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SPECIAL ISSUE: GLOSSY IBIS ECOLOGY & CONSERVATION

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)

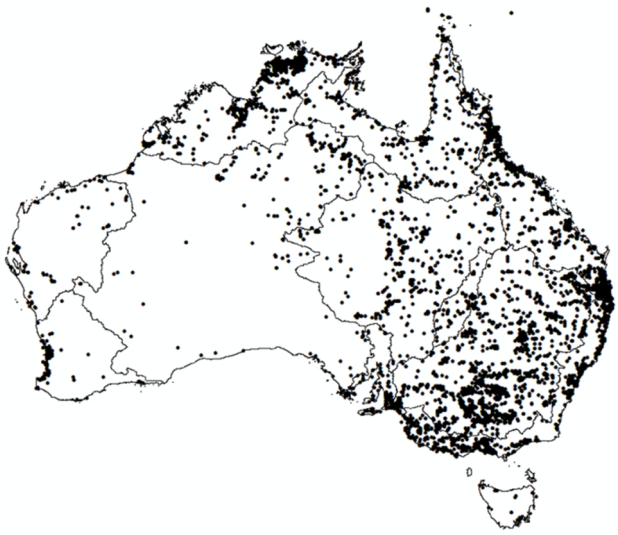
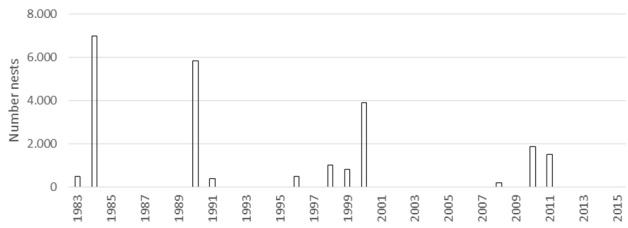
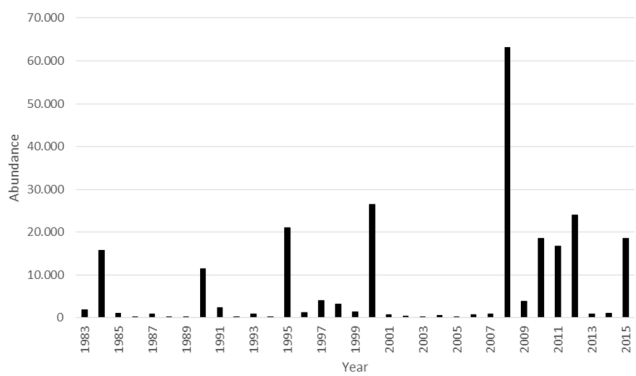


Figure 3. A) Total Glossy Ibis nest counts (1983-2015) and B) total abundance in eastern Australia (source: EAWS 2017). X axis shows year

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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