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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).

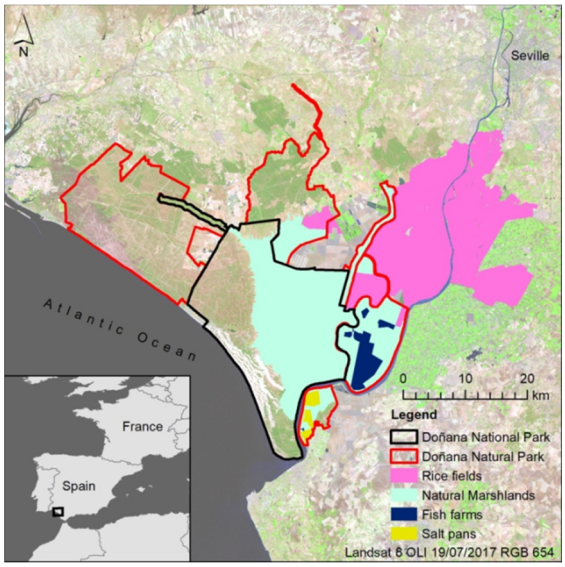
After decades of absence, in 1993 the species recolonized the Iberian Peninsula (Albufera de Valencia, Spain) as breeders (Dies *et al.* 1997), and later in 1996 started to breed in the Ebro Delta (Martínez-Vilalta 1996) and Doñana (Máñez and

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

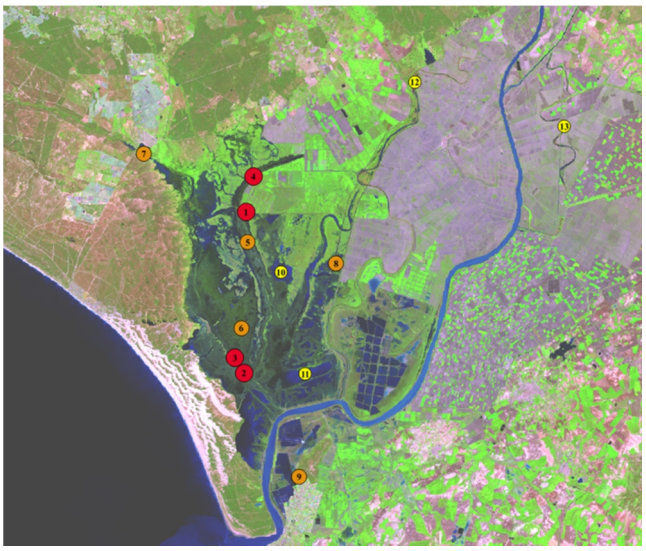
Doñana typically requires the support of between 15 and 40 field assistants. Before starting the field-work, all of the participants are instructed on details of the field-work which consists of a coordinated surrounding of the big chicks, their manual capture and transportation to a neighbouring location 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

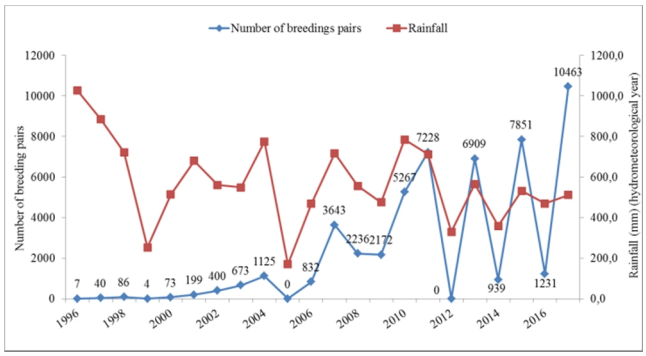
There are several colonies that have never exceeded 1,000 breeding pairs.

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

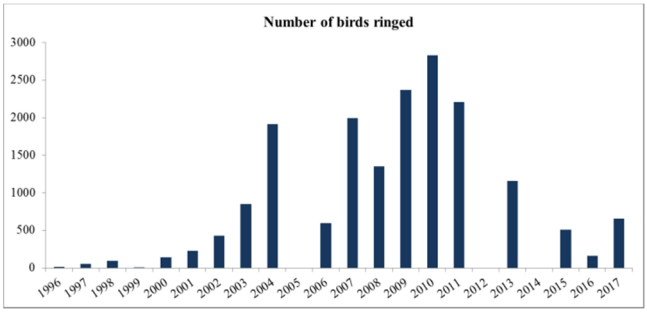
The colony installed in the "Lucio de las Casas" of the FAO grew from 7 pairs in 1996 to 40 the following year. In 1998, the nesting population in FAO doubled, and for the first time they tried to nest in a different site, specifically in a purple heron colony located in the Caño de Guadiamar, in a *Schoenoplectus 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

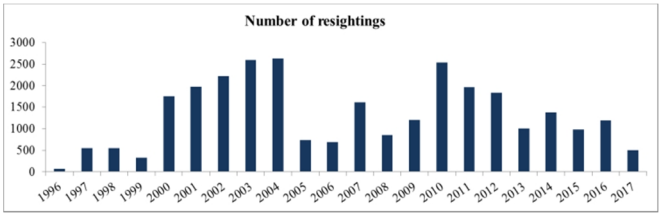
The number of ringed chicks for each breeding season is shown in Figure 4. At the present time, the total number of birds ringed over the last 22 years is 17,565. This number represents 97.44% of all Glossy Ibis ringed in Spain (N = 18,025).

Figure 4. Number of chicks ringed per breeding season



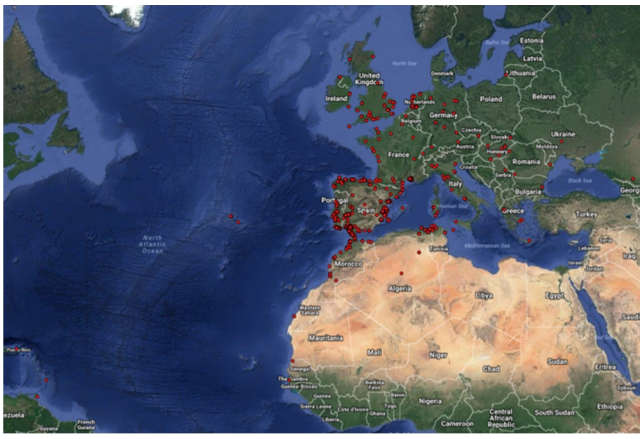
The annual number of resightings of chicks ringed in Doñana is shown in Figure 5. At this time, the total number of resightings reported is 29,199. This number represents 99% of all the resightings of Glossy Ibis ringed in Spain (N = 29,495).

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.

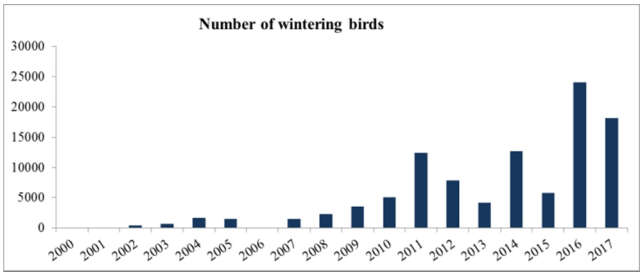
Figure 6. Countries and localities where the resightings of the Doñana ringed chicks (red circles)



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

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