibis *Plegadis facinellus* Nesting in the New York City, New York, USA

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ABSTRACT

The urban landscape of New York City's harbor can provide important habitat for colonially nesting waterbirds, including Great Egret *Ardea alba*, Snowy Egret *Egretta thula*, Little Blue Heron *Egretta caerulea*, Western Cattle Egret *Bubulcus ibis*, Tricolored Heron *Egretta tricolor*, Green Heron *Butorides striatus*, Black-crowned Night-Heron *Nycticorax nycticorax*, Yellow-crowned Night-Heron *Nyctanassa violacea*, Glossy Ibis *Plegadis facinellus*, Double-crested Cormorants *Phalacrocorax auritus*, Herring Gull *Larus argentatus*, and Great Black-backed Gull *Larus marinus*. NYC Audubon, a non-profit conservation organization, has been conducting nesting surveys of these mixed-species colonies since 1985. The average number of pairs nesting on all islands each year (1985 – 2016) is 4,000. Following a northward range expansion in the 1990s, Glossy Ibis started nesting in these mixed-species colonies. The average number of nesting ibis, harbor-wide, since 1982 is 188 pairs (SD 84). The high count occurred in 2004 (N=350 pairs) and the low count was in 1985 (N=51 pairs). The total population size in 2018 was 5,319 pairs, with 128 nesting Glossy Ibis. We plan to continue our banding efforts and to collect feathers for a world-wide genetic analysis project.

Introduction

The Glossy Ibis *Plegadis falcinellus* is a cosmopolitan species (Davis and Kricher 2000). In North America, they occur along the east coast, ranging from New Brunswick, Canada, throughout Florida, and along the Gulf Coast of Louisiana. The current distribution reflects a well-documented northward range expansion in that occurred in the 1990s (Stewart 1957; Hailman 1959; Bull 1974; Miller and Burger 1977; McGowan and Corwin 2008). This paper discusses changes in colony sites and breeding population size within the New York Harbor, NY City, NY, USA, from 1982 through 2018.

After the range expansion, Post *et al.* (1970) published the first record of Glossy Ibis breeding in New York City. It was not until 1980 when nine pairs were seen breeding in a mixed-species colony on Pralls Island, between New York City, NY and New Jersey (NYCA website). New York City Audubon (NYCA) staff or consultants have been responsible for conducting the waterbird nesting surveys on an annual basis since 1985. NYCA is a non-profit conservation organization whose mission is to protect wild birds and their habitat in New York City. NYCA has been conducting annual colonial waterbird nesting surveys in the New York Harbor since 1985. The annual survey results are published on NYCA's website (www.nycaudubon.org).

Methods

17 of 19 undeveloped islands in the New York Harbor have been occupied at one time or another by colonially nesting waterbird species, and NYCA has been responsible for the island surveys every year since 1985, recording location, species identification, and number of nesting pairs on each island. Nest surveys continue through the present and are conducted using protocols established by Parsons (1986) and the New York State Department of Environmental Conservation's Long Island Colonial Waterbird and Piping Plover Survey (Litwin *et al.* 1993), summarized in Winston (2016). All counts are conducted between 0600 and 1600 hours, under clear conditions, low winds (<8 knots), and temperatures not exceeding 29°C. Counts are done in May, during the last two weeks of the month. The number of active nests is used as a proxy for the number of nesting pairs; the number of birds on a colony is greater than twice the number of nests (not all adults breed).

In New York, Glossy Ibis nest in mixed-species colonies on any one of seven of the 19 uninhabited islands in the harbor (Figure 1). Co-occurring species include: Great Egret *Ardea alba*, Snowy Egret *Egretta thula*, Little Blue Heron *Egretta caerulea*, Western Cattle Egret *Bubulcus ibis*, Tricolored Heron *Egretta tricolor*, Green Heron *Butorides virescens*, Black-crowned Night-Heron *Nycticorax nycticorax*, Yellow--crowned Night-Heron *Nyctanassa violacea*. Double-crested Cormorant *Phalacrocorax auritus*, Herring Gull *Larus argentatus*, and Great Black-backed Gull *Larus marinus* (Elbin and Tsipoura 2010; Winston 2017). Note: Local and regional conservation status for these species are listed in Table 1.

Figure 1. Uninhabited islands in the New York Harbor provide nesting habitat for colonial waterbirds. Red circles indicate islands that are or have been used by Glossy Ibis for nesting

Table 1. Conservation status for colonially nesting waterbirds of the New York Harbor. Nesting colonies are located in New York (NY). New Jersey (NJ) is a neighboring state within the harbor estuary. Mid-Atlantic Northeast Maritime (MANIM) is the region along the Atlantic Ocean, extending from Maine to Virginia. The US Fish and Wildlife Service Joint Ventures program for Bird Conservation Region 30 also extends from Maine to Virginia (BCR30), but includes coastal and upland bird species of 'highest' and 'high' conservation priority, as reflected in state wildlife conservation action plans. SCGN is 'species of greatest conservation concern' in New York; SC is 'species of concern' in New Jersey. NA is 'not at risk. "0" indicates that is it not listed

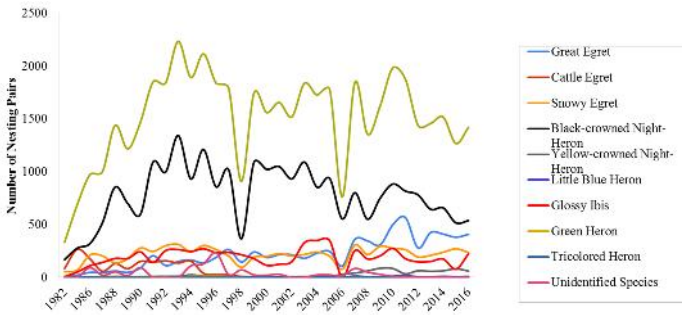
Common Name	Scientific Name	New York (Smith 2018)	New Jersey (NJ Fish and Wildlife 2018)	NAWCP (Kushlan et.al 2002)	BCR 30 (Steinkamp 2008)
Great Egret	*Ardea alba*	SGCN	0	NA	0
Snowy Egret	*Egretta thula*	SGCN	SC	High Concern	Moderate priority
Cattle Egret	*Bulbulcus ibis*	SGCN	SC	0	0
Little Blue Heron	*Egretta caerulea*	SGCN	SC	High Concern	Moderate priority
Tricolored Heron	*Egretta tricolor*	SGCN	SC	High Concern	Moderate priority
Green Heron	*Butorides virescens*	SGCN	SC	Low Concern	0
Black-crowned Night-Heron	*Nycticorax nycticorax*	SGCN	Threatened	Moderate Concern	Moderate priority
Yellow-crowned Night-Heron	*Nyctanassa violacea*	SGCN	SC	Moderate Concern	Moderate priority
Glossy Ibis	*Plegadis facinellus*	SGCN	SC	Low Concern	High
Double-crested Cormorant	*Phalacrocroax auritus*	0	0	NA	0
Herring Gull	*Larus argentatus*	0	0	0	0
Great Black-backed Gull	*Larus marinus*	0	0	0	0

Results

All species

The average number of colonial waterbirds nesting the harbor each year is approximately 4,000 pairs, with a high count of 5,900 pairs in 1993. We used linear regression analysis for long-term trends (Sauer, *et al.* 2004) to analyze the breeding population for long-legged wading birds only (excluding cormorants and gulls) and found the mixed-species, harbor-wide breeding population is stable, with a slow, positive trend (p=0.6, Figure 2) (Elbin and Tobón 2018). Two species, however, exhibited a decline: Western Cattle Egret and Green Heron. Western Cattle Egrets were present in very low numbers (less than 1,000 active nests in some sites) since late 1990s and disappeared from the harbor in 2010. Green Herons have always been present in low numbers, and the last island-breeding birds were seen in 2010.

Figure 2. Colonial waterbird nesting populations for the New York Harbor from 1982–2017. Species are represented by different colored lines as indicated in the key. The mustard-colored line represents all wading birds. Data have been extracted from New York City Audubon's annual Harbor Herons Nesting Surveys (Kerlinger 2004; Bernick 2007; Craig 2013; Winston 2017)



Glossy Ibis

The New York Harbor Glossy Ibis breeding population has remained stable over time (Winton 2017). A linear regression analysis (Sauer, *et al.* 2004) confirmed this result (p = 0.4, Figure 3) (Elbin and Tobón 2018). The average number of nesting ibis, harbor-wide, since 1982 is 188 pairs (s.d. 84). The high count occurred in 2004 (N=350 pairs) and the low count was in 1985 (N=51 pairs) (Figure 4). The population size in 2018 was 5,319 pairs (N=128 Glossy Ibis).

Figure 3. Glossy Ibis nesting population within the New York Harbor from 1982 -2016. Number of pairs is summed across all islands during a given survey year. In year 2006, weather prohibited the surveys for the two major nesting islands (Hoffman and Canarsie Pol). X axis: Survey year.

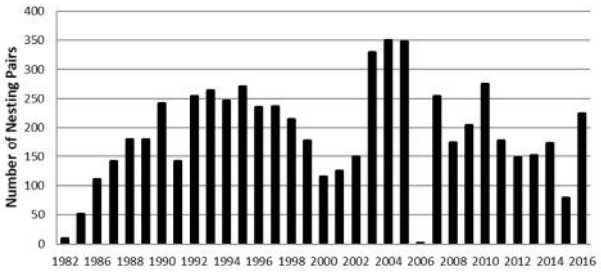
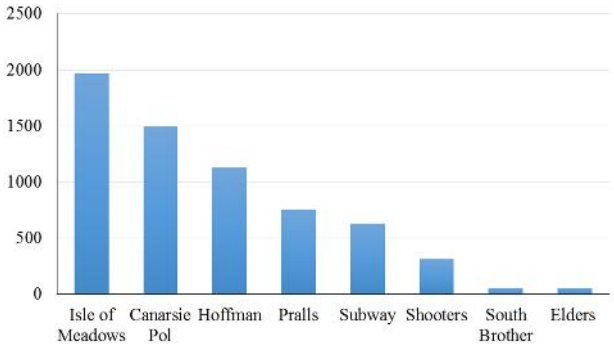


Figure 4. Glossy Ibis nest numbers as a function of Island in the New York Harbor. The number of nests represents all pairs of birds nesting in the Harbor from 1982 to through 2017. For island location, refer to the map in Figure 1. The Isle of Meadows and Canarsie Pol had the highest number of nesting ibis. Those two islands no longer support nesting wading birds, and Hoffman Island has become the location for the greatest number of nesting ibis. Pralls and Shooters are no longer active colonies. Subway has become the second most important site for ibis nesting in the Harbor. Elders refers to two closely situated islands: Elders East and Elders West. Y axis: Number of nesting pairs



Use of Specific Islands

A colony shift occurred in the harbor during 1999 and 2000. The three previously productive islands between NY and NJ (Pralls, Isle of Meadows, and Shooters) were gradually abandoned. In 1990 there was a 40,000 gallon oil spill from a nearby refinery that impacted foraging habitat for the birds nesting on those three islands (Burger 1994). Birds did not leave immediately, but by 1994, they shifted southward along the western shore of Staten Island. Four years later (1998) birds were colonizing Hoffman Island in the Lower Bay off the eastern shore of Staten Island.

Discussion

Species composition of colonies is most likely influenced by changes not only in island habitat but also perturbation to nearby foraging sites. NYCA is currently analyzing the nesting data with respect to environmental variables. For example, in the winter of 1990, 5.7 million l. of oil, including 2.1 million l of No. 2 fuel oil, leaked from cracked pipes and spills into the waters near Pralls Island (Figure 1) (Burger 1994). At the time, the islands in that waterway supported the large, productive colonies of mixed-species, long-legged wading birds. There was no apparent immediate effect on the size of the breeding colonies that formed that spring. An affect was seen in reproduction of two species: Snowy Egret and Glossy Ibis – two species that are tactile feeders and probe in mudflats for their food (Hancock et.al 1992; Parsons 1996). Glossy Ibis returned to breed for the next two to three years, but had low reproduction (Parsons 1996). Since that time, the nesting colonies shifted the location of their colonies from the islands in the affected waterway to those further north or east. Challenges continue for Glossy Ibis and their allies in the NY Harbor. Invasive species (Asian long-horned beetles), major storm events, sea level rise, human disturbance, and other identified insults continue to impact those islands.

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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

First Insights into the Glossy Ibis *Plegadis falcinellus* Population Dynamics in l'Albufera de València (Eastern Spain)

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ABSTRACT

Since 2004, the breeding and wintering Glossy Ibis populations are experiencing a steep increase in the Valencia Region, with Albufera de València being the main breeding and wintering ground in the region. In Albufera de València, the monitoring of the Glossy Ibis population began in 2013 as part of a broader waterbird monitoring program to raise understanding on the relationship between waterbird population dynamics and the agronomic practices of rice farming. It was until 2016 that enough data was obtained to estimate the breeding phenology. The data show a bimodal distribution, with a first group of breeders starting egg-laying around the second week of April, and another cohort starting in the third week of May. Different values were observed between years in the clutch size, number of hatched eggs, hatching success and breeding success. Within the breeding season of 2016, the first cohort showed significant higher numbers of eggs hatched and hatching success than the second cohort. Breeding success was also higher for the first cohort but differences were not significant. We also developed a preliminary movement assessment to understand the origin of birds present during the breeding and wintering period, showing that in both cases there is a significant bias to a French origin of the birds rather than of Doñana colonies.

Introduction

In addition to being cited since the 19th century as a migratory bird in l'Albufera de València (Vidal 1856; Arévalo 1887), some historical texts and literature evidence the historical occurrence of the Glossy Ibis *Plegadis falcinellus* in l'Albufera de València up until the first decades of the 20th century. However, it was not until 1985 when the species began to be observed with some regularity, in groups of 1-4 birds and in increasing numbers, feeding in areas of flooded marsh and in rice fields near the lagoon, such as those of Zacarés, Sueca or Catarroja (Dies *et al.* 1999).

After several years of scarce but regular occurrences in Albufera, in 1993 and 1994 breeding was verified for the first time in Albufera (and thus in Spain), with two and one pair, respectively (Dies *et al.* 1997). Breeding in 1993 coincided with the occurrence of a rice field annexed to the colony that was not cultivated, and where the growth of adventitious herbs created waterlogged herbaceous, prairie vegetation. Given that in l'Albufera de València this type of natural habitat does not occur, this situation favoured the availability of an adequate feeding

habitat for the species during the nesting period. However, in the following years this rice field was farmed according to regular agronomic management, and it is possible that this made l'Albufera de València subsequently a less suitable wetland for the breeding of the species.

The reproduction of the Glossy Ibis in the València Region took place again in 1997 in the Santa Pola saltpans, within the complex of wetlands in the south of Alicante (Ramos and Fidel Sarmiento 1999). In this wetland, there was a slow, gradual increase in the number of breeding pairs (Table 1), representing the only breeding ground for the Glossy Ibis in the València Region until it occurs in a new breeding attempt in l'Albufera in 2010. At the beginning of the breeding season, 4-5 couples started to build nests and emitting vocalizations in Tancat de la Pipa. This site was just restored as a green filter and had a suitable structure of vegetation to establish a small colony, as well as flooded prairies and lagoons where the Glossy Ibis could feed. Following the desertion of this small colony, at least three couples settled and started to successfully breed in a heron colony a few days later. Since then, the number of Glossy Ibis breeding pairs has increased at a rapid rate in both l'Albufera de València and the Valencia region, reaching 765 breeding pairs in 2017, and having settled colonies in 8 different wetlands (Table 1). This follows a similar yet smoother trend showed in Doñana after the colonization of the wetland (Santoro *et al.* 2010).

The monitoring of the Glossy Ibis populations in l'Albufera de València, its main breeding colony in the Valencia Region, began in 2013 as part of a broader waterbird monitoring program to raise understanding on the relationship of waterbird population dynamics and rice fields as breeding sites (Fasola & Ruiz 1996), but also feeding sites (Pernollet *et al.* 2015; Sánchez-Guzmán *et al.* 2007; Czech and Parsons 2002). This program is intended to monitor not only the population size of species of higher conservation value or more representative of the aquatic habitats of this wetland, but also other parameters related to breeding in order to better understanding how waterbirds are influenced by the agronomic practices of rice farming, specifically assessing the effects of agri-environmental measures on biodiversity (i.e. Toral and Figuerola, 2010; Wretenberg et at. 2007).

Methods

Study Area

Our research on the Glossy Ibis population is focused in l'Albufera de València. This is a 21,120 ha coastal wetland located in the Gulf of Valencia (Figure 1) designated as a Natural Park (1986), RAMSAR Site (1989), IBA (Important Bird Area, according to the criteria of BirdLife International), Special Protection Area for Birds (SPA, according to the criteria established by the Birds Directive), and Site of Community Interest (SCI, according to the criteria established by the Habitats Directive).

Figure 1. Location of Albufera de València Natural Park in the Western Mediterranean context

L'Albufera de València presents high landscape diversity, created over the last three centuries due to continuous anthropic land use transformation. The brackish, shallow lagoon, of about 3,000 ha, has several islands of helophytes and a narrow belt of helophytic vegetation on the banks, which are wider in the shallower areas. Colonial herons such as Grey Heron *Ardea cinerea*, Purple Heron *Ardea purpurea*,

Little Egret *Egretta garzetta*, Western Cattle Egret *Bubulcus ibis*, Squacco Heron *Ardeola ralloides* and Black-crowned Night Heron *Nycticorax nycticorax* are the most relevant breeders in this habitat (reaching a total of 3,000-5,000 breeding pairs), being one of the main colonial zones of the western Mediterranean for these species.

Rice fields cover about 14,000 hectares of the Natura 2000 site. Therefore, strong seasonal water fluctuations that are a consequence of rice cultivation and hunting practices characterizes this intensive agrarian landscape. Currently, the number and diversity of waterbirds whose breeding or feeding grounds are linked to rice fields depend on the water management and flood conditions that are maintained throughout the year.

Table 1. Glossy Ibis breeding population between 2004 and 2017 in the Valencia Region (Data summarized after Generalitat Valenciana's Breeding waterbirds reports)

Wetland	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Marjal Almenara	0	0	0	0	0	0	0	0	1	0	0	1	44	0
Marjal del Moro	0	0	0	0	0	0	0	0	0	55	25	90	82	24
Albufera de València	0	0	0	0	0	0	3	21	55	91	124	175	217	442
Marjal Xeresa	0	0	0	0	0	0	0	0	0	0	15	10	20	15
Marjal Pego-Oliva	0	0	0	0	0	0	0	0	0	0	0	3	13	58
Santa Pola	12	10	9	15	23	30	35	51	63	26	11	0	15	0
Hondo Elche	0	0	0	0	0	3	3	3	0	5	90	110	266	226
Hondo Amorós	0	0	0	0	0	0	0	0	0	5	50	10	45	0
València Region	**12**	**9**	**11**	**18**	**23**	**33**	**41**	**75**	**119**	**182**	**315**	**399**	**702**	**765**

Glossy Ibis population monitoring program

The monitoring of the Glossy Ibis breeding colonies started in 2013, testing different methodologies. Since 2015 (data here analysed) the monitoring is initiated approximately four weeks after the different sub-colonies begin to form, to avoid interfering in the establishment process. With the aim of understanding several breeding population parameters of Glossy Ibis (such as egg-laying dates, clutch size, chick survival and fledging rate), 2-3 sub-colonies with confirmed breeding are selected within the two main colonies. Visits were made every 7-10 days, always in favourable weather conditions (avoiding days with wind, rain or temperatures lower or higher than usual) and during the first three hours after dawn or before sunset, staying for a maximum of 1 h inside the colony. Only nests with known clutch size and the number of birds that fledged the nest by themselves (which were assumed as successful chicks) were considered for the estimation of these parameters. Differences between parameters were explored with T-test not assuming homogeneity of variances using SPSS 22.0.

A banding program started in 2013 and was extended to nearby wetlands (i.e. Marjal del Moro) since 2016. 53 birds were ringed in l'Albufera de València breeding colony between 2013 and 2017. Because of the big asynchrony in Glossy Ibis egg-laying dates and the fact that Glossy Ibis nests are usually located within dense reedbeds, it is not easy to locate and capture a large number of birds with a tibia well enough developed for ringing with a darvic ring, while the birds also tend to jump from the nest and hide. For preliminary movement data of ringed Glossy Ibis in Albufera, the information gathered belonged to 22 resighting events in the rice fields surrounding the colonies between the 15th of May and the 30th of June for the period between 2011-2017 (considered the breeding period), and 202 resighting events in December and January from 2011 to 2017 (considered the wintering period). Comparisons between numbers of Glossy Ibis chicks ringed in the two main Western Mediterranean colonies were done with the ringing data provided by Mañez *et al.* (2017) for Doñana and by Champagnon *et al.* (2017) for the Camargue, and following an F-Fisher test.

Wintering Glossy Ibises were counted every 15 days during the 2015, 2016 and 2017 winters. During the field work, habitat availability in the Albufera rice fields was mapped at least five times during each winter, considering the following categories: flooded fields (those with more than 20 cm depth), puddled fields (when the presence of stubble on the substrate is observed, and without having been farmed), fields wrought with water (in which the tractor has worked recently and the fields remain wet), and dry fields.

Results

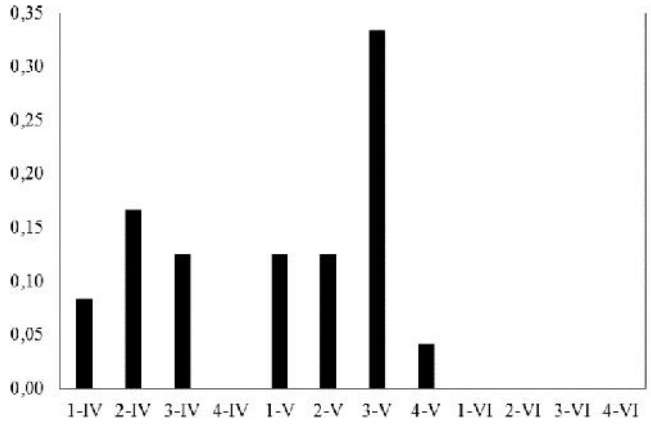
Breeding sites

Since 2010 Glossy Ibis breeding has been verified in four different colonies in l'Albufera de València. However, since 2016 breeding only occured in two colonies: Mata del Fang and Replaza de Sacarés, where several scattered sub-colonies occur. The nests are settled on dense helophytic vegetation dominated by *Phragmites australis* and *Typha domingensis*. Breeding Glossy Ibises always settled within heron colonies formed by Grey Heron, Little Egret, Western Cattle Egret, Squacco Heron and Black-crowned Night Heron. Purple Heron was also present in a concrete heron colony with breeding Glossy Ibises.

Breeding phenology and breeding success

Only in 2016 enough data were obtained to estimate the breeding phenology with certain representation, being similar to other reported estimates (i.e. Boucheker *et al.* 2009). These data show a bimodal distribution, with a first group of breeders starting egg-laying around the second week of April, and another cohort starting in the third week of May (Figure 2).

Figure 2. Proportion of Glossy Ibis monitored nests according to their egg-laying dates (in weeks) in Albufera de València colonies during 2016



Different values were observed between years in the clutch size, number of hatched eggs, hatching success (considered as the proportion of eggs hatched with respect to the clutch size) and breeding success (considered as the proportion of fledglings with respect to the clutch size) (Table 2). Within the breeding season of 2016, the first cohort showed significantly higher number of eggs hatched and hatching success than the second cohort (Table 3). Breeding success was also higher for the first cohort but differences were not significant.

Table 2. Mean and standard deviation of breeding success parameters showed by Glossy Ibis in Albufera de València. In parenthesis, number of cases. - : no information available due to scarcity of data (n < 5)

	2015	2016
Clutch size	4.00 ± 0.63 (6)	3.15 ± 0.54 (26)
Eggs hatched	3.17 ± 0.41 (6)	2.07 ± 1.41 (26)
Hatching success	0.80 ± 0.10 (6)	0.65 ± 0.41 (26)
Breeding success	-	0.32 ± 0.28 (25)

Table 3. Mean and standard deviation of breeding success parameters shown by first and second cohorts of Glossy Ibis in Albufera de València in 2016

	First cohort	Second cohort	t	df	*P*
Clutch size	3.14 ± 0.69	3.26 ± 0.45	-0.429	8	0.679
Eggs hatched	2.86 ± 0.90	1.79 ± 1.48	2.226	18	0.039
Hatching success	0.90 ± 0.16	0.52 ± 0.41	3.429	24	0.002
Breeding success	0.40 ± 0.27	0.33 ± 0.30	0.626	12	0.543

Preliminary movement data

A total of 22 banded birds have been sighted in the rice fields surrounding the colonies between the 15$^{th\ of}$ May and the 30th of June for the period between 2011-2017. All of them were ringed as chicks in their origin colonies, with 18 of them born in Camargue and only 4 in Doñana. According to the total number of birds ringed in Doñana (Mañez *et al.* 2017) and Camargue (Champagnon *et al.* 2017), the birds present in l'Albufera de València show a significant bias to a French origin ($F = 0.001$; d.f. = 2; $p < 0.001$).

On the other hand, the 53 birds ringed in l'Albufera de València breeding colony between 2013 and 2017 has provided 30 resighting events along the

Mediterranean coast (Figure 3). In this period, resighting events have occurred in non-coastal areas of Spain or Central Europe. Within the resighting events, the only Glossy Ibis born in l'Albufera de València and sighted in another breeding colony is one chick ringed in 2013 and sighted in Scamandre colony (Camargue) in June 2015.

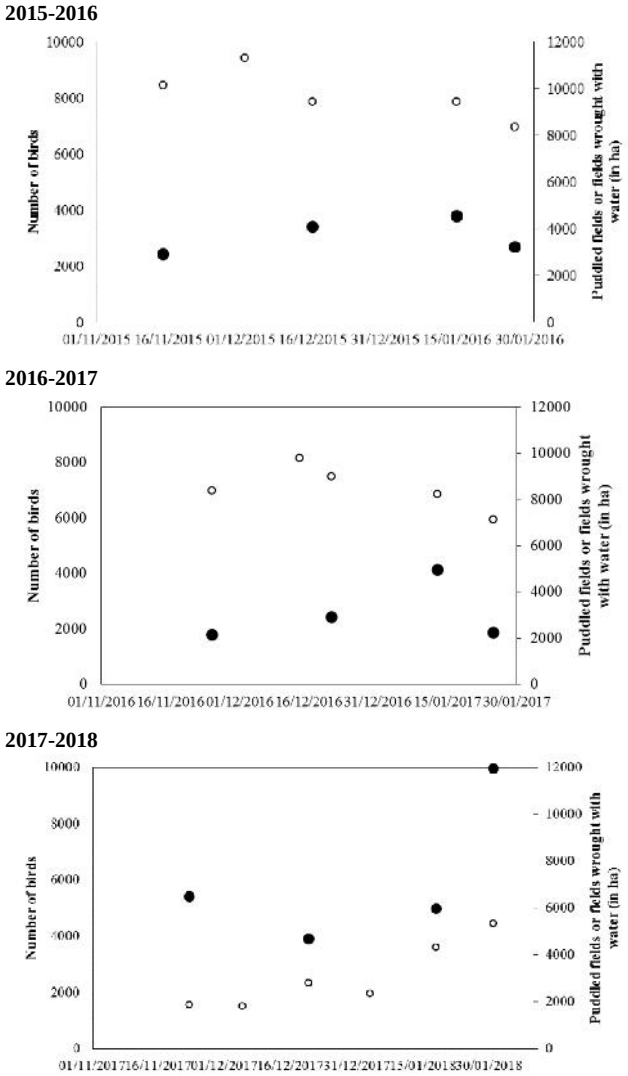
Figure 3. Localities with resightings of Glossy Ibis banded in Albufera de València and Marjal del Moro between 2013 and 2017 (data incorporated until April 2018)

Wintering population

178 of the 202 (88%) of the resighting events registered in the months of December and January from 2011 to 2017 belonged to birds ringed as chicks in Camargue colonies, 11 (5%) events were of birds ringed as chicks in Delta del Ebro, 9 (4%) from Doñana and 4 (2%) from Albufera. In reference to the population present during the breeding period, these resighting events show a strong bias to birds born in Camargue, although numbers of birds ringed presently show an inverse distribution, with a bigger number of birds ringed in Doñana (Champagnon *et al.* 2017; Mañez *et al.* 2017), the birds present in Albufera de València show a significant bias to a French origin ($F = 0.015$; d.f. = 2; $p < 0.001$).

However, during the winter, the census shows a certain stability in the wintering population, which is not necessarily related to the availability of adequate habitat, considered as paddy fields or puddles after rice harvesting (Figure 4).

Figure 4. Number of Glossy Ibis sighted in Albufera de València during bi-monthly winter counts in relation to the number of flooded fields available during 2016-2018 winters. Solid dots: Number of Glossy Ibis. Blank dots: Surface of suitable habitat for feeding (considered as puddled fields or wrought with water)



Discussion

Breeding population

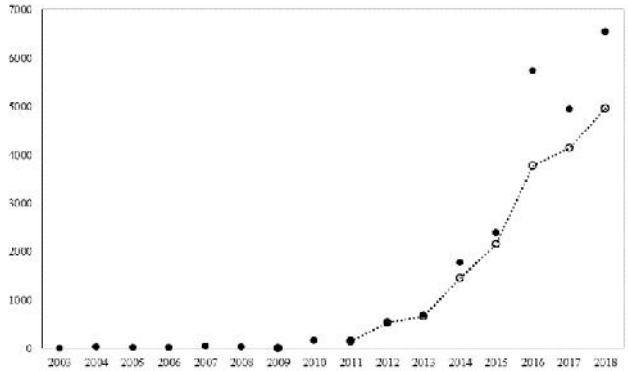
Laying dates suggest the occurrence of two cohorts of Glossy Ibis breeding in l'Albufera de València. This second cohort initiates egg-laying coupled with the beginning of the flooding of the rice fields. This is a critical moment as occur during an important increase of the surface of the flooded environment in the colony surroundings. However, although the clutch sizes show very similar values between cohorts, the rest of breeding parameters suggest that the first cohort has a higher breeding success than the second one, although the chicks of the first cohort hatch when rice fields are still dry. Methodologically, these differences are important as they show the importance of considering the two well-represented cohorts when estimating the reproductive success of the whole of the breeding population.

Preliminary movement data assessment suggests that the l'Albufera de València breeding colony has grown from individuals from French colonies. In fact, the only evidence of the presence of a Glossy Ibis with known origin during the colonization of the wetland in 2010 supports this hypothesis, as the bird with a darvic ring A14 was born in the Buisson Gros-Petit Camargue colony in 2007 and was sighted in Tancat de la Pipa during the 2009 breeding season. This probably suggests flow is a consequence of a dispersal from Camargue colonies following rapid increase in colony size following the colonization of Camargue of birds from Doñana after environmental instability episodes experienced in Doñana (Santoro *et al.* 2013) and would explain also the steep trend of increasing population not only in Albufera but also in the Valencia Region (Santoro *et al.* 2016). However, a combined origin also from Ebro Delta can not be discarded as the number of recently ringed individuals is too small in comparation with Camargue and Doñana.

Wintering population

Overwintering Glossy Ibis in the València Region have been scarce until 2010 (Generalitat Valenciana, 2018). According to Generalitat Valenciana data, there is an annual steep increase starting in 2011 for the whole region, driven by the growth of l'Albufera de València wintering population (Figure 5).

Figure 5. Glossy Ibis recorded in the International Waterbird Counts in the València Region (black dots) and Albufera de València (white dots with dashed line). Data summarized after Generalitat Valenciana's wintering waterbirds reports



The number of resighting events during December and January from 2010 to 2017 (202) is a small number in relation to the entire census of wintering Glossy Ibis. This is due to difficulties in the conditions related to carrying out the fieldwork during the hunting period in l'Albufera de València. Birds keep a wide security distance in response to disturbances, and when spotted, birds are usually feeding on fields with stubble that hide their legs. However, the strong bias for the occurrence of birds ringed in Camargue in relation to the scarcity of birds ringed in Doñana suggests that l'Albufera de València works as a wintering ground for birds born northwards, following the connectivity shown with the breeding grounds. During the end of winter, the number of birds in l'Albufera de València increases (i.e. data of end of January 2018), probably as a response to the drying of large areas of rice fields in the Ebro Delta (A. Curcó, pers. comm.), showing the relevance of l'Albufera de València at a regional level as the most important wintering ground.

Big flocks of Glossy Ibis occur until the end of the drainage of the fields and channels in the beginning of March, a period in which an analysis of resightings events suggests an ongoing northwards migration period for the species, with birds sighted in

December-January and spotted northwards in mid-February, and also a rise of transient birds (unpublished data). In this scenario, l'Albufera de València would act as a relevant stopover site at regional level. However, drainage dates have been advanced as modernization of pumps is widely applied, so this could be considered a potential threat to the conditions of migrating and resident birds.
Glossy Ibis which are likely to be local breeders show a significant shift of habitat selection and use, feeding on orchards and orange grove flooded during March and April, and creating new roosts on a reedbed with trees in the Magro river (unpublished data).

Questions to be addressed in the future

The preliminary data obtained in the monitoring of Glossy Ibis in l'Albufera de València give some room for questions to be addressed through several research initiatives. The first one question to be addressed is related to rice field management during the breeding season, a key concern for the species as Toral *et al.* (2012) demonstrated in Doñana. Specifically, how are farming practices and food availability affecting breeding success? The second issue relates to the exploitation of resources from the rice fields: Since the Glossy Ibis is a species able to adapt its diet to the availability of resources (Acosta *et al.* 1996; Macías *et al.* 2004; Bertolero and Navarro 2018), does the steep increase in Glossy Ibis affect the breeding population dynamics of herons and egrets? Do they compete for the most abundant resources in the rice fields, such as Red Swamp Crayfish *Procambarus clarkii* is? Finally, some questions emerge from the definition of two cohorts of breeding birds. Where are the Glossy Ibis breeders at the beginning of the breeding season feeding when the rice fields are dry? Are these early breeders experienced Glossy Ibis, and late birds "less quality"-Glossy Ibis? In this sense, is l'Albufera de València working as a source of birds for other regional wetlands as other wetlands did after colonization and rapid increase of breeding birds (Santoro *et al.* 2016), or maybe is it working as a sink for inexperienced or first-time breeders? Alternatively, does it have both roles?

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Glossy Ibis Distribution and Abundance in an Indian Agricultural Landscape: Seasonal and Annual Variations

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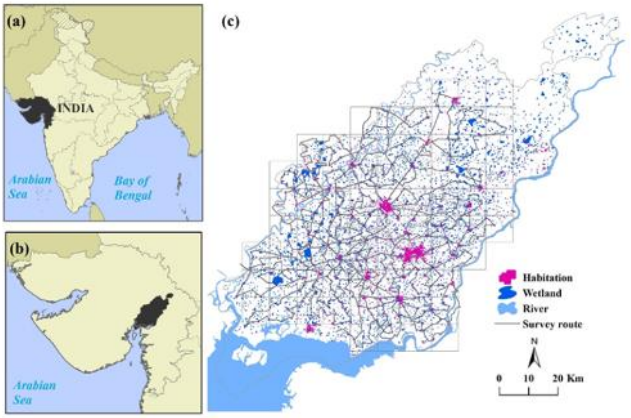
ABSTRACT

Glossy Ibis is assumed to be a non-breeding, winter migrant in India but its habits in the region are poorly documented. Their ability to use agricultural landscapes is known, but how they would use such landscapes with seasonal crops is not clearly understood. We carried out year-round observations of Glossy Ibis in Anand and Kheda districts of Gujarat between November 2015 and June 2017. Glossy Ibises were resident year-round, with the least counts during the monsoon. Glossy Ibises showed strong scale-dependent use of the landscape preferring areas with at least intermediate amounts of wetlands (50-100 ha), and preferentially using areas with the most wetlands (>200 ha) in summers. Additional effort to survey similar agricultural areas is needed to develop a more complete understanding of Glossy Ibis status in south Asia.

Introduction

We carried out the study in the adjoining districts of Anand and Kheda in Gujarat state in western India (Figure 1a, b). Agriculture was the primary land use in the two districts with a minimum of three crops grown in fields annually. A range of wetland types persisted including coastal wetlands in the south, seasonal marshes, and perennial artificial reservoirs that aided farming. Wetlands were used extensively by people throughout the year for grazing livestock, fishing, extracting water for irrigation, and provided a range of natural resources (personal observations). The landscape had a high human footprint with a large number of villages, towns and cities interspersed with agricultural areas and wetlands (see Figure 1c). Crops were seasonal with dominant crops being wheat and mustard during the winter (November – February), mixed dry crops such as vegetables and cereals during the summer (March – June) and rice and corn during the rainy or monsoon season (July – October). The landscape was therefore wettest during the monsoon, intermediate during the winter, and driest during the summer. However, irrigation canals and reservoirs provided considerable hydrological complexity. We digitized all wetlands located on Government of India 1:50,000 topographic sheets published in 2011 and overlaid the entire area with 5'x5' grids that measured ~10x10 km^2. We trained a local resident as our field associate to survey the two districts using the extensive road network. The survey route (see Figure 1c) was covered once in each of three seasons between November 2015 and June 2017 for five consecutive seasons.

Figure 1. Glossy Ibis survey location in the western Indian state of Gujarat (a,b). The focal districts of Anand and Kheda (c) are shown with all human habitations and wetlands digitized from topographic sheets, and the survey route taken each season to study ibis. Grids are ~10x10 km in size

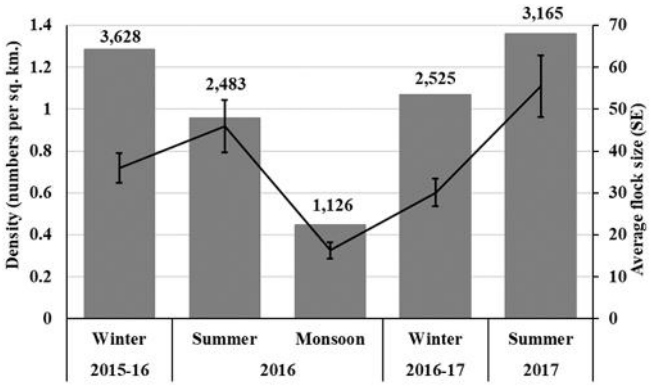


Using a hand-held Global Positioning System, the survey effort and locations of all observed Glossy Ibises *Plegadis falcinellus* were marked. It took 60-75 days to complete each seasonal survey. It is therefore likely that individual Glossy Ibis moved around and were counted multiple times. The counts, therefore, cannot be used to represent population numbers.Wetland numbers and extent (in ha) were extracted grid-wise in the Global Information Systems domain, and showed a strong linear correlation at the grid-level ($p < 0.01$). We therefore retained only wetland extent for analyses. We were able to use only one set of wetland maps and have assumed that grids with higher wetland extent would remain so in all seasons. We stratified grids into five classes of wetland extent (0-50, 50-100, 100-150, 150-200 and >200 ha). Density was estimated as observed number of Glossy Ibises per km^2 using a transect width of 300 m on either side of the road. Ibis flocks were plotted seasonally on stratified grids, and maps were created for each season showing ibis distribution against wetland presence. Glossy Ibises occurred primarily in flocks and each flock was taken as the unit for analyses. We assessed scale-dependence at the landscape level. We plotted bar-graphs of proportions of grids with each class of wetland alongside number of flocks that used each wetland strata in a season. If Glossy Ibises used grids randomly proportions of flocks in each stratum would match availability. We used bar graphs to assess if Glossy Ibis used wetland strata similar to their availability, or if they showed scale-dependence by using some strata less or more than what was available.

Results

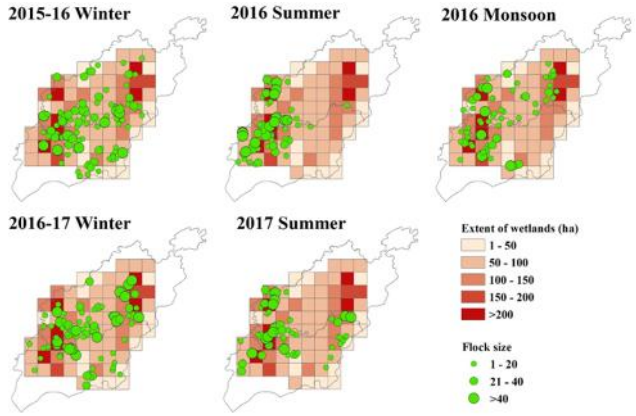
A total of 365 flocks with 12,927 individual Glossy Ibis were enumerated in this study. Glossy Ibis were present on the landscape throughout the year, with the least abundance during the 2016 monsoon season (Figure 2). Average flock sizes also varied seasonally and tracked overall abundance. Flocks of over 50 ibis were not uncommon (15% of all flocks sighted), with flocks of over 100 (9%) and 250 (2%) being rarer. The largest flock had over 1,000 ibis.

Figure 2. Seasonal density (grey bars) and average flock size (± SE; black line) of Glossy Ibis in the agricultural landscape of Anand and Kheda districts, Gujarat India. Numbers above graphs indicate the total number of ibis counted



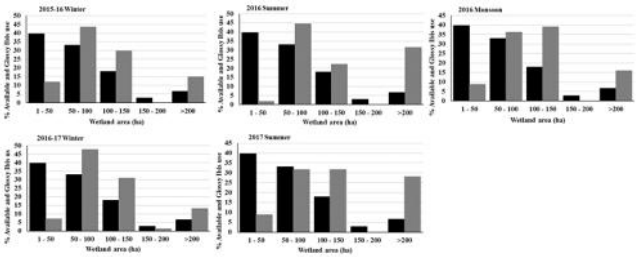
Seasonal abundances varied dramatically with the highest abundance being over three-times the season with the lowest abundance. Seasonal spatial distribution varied greatly with ibis being the most dispersed in winters and most concentrated within the least number of grids in summers each year (Figure 3).

Figure 3. Seasonal variation in Glossy Ibis distribution (green dots) in Anand and Kheda districts, Gujarat, India. Grids are ~10x10 km and show extent of wetlands in hectares. Areas not surveyed are in white



Grids with the smallest wetland extents were used the least by Glossy Ibis (Figure 4). Grids with intermediate levels of wetland extents were used higher than their availability in nearly all seasons in both years, and the grids with the highest wetland extent were used disproportionately more during summers (Figure 4).

Figure 4. Availability (black bars) of grids with different extents of wetlands, and use by Glossy Ibis represented as proportions of flocks seen in each (grey bars) in the agricultural landscape of Anand and Kheda districts, Gujarat, India



Discussion

Glossy Ibis were resident throughout the year in Anand and Kheda districts, and used the agricultural landscape extensively. Glossy Ibis nesting has been recorded in Gujarat (Tiwari and Rahmani 1998) and in several locations in south India (Subramanya 2005; Venkatraman 2009; Matheu *et al.* 2018). These observations collectively indicate that Glossy Ibises are a year-round resident in India. Glossy Ibis numbers increased in winters in a south Indian reserve (Venkatraman 2009) identical to our observations in the agricultural landscape of Gujarat. The dramatic reduction of numbers of ibis in Anand and Kheda districts during the monsoon is indicative of local movements. Glossy Ibis nesting in Gujarat was observed in September and October (Tiwari and Rahmani 1998) suggesting that the movements in Anand and Kheda during the monsoon are linked to breeding. Flock sizes varied greatly, and the majority of flocks were <50 birds. However, the largest flocks in each season ranged from 100-1,000 birds. There are no studies at landscape scales providing abundance estimates and flock sizes along with seasonal variations of both to compare with observations in Anand and Kheda. It is likely that there are several other landscapes in south Asia that are equally or perhaps more important for Glossy Ibis populations, and surveys to cover additional agricultural landscapes are essential.

Distribution maps and use of grids with different wetland extents showed clear scale-dependent use of the landscape by Glossy Ibis. They largely used grids with intermediate extents of wetlands (50-100, and 100-150 ha; Figures 3, 4). However, the grids with the highest wetland extents were most important during summers suggesting that agricultural areas with large wetlands are crucial for Glossy Ibis to survive the dry season. The extensive network of canals and the presence of several perennial reservoirs undoubtedly aided retaining the Glossy Ibis throughout the year in Anand and Kheda. It will be important to understand if and how Glossy Ibis persist throughout the year in other agricultural landscapes that have different amounts of artificial structures such as canals and reservoirs.

The importance of landscapes that are cultivated year-round with substantial human presence to sustain relatively high abundances of Glossy Ibis was not previously known. It is likely that wet crops and supporting structures such as canals and reservoirs favour Glossy Ibis, suggesting that this species is likely to do well in other areas where agriculture dominates the landscape. This is similar to the high conservation value that multi-cropped landscapes in several locations in India provide to other ibis species

such as the Black-headed Ibis *Threskiornis melanocephalus* (Sundar 2006; Chaudhary and Koli 2018). Breeding locations and ecology of Glossy Ibis in south Asia is poorly documented. A concerted and robust effort to overcome this lacuna is necessary if a holistic status assessment of Glossy Ibis is to be had for this region.

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Long-distance Dispersal of the Afro-Eurasian Glossy Ibis From Ring Recoveries

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ABSTRACT

The Glossy Ibis is among the most widespread bird species in the world. However, the Glossy Ibis erratic occurrence and distribution makes it a difficult species to study, and we know little about its dispersal and metapopulation dynamics. This study summarises previously-scattered and unpublished information by collating, in a single database, the largest number of long-distance recoveries ever reached for this species (190 individuals). Our findings suggest that (i) according to old records (about 1910 - 1995) the dispersal from the breeding grounds in East Europe was directed towards the Sahelian floodplains, North-East Africa, the Middle East and India; (ii) West and East Europe populations are probably connected; (iii) the recently (about 1995 onwards) increasing and spreading populations in West Europe do not tend to migrate south and overwinter in Sub-Saharan Africa; and, (iv) the genetic distance between geographically distant populations might be low considering the records of long-distance flights with the most impressive, and unpublished, one being that of an individual moving from Spain to the Virgin Islands (> 6,000 Km). Overall, these findings highlight the need for a research network capable of dealing with the frequent changes in the distribution and dispersal dynamics of the Glossy Ibis and its fast responses to environmental changes.

Introduction

Of the 35 extant species of ibises and spoonbills (Aves: *Threskiornithidae*) in the world (Matheu and del Hoyo 2018), the Glossy Ibis *Plegadis falcinellus* is the most widely distributed, living and breeding on all continents except Antarctica (Hancock *et al.* 1992; del Hoyo *et al.* 1992). The species is often described as nomadic or semi-nomadic in some parts of its range, with established colonies dwindling and disappearing as new breeding colonies crop up elsewhere where the

species was previously absent or a rare non-breeder (Santoro *et al.* 2013; Santoro *et al.* 2016; Zwarts *et al.* 2009). The Glossy Ibis is also a migratory species, and it has been suggested it utilises different flyways between breeding sites in the Western Palearctic and wintering areas in tropical Africa (Schogolev 1996; Kirby *et al.* 2008; Zwarts *et al*. 2009). Several ringing programs were carried out in East Europe in the period between 1908 and 1982 (EURING database; Pigniczky and Vadász 2009; Zwarts *et al*. 2009). Overall, the ring recoveries from these areas suggest they mainly fly to the Sahel but also East Africa and the Middle East.

Over the past century, the Glossy Ibis has declined dramatically in its former breeding strongholds in eastern Europe and the Black and Caspian seas and, over a similar period of time, their numbers have remarkably decreased in their wintering areas in the Sahel (BirdLife International 2016; Hancock *et al.* 1992; del Hoyo *et al.* 1992; Schogolev 1996; Zwarts *et al*. 2009). Indeed, although counting data from local monitoring programmes have been collected intermittently and not always exhaustively, the overall impression is of decreasing numbers of breeding pairs in East Europe (Hungary, Serbia, Romania, Bulgaria, Ukraine, Russia, Azerbaijan, Turkey and Greece) over the 20th century, especially in the last 30-40 years (Zwarts *et al.* 2009). An analogous but, apparently more severe, situation seems that of the populations wintering in the Sahelian zone that, from 1980 onwards, have shown a sharp decline of about 90% in the Inner Niger Delta (Zwarts *et al.* 2009). Opposite to the declining pattern observed in the Eurasian-African region, over the last two decades the species has shown a remarkable increase in numbers and a regular presence during the breeding, but also the wintering, season in several sites of West Europe from where it had been locally extinct for decades as a breeder species (Santoro *et al.*, 2013; Champagnon *et al.* 2019; Santoro *et al.* 2010; Volponi 2019; Belhadj *et al.* 2007; Boucheker *et al.* 2009). The reasons why this has happened are still unclear and, as Zwarts *et al.* (2009) note, "*the recent increase in Spain is something of an enigma*". Interestingly, a considerable increase in populations' size and range expansion has been recorded in North America (150% increase per decade over the last 40 years, Butcher and Niven 2007; see also Patten and Lasley 2000). Similarly, in South Africa, the Glossy Ibis has increased in both range and abundance over the Western Cape in the period between 1987 and 2007 onwards (Underhill *et al.* 2016).

Although the population trend at the global scale is considered to be decreasing, the Glossy Ibis is regarded as a "Least Concern" species because of the vast population size (230,000-2,220,000 individuals, Wetlands International 2019) and the wide distribution range (BirdLife International 2019). The Glossy Ibis is also listed in Annex II of the Convention on Migratory Species (CMS) and protected by the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) (BirdLife International 2019). Within the AEWA area, according to data collated by Wetlands International and BirdLife International (2019), four different Glossy Ibis populations have been proposed based on a previous study by Kirby and colleagues (2008): (i) Sub-Saharan Africa, (ii) North Africa and Eastern and Southern Europe, (iii) South-west Asia, and (iv) Madagascar. This classification depends on a considerable amount of counts showing variable population size across the Important Bird Areas (IBA – BirdLife International) in Europe and Africa. We note that while these data provide information to envision the distribution of different populations and subpopulations in this vast area, this approach may be too simplistic as it does not contain any information on the individuals' movement and, therefore, on populations' connectivity. All the information currently available on the dispersal of the Eurasian African Glossy Ibises comes from ringing programs carried out in the breeding regions in the Eurasian zone. In contrast to the pioneering Glossy Ibis ringing programmes in eastern Europe (see e.g. Pigniczki and Vadász 2009) and the Black and Caspian sea areas, the ringing programs launched in western Europe and North Africa since 1996, when the species established in Doñana, use darvic rings, coloured and inscribed to allow for multiple resightings of the same individual, in addition or not to the traditional metal ring (Champagnon *et al.* 2019; Máñez *et al.* 2019;

Nedjah *et al.* 2019; Samraoui *et al.* 2012; Volponi 2019). Also, a ringing program was started by Dr Savas Kazantzidis in Greece in spring 2018 within the International Glossy Ibis Network, the research network on this species we launched in November 2017.

Overall, the literature based on ringing and count programs has so far provided details, often at a local scale, on the distribution and the potential migratory routes of the Eurasian-African Glossy Ibis. However, a comprehensive view of the metapopulation dynamics of this species is still almost unknown, mainly because it is challenging to study a species, such as the Glossy Ibis, so fluid in terms of site fidelity and dispersal habits. In this study, we aimed to take the first step in trying to understand the large-scale dispersal strategies of the Glossy Ibis in the Western Palearctic and Afro-Tropical. Therefore, we summarized and updated the existing information obtained from ringing recovery data (i.e. from dead individuals) in order to (i) propose a tentative sketch of the migratory flyways of the Glossy Ibises breeding in Europe, (ii) evaluate the potential connectivity between different Glossy Ibis populations (or subpopulations), and (iii) discuss whether and how our results match the four Glossy Ibis populations delineated by Kirby *et al.* (2008) for the AEWA area.

Study Area

The study area encompasses the region included in the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) where the Glossy Ibis is known to breed or winter. This region encompasses western, central, and Eastern Europe, the Black and Caspian Sea areas, Africa, and West Asia.

Methods

We obtained recovery data for the Glossy Ibis from the EURING database (n = 34) individuals). We collated these data with additional data provided by the SAFRING (in South Africa, n = 1), the Tour du Valat ringing database (n = 1), the Bird Ringing Centre of Russia (BRCR, n = 114) and by Zwarts and colleagues (ZDB, n = 40) which, in turn, obtained data from EURING and Wetlands International, Schogolev (1996), Sapetin (1978), Mullié *et al.* (1989) and Thonnerieux (1988). Given that our focus was on long-distance movements and because of visual clarity, we removed the records of < 200 Km far from the ringing area. Also, we did our best to remove any error and duplicate in the dataset. In particular, we eliminated several records from the EURING dataset because they appeared either in the ZDB or in the BRCR. We are confident that, if some error escaped to our control, it would not invalidate the overall pattern we describe.

Our data come from eleven Glossy Ibis breeding areas spanning western Eurasia, from the Caspian Sea to Spain, which we consider representative of the metapopulation and where ringing programs have been carried out. We cannot discard that the populations from the northern and southern Hemispheres are connected, so we also included recovery data from a ringing site in South Africa. In total, we used recovery records of 190 individuals proceeding from eleven ringing areas. Ringing programmes carried out between 1928 and 1982 (mostly from 1977-1982) are indicated as old ringing areas (ORA). In the ORA, only metal rings have been used. In the recent, still active, ringing areas (RRA; Doñana wetlands: since 1996; Ebro River Delta: since 1998; Camargue wetlands: since 2006), both metal and darvic rings with individual codes are used. For the sake of simplicity and homogeneity between ORAs and RRAs, in this study, we only used information proceeding from recovery data. At least four RRAs are not represented in our study because no recovery data that meet the > 200 Km criterion are available from these programs; they are located in: East and North-East Spain (Curcó and Brugnoli 2019; Vera *et al.* 2019), North Algeria (Nedjah *et al.* 2019), and North Italy (Volponi 2019) and Greece (Savas Kazantzidis).

Results

Most of the recovery records available for the Eurasian-African Glossy Ibis are of individuals marked in the ORAs (95.8 %). Eight out of nine ORAs are in the region comprised between

Hungary and the Caspian and Black Seas (Figure 1). One is in South Africa. The remaining recoveries (4.2 %) are from the RRAs which are located in Spain and France.
In the Eurasian region, from West to East, and then in South Africa, they are mainly from these areas (in brackets the country and the range of recoveries' years): 1) Espacio Natural de Doñana (Spain, 2000 – 2011), 2) Camargue wetlands (France, 2009 – 2015), 3) Kis Balaton (Hungary, 1913 – 1937), 4) Pusztaszer Landscape Protection Area (Hungary, 1991-1992), 5) Special Nature Reserve Obedeska Bara (Serbia, 1912-1940), 6) Dniestr River Delta (Ukraine, 1971 – 1982), 7) Kuban River (Russia, 1958 – 1966), 8) Volga River Delta (Russia, 1978 – 1980) , 9) Dagestan (Russia 1956 – 1995), 10) Kyzyl-Agach Nature Reserve (Azerbaijan, 1954 – 1960), 11) Benoni (South Africa, 1970 – 1988).

Recoveries from old ringing areas

The recoveries of Glossy Ibises ringed in Kis-Balaton (Hungary) suggest a scattered dispersal towards different directions which include Netherlands, Norway, Russia (west and north of Caspian Sea), Rumania, Egypt and South Italy. Those from the Black sea seem to fly to Italy and the Sahelian floodplains. The individuals ringed in the Southern Caspian Sea have been mainly recovered in the Middle East, Sudan and Arabian Peninsula whereas those ringed in the northern Caspian Sea in Sudan, Kazakhstan, Pakistan and India. Finally, a single long-distance record, from Zambia, has been detected from those ringed in South Africa.

Recoveries from recent ringing areas

Most of the dispersal data from the RRA monitoring programs come from the resighting of alive Glossy Ibises not represented in this study. The few RRA recoveries suggest that Glossy Ibises born in western Europe move towards North Africa (in the area comprised between Morocco and Tunisia) and the United Kingdom. An individual born in the Camargue wetlands was found dead in the Ebro Delta River (North-East Spain) and another one in Croatia. Finally, one individual born in Doñana wetlands (South Spain) has been recovered in the Virgin Islands (> 6,000 Km far from the natal site).

Discussion

Our study confirms that the Glossy Ibis is a bird species capable of impressive long-distance movements between the breeding and wintering areas. According to the recovery data we have gathered from different sources, the populations breeding in the eastern Eurasian region move to a area comprised between West and East Africa, with a large number of recoveries recorded in the Sahelian zone. Whereas the birds ringed in the Black Sea seem to prefer the Sahel and West Africa to winter, those ringed in the Caspian Sea have been found to move to East Africa, the Arabic peninsula and as far east as Pakistan and India. The majority of dispersal events from western Europe breeding sites is available in the form of recaptures (especially resightings) of alive individuals, a type of data we have not used in this study. However, the few recoveries from the new ringing areas suggest a similar pattern to that found in Santoro *et al.* (2016) with the resightings of Doñana-ringed Glossy Ibises during the breeding season. In both cases, the individuals breeding in West Europe seem to move preferentially to North Africa (from Morocco to Algeria) and Europe. The record of a Doñana-ringed individual recovered in the Virgin Islands that has been made in 2013 represents an unpublished data which adds to three other similar records made in Trinidad and Tobago (2008), Barbados (2010) and Bermudas (2013).
An enigma this study cannot solve is about the origin of the Glossy Ibises which settled in western Europe at the end of the 20th century and whose population is showing a sharp increase (Champagnon *et al.* 2019; Mañez *et al.* 2019; Santoro *et al.* 2013, 2016). The more plausible hypotheses seem to be either that they came directly from the declining eastern populations or that they came from the wintering grounds, more probably in West Africa. Interestingly, both the individuals ringed in the Black and Caspian Seas have been recovered in the Mediterranean, especially in Italy (Spina and Volponi 2008), suggesting they cross

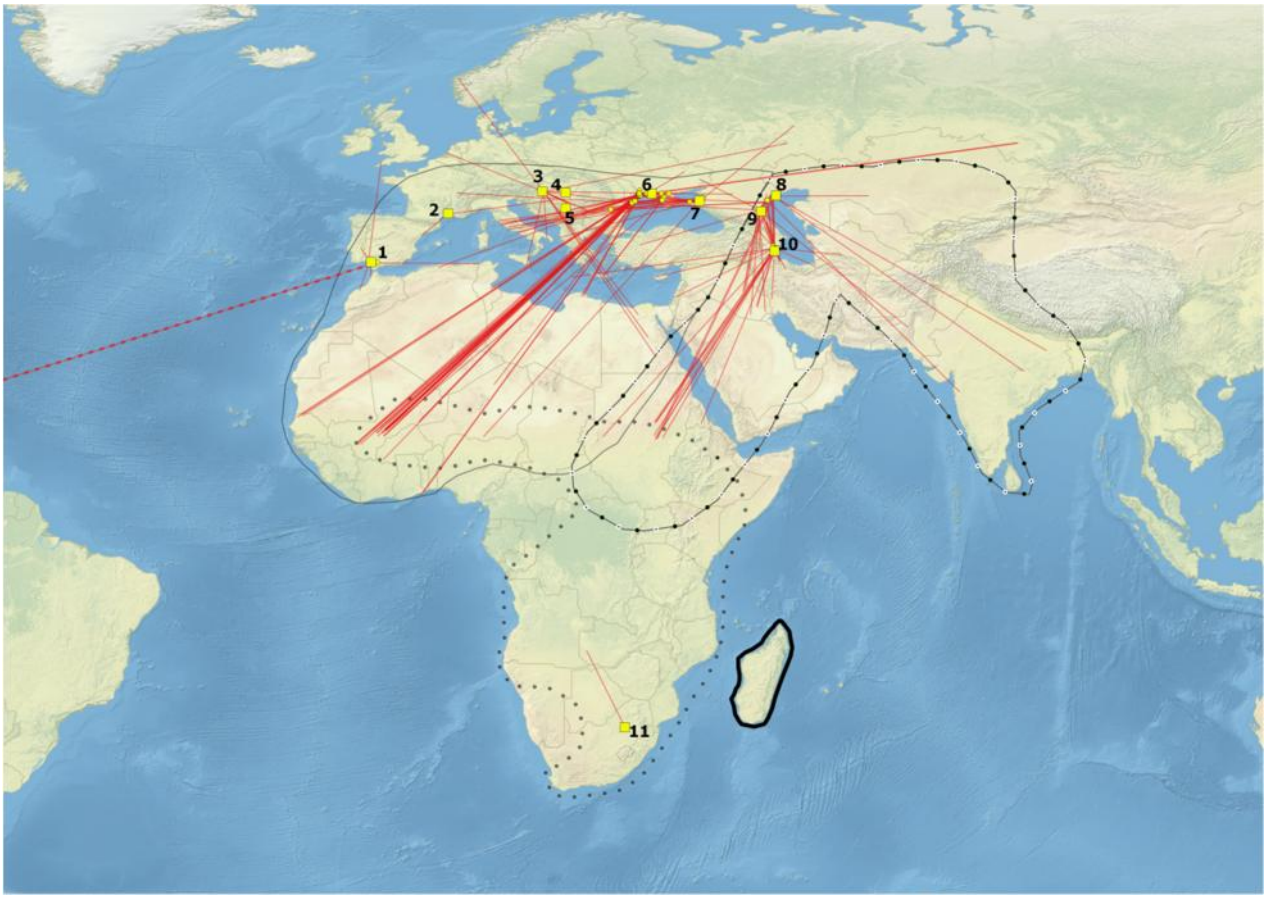
the central Mediterranean and enter Africa in particular through Tunisia and Algeria. However, the Doñana area is only a few hundred Km far from Morocco that is also a plausible gate of entry to Africa for the Eastern Glossy Ibises populations (Zwarts *et al.* 2009). Moreover, the resightings of individuals born in Doñana suggest connectivity at least with the Black Sea areas. On the other hand, unpublished data collated by the Estación Biológica de Doñana suggests that Doñana-born individuals may fly to West Africa too. There is a need to undertake monitoring studies of the species also in Eastern Europe. This is one of the priority objectives of the International Glossy Ibis Network (IGIN), and the recent start of a species banding program in Greece is encouraging.

A substantial limitation of our study is that data have not been collected over the same period. Thus, one might wonder whether the shown spatial variability is a consequence of spatial or of temporal dynamics. In other words, is the migration dynamic of the Glossy Ibises born in East Europe still the same? Are, for example, the old (1928 – 1952) recoveries from the Kis-Balaton in the nowadays deteriorated Nile Delta (Stanley and Warne 1998) informative of the current population dynamics? Most likely, they are not. The Glossy Ibis is a species that have demonstrated to be capable of adapting fast to environmental changes (e.g. Santoro *et al.* 2013) and to change its distribution range very quickly as it has been the case of West Europe, North America (Patten and Lasley 2000; Patten 2019) and South Africa (Underhill 2019). Therefore, we cannot be entirely sure that the data used in this study are informative of the current dispersal and migration dynamics of the species across the Eurasian-African region. The recoveries and resightings of the individuals ringed in the western populations suggest infrequent connectivity with West Africa and no movements to East Africa. A tentative explanation is that the distribution range of the species has shifted northward and this could be a consequence of the deteriorating conditions in their historical wintering zones in the Sahelian zone. This hypothesis is in line with the frequent observation, in winter, of large flocks of Glossy Ibises in Spain and other West Europe areas similar to what is being observed with other bird species. Many Holarctic bird species, like the White Storks *Ciconia ciconia*, are increasingly found in the last decades to overwinter at higher latitudes, closer to breeding grounds (Samraoui 1998; Rotics *et al.* 2017) because they rely on easy-to-access anthropogenic resources (landfills and agricultural areas). Also, dispersal is generally higher in juvenile than adults (Clobert *et al.* 2012) and, in this study, we did not access to the age of the recovered individuals. Dispersal of juveniles probably differs from the range of established populations and, therefore, the information presented in this study may not adequately reflect the exchanges among populations or their migration routes.

Finally, in the absence of any evidence of Glossy Ibises crossing the equator in Africa, birds that breed in southern Africa may be genetically distinct from those breeding in the Northern Hemisphere which would be in line with the classification made by Kirby and colleagues (2008). The few long-distance records coming from the South African ringing area might suggest this population is more sedentary compared to the others in the Eurasian region, although this could be an artefact due to detectability issues (i.e. lower probability of recovery). However, we think it is more probable that these birds form a panmictic population with little or no genetic structure. In support of this hypothesis, our results suggest that emigration to non-natal colonies and broad overlap in wintering areas provide ample opportunity for gene flow among Glossy Ibises that breed in western Eurasia and Mediterranean Africa. It has been suggested the Glossy Ibis has recently colonised America from the old world (Oswald *et al.* 2019) and that it started breeding in South Africa in the middle of the 20th century from Eurasian specimens (Underhill *et al.* 2016). A large-scale genetic study and the use of tracking devices (both among the IGIN goals) would undoubtedly help to disentangle the Glossy Ibis metapopulations' dynamics. The difficulty of studying the Glossy Ibis, which explains why there are so few studies on this species, lies in the sudden changes in its distribution and its changing dispersal habits. This plasticity, however, should be a priority research target in times, like these, when the global changes are threatening all ecosystems and living

organisms, and we urge others to understand the ecological processes driving the changes in distribution and abundance of species.

Figure 1. **European ringing locations of Glossy Ibis recovered in the Eurasian-African region. The red lines show the dispersal movements from the ringing areas that are yellow squares (main ringing sites) or circles (sporadic ringing sites). The main ringing sites are numbered clockwise starting from (1) Espacio Natural de Doñana (Spain), (2) Camargue wetlands (France), (3) Kis-Balaton (Hungary), (4) Pusztaszer Landscape Protection Area (Hungary), (5) Special Nature Reserve Obedeska Bara (Serbia), (6) Dniestr River Delta (Ukraine), (7) Kuban River (Russia), (8) Volga River Delta (Russia), (9) Dagestan (Russia), (10) Kyzyl-Agach Nature Reserve (Azerbaijan), (11) Benoni (South Africa). The ringing sites (1) and (2) are still active whereas all the others are old (between 1910s and 1990s) ringing programs. One dispersal movement signalled with a dashed red line departs from Doñana wetlands to Virgin Islands (not shown for visual clarity). The polygons delineate the four populations as suggested by Kirby et al. (2008). See the text for more details.**



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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

Westward Expansion of the Glossy Ibis *Plegadis falcinellus* in North America: Records for the New Millennium

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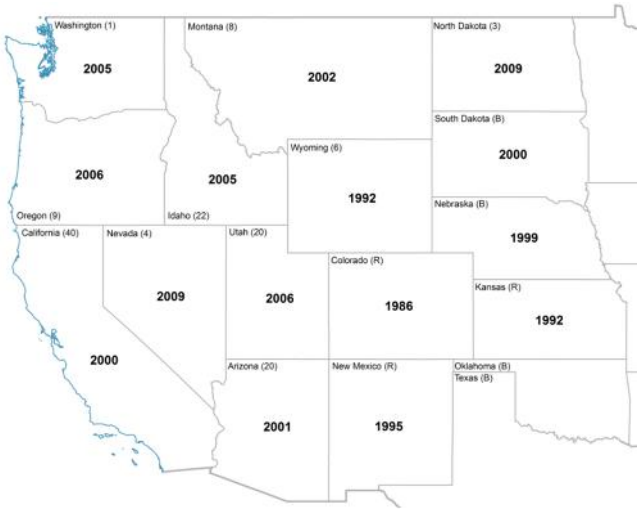
Short Note

When Europeans colonized the New World, the Glossy Ibis *Plegadis falcinellus* remained in its Old World haunts, a broad, discontinuous breeding distribution from southern Europe east to southern Asia and wintering distribution from Africa east to Australasia. As the Cattle Egret *Bubulcus ibis* would accomplish decades later, the Glossy Ibis colonized the New World, in its case in the early 1800s (Patten and Lasley 2000; Oswald *et al.* 2019). The ibis had established itself as a breeder in the southeastern United States by the turn of the twentieth century and had begun to expand westward by the turn of the twenty-first century (Patten and Lasley 2000). Expansion apparently was rapid: by 2000, the species had become more-or-less regular in the southern Great Plains and southern Rocky Mountain region and had occurred as far west as southeastern California (Patten and Lasley 2000).

The Glossy Ibis's manifest density did not halt with the new millennium; rather, records continued to accumulate across the western United States (Faulkner 2004). By 2009 the species had been recorded in each of the western states (Figure 1). To the north, the species regularly occurs at a single site in southwestern Manitoba (Artuso *et al.* 2018) and has reached the Pacific Northwest in both Oregon (Contreras *et al.* 2006) and Washington (Mlodinow and Aanerud 2008), yet it is considered hypothetical in Saskatchewan (Smith 2017).

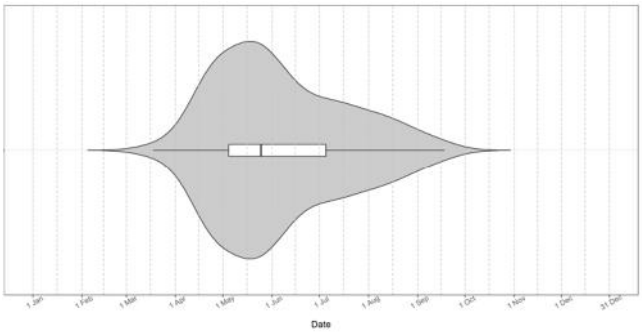
Figure 1. Year of first occurrence of the Glossy Ibis by state in the western United States. Figures in parentheses are the approximate number of accumulated records of the state, or "R" indicates regular occurrence and "B" signifies breeding documented



Twentieth century vanguards were concentrated in April and May (Patten and Lasley 2000), a pattern that has not changed: records since 2000 in the western United States are overwhelming from the

early spring (Figure 2), suggesting the possibility that most occurrences are of early migrants that "overshot"—to the north and west—traditional breeding sites, perhaps to establish new breeding sites. Indeed, the Glossy Ibis has begun to breed in the central Great Plains states of Nebraska (Jorgensen and Silcock 2015) and South Dakota (Drilling 2013), the latter only a dozen years after the first state record (Bardon 2001). Breeding, presumptive breeding, or interbreeding with the White-faced Ibis *P. chihi* has been reported in Oklahoma, Wyoming, and Colorado (Arterburn and Grzybowski 2003; Faulkner 2005; Leukering 2008).

Figure 2. Violin plot of seasonal occurrence of twenty-first century records (N=136) of the Glossy Ibis in the western United States. Note the high seasonal peak in May, a pattern that has held for several decades



Hybridization remains a challenge to field observers and continues to hinder tracking of the Glossy Ibis's westward expansion. Individuals with a phenotype intermediate with the White-faced Ibis have been documented in Texas, Oklahoma, Wyoming, Colorado, Arizona, and California (Arterburn and Grzybowski 2003; Faulkner 2005; Leukering 2008; Rosenberg *et al.* 2011; McCaskie *et al.* 2018). No clear hybrid zone exists between these two species; rather, admixture is dispersed widely (Oswald *et al.* 2019), implying adventitious and occasional hybridization, perhaps typically of lone individual Glossy Ibis in White-faced Ibis rookeries. Many individuals with intermediate phenotype had an introgressive genotype that pointed toward past hybridization rather than F_1 hybrids (Oswald *et al.* 2019), implying that hybrids are fertile.

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