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## 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 19<sup>th</sup> 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 20<sup>th</sup> 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 salt pans, 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 al.* 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
<b>Marjal</b>														
Almenara	0	0	0	0	0	0	0	0	1	0	0	1	44	0
<b>Marjal del</b>														
Moro	0	0	0	0	0	0	0	0	0	55	25	90	82	24
<b>Albufera de</b>														
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
<b>Marjal Pego-</b>														
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
<b>València</b>														
<b>Region</b>	<b>12</b>	<b>9</b>	<b>11</b>	<b>18</b>	<b>23</b>	<b>33</b>	<b>41</b>	<b>75</b>	<b>119</b>	<b>182</b>	<b>315</b>	<b>399</b>	<b>702</b>	<b>765</b>

*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 15<sup>th</sup> of May and the 30<sup>th</sup> 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

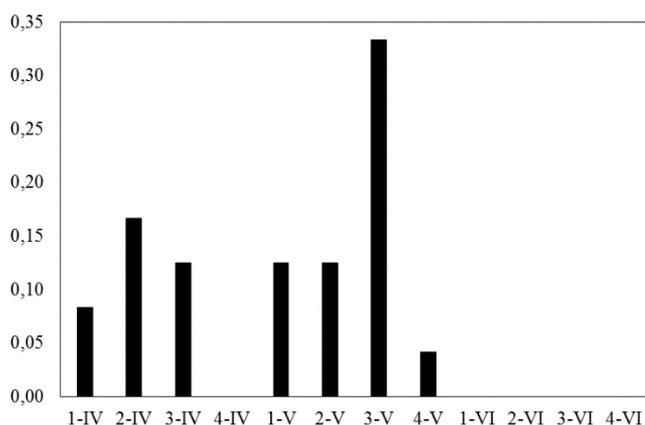
### Breeding sites

Since 2010 Glossy Ibis breeding has been verified in four different colonies in l'Albufera de València. However, since 2016 breeding only occurred 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. Bouchecker *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<sup>th</sup> of May and the 30<sup>th</sup> 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.

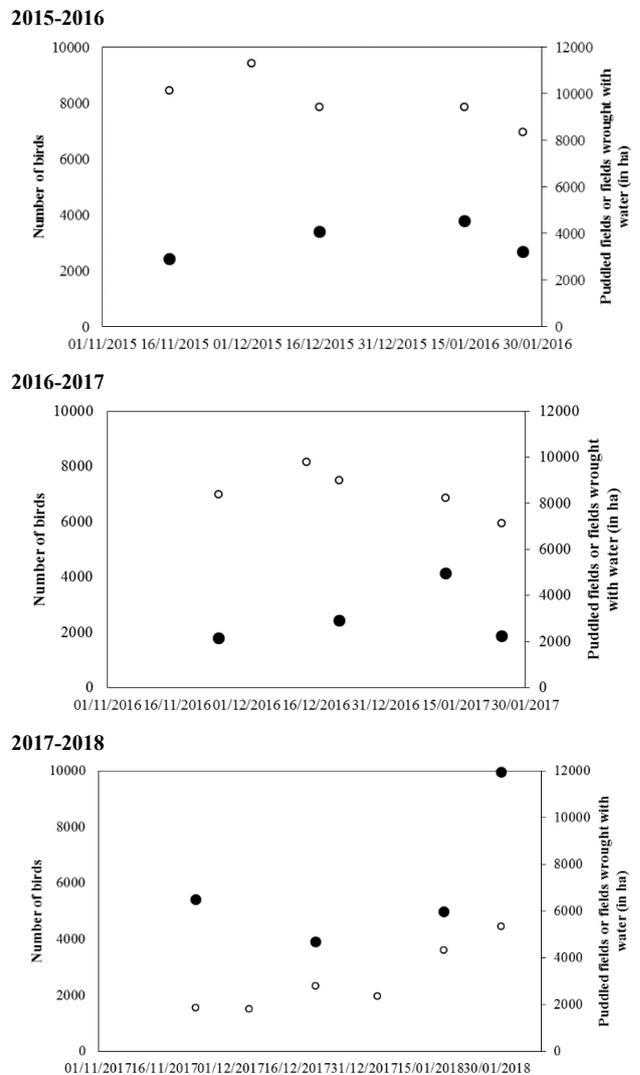
**Figure 3. Localities with resightings of Glossy Ibis banded in Albufera de València and Marjal del Moro between 2013 and 2017 (data incorporated until April 2018)**



*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.

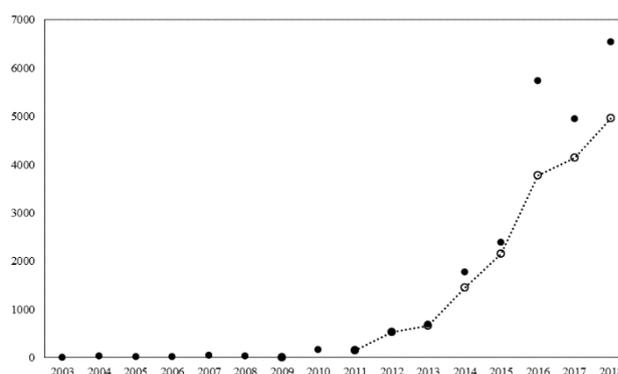
Preliminary movement data assessment suggests that the l'Albufera de València breeding colony has grown from individuals from French colonies. In fact, the only evidence of the presence of a Glossy Ibis with known origin during the colonization of the wetland in 2010 supports this hypothesis, as the 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 comparison 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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