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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

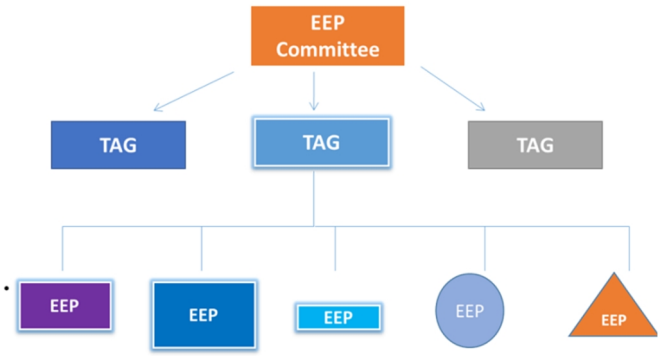
Although Glossy Ibis *Plegadis falcinellus* are found in zoos throughout the world, most (421, including 135 males, 150 females and 136 of unknown gender) are held in 44 European Association of Zoos and Aquaria (EAZA) zoos. Taxon Advisory Groups (TAGs) have been established for all animal groups that 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.

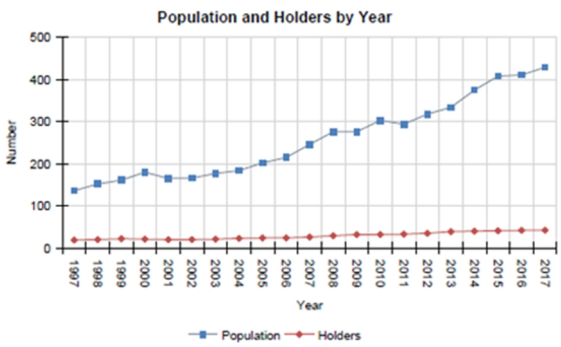
Table 1. Glossy Ibis in Zoos by Geographical Region, *: unknown gender

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.

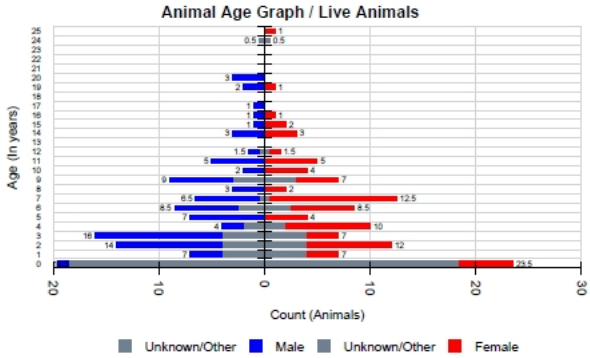
The EAZA Glossy Ibis population has been steadily growing for the last 20 years, as has the number of zoos holding them (Figure 2). Nonetheless, 19 (43.2%) of the 44 EAZA institutions hold less than 6 specimens, including six (13.6%) that hold single specimens (Species 360 2018).

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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