Corella, 2006, 30(2): 41–45

BREEDING BIOLOGY OF THE AUSTRALIAN WHITE IBIS *Threskiornis molucca* AT AN URBAN BREEDING COLONY, SOUTH-EAST QUEENSLAND

NICHOLAS J. MURRAY[1,2] and PHILLIP P. SHAW[1]

[1]Ecosure, PO Box 287 Tugun, Queensland, Australia 4224. E-mail: nmurray@ecosure.com.au
[2]Centre for Innovative Conservation Strategies, Griffith University, Gold Coast, PMB 50, Gold Coast Mail Centre, Bundall, Queensland 9726

Received: 30 November 2005

The Australian White Ibis *Threskiornis molucca* has increased in range and abundance in Australia since European settlement, and has recently reached pest proportions in urban environments. Aspects of Australian White Ibis breeding ecology at an urban breeding colony on the Gold Coast, Queensland were studied in the 2002/2003 breeding season. Breeding activity commenced in late June and lasted for six months, with the last egg hatched in late December. A total of 124 clutches was initiated in 95 nests, and a further ten nests produced no eggs. The mean clutch size was 2.46 eggs and the mean incubation period was 21.61 days. Hatching success was 47.9 per cent, fledging success was 60.3 per cent and overall breeding productivity, that is the proportion of chicks fledged to eggs laid, was 28.9 per cent. Results reported here may be used in optimising the timing of visitation to urban breeding colonies for implementation of ibis management programmes that are aimed at controlling urban Australian White Ibis populations.

INTRODUCTION

The large-scale conversion of natural and agricultural areas to urban environments has led to dramatically altered coastal habitats (Adams 1994; Marzluff 2001). Whilst urban areas typically contain reduced fauna diversity compared to surrounding areas, some species have colonized the urban environment and have benefited from anthropogenic food sources, increased protection from predators, permanent water sources and the presence of suitable breeding sites (Blair 1996; Marzluff 2001). Compared to their non-urban counterparts, urban populations of 'winning' avian species have exhibited longer yearly breeding seasons, earlier onset of breeding within the season, and increased breeding success and survival rates (Perrins 1970; Svensson 1995; Rollinson and Jones 2002; Partecke *et al.* 2005).

The Australian White Ibis *Threskiornis molucca* is one of only a few Australian waterbird species to have increased in range and numbers in recent years (Blakers *et al.* 1984; Kentish 1999; Kingsford and Norman 2002; Barrett *et al.* 2004). This has been attributed to the increase in suitable habitats through the conversion of land for agriculture, the utilization of new and constant food sources and broad habitat tolerance (Kentish 1999). Urban populations of ibis have also increased considerably since the 1970s (Ross 2004). Suspected causes for the increase include the relocation of natural populations as a response to inland drought, exploitation of anthropogenic food sources, translocation of individuals and increased protection of nesting colonies (Shaw 1999; Ross 2004). Breeding colonies of Australian White Ibis are now common in many urban centres (Nick Murray, pers. obs.).

At urban breeding colonies, damage to remnant vegetation and faecal contamination of water bodies caused by high densities of nesting Australian White Ibis have led to elevated nutrient levels at some sites, and lower breeding performance and nest abandonment of other native waterbird species (Kentish 1994, 1999). Large numbers of Australian White Ibis in urban areas also have a detrimental effect on human social values and, therefore, may be considered a pest species (Bomford and Sinclair 2002). As opportunistic foragers, they scavenge on human food waste in a variety of urban environments (Marchant and Higgins 1990) and are known to harbour a variety of pathogens, which may present a risk to humans (Epstein 2001; McKee 2002). Furthermore, Australian White Ibis pose a significant risk to air safety at several Australian metropolitan airports (Shaw 1999; Australian Transport Safety Bureau 2003).

The negative impacts of Australian White Ibis populations in urban areas have led to the formulation of broad scale management programmes (Shaw 1999; Ross 2004). Management strategies have included egg and nest disturbance at breeding colonies, culling, habitat modification, active dispersal and physical exclusion from foraging sites (Ross 2004; Shaw and Murray 2004). Egg and nest disturbance, including egg and nest destruction, removal of eggs, egg replacement, egg pricking and egg oiling requires regular repeated visitation during the breeding season. Information on the breeding biology of Australian White Ibis in urban areas may be used to optimize timing of visitation to urban breeding colonies, which will increase the efficiency of management programmes for those that rely on the management of urban breeding colonies.

Several studies have reported on the breeding biology of Australian White Ibis in natural environments (Lowe 1984; Beilharz 1988; Kentish 1999). However, despite being a common species in many urban areas and the reported conflicts with humans, few studies on ibis breeding biology have been conducted in an urban context. In this paper, data on the breeding biology of Australian White Ibis in

an urban environment are presented and management options for pest populations are discussed.

METHODS

Study site

The breeding biology of an urban Australian White Ibis population at Movieworld Lake, south-east Queensland (27°55'S, 153°19'E) between July 2002 and June 2003 was studied. Movieworld Lake drains from an urban catchment and is approximately one hectare in size. The lake is largely open shallow water (up to 1.5 m deep) with some areas exposed as mudflats during periods of little rain. The site is dominated by *Melaleuca quinquinervia*, which forms clusters within the waterbody and provides nesting sites for several ibis pairs in any one aggregation. Surrounding Movieworld Lake are areas of urban development, farmland and a theme park. Two waste landfills are potential foraging sites — a putrescible waste landfill 21 kilometres to the north and a general waste landfill nine kilometres to the south of the breeding site. Australian White Ibis have been recorded breeding at Movieworld Lake in all years since observations began in 1998, and no management of the breeding colony has been undertaken at the site.

Colony occupation

Counts of Australian White Ibis roosting at Movieworld Lake were conducted during the study period, from July 2002 to June 2003. Weekly counts were conducted early in the breeding season, and then fortnightly from October onwards. Commencing approximately two hours before last light, all ibis at the colony were counted. Subsequently, counts of all ibis entering and leaving the colony were made until approximately ten minutes after last light and the number of ibis, which roosted overnight, was calculated. Weekly counts were conducted during the 2002 breeding season.

Nest monitoring

The Movieworld Lake colony was visited three times per week during the 2002 breeding season, from 15 July 2002 until all chicks fledged (31 January 2003; n = 86 visits). Every nest in the colony was individually marked with flagging tape and on each visit new nests were identified. During each visit, the content of each nest was recorded. When first encountered, eggs were weighed to the nearest gram using digital scales, measured to the nearest 0.02 millimetres with vernier calipers (length and maximum width) and marked with a felt-tipped pen. The laying order of eggs and incubation period were determined by marking the eggs in numerical order. In cases where two or more eggs were laid between visits, it was usually possible to establish laying order by examining the egg and differentiating between the recently laid whiter eggs and older, dirtier eggs. Where laying order could not be determined, eggs were excluded from the analysis of eggs size. Care was taken during monitoring to ensure that disturbance of ibis in the colony was kept to a minimum.

Clutch size was defined as the maximum number of eggs observed in one nest. Reproductive success was assessed in terms of (1) hatching success (the proportion of eggs hatched to the number of eggs laid), (2) fledging success (the number of chicks which reached 21 days old or were capable of flight as a proportion of the number of chicks hatched) and (3) overall breeding productivity (the number of chicks fledged as a proportion of the number of eggs laid). Because chicks were not individually marked and often departed the nest at approximately nine days old to form groups with neighbouring chicks, fledging success and breeding productivity were determined for groups of nests as opposed to individual nests. Despite fledglings roosting and foraging at the site for several weeks after fledging from the nest the success of chicks from fledging to independence could not be determined. Breeding pairs were not individually identified and, therefore, it was not possible to determine the number of clutches produced by one pair for the breeding season.

RESULTS

Colony occupation

Australian White Ibis were present at Movieworld Lake in all months between June 2002 and June 2003 (Fig. 1). Maximum counts occurred in early August 2002 (284 individuals) and in March 2003 (308 individuals). Numbers of Australian White Ibis roosting at the colony were usually higher between July and December, when nesting was observed (Fig. 1).

Nests, eggs and clutches

During the 2002 breeding season, a total of 105 active nests was located at Movieworld Lake. Nests were predominantly found over water in mature *Melaleuca* trees (93.3%) but some nests were built up to eight metres high in eucalypts surrounding the lake (6.7%). Nests were built either singly or in aggregations and were constructed from interwoven small to medium sticks and were occasionally lined with fresh eucalypt leaves immediately before laying. Mean number of nests in each aggregation was 4.6 ± 2.7 nests (range = 1–11, n = 26 aggregations).

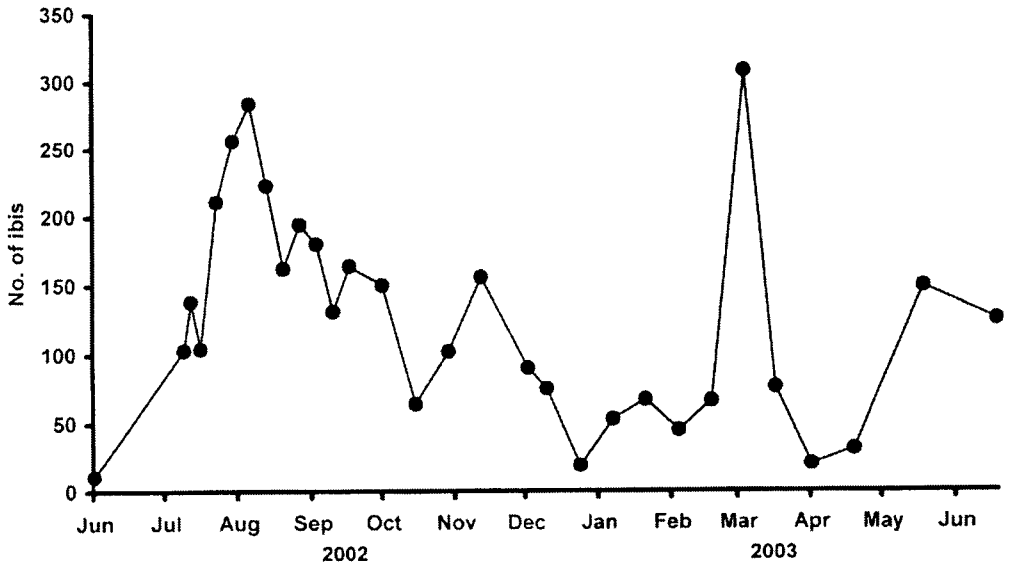

Figure 1. *Number of Australian White Ibis counted during roost counts at Movieworld between 11 June 2002 and 28 June 2003.*

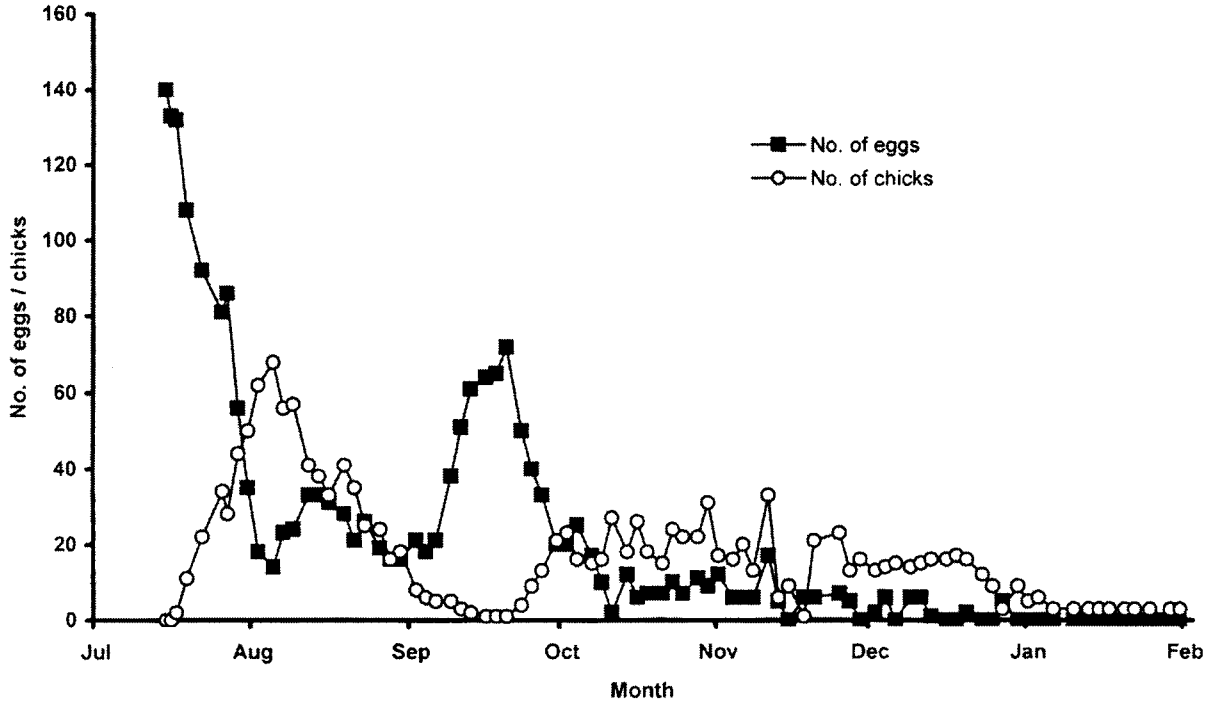

Figure 2. *Number of eggs and chicks recorded per visit at Movieworld breeding colony from 15 July 2002 to 31 January 2003 (n = 86 visits).*

During the first visit in the 2002 breeding season (July 15), several nests contained eggs and the first eggs to hatch were observed. On the basis of hatching dates and incubation periods (see below), egg-laying most likely began in the week beginning 23 June 2002. In total, 305 eggs were laid during the 2002 breeding season. Laying was concentrated in the early stage of the breeding season with 58 per cent of all eggs laid within 60 days after the first egg was estimated to have been laid (Fig. 2). A second peak in laying was recorded in September. The last egg hatched on 27 December. The mean length and width of a subsample of 124 eggs were 63.62 millimetres and 42.97 millimetres respectively, which are amongst the smallest eggs observed in this species (Table 1). Egg sizes within clutches were not significantly different and clutch size had no significant effect on egg size.

A total of 124 clutches was initiated in 95 nests, and no eggs were recorded in a further ten nests which were considered active due to their structure and form. The mean clutch size at Movieworld Lake was 2.46 ± 0.7 eggs (range = 1–4, n = 124 clutches; Table 2). The modal clutch size was three eggs. Hatching success was 47.9 per cent. Complete nest failure was common, with 46.8 per cent of all clutches initiated, failing. Causes of egg mortality were not known because egg loss was mostly attributed to the disappearance of eggs between visits. Heavy rainfall on 21 August resulted in ten nests being submerged. The mean incubation period, defined as the time elapsed between when an egg was first encountered to when it hatched, was 21.61 ± 1.35 days (range = 18–24 days, n = 41 eggs). After hatching, eggshells were usually ejected from the nest.

A total of 88 chicks fledged from the 95 nests containing eggs. Fledging success was 60.3 per cent and overall breeding productivity was 28.9 per cent. Chick losses were mainly attributable to their disappearance between visits, although several dead chicks were found in and around nests. There was no direct observation of predation at Movieworld Lake during the study period, and no chicks found dead showed any visible indication of predation. In some cases adults from adjacent nests were observed attacking chicks, which ventured into their nests, although no deaths were recorded.

TABLE 1

Dimensions of Australian White Ibis eggs at Movieworld Lake, south-east Queensland and various locations in Victoria.

Location	n	Mean Length	Mean Width	Source
Movieworld Lake, Queensland	124	63.62	42.97	This study
Lake Cowal, Victoria	24	66	45	Vestjens 1977 (cited in Marchant and Higgins 1990)
Phillip Island, Victoria	166	66.45	43.9	Marchant and Higgins (1990)
Rhyll, Victoria	33	66.4	44	Lowe (1984)
Rhyll, Victoria	84	66.3	43.8	Lowe (1984)
Coolart, Victoria	60	67.1	43.6	Lowe (1984)
Healesville, Victoria	36	64.6	42.4	Lowe (1984)

TABLE 2

Summary of the reproductive parameters of Australian White Ibis at Movieworld Lake, south-east Queensland, during the 2002 breeding season (mean ± S.E.). Hatching success is the proportion of eggs hatched to the number of eggs laid. Fledging success is the proportion of chicks that fledged from the nest to the total number of eggs hatched. Breeding productivity is the number of chicks that fledged as a proportion of the number of eggs laid.

Breeding parameter	2002 breeding season
Egg dimensions	
Mean egg length (mm)	63.62 ± 7.81 (n = 124 eggs)
Mean egg width (mm)	42.97 ± 3.07 (n = 124 eggs)
Mean incubation period (days)	21.62 ± 1.36 (n = 41)
Mean clutch size (eggs)	2.46 ± 0.71 (n = 124 clutches)
% clutch failed before hatching	46.8
Success	
Hatching success	47.9%
Fledging success	60.3%
Breeding productivity	28.9%

DISCUSSION

Australian White Ibis at Movieworld Lake bred either singularly or in aggregations, and were recorded in a variety of nesting sites including aggregations over water and single nests in trees. Variability in nesting sites has also been observed at other nesting sites in urban areas of south-east Queensland where ibis commonly nest in tall eucalypts, rainforest remnants, Norfolk Pines and Cocos Palms (Nick Murray, pers. obs). Elsewhere, ibis have been recorded nesting in a similar range of environments including clumps of mistletoe in eucalypts, bare ground and artificial structures (Carrick 1962; Marchant and Higgins 1990).

The mean clutch size, clutch failure rate, fledging success and overall breeding productivity found in this study was similar to that recorded in New South Wales and Victoria (Carrick 1962; Lowe 1984; Beilharz 1988; Kentish 1999). The breeding season at Movieworld Lake lasted seven months, with the onset of egg laying in late June. Lowe (1984) studied the breeding of Australian White Ibis at several breeding colonies in Victoria and found that ibis breeding in colonies at inland and coastal sites exhibited variable breeding seasons lasting up to five months. The presence of abundant anthropogenic food sources resulted in extended breeding seasons in some colonies. One colony at Healesville Victoria, supported by a waste landfill, began breeding up to one month earlier than all other sites, with the breeding season lasting from June to December (Lowe 1984). Similarly, a seven-month breeding season was reported in Ballarat, where ibis were thought to forage at a nearby waste landfill (Kentish 1999). Lowe (1984) and Bielharz (1988) reported much higher fledging success and breeding productivity at Healesville than at other Victorian colonies, which was attributed to the constant food supply at the nearby waste landfill. Australian White Ibis are opportunistic foragers and scavenge on human food waste in a variety of urban environments, including waste landfills, urban parks and gardens, and remnant wetlands (Marchant and Higgins 1990; Ross 2004). Therefore, variation in the timing and breeding success of Australian White Ibis is likely influenced by differences in abundance and consistency of food resources.

Variation in the breeding biology and timing of reproduction within bird species is known to occur across populations living at different latitudes, as well as among subpopulations which utilise different habitats, food resources, or are subject to differing rates of nest predation (Svensson 1995; Partecke *et al.* 2005). Furthermore, quality, availability and consistency of food resources can influence timing of breeding and reproductive success in birds (Perrins 1970; Svensson 1995). Several studies have reported extended breeding seasons and increased success in colonial bird species obtaining food from waste landfills (Belant *et al.* 1998; Tortosa *et al.* 2002; Yorio 2002). However, it should be noted that other factors such as latitude, rainfall, environmental predictability and prevailing weather conditions were not addressed in this study (Halse and Jaensch 1989; Bildstein *et al.* 1990).

As in other colonial birds, ibis are susceptible to human disturbance at breeding colonies and increased predation, exposure and stress as a result of human disturbance is well documented in the literature (Gotmark 1992; Hancock *et al.* 1992). In this study, observer disturbance may have affected breeding performance, despite the precautions taken to avoid this. Egg and chick predation is a major cause of breeding failure in many species of ibis (Miller and Burger 1978; Donazar *et al.* 1994; Bowden *et al.* 2003; Olmos 2003). Lowe (1984) reported scavenging by ravens *Corvus* sp. and Red Fox *Vulpes vulpes* on carcasses and abandoned eggs at some Australian White Ibis breeding colonies. In this study, no incidences of predation were observed.

Management implications

In Australia, a range of methods has been used for the management of Australian White Ibis populations. Direct management of ibis breeding colonies through egg and nest destruction, egg suppression through oiling or pricking and culling of selected individuals is undertaken widely (Ross 2004; Shaw and Murray 2005). Results reported here may be used in optimising the timing of visitation to urban breeding colonies for implementation of management programmes which include egg and nest destruction or egg suppression.

The results of this study suggest that management of anthropogenic food sources is likely to influence the timing of breeding and reproductive success of Australian White Ibis in urban environments. Shaw (2001) reported that landfills were a significant foraging site for between 66 and 78 per cent of the urban population of ibis on the Gold Coast. An urban colony near a putrescible waste landfill in south-east Queensland was abandoned mid-breeding season when birds were prevented access to waste through a program of disturbance (P. Shaw, pers. obs.). Dispersal of ibis from waste landfills using a range of bird scaring techniques is employed at least three landfills in south-east Queensland in order to reduce access to food on an ongoing basis (Shaw and Murray 2004). At Ballina Landfill (north-east New South Wales), complete physical exclusion of birds from the landfill was achieved through the construction of a permanent net, which was erected over the entire active cell (Shaw and Patrick 2005). Despite significant costs involved, numbers of ibis reported

foraging at the landfills were reduced, although no studies at breeding colonies were undertaken.

Several studies have reported that management of urban bird pest populations through clutch reduction alone was ineffective, and an integrated programme of food management, population control through culling or egg suppression, habitat modification at breeding sites and the implementation of a disturbance regime is necessary (Smith and Carlile 1993; Belant 1997; Watola *et al.* 2003). Given the results of this study, effective management of urban Australian White Ibis populations should include an integrated management approach centred on the management of food resources.

ACKNOWLEDGMENTS

Simon Muirhead and Damian White helped with fieldwork. The Griffith University Terrestrial Ecology Group provided valuable comments on the manuscript. We thank the Ibis Management Coordination Group (IMCG) for its commitment to the Gold Coast Ibis Management Program. Gold Coast City Council provided the funding for this study as part of the Gold Coast Ibis Management Program.

REFERENCES

Adams, L. W. (1994). 'Urban Wildlife Habitats'. (University of Minnesota Press: Minneapolis.)

Australian Transport Safety Bureau (2003). 'The Hazard Posed to Aircraft by Birds'. (Australian Transport Safety Bureau: ACT.)

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2004). 'The New Atlas of Australian Birds'. (Birds Australia: Melbourne.)

Beilharz, M. I. (1988). 'Individual variation in reproductive success in the Sacred Ibis'. (University of Melbourne: Melbourne.)

Belant, J. L. (1997). Gulls in urban environments: landscape-level management to reduce conflict. *Landscape Urban Plann.* **38:** 245–258.

Belant, J. L., Ickes, S. K. and Seamans, T. W. (1998). Importance of landfills to urban-nesting herring and ring-billed gulls. *Landscape Urban Plann.* **43:** 11–19.

Bildstein, K. L., Post, W., Johnson, J. and Frederick, P. C. (1990). Freshwater wetlands, rainfall, and the breeding ecology of White Ibises in coastal South Carolina. *Wilson Bull.* **102:** 84–98.

Blair, R. B. (1996). Land use and avian species diversity along an urban gradient. *Ecol. Applications* **6:** 506–519.

Blakers, M., Davies, S. J. J. F. and Reilly, P. N. (1984). 'The Atlas of Australian Birds'. (Royal Australian Ornithologists Union: Melbourne.)

Bomford, M. and Sinclair, R. (2002). Australian research on bird pests: impact, management and future directions. *Emu* **102:** 29–45.

Bowden, C. G. R., Aghnaj, A., Smith, K. W. and Ribi, M. (2003). The status and recent breeding performance of the critically endangered Northern Bald Ibis *Geronticus eremita* population on the Atlantic coast of Morocco. *Ibis* **145:** 419–431.

Carrick, R. (1962). Breeding, Movements and Conservation of Ibises (Threskiornithidae) in Australia. *CSIRO Wildl. Res.* **7:** 71–88.

Donazar, J. A., Ceballos, O., Travaini, A., Rodriguez, A., Funes, M. and Hiraldo, F. (1994). Breeding performance in relation to nest-site substratum in a Buff-necked Ibis (*Theristicus caudatus*) population in Patagonia. *Condor* **96:** 994–1002.

Epstein, J. (2001). 'Determining the Health Status of Coastal Wild Ibis and Assessing the Potential for Disease Transmission to People and Other Animals'. (Tufts University School of Veterinary Medicine: Massachusetts, USA.)

Gotmark, F. (1992). The effects of investigator disturbance on nesting birds. In 'Current Ornithology'. (Ed. D. M. Power). (Plenum Press: New York.)

Halse, S. A. and Jaensch, R. P. (1989). Breeding seasons of waterbirds in South-western Australia — the importance of rainfall. *Emu* **89:** 232–249.

Hancock, J. A., Kushlan, J. A. and Kahl, M. P. (1992). 'Storks, Ibises and Spoonbills of the World'. (Academic Press: London.)

Kentish, B. (1994). The effects of revegetation on Silver Gull and Sacred Ibis populations at Winter Swamp, Ballarat. *Corella* **18:** 71–76.

Kentish, B. (1999). Breeding of Australian White Ibis, Straw-necked Ibis and Silver Gulls on Winter Swamp, Ballarat from 1990–1997. *Corella* **23:** 37–42.

Kingsford, R. T. and Norman, F. I. (2002). Australian waterbirds — products of the continent's ecology. *Emu* **102:** 47–69.

Lowe, K. W. (1984). The feeding and breeding biology of the Sacred Ibis *Threskiornis aethiopicus* in southern Victoria. PhD Thesis. University of Melbourne: Melbourne.

Marchant, S. and Higgins, P. J. (Eds) (1990). 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 1: Ratites to Ducks — Part B Australian Pelican to Ducks'. (Oxford University Press: Melbourne.)

Marzluff, J. M. (2001). Worldwide urbanization and its effects on birds. In 'Avian Ecology and Conservation in an Urbanizing World'. (Eds J. M. Marzluff, R. Bowman and R. Donnelly). (Kluwer Academic Publishers: Massachusetts.)

McKee, J. (2002). 'A Synopsis of the Disease Risk Associated with Australian White Ibis, (*Threskiornis molucca*), in the Tweed-Gold Coast Region'. Report to the Ibis Management Co-ordination Group.

Miller, L. M. and Burger, J. (1978). Factors affecting nesting success of the Glossy Ibis. *Auk* **95:** 353–361.

Olmos, F. (2003). Nest location, clutch size and nest success in the Scarlet Ibis *Eudocimus ruber*. *Ibis* **145:** E12–E18.

Partecke, J., Hof, T. J. V. and Gwinner, E. (2005). Underlying physiological control of reproduction in urban and forest-dwelling European blackbirds *Turdus merula*. *J. Avian Biol.* **36:** 295–305.

Perrins, C. M. (1970). The timing of birds breeding seasons. *Ibis* **112:** 242–255.

Rollinson, D. J. and Jones, D. (2002). Variation in breeding parameters of the Australian Magpie *Gymnorhyna tibicen* in suburban and rural environments. *Urban Ecosys.* **6:** 257–269.

Ross, G. A. (2004). Ibis in urban Sydney: a gift from Ra or a Pharaoh's Curse? In 'Urban Wildlife: more than meets the eye'. (Eds D. Lunney and S. Burgin). (Royal Zoological Society of New South Wales: Mosman.)

Shaw, P. P. (1999). Integrated management systems for Australian White Ibis *Threskiornis molucca* on the Gold Coast, Queensland, Australia. *Bird Strike '99.* (Vancouver, Canada.)

Shaw, P. P. (2001). 'Ibis Management Program: Annual Report'. Report to the Ibis Management Coordination Group. (Ecosure: Queensland.)

Shaw, P. P. and Murray, N. J. (2004). 'Australian White Ibis Management Program: Annual Report 2003/2004. Tweed-Gold Coast Region'. Report to the Ibis Management Coordination Group. (Ecosure: Queensland.)

Shaw, P. P. and Murray, N. J. (2005). 'Australian White Ibis Management Program: Annual Report 2004/2005'. Report to the Ibis Management Coordination Group. (Ecosure: Queensland.)

Shaw, P. P. and Patrick, K. (2005). 'Bird Management Plan: Ballina Airport'. Report to Ballina Shire Council. (Ecosure: Queensland.)

Smith, G. C. and Carlile, N. (1993). Methods for Population Control within a Silver Gull Colony. *Wildl. Res.* **20:** 219–226.

Svensson, E. (1995). Avian reproductive timing: when should parent be prudent? *Anim. Behav.* **49:** 1569–1575.

Tortosa, F. S., Caballero, J. M. and Reyes-Lopez, J. (2002). Effect of rubbish dumps on breeding success in the White Stork in Southern Spain. *Waterbirds* **25:** 39–43.

Watola, G. V., Stone, D. A., Smith, G. C., Forrester, G. J., Coleman, A. E., Coleman, J. T., Goulding, M. J., Robinson, K. A. and Milsom, T. P. (2003). Analyses of two mute swan populations and the effects of clutch reduction: implications for population management. *J. App. Ecol.* **40:** 565–579.

Yorio, P. (2002). Breeding biology of Kelp Gulls (*Larus dominicanus*) at Golfo San Jorge, Patagonia, Argentina. *Emu* **102:** 257–263.