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# Breeding events and success of Yellow-billed and Royal Spoonbills in Victoria

**Kim W. Lowe**

Department of Environment and Genetics, La Trobe University, Bundoora Victoria 3086.
Email: Dribis@bigpond.com

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**Abstract.** Two species of spoonbills occur in Australia: the Yellow-billed Spoonbill *Platalea flavipes* and the Royal Spoonbill *P. regia*. The biology of these species is poorly known with only a handful of studies on breeding by Royal Spoonbill and no published studies of breeding by Yellow-billed Spoonbill. Australian waterbird populations have significantly declined over the past 40 years and in response water management authorities are increasingly focussing on environmental watering. Basic ecological data on water-dependent target species, such as the spoonbills, from across their range is required. To fill this knowledge gap, breeding events, clutch size and success of Yellow-billed and Royal Spoonbills in Victoria were studied in the field at four locations between 1981 and 1984. In addition, records of breeding in Victoria collected by others were collated from the publicly available databases, Birdlife Australia's Birdata, Cornell University's eBird and the Atlas of Living Australia to provide a broader overview of breeding events. Royal Spoonbill nested in loose colonies, whereas Yellow-billed Spoonbill nearly always nested alone. They laid eggs between October and May and this varied between years and location. The modal clutch size was three for both species and from 128 clutches of both species 153 fledglings were produced. Yellow-billed Spoonbill breeding was more successful, lasted longer and fledged more broods of two and three chicks than that of Royal Spoonbill. Online data sources (observations made mostly by volunteers) recorded breeding at 59 sites across Victoria between 1979 and 2024. Both species were recorded breeding together at a minority of sites and occasionally in the company of Australian White Ibis *Threskiornis moluccus* and Straw-necked Ibis *T. spinicollis*. Yellow-billed Spoonbill was recorded breeding at more sites than Royal Spoonbill, but the total number of nests reported was an order of magnitude higher for Royal Spoonbill than for Yellow-billed Spoonbill. Spoonbills of both species bred at 12 urban sites, the first report of this kind. The earliest record of urban breeding was in 2006 at the end of the Millennium Drought. The interaction between conditions at the breeding sites, timing of breeding and breeding success are discussed in relation to food availability and predictability and post-breeding movement patterns. More monitoring, especially at the many small ephemeral wetlands where they breed, is recommended as is further use of satellite tracking, especially for Yellow-billed Spoonbill, and at breeding sites outside the southern Murray-Darling Basin.

**Keywords:** Yellow-billed Spoonbill, Royal Spoonbill, *Platalea*, breeding, clutch size, sites, food

## INTRODUCTION

Two species of spoonbills occur in Australia. The Yellow-billed Spoonbill *Platalea flavipes* is endemic and the Royal Spoonbill *P. regia* occurs in south-east Asia and Australasia (Hancock *et al.* 1992). The breeding biology of these species is poorly known with only a handful of studies on breeding by Royal Spoonbill from a small part of their range and with small samples of breeding birds (McGinness and Brandis 2016, Brandis 2017, Brandis *et al.* 2020). There are no published studies of breeding by Yellow-billed Spoonbill. Habitat requirements, distribution, effects of environmental watering and chick growth have been studied for Royal Spoonbill in the Murray-Darling Basin (Arthur *et al.* 2012, Hale *et al.* 2023, McGinness *et al.* 2020, 2023, O'Brien and McGinness 2019). While there are no published studies of breeding by Royal Spoonbill in New Zealand, age of first breeding for two banded birds has been reported there (Schweigman 1999). Censuses of the New Zealand national population (Schweigman 2000) and seasonal movements and survival of banded Royal Spoonbill have been studied (Schweigman *et al.* 2014). Studies of breeding of congeners elsewhere in the world are similarly few, exceptions being on African Spoonbill *P. alba* (Whitelaw 1968), on Roseate Spoonbill *P. ajaja* (White *et al.* 1982), on Black-faced Spoonbill *P. minor* (Son *et al.* 2021) and on European Spoonbill *P. leucorodia* (Kazantzidis *et al.* 2023).

In Australia only a small proportion (less than 4%) of wetlands are used by colonial waterbirds for breeding (Brandis *et al*. 2020). Many of these wetlands have been impacted by water resource development, which has reduced species abundance and diversity, breeding frequency and numbers breeding due to flow reductions (Kingsford and Johnson 1998, Leslie 2001). In response, water management authorities are increasingly focussing on how much environmental water is required for conservation benefits and where, when and how to use the environmental water most effectively (DELWP 2021). To achieve this, basic ecological data on water-dependent target species, such as the spoonbills, from across their range is required. This study aimed to document aspects of breeding by the Australian spoonbills at a variety of sites across Victoria and to provide comparisons between the species. It collates all available Victorian breeding event data collected through public record databases and in the literature.


**Figure 1.** *Location of the study sites in Victoria.*

## METHODS

### *Field survey methods 1979-84*

*Study area*

Breeding of Yellow-billed and Royal Spoonbill was studied opportunistically at sites near Kerang and Tungamah in northern Victoria and on Phillip Island in southern Victoria (Fig. 1) between 1979 and 1984. Both species were studied at Lake Lalbert (35.667ºS, 143.333ºE) and Third Marsh (35.598ºS, 143.726ºE) near Kerang from October 1981 to January 1982. Yellow-billed Spoonbill was studied at the Tungamah Swamp Wildlife Reserve (36.148ºS, 145.928ºE) from September to December in 1981 and at Third Marsh from September 1983 to May 1984. No breeding occurred at the Kerang or Tungamah sites in 1982-83, which was a drought year. Royal Spoonbill was studied at Rhyll Swamp (38.467ºS, 145.283ºE) from August 1979 to January 1982 with two visits during later in 1982.

The Tungamah site is a shallow freshwater marsh covering up to 146 ha that receives floodwaters from semi-permanent creeks. Water depth below nests was less than 1m and could be waded. Lake Lalbert (680 ha) and Third Marsh (946 ha) are deeper and a boat was used to move around. The lakes are regulated and water is held in the marshes by retaining mounds and spillways and dries out irregularly. The vegetation of all three inland sites is dominated by forests of River Red Gums *Eucalyptus camaldulensis* less than 10 m tall. Herons, cormorants, ducks and other waterbirds also bred at these sites. At Rhyll Swamp, Royal Spoonbill nested in the crowns of Swamp Paperbark *Melaleuca ericifolia* trees. Rhyll Swamp is a freshwater marsh filled by runoff from adjacent farmland. Water depth below nests was at least 1 m near nests and required boats to approach nest trees. The area of water in the marsh was approximately 41 ha and dried out only once between 1961 and 1984. Straw-necked *Threskiornis spinicollis* and Australian White Ibis *T. moluccus*, cormorants and ducks also bred there during the study.

Sites were visited at least fortnightly. Visits to nests were of short duration and avoided extremes of weather. Nests were approached quietly to reduce adverse effects on birds. Most nests were in trees and were inaccessible and contents of nests were inspected using a mirror attached to a pole that was extendable up to 4 m long. Nests were individually marked when first located and mapped to aid relocation. Clutch size was defined as the maximum number of eggs seen in a nest at least two days apart. Hatching success was defined as the proportion of eggs that hatched; egg success as the proportion of eggs producing fledged young; and fledging success as the number of young fledged from a nest. Nestlings were considered fledged if they were observed over three weeks old. Most chicks had hatched close to the time of a visit and were followed until they were at least four weeks old. Chicks found dead were allocated to the nearest nest. Observations of potential predators of eggs and nestlings were made opportunistically in the study sites.

*Public data 1979-2024 methods*

Records of breeding by spoonbills in Victoria up to the end of 2024 were obtained from the Birdata (BirdLife 2024), eBird (2024) and Atlas of Living Australia (ALA 2024) databases, from online literature searches and targeted approaches to field observers. Only records which had direct observation of adult birds sitting on nests were used in this analysis. Records that only listed sightings of fledglings could not be included as it was unclear if the birds had been bred at the nest or had moved there since fledging. Records of suspected breeding were also excluded. Records that had a generic location, such as ‘Kerang Lakes’, were also excluded. Wherever possible, nesting attempts were checked with the original observer to verify the records including location, number of nests and dates of nesting.

*Statistical methods*

Statistical analyses followed the methods of Zar (1974), Sokal and Rohlf (1981) and Siegal (1956). The tests abbreviated in the text are: t-test for Student's t-test (Zar 1974), ANOVA for 1-way ANOVA (Zar1974), K-W ANOVA for Kruskal-Wallis 1-way ANOVA (Siegal 1956).

## RESULTS

*Field survey*

Royal Spoonbill nested in loose colonies (i.e. two or more nests in the same tree), whereas Yellow-billed Spoonbill nearly always nested alone: only four of 47 Yellow-billed Spoonbill nests in 1983-84 were not solitary and these consisted of two nests in each of two trees. Yellow-billed Spoonbill nests were nearly always in sight of other conspecifics and usually (91%) within 25 m. Sometimes cormorants nested in the same tree as Yellow-billed Spoonbill. Australian White Ibis and Straw-necked Ibis nested at water level below Royal Spoonbill nests at Rhyll, which were in the crown of the trees.

At Rhyll, Royal Spoonbill laid from early October to late November each year. At Kerang, Yellow-billed Spoonbill laid from October to late December 1981 and from October 1983 to April 1984. Royal Spoonbill at Kerang laid from mid-December 1981 to at least January 1982 (after which no visits were made). At Tungamah, Yellow-billed Spoonbill laid only during October in 1981 (Table 1).

The total number of clutches for both species across all sites between 1981 and 1984 was 128: Royal Spoonbill 39 clutches at Rhyll , 11 at Kerang; Yellow-billed Spoonbill 63 at Kerang and 15 at Tungamah. The incubation period for Royal Spoonbill was 20-25 days (n=3 nests) and for Yellow-billed Spoonbill was 26-31 days (n=4 nests). Hatching was asynchronous (i.e. not on the same day). The period that chicks remained in the nest was approximately five weeks for both species.

The modal clutch size was three eggs for both species (Table 2). Mean clutch size of Royal Spoonbill was the same between years at Rhyll (ANOVA, $p>0.2$) and between Rhyll (all years pooled) and Kerang (t-test, $p>0.2$). Mean clutch size of Yellow-billed Spoonbill was the same between years at Kerang and between Kerang and Tungamah in the same year (ANOVA, $p>0.2$). Mean clutch size of both species (pooled years and site) was the same (t-test, $p>0.2$).

The total number of fledglings (fully-feathered juveniles in the nest) recorded for both species across all sites between 1981 and 1984 was 153: Royal Spoonbill 53 at Rhyll, nine at Kerang; Yellow-billed Spoonbill 75 at Kerang, 16 at Tungamah. The mean number of fledglings per clutch started was 0.27-0.55 for Royal Spoonbill and 0.75-1.63 for Yellow-billed Spoonbill. Royal Spoonbill were less successful than Yellow-billed Spoonbill at Kerang in 1981-82 (U-Test, $p<0.01$). At Kerang, only a small proportion of Yellow-billed Spoonbill nests was unsuccessful and broods of two and three were common. Royal Spoonbill were equally successful at both sites and in all years (K-W ANOVA,

**Table 1**

Laying periods of spoonbills at study sites.

| Species | Site | Year | Month of laying | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| Royal | Rhyll | 1979-80 | ■ | ■ | | | | | |
| Royal | Rhyll | 1980-81 | ■ | ■ | | | | | |
| Royal | Rhyll | 1981-82 | ■ | ■ | | | | | |
| Royal | Kerang | 1981-82 | | | ■ | ■ | | | |
| Yellow-billed | Kerang | 1981-82 | ■ | ■ | ■ | | | | |
| Yellow-billed | Tungamah | 1981-82 | ■ | | | | | | |
| Yellow-billed | Kerang | 1983-84 | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

**Table 2**

Clutch size and breeding success of spoonbills at study sites.

| Species | Site | Year | Clutch size | | | | | | | | Number of young fledged | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | eggs | | | | mean | SD | Total clutches | Total eggs laid | % of total clutches started | | | | | Total fledged | Mean no. per clutch started | % total no fledged / eggs laid |
| | | | 1 | 2 | 3 | 4 | | | | | 0 | 1 | 2 | 3 | 4 | | | |
| Royal | Rhyll | 1979-80 | 0 | 1 | 14 | 3 | 3.11 | 0.47 | 18 | 67 | 48 | 52 | 0 | 0 | 0 | 21 | 0.52 | 31.3 |
| Royal | Rhyll | 1980-81 | 0 | 0 | 3 | 2 | 3.4 | 0.55 | 5 | 17 | 73 | 27 | 0 | 0 | 0 | 11 | 0.27 | 64.7 |
| Royal | Rhyll | 1981-82 | 0 | 0 | 16 | 0 | 3 | 0 | 16 | 48 | 67 | 33 | 0 | 0 | 0 | 21 | 0.33 | 43.8 |
| Royal | Kerang | 1981-82 | 0 | 1 | 6 | 4 | 3.27 | 0.65 | 11 | 36 | 67 | 11 | 22 | 0 | 0 | 9 | 0.55 | 25 |
| Yellow-billed | Kerang | 1981-82 | 0 | 2 | 23 | 3 | 3.04 | 0.43 | 28 | 85 | 18 | 24 | 34 | 24 | 0 | 38 | 1.63 | 44.7 |
| Yellow-billed | Tungamah | 1981-82 | 0 | 1 | 10 | 4 | 3.2 | 0.56 | 15 | 48 | 56 | 13 | 31 | 0 | 0 | 16 | 0.75 | 33.3 |
| Yellow-billed | Kerang | 1983-84 | 0 | 1 | 33 | 1 | 3 | 0.27 | 35 | 105 | 38 | 22 | 32 | 8 | 0 | 37 | 1.11 | 35.2 |

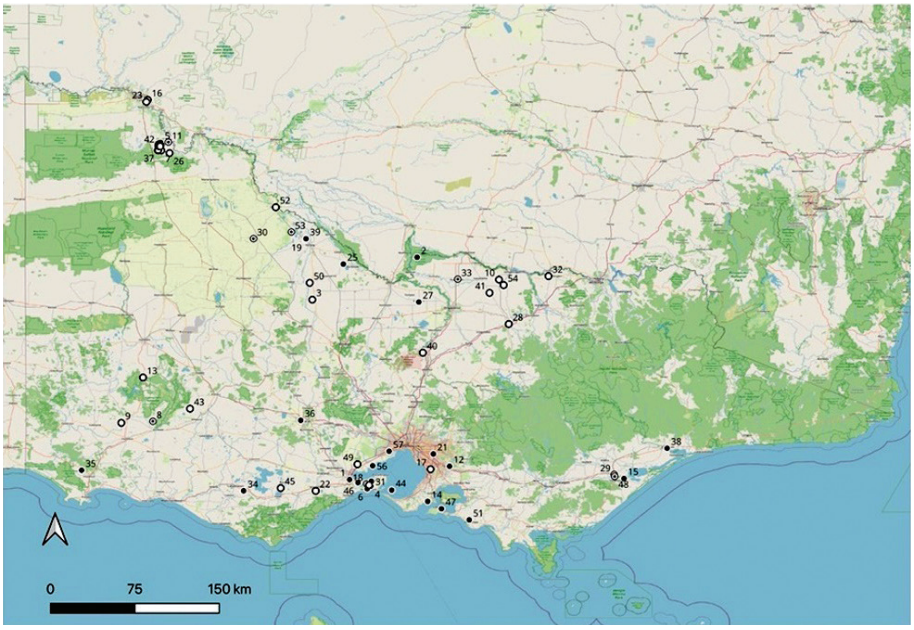


**Figure 2.** *Location of spoonbill breeding sites across Victoria. Open circles are sites where only Yellow-billed Spoonbill bred, closed circles are sites with only Royal Spoonbills, circles with a central dot are sites with both species. Numbers are site identifiers given in Table 3.*

p>0.5). Yellow-billed Spoonbill were more successful in 1981-82 than 1983-84 at Kerang and more successful at Kerang (both years) than at Tungamah in 1981-82 (K-W ANOVA, p<0.025). A few dead chicks were found near nests at all times and most had no external damage and did not seem to have been preyed upon. At Tungamah, a Swamp Harrier *Circus approximans* was observed once attacking a nestling. No other direct observations of predation of chicks or adults were made.

*Public data collation*

Records by other observers of nesting were made at 59 sites across Victoria between 1979 and 2024 (Table 3). Records were made at some sites in more than one year and there was 150 combinations of year, site and spoonbill species (Appendix 1). Most (73%) records were made since 2014 with 41 made before this. Both species were recorded breeding at eight sites, Royal Spoonbill only at 24 sites and Yellow-billed Spoonbill only at 27 sites (Fig. 2). Yellow-billed Spoonbill records are more widespread than those for Royal Spoonbill. Spoonbills were recorded breeding at 12 urban sites and 47 rural sites. Urban sites were large parkland/wetland areas surrounded by high density housing. Two sites had both species, six had only Yellow-billed Spoonbill and four had only Royal Spoonbill. At five urban and 14 rural sites spoonbills nested alongside ibis in the same year.

The earliest records of spoonbills nesting in urban sites were at Balyang Sanctuary in 2005 by Royal Spoonbill, at Swan Hill in 2007 by Yellow-billed Spoonbill and at Lake Benalla in 2009 by Yellow-billed Spoonbill. At some urban sites spoonbills bred before other species of large wading birds at the site: at Jells Park Royal Spoonbill were first recorded in 2016, Australian White Ibis in 2018, Straw-necked Ibis in 2021; at Cardinia Creek Parklands North Royal Spoonbill were first recorded in 2019 and Australian White Ibis in 2021. The sequence of breeding at sites where both spoonbills bred included at Edsall Reserve where Yellow-billed Spoonbill first bred in 2016 and 2017, then both spoonbills in 2018 and 2019. At Lake Guthridge Royal Spoonbill bred in 2016 and 2019 and both spoonbills and Australian White Ibis in 2020.

Some sites had runs of records over successive years: at Jells Park for seven successive years, at Lake Guthridge for six successive years and at Cardinia Creek Parklands North for five successive years. Other sites had breeding irregularly between years. Sites with the most records were at Serendip Sanctuary (wild birds) with records in ten years over a 17 year span, Lake Benalla seven over 14 years, Lake Guthridge seven over eight years and Coolart Lagoon six over 16 years.

Most records (75%) came from volunteer observers (112 records); researchers reported 26 (17%) in the literature and 12 (8%) records were reported by consultants employed by land management agencies. Nesting sites of both species were recorded in Monterey Pines *Pinus radiata*, samphire *Tecticornia* spp., dead eucalypts *Eucalyptus* spp. and willow *Salix* spp. (Royal Spoonbill only).

There were 63 records where the number of nests was reported: the total number of nests was 1192, consisting of 186 for Yellow-billed Spoonbill alone, 975 for Royal Spoonbill alone and 31 for both species (individual species numbers not specified). Yellow-billed Spoonbill were mostly (96%) recorded as solitary nests or small groups up to nine nests. Royal Spoonbill were recorded as solitary nests (25%), 2-9 nests (38%) through to 120 nests at First Reedy Lake and 200 nests at Lake Guthridge.

## DISCUSSION

Yellow-billed Spoonbill breeding was more successful, lasted longer and fledged more broods of two and three chicks than that of Royal Spoonbill. Yellow-billed Spoonbill bred

**Table 3**

Records by other observers of nesting at 59 sites across Victoria between 1979 and 2024

| Site number | Site name | Latitude | Longitude | Species | Landscape | Other breeders |
|---|---|---|---|---|---|---|
| 1 | Balyang Sanctuary | -38.164 | 144.33 | Royal | Urban | |
| 2 | Barmah-Millewa | -35.86 | 145.03 | Royal | Rural | Ibis |
| 3 | Bears Lagoon | -36.3 | 143.943 | Yellow-billed | Rural | |
| 4 | Bellarine Bushland Reserve | -38.231 | 144.55 | Royal | Rural | |
| 5 | Bitterang Lake Hattah | -34.67 | 142.37 | Royal | Rural | Ibis |
| 6 | Blue Waters Lake Reserve | -38.259 | 144.513 | Royal | Urban | |
| 7 | Brockie Lake Hattah | -34.754 | 142.377 | Yellow-billed | Rural | |
| 8 | Bryan Swamp | -37.56 | 142.29 | Both | Rural | Ibis |
| 9 | Bulart Bridge | -37.576 | 141.962 | Yellow-billed | Rural | |
| 10 | Burramine South Swamp | -36.092 | 145.88 | Yellow-billed | Rural | |
| 11 | Cantala Lake Hattah | -34.667 | 142.45 | Both | Rural | |
| 12 | Cardinia Creek Parklands North | -38.026 | 145.367 | Royal | Urban | Ibis |
| 13 | Cherrypool | -37.106 | 142.187 | Yellow-billed | Rural | |
| 14 | Coolart Lagoon | -38.39 | 145.14 | Royal | Rural | Ibis |
| 15 | Dowd Morass | -38.153 | 147.177 | Royal | Rural | |
| 16 | Ducks Foot Lagoon | -34.229 | 142.236 | Yellow-billed | Rural | |
| 17 | Eastern Treatment Plant | -38.056 | 145.17 | Yellow-billed | Urban | |
| 18 | Edsall Reserve | -38.209 | 144.508 | Both | Rural | |
| 19 | First Reedy Lake | -35.674 | 143.875 | Royal | Rural | |
| 20 | Hattah Lake | -34.753 | 142.343 | Yellow-billed | Rural | Ibis |
| 21 | Jells Park | -37.898 | 145.199 | Royal | Urban | Ibis |
| 22 | Karngun Bridges Swamp | -38.281 | 143.979 | Yellow-billed | Rural | Ibis |
| 23 | Kings Billabong | -34.25 | 142.222 | Yellow-billed | Rural | Ibis |
| 24 | Konardin Lake Hattah | -34.69 | 142.35 | Yellow-billed | Rural | Ibis |
| 25 | Kow Swamp | -35.931 | 144.265 | Royal | Rural | |
| 26 | Kramen Lake Hattah | -34.78 | 142.463 | Yellow-billed | Rural | |
| 27 | Kyabram Fauna Park | -36.324 | 145.048 | Royal | Rural | |
| 28 | Lake Benalla | -36.552 | 145.981 | Yellow-billed | Urban | |
| 29 | Lake Guthridge | -38.112 | 147.075 | Both | Urban | Ibis |
| 30 | Lake Lalbert | -35.667 | 143.333 | Both | Rural | |
| 31 | Lake Lorne | -38.181 | 144.557 | Royal | Rural | Ibis |
| 32 | Lake Moodemere | -36.056 | 146.393 | Yellow-billed | Rural | |
| 33 | Lake Numurkah | -36.087 | 145.452 | Both | Urban | |
| 34 | Lake Purrumbete | -38.28 | 143.231 | Royal | Rural | Ibis |
| 35 | Lake Sinclair | -38.067 | 141.55 | Royal | Rural | |
| 36 | Lake Wendouree | -37.55 | 143.823 | Royal | Urban | Ibis |
| 37 | Little Hattah Lake | -34.749 | 142.344 | Yellow-billed | Rural | |
| 38 | MacLeod Morass Wildlife Reserve | -37.839 | 147.624 | Royal | Rural | |
| 39 | Middle Reedy Lake | -35.668 | 143.878 | Royal | Rural | |
| 40 | Mitchelton Winery | -36.849 | 145.09 | Yellow-billed | Rural | |
| 41 | Moodie Swamp Wetland Reserve | -36.229 | 145.782 | Yellow-billed | Rural | |
| 42 | Mournpall Lake Hattah | -34.707 | 142.348 | Yellow-billed | Rural | |
| 43 | Mt William Swamp | -37.429 | 142.675 | Yellow-billed | Rural | |
| 44 | Mud Islands | -38.273 | 144.767 | Royal | Rural | Ibis |
| 45 | Ondit Quarry | -38.252 | 143.615 | Yellow-billed | Rural | |
| 46 | Reedy Lake Geelong | -38.195 | 144.417 | Royal | Rural | Ibis |
| 47 | Rhyll Swamp | -38.466 | 145.283 | Royal | Rural | Ibis |
| 48 | Sale Common Nature Conservation Reserve | -38.131 | 147.08 | Both | Rural | |
| 49 | Serendip Sanctuary | -38.005 | 144.412 | Yellow-billed | Rural | |
| 50 | Serpentine Creek at Durham Ox | -36.125 | 143.917 | Yellow-billed | Rural | |
| 51 | Skip Road Wonthaggi | -38.581 | 145.571 | Royal | Rural | |
| 52 | Swan Hill | -35.342 | 143.564 | Yellow-billed | Urban | |
| 53 | Third Marsh | -35.598 | 143.726 | Both | Rural | |
| 54 | Tungamah | -36.148 | 145.928 | Yellow-billed | Rural | |
| 55 | Wallington | -38.221 | 144.532 | Yellow-billed | Urban | |
| 56 | Western Treatment Plant | -38.02 | 144.57 | Royal | Rural | |
| 57 | Williams Landing | -37.87 | 144.74 | Royal | Urban | Ibis |
| 58 | Yelwell Lake Hattah | -34.7 | 142.37 | Yellow-billed | Rural | Ibis |
| 59 | Yerang Lake Hattah | -34.711 | 142.365 | Yellow-billed | Rural | |

before Royal Spoonbill at Kerang and Tungamah. Timing and period of breeding by Yellow-billed Spoonbill and Royal Spoonbill was variable between years at Kerang but consistent for Royal Spoonbill between years at Rhyll.

Comparison of results from this study between spoonbill species showed a difference in only one breeding parameter – fledglings per clutch. Yellow-billed Spoonbill clutch size (mean range: 3.0-3.2) was similar to that of Royal Spoonbill, as was fledging success (33-45%) and proportion fledging at least one (44-82%) but the mean number of fledglings per clutch started was much higher for Yellow-billed Spoonbill than Royal Spoonbill (mean range: 0.75-1.63 compared to 0.27-0.55). This may possibly indicate that food supply for Yellow-billed Spoonbill nestlings was more available than for Royal Spoonbill.

In both species at the four study sites there was little evidence of predation of eggs, young or adults and chick deaths were apparently due to starvation, as was found by McGinness and Brandis (2016). Spoonbills in this study nested in trees above water levels that provided protection from ground predators such as foxes. This compares with Glossy Ibis *Plegadis falcinellus* nesting in lignum close to water level that suffered high rates of predation especially when water levels at the nests drop (Lowe 1983). Spoonbills were sometimes the first waterbird breeding at a site, indicating that they are not dependent on the presence of other species (such as for 'cover' from predation) to breed. There was no clear pattern of which spoonbill species established a site and Yellow-billed Spoonbill were less gregarious than Royal Spoonbill, mostly nesting alone. This is consistent with low levels of predation and not seeking 'safety in numbers' in colonies.

Comparison of results from this study with previous studies showed few differences. Clutch size of Royal Spoonbill (all sites) reported here was higher than those previously reported (McGinness and Brandis 2016, Brandis 2017, Brandis *et al.* 2020). Fledging success (total number fledged/eggs laid) was much higher in this study (25-65%) than that reported by Brandis (2017) at Zoo Paddock (12.7%), but lower than at Monkeygar (77%). The proportion of nests fledging at least one Royal Spoonbill young varied greatly between years (27-52%) in this study and was similar to the range reported by Brandis (2017) and lower than by Brandis *et al.* (2020), although their sample size there was small. Larger clutches did not appear to result in greater fledgling success.

The Australian spoonbills have similar breeding ecology to the congeners elsewhere in the world. All have small clutches (mean of ~3 eggs), incubation period of 20-30 days, asynchronous hatching and low breeding success (generally less than one young fledged). However the factors limiting breeding success and length of the nesting period vary within the group. The breeding success of European Spoonbill was affected by food, weather and human disturbance (Vespremeanu 1978, Kazantzidis *et al.* 2023) and not by predation. There is evidence that African Spoonbill, like Sacred Ibis, are subjected to high levels of predation (Whitelaw 1968, Manry 1978). Predation of Roseate Spoonbill (White *et al.* 1982) and of Royal Spoonbill and Yellow-billed Spoonbill (this study) was rare. These differences may be reflected in the length of breeding seasons with European Spoonbill having long nestling periods while African Spoonbill had remarkably short nestling periods (21 days), perhaps in response to predation. In other words, when predation pressure is low, breeding success may be increased by reducing the growth rate of nestlings to maximise food availability to nestlings and increase overall success.

There are indications that the Australian spoonbills may have different breeding strategies between the species and between locations and that this may be related to their food supply. Food availability in closely related Australian White Ibis and Straw-necked Ibis has been shown to influence timing and length of breeding season, clutch size and fledging success (Brandis *et al.* 2020, Lowe 1984, Martin *et al.* 2007). Spoonbills are long-lived (ABBBS 2025; Marchant and Higgins 1990) and a long life would facilitate intimate knowledge of their habitats and provide for development of sophisticated breeding strategies.

At Rhyll, Royal Spoonbill fed almost exclusively in the marine environment and their diet is dominated by one species of caridean shrimp, *Macrobrachium intermedium* (Lowe 1982). The breeding of Royal Spoonbill occurred just prior to the peak in density and biomass of shrimps (Howard 1981, Howard and Lowe 1984), and food availability was low when chicks were hatched and high when they had fledglings. Royal Spoonbill may have been maximising fledging survival. Lowe (1982) showed that Royal Spoonbill were sedentary there and as a result their experience with the predictable nature of their food supply would support such a strategy.

By contrast, Royal Spoonbill had a shorter breeding season at Kerang than at Rhyll Swamp. Other studies have documented highly variable timing for Royal Spoonbill breeding in the Murray-Darling region related to unpredictable water availability (Brandis 2017, Brandis *et al.* 2020, McGinness and Brandis 2016). McGinness *et al.* (2024) showed that many Royal Spoonbill adults and juveniles leave the breeding areas, travel long distances and may be classified as nomadic in this area of high environmental variability and unpredictability. The northern Victorian sites regularly dry out, whereas Rhyll Swamp is rarely dry and this may provide differences in food supply and nest safety. Royal Spoonbill in northern Victoria may have concentrated their breeding events temporally to allow them to quickly complete breeding and leave the breeding sites to locate better feeding sites to maximise post-fledging survival rates.

Another factor possibly affecting Yellow-billed Spoonbill breeding before Royal Spoonbill at Kerang and Tungamah may be their dietary differences: At inland sites Yellow-billed Spoonbill eat more crustaceans and insects and less fish than Royal Spoonbill (Vestjens 1975). Crustaceans and insects are known to recolonise dried wetlands quickly following flooding (Maher 1984) and so become available as prey before the food of Royal Spoonbill. Yellow-billed Spoonbill familiarity with local conditions due to their possibly sedentary nature, early food availability and a breeding season that allowed for double-brooding resulted in these birds maximising their fecundity.

*Public records*

The collation of records of spoonbill breeding events across Victoria reveals more records and events than previously reported (McGinness *et al*. 2020). These records indicate that breeding is less geographically widespread than that of ibis breeding (Lowe 2025). Spoonbill breeding showed considerable variability

between sites, years and species. Some sites had records in only one year, others were used in up to seven successive years and a few were used intermittently over a 17 year period. The longest time span of use was at Rhyll Swamp (34 years) but with only five records in this period. Yellow-billed Spoonbill breeding records are more geographically spread than those for Royal Spoonbill. This study is also the first report of Royal Spoonbill and Yellow-billed Spoonbill breeding in urban sites across Victoria and occurred soon after the Millennium Drought and, like ibises (Lowe 2025), this may be a response to 'traditional' wetland sites no longer being suitable due to habitat loss, lack of watering and the prolonged effects of climate change. Urban sites are often water retention areas from housing and likely provide reliable food supplies and nest safety. Many of the Victorian breeding sites used historically, such as between 1960 and 1990, have few recent reports of breeding. The trends reported here are consistent with the decline in populations of waterbirds recorded in other studies but also represents a shift in the breeding distribution.

## CONCLUSIONS

It is very likely that the breeding events reported here are only a fraction of the amount of breeding that actually occurs. Most records came from volunteer observers and there were fewer records reported in the literature than for the ibises (Lowe 2025). Spoonbills breed in a relatively small number of sites and these are of a wide variety of type, including both wetlands, drylands and numerous small ephemeral drainage basins scattered across the landscape. Few observers visit these smaller sites and reporting by consultants employed by land management agencies is directed to the larger public wetlands. A large proportion of the sites recorded in this study are from urban areas and this is probably over-represented but nevertheless reflects trends in other waterbirds (Lowe 2025) and may be a post-Millennium Drought response. McGinness *et al.* (2024) highlighted the need for land management agencies to provide water for non-breeding feeding sites away from the large waterbird colony sites, but it is equally important to protect and manage the scattered small wetlands, such as at Tungamah, that in aggregate may support a large proportion of the spoonbill population. Monitoring at these sites is virtually non-existent and this could be remedied by encouraging and co-ordinating volunteer bird observers to provide essential surveillance on the fate of these areas and of many wetland species, not only the spoonbills.

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## APPENDIX 1

Annual records of breeding by spoonbills in Victoria. Year refers to period from 1 July to 30 June. Max nests refers to maximum number of nests of spoonbills recorded at that site in that year. Blanks indicate no information was provided. Source refers to where the record was obtained including databases such as eBird and Birdata or to a publication or a personal communication. Nest species refers to the vegetation where the nests were recorded. Blanks indicate no information was provided.

| Site name | Species | Year | Max nests | Source | Nest species |
|---|---|---|---|---|---|
| Balyang Sanctuary | Royal | 2005-06 | 2 | eBird | |
| Balyang Sanctuary | Royal | 2013-14 | 1 | Morley (2018) | |
| Barmah-Millewa | Royal | 1960-61 | | McGinness et al.(2020) | |
| Barmah-Millewa | Royal | 1977-78 | | McGinness et al.(2020) | |
| Barmah-Millewa | Royal | 1979-80 | | McGinness et al.(2020) | |
| Barmah-Millewa | Royal | 2002-03 | | McGinness et al.(2020) | |
| Barmah-Millewa | Royal | 2005-06 | | McGinness et al.(2020) | |
| Barmah-Millewa | Royal | 2010-11 | | McGinness et al.(2020) | |
| Barmah-Millewa | Royal | 2016-17 | | McGinness et al.(2020) | |
| Bears Lagoon | Yellow-billed | 2020-21 | | Birdata | |
| Bellarine Bushland Reserve | Royal | 2019-20 | 2 | eBird | |
| Bitterang Lake Hattah | Royal | 2021-22 | 2 | GHD (2022) | |
| Blue Waters Lake Reserve | Royal | 2022-23 | 1 | eBird | |
| Brockie Lake Hattah | Yellow-billed | 2021-22 | 1 | GHD (2022) | |
| Brockie Lake Hattah | Yellow-billed | 2022-23 | 9 | GHD (2023) | |
| Bryan Swamp | Royal | 2004-05 | | McGinness et al.(2020) | |
| Bulart Bridge | Yellow-billed | 2016-17 | | Birdata | |
| Burramine South Swamp | Yellow-billed | 1981-82 | | eBird | |

**APPENDIX 1 (continued)**

| Site name | Species | Year | Max nests | Source | Nest species |
|---|---|---|---|---|---|
| Cantala Lake Hattah | Royal | 2021-22 | 1 | GHD (2022) | |
| Cantala Lake Hattah | Yellow-billed | 2021-22 | 3 | GHD (2022) | |
| Cardinia Creek Parklands North | Royal | 2019-20 | 2 | eBird | |
| Cardinia Creek Parklands North | Royal | 2020-21 | | eBird | |
| Cardinia Creek Parklands North | Royal | 2021-22 | | eBird | |
| Cardinia Creek Parklands North | Royal | 2022-23 | | eBird | |
| Cardinia Creek Parklands North | Royal | 2023-24 | | eBird | |
| Cherrypool | Yellow-billed | 2006-07 | 1 | eBird | |
| Coolart Lagoon | Royal | 1985-86 | 1 | Brian Thomas, pers. comm. 2024 | |
| Coolart Lagoon | Royal | 1989-90 | 1 | Brian Thomas, pers. comm. 2024 | |
| Coolart Lagoon | Royal | 1992-93 | 1 | Brian Thomas, pers. comm. 2024 | |
| Coolart Lagoon | Royal | 1993-94 | 1 | Brian Thomas, pers. comm. 2024 | |
| Coolart Lagoon | Royal | 1995-96 | | Brian Thomas, pers. comm. 2024 | |
| Coolart Lagoon | Royal | 2001-02 | | Brian Thomas, pers. comm. 2024 | |
| Dowd Morass | Royal | 2022-23 | 30 | Birdata | |
| Ducks Foot Lagoon | Yellow-billed | 2019-20 | | Birdata | |
| Eastern Treatment Plant | Yellow-billed | 2016-17 | 1 | Birdata | |
| Eastern Treatment Plant | Yellow-billed | 2020-21 | 1 | Birdata | |
| Eastern Treatment Plant | Yellow-billed | 2022-23 | 1 | Birdata | |
| Edsall Reserve | Yellow-billed | 2016-17 | 3 | eBird | |
| Edsall Reserve | Yellow-billed | 2017-18 | 3 | eBird | |
| Edsall Reserve | Both | 2018-19 | | McGinness *et al.* (2020) | |
| Edsall Reserve | Both | 2019-20 | 1 | eBird | Pine |
| First Reedy Lake | Royal | 2020-21 | 12 | Birdata | |
| First Reedy Lake | Royal | 2021-22 | 50 | Birdata | |
| First Reedy Lake | Royal | 2023-24 | 10 | Birdata | |
| Hattah Lake | Yellow-billed | 2021-22 | 1 | eBird | |
| Jells Park | Royal | 2016-17 | | eBird | |
| Jells Park | Royal | 2017-18 | | eBird | |
| Jells Park | Royal | 2018-19 | | eBird | |
| Jells Park | Royal | 2019-20 | 1 | eBird | |
| Jells Park | Royal | 2020-21 | | eBird | |
| Jells Park | Royal | 2021-22 | | eBird | |
| Jells Park | Royal | 2022-23 | | eBird | |
| Karngun Bridges Swamp | Yellow-billed | 2020-21 | 1 | eBird | |
| Karngun Bridges Swamp | Yellow-billed | 2021-22 | 1 | eBird | |
| Kings Billabong | Yellow-billed | 2022-23 | 2 | eBird | |
| Konardin Lake Hattah | Yellow-billed | 2021-22 | | GHD (2022) | |
| Kow Swamp | Royal | 2016-17 | | McGinness *et al.* (2020) | |
| Kow Swamp | Royal | 2017-18 | | Birdata | |
| Kow Swamp | Royal | 2019-20 | | McGinness *et al.* (2020) | |
| Kramen Lake Hattah | Yellow-billed | 2022-23 | | GHD (2023) | |
| Kyabram Fauna Park | Royal | 2020-21 | 6 | eBird | |
| Lake Benalla | Yellow-billed | 2009-10 | | eBird | |
| Lake Benalla | Yellow-billed | 2014-15 | 1 | eBird | Redgum |
| Lake Benalla | Yellow-billed | 2016-17 | 3 | eBird | |
| Lake Benalla | Yellow-billed | 2017-18 | 2 | eBird | |
| Lake Benalla | Yellow-billed | 2021-22 | 11 | eBird | |
| Lake Benalla | Yellow-billed | 2022-23 | 1 | eBird | |
| Lake Benalla | Royal | 2023-24 | | Birdata | |
| Lake Guthridge | Royal | 1978-79 | | McGinness *et al.* (2020) | |

**APPENDIX 1 (continued)**

| Site name | Species | Year | Max nests | Source | Nest species |
|---|---|---|---|---|---|
| Lake Guthridge | Royal | 2016-17 | 6 | eBird | |
| Lake Guthridge | Royal | 2019-20 | | eBird | |
| Lake Guthridge | Both | 2020-21 | 30 | eBird | |
| Lake Guthridge | Royal | 2021-22 | 200 | eBird | |
| Lake Guthridge | Royal | 2022-23 | 2 | eBird | |
| Lake Guthridge | Royal | 2023-24 | | eBird | |
| Lake Guthridge | Royal | 2024-25 | | Birdata | |
| Lake Lalbert | Yellow-billed | 1981-82 | 5 | Lowe (1984) | |
| Lake Lorne | Royal | 2018-19 | | McGinness et al.(2020) | |
| Lake Lorne | Royal | 2019-20 | 20 | eBird | |
| Lake Lorne | Royal | 2020-21 | | eBird | |
| Lake Lorne | Royal | 2021-22 | | eBird | |
| Lake Moodemere | Yellow-billed | 2021-22 | | Birdata | |
| Lake Moodemere | Yellow-billed | 2022-23 | 1 | Birdata | |
| Lake Numurkah | Both | 2023-24 | | eBird | |
| Lake Purrumbete | Royal | 2020-21 | | eBird | |
| Lake Sinclair | Royal | 2013-14 | | McGinness et al.(2020) | |
| Lake Wendouree | Royal | 2022-23 | | eBird | |
| Little Hattah Lake | Yellow-billed | 2021-22 | 1 | GHD (2022) | |
| MacLeod Morass Wildlife Reserve | Royal | 2016-17 | | Birdata | |
| MacLeod Morass Wildlife Reserve | Royal | 2020-21 | | Birdata | |
| MacLeod Morass Wildlife Reserve | Royal | 2021-22 | | Birdata | |
| MacLeod Morass Wildlife Reserve | Royal | 2023-24 | | Birdata | |
| MacLeod Morass Wildlife Reserve | Royal | 2024-25 | | Birdata | |
| Middle Reedy Lake | Royal | 2017-18 | | Birdata | |
| Middle Reedy Lake | Royal | 2019-20 | 20 | Birdata | |
| Middle Reedy Lake | Royal | 2020-21 | 95 | Birdata | |
| Middle Reedy Lake | Royal | 2021-22 | 50 | Birdata | |
| Middle Reedy Lake | Royal | 2022-23 | 120 | Birdata | |
| Middle Reedy Lake | Royal | 2023-24 | 10 | Birdata | |
| Mitchelton Winery | Yellow-billed | 2016-17 | 1 | eBird | |
| Moodie Swamp Wetland Reserve | Yellow-billed | 2019-20 | | eBird | |
| Mournpall Lake Hattah | Yellow-billed | 2022-23 | | GHD (2023) | |
| Mt William Swamp | Yellow-billed | 2016-17 | 1 | eBird | Dead redgum |
| Mud Islands | Royal | 2009-10 | 31 | eBird | Tecticornia sp. |
| Mud Islands | Royal | 2012-13 | 8 | eBird | |
| Mud Islands | Royal | 2022-23 | 12 | eBird | |
| Ondit Quarry | Yellow-billed | 2021-22 | 2 | eBird | Pine |
| Reedy Lake Geelong | Royal | 2019-20 | 20 | Birdata | |
| Reedy Lake Geelong | Royal | 2020-21 | 95 | Birdata | |
| Reedy Lake Geelong | Royal | 2021-22 | 50 | Birdata | |
| Reedy Lake Geelong | Royal | 2022-23 | 10 | eBird | |
| Rhyll Swamp | Royal | 1979-80 | 18 | Lowe (1984) | |
| Rhyll Swamp | Royal | 1980-81 | 5 | Lowe (1984) | |
| Rhyll Swamp | Royal | 1981-82 | 16 | Lowe (1984) | |
| Rhyll Swamp | Royal | 2012-13 | 15 | Birdata | |
| Rhyll Swamp | Royal | 2013-14 | 9 | Birdata | |
| Sale Common Nature Conservation Reserve | Both | 2020-21 | | eBird | |
| Sale Common Nature Conservation Reserve | Both | 2021-22 | | eBird | |
| Sale Common Nature Conservation Reserve | Yellow-billed | 2022-23 | 4 | eBird | |
| Sale Common Nature Conservation Reserve | Both | 2023-24 | 1 | eBird | |

**APPENDIX 1 (continued)**

| Site name | Species | Year | Max nests | Source | Nest species |
|---|---|---|---|---|---|
| Sale Common Nature Conservation Reserve | Yellow-billed | 2024-25 | | Birdata | |
| Serendip Sanctuary | Yellow-billed | 2005-06 | 1 | eBird | |
| Serendip Sanctuary | Yellow-billed | 2006-07 | | eBird | |
| Serendip Sanctuary | Yellow-billed | 2010-11 | 4 | eBird | |
| Serendip Sanctuary | Yellow-billed | 2011-12 | | eBird | |
| Serendip Sanctuary | Yellow-billed | 2014-15 | | eBird | |
| Serendip Sanctuary | Yellow-billed | 2016-17 | 4 | eBird | |
| Serendip Sanctuary | Yellow-billed | 2017-18 | | eBird | |
| Serendip Sanctuary | Yellow-billed | 2019-20 | | eBird | |
| Serendip Sanctuary | Yellow-billed | 2020-21 | | eBird | |
| Serendip Sanctuary | Yellow-billed | 2022-23 | | eBird | |
| Serpentine Creek at Durham Ox | Yellow-billed | 2017-18 | | eBird | |
| Serpentine Creek at Durham Ox | Yellow-billed | 2021-22 | | eBird | |
| Serpentine Creek at Durham Ox | Yellow-billed | 2022-23 | | eBird | |
| Skip Road Wonthaggi | Royal | 2012-13 | 2 | Birdata | |
| Skip Road Wonthaggi | Royal | 2013-14 | 1 | Birdata | |
| Skip Road Wonthaggi | Yellow-billed | 2017-18 | 1 | Birdata | |
| Swan Hill | Yellow-billed | 2007-08 | | eBird | |
| Swan Hill | Yellow-billed | 2022-23 | 1 | Birdata | |
| Third Marsh | Royal | 1981-82 | 11 | Lowe (1984) | |
| Third Marsh | Yellow-billed | 1981-82 | 28 | Lowe (1984) | |
| Third Marsh | Yellow-billed | 1983-84 | 35 | Lowe (1984) | |
| Tungamah | Yellow-billed | 1981-82 | 15 | Lowe (1984) | |
| Wallington | Yellow-billed | 2017-18 | | eBird | |
| Western Treatment Plant | Royal | 1978-79 | | McGinness et al.(2020) | |
| Western Treatment Plant | Royal | 2018-19 | | McGinness et al.(2020) | |
| Williams Landing | Royal | 2019-20 | | McGinness et al.(2020) | |
| Yelwell Lake Hattah | Yellow-billed | 2021-22 | 9 | GHD (2022) | |
| Yelwell Lake Hattah | Yellow-billed | 2022-23 | 10 | GHD (2023) | |
| Yerang Lake Hattah | Yellow-billed | 2022-23 | 16 | GHD (2023) | |