

Breeding Seasons of Birds in Subcoastal Northern Territory

By H. J. FRITH* and S. J. J. F. DAVIES*

During field-work associated with a study of the ecology of the Magpie-Goose (*Anseranas semipalmata*) in the Northern Territory (Frith & Davies, 1958) many nests of other birds were found.

Although Serventy and Marshall (1957) have recently discussed the breeding seasons of birds in Western Australia south of the Kimberley Division itself, there is no summary available of the breeding seasons in the far north.

This paper summarizes the data collected in the period 1955-57 and includes that collected earlier by Le Souef (1902-03).

I. METHODS

The main work was located in the Adelaide River valley, but the authors frequently had occasion to carry out field-work on the other river-plains between Darwin and the western edge of Arnhem Land. The region comprises the flood-plains of the Adelaide, the Mary, the Wildman, and the East, South, and West Alligator Rivers and the intervening higher land. Observations from that whole strip of country are considered. No organized searching for nests of birds other than Magpie-Geese was undertaken, but all nests found were examined and observations of birds engaged in courting behaviour or of the presence of young were recorded. In some cases specimens were collected and the gonads examined.

In this manner data on the breeding season of 110 species were collected. The breeding dates recorded by Le Souef (1903) were also considered; these covered 122 species, 108 of which were recorded by the present authors. Data were thus available for a total of 124 species.

The breeding season was defined as the month or months in which clutches were begun. It was not possible to assign the data to periods of less than one month in most cases. The method of assigning each clutch to the month in which it was begun is best shown by examples. Clutches found apparently incomplete were visited again whenever possible. The age of clutches found part-incubated was estimated by flotation, by revisiting to note approximate hatching date, or in some cases by examination of the embryo. From these observations it was possible to estimate the date of the laying of the first egg with sufficient accuracy for the present purpose. When nests were found containing young the age of the young was estimated from the meagre data available concerning fledging period of that family, and the approximate date of the first egg was calculated.

* Wildlife Survey Section, C.S.I.R.O., Canberra, A.C.T.

In no case, except that of the Australian Pratincole, was behaviour of the birds alone taken as proof of breeding.

In Le Souef's data he usually recorded whether the eggs were fresh or slightly or heavily incubated and the approximate laying-date could be calculated.

A species found breeding in any month scored one record only for that month, no matter how many nests were found. This procedure was adopted in order to avoid the bias that could be introduced by species that nest in colonies, whose nests were easily found, or for which special search was made.

II. THE ENVIRONMENT

Climate

The climate is under monsoonal influence, having a pronounced wet season extending from September to October until March or April, and a dry season for the remainder of the year. For five months in summer the relative humidity exceeds 70 per cent, and the mean temperature of the hottest month, November, is 85.9°F. In the winter the mean maximum temperature for the period May to September is 89.4°F. and the mean minimum 70.5°F. The mean temperature of the coolest month, July, is 77.4°F.

The mean rainfall for Darwin is 60 in. and for Humpty Doo, where many of the observations were made, it is 47 in. The average monthly rainfall for the period 1955-1958, during which the work was done, is shown in Figure 1.

Habitats

Open Forests.—Tall open forests are dominant on the higher land, consisting usually of *Eucalyptus miniata* and *E. tetradonta*. The understory is variable and the ground carries mixed annual grasses. These range in height from 2 to 20 ft. in the wet season. Several other types of forest occur, including low open forest, parkland, *Tristania-Grevillea* communities, *Pandanus* scrubs, and *Melaleuca* scrubs.

For the present purpose these are all included in the general term forest.

A characteristic of the forests is that in the dry season the ground is bare and dry, having been cleared by grass-fires. With the first storms of the wet season, however, there is a general resurgence of growth. Grass shoots up immediately and the trees begin to flower and develop new growth. The grass grows very rapidly and is soon several feet high.

Monsoon Forests.—These are restricted to margins of streams and springs. They are small areas of dense, broad-leaved, often deciduous, trees comprising several layers. The ground flora is sparse and lianas are numerous.

The monsoon forest is more constant than the open forest and the seasonal changes are not so marked, but in the wet season there is abundant growth and many of the trees flower and fruit.

Mangroves.—The rivers and their mouths are fringed with mangroves.

Grasslands.—On those parts of the river-plains not subject to prolonged flooding *Themeda-Eriachne* or *Ischaemum* grassland occur. These flourish in the wet season but during the dry season they dry off and are frequently burned.

Swamps.—*Eleocharis-Oryza* (sedge-wild rice) swamps develop in the wet season on large areas of the subcoastal plains, which are inundated for several months each season. They normally fill in November or December and begin to dry in March; by April they are usually very low and by June completely dry. During the dry season some small areas remain boggy in some swamps but there is no free water.

Lagoons.—Permanent lagoons are found both on the plains and in the forests, but their extent is not great. The dominant vegetation is of water-lilies, *Utricularia*, and various sedges. During the dry season their level declines greatly but during the wet they fill and overflow and the lilies and other plants grow and flower profusely.

III. RESULTS

In the following descriptions and discussions, land, water, and raptorial birds are considered separately, and, in addition, the first two groups have been further subdivided. Among the water-birds this subdivision is based upon the natural affinities of the species, which in turn reflects their ecology. On the other hand, the forest-birds, a very heterogeneous group, have been divided into frugivorous, insectivorous, and graminivorous forms, but as their detailed food-habits are unknown this grouping must be considered only approximate. In some cases, as in the frugivorous and insectivorous groups, there is a considerable overlap; the graminivorous species are, however, quite sharply defined from the others.

The breeding seasons are summarized in Table 1, and the data are illustrated in Figure 1.

TABLE 1

Number of Birds in the Different Ecological Groups found breeding in Each Month

Ecological Group	Total No. of Species	No. of Species breeding in each Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Water-birds ..	28	6	9	14	16	15	4	1	0	1	1	1	3
Raptores ..	13	1	0	0	5	7	7	4	1	1	0	0	0
Forest-birds													
Graminivorous	21	11	8	7	8	5	4	2	3	4	3	5	2
Frugivorous	21	13	3	2	1	0	0	0	0	4	6	12	11
Insectivorous	41	15	9	2	5	2	1	1	2	8	15	14	17
Total ..	124	46	29	25	35	29	16	8	6	18	25	32	33

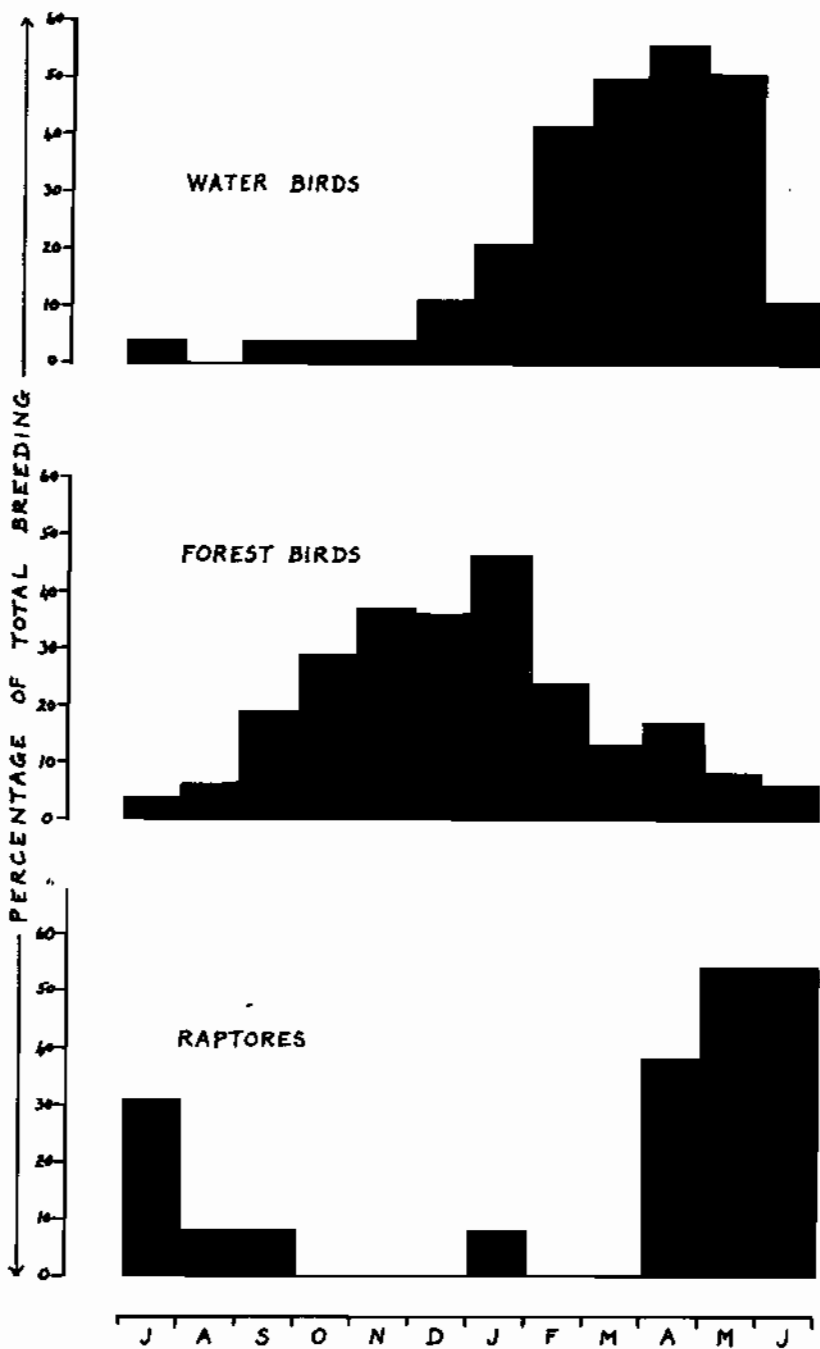


Fig. 1.

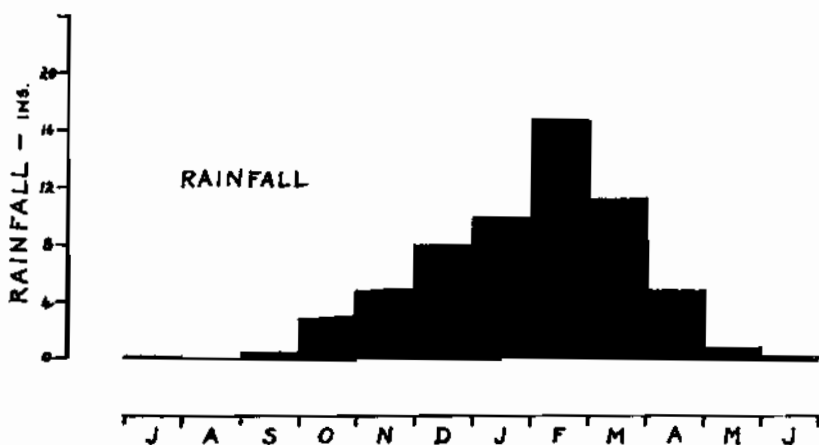


Fig. 1. Average monthly rainfall, 1955-1958.

From Table 1 and Figure 1 it can be seen that some birds were found breeding in each month of the year, but that breeding was very much more widespread during the wet season. The peak occurred in January when 42 species, 33.9 per cent of those for which there are data, were breeding. The least breeding was recorded in August, when only two species, the Nankeen Kestrel and the Willie Wagtail, were found nesting.

Water-birds.—Some water-birds were breeding throughout the whole wet season but the greatest number bred at its end or immediately afterwards. The only water-birds' nests recorded in the mid-dry season were those of the Eastern Swamphen, as noted by Le Souef in June and July.

The first rains of the wet season were followed by sexual activity in many water-birds, including the Brolga, the Magpie-Goose, the Burdekin Duck, the Green Pigmy-Goose, the tree-ducks, and the White Egret. The earliest water-bird's nest found was that of the Brolga, in October, but the main breeding season of the group began in March, when nests of 14 species (50 per cent of the aquatic group) were found. Extensive breeding continued through April and May as the swamps receded, but by June the season was virtually over.

Within the broad grouping of the water-birds, differences in breeding seasons occurred between species and between groups of ecologically similar species.

Ducks and Geese.—Special efforts were made to examine nests and gonads of all species of Anatidae encountered. As a group the family were seen to breed at the end of the wet season or in the early dry season.

The first to breed were the tree-ducks, and of the two species the Whistling Tree-Duck was slightly ahead of the Plumed Tree-Duck. The earliest Whistling Tree-Duck's nest

examined contained fresh eggs on January 10, 1956, and examination of broods and gonads showed that breeding continued until May. In 1956 no Plumed Tree-Duck broods were seen until April 24, indicating that the first eggs had been laid in mid-March.

The tree-ducks nest on the ground far from water, and depend for food on the seeds of aquatic grasses. There is no danger of flooding to their nests so that early breeding, before the maximum water-level is achieved in the swamps, is "safe", and the broods are abroad when the seed-crop is at its maximum.

Of the two species the Whistling Tree-Duck is more nomadic than the Plumed; it is of interest to compare the situation with that which exists in the genus *Anas*, where it has been shown that the nomadic species, the Grey Teal, also breeds much earlier than the more sedentary species, the Black Duck (Frith, 1959). There is an obvious advantage in a nomadic species having a relatively quick-triggered sexual cycle to ensure that good conditions for breeding can be rapidly exploited.

The Pigmy-Goose, which is confined to the permanent lagoons and also nests away from water, breeds in January and February. The ducklings are dependent on the lagoons in February, March, and April, i.e. when they are at their maximum level and the water-lilies (the birds' principal food) are in flower or setting seed.

The Black Duck and the Burdekin Duck are sexually stimulated in the early wet season and their testes increase in size in November and December, in which months both species were defending breeding territories. Ovulation, however, is delayed until March, April, and May, when the swamps are drying rapidly. Both species feed on animals characteristic of "mature" water and breed at the time of greatest abundance of that food.

The breeding of the Magpie-Goose will be discussed in detail in a later publication. The species breeds at the end of the wet season, in February, March, and April. The breeding is strongly affected by the water-level and the density of the swamp-vegetation.

Egrets and Herons.—The breeding of these species was observed mainly from low-flying aircraft over large rookeries on the Adelaide and Mary Rivers; the Adelaide River rookery was also visited by boat on May 26, 1957, when it was possible to confirm the sequence of breeding observed from the air.

The first of the group to breed were the Cattle Egrets, which in 1957 were first noted beginning to assume breeding plumage in the first week of November. On December 23 the rookery was occupied by an estimated 10,000 birds, most of them incubating. There were no other species in the rookery. The young had left the nest by January 20, 1958.

Following the Cattle Egrets the rookery was occupied by

several thousands each of Pied Herons, Little Egrets, and White Egrets, and a few Plumed Egrets, ibises and cormorants. By examination of eggs and young it was possible to determine that the Pied Herons had begun nesting first. The Plumed and Little Egrets began together about three weeks later. The White Egrets had begun a little later than the Pied Herons, but had a more extended breeding season, and in May all stages were found from fresh eggs to fully fledged young.

White-faced Herons did not use the rookery but several nests were found in paperbark swamps in January, the same month as the sole record for the Pacific Heron.

Apart from the fact that all herons and egrets feed in shallow water (except the Cattle Egret, which feeds in wet grassland), the food-requirements of this group are not known. It is of interest to note that all bred at a time when the water-level was rapidly receding, with the exception of the Cattle Egret, which bred when the grass was sprouting and wet grasslands were approaching their maximum development. These observations suggest a correlation with the abundance of food.

Ibises.—The ibises used the same rookery as the egrets and herons, as well as several smaller rookeries along the Adelaide. In 1957 White Ibises bred in March and April, eggs being laid in both months. On May 26 the nests contained everything from newly hatched young to fully fledged young. No Straw-necked Ibises were present, but according to Mr. G. Palmer, whose business of crocodile-shooting takes him frequently to the rookery, that species had finished some weeks before. As juvenile Straw-necked Ibises were numerous on the Adelaide River plains in May, and several were collected, there is no reason to doubt his observation. (This is in contrast to inland New South Wales, where in seasons favourable for breeding the White Ibis breeds before the Straw-necked species.) In 1958, a dry year, the White Ibis bred again in February and March, but the Straw-necked apparently failed to breed.

Other Water-birds.—The Masked Plover was found nesting each year on the levee-banks of the rice-fields and on higher ground on the flood-plains. Eggs were laid in the period January to May. The Brolga avoided the large swamps, and its nests were found in smaller depressions on the plain that received rain-water; eggs were laid in September and October and in March, but no nesting was begun in the months in which heavy rain fell and the water-level of these swampy areas increased rapidly. The Jabiru similarly bred at the end of the wet season in April and May.

The nests of the Australian Pratincole were not found, but in March and April the behaviour of the species clearly suggested breeding and the testes of three males examined in those months were found to contain spermatozoa.

Forest-Birds.—The birds of the forest bred throughout the wet season. Breeding began in September, very soon after the first storms, when nests of very different birds—including a dove, a quail, a nightjar, a flycatcher, a pardalote, a tree-creeper, a fruit-pigeon, a lorikeet, and a honeyeater—were found. After September the number of species breeding increased each month until the peak was reached in January. Thereafter the number breeding each month decreased until by April, when the last showers of rain had fallen, the season was practically over.

From Table 1 it can be seen that the breeding seasons of these three groups of birds differed. The insectivorous birds bred in large numbers earlier than the other groups. By October, 36 per cent of the total of insectivorous species were breeding, compared with 29 per cent and 14 per cent in the frugivorous and graminivorous groups, respectively. The breeding numbers remained high until January but sharply declined in February, the wettest month. The Willie Wagtail provides an apparent exception among the insectivorous birds by confining its breeding to the dry season.

The frugivorous group tended to begin breeding a little later than the insectivorous birds. Apart from this difference, which because of the overlap in their food-habits might not be significant, the breeding seasons of the two groups were similar.

The breeding of the graminivorous group was more extended than that of the other groups and, unlike the other forest birds, they extended their breeding well into the dry season; nests were common, especially among the grass-finches, in April and May.

The breeding of the graminivorous birds may be summarized as occurring mainly in the late wet season and early dry season, whereas that of the other forest birds occurred in the early wet season.

It has been pointed out (Lack, 1950; Slater, 1959) that the pigeons and doves tend to have extended breeding seasons, nests being found in most months of the year. In this survey the Bar-shouldered Dove and the Peaceful Dove were no exceptions. Their nests were found in most months of the year, but they were much more common in April and May, the early dry season, than in other months. The two fruit-pigeons, the Torres Strait Pigeon and the Purple-crowned Pigeon, had more restricted breeding seasons, nests being seen only in the wet season. It is of interest to note that the breeding seasons of both the seed-eating and the fruit-eating pigeons conformed to those of the other birds in their food-habits groups.

There were similar contrasts among the parrots and cockatoos. The seed-eating, ground-feeding Little Corella, Galah, Red-tailed Black Cockatoo and Northern Rosella all bred in the dry season, thus conforming to the graminivorous group. The Red-collared Lorikeet, which feeds on nectar and seeds

of fruits on the growing shrubs and trees, and the Red-winged Parrot, which also feeds largely on growing seeds and fruits, bred in the wet season with the other frugivorous birds.

Raptores.—The breeding season of the Raptores differed from that of other birds and was almost confined to the dry season. The sole exception was the Wedge-tailed Eagle, recorded by Le Souef (1903) as breeding in January. It is pointed out that in regions of Africa, similar ecologically to that part of Australia discussed here, Moreau (1950) observed a tendency for the large Raptores to breed in the wet season, whereas the smaller species bred in the dry season. The present data for the Wedge-tailed Eagle support that finding but those for the Red-backed Sea-Eagle do not.

Moreau concluded that Raptores breed in the dry season because at that season the ground-cover is sparse and the prey easier to catch. It is difficult to reconcile this reasoning with the data for some forest birds that have food-habits similar to those of some of the Raptores. Thus the butcher-birds, the nightjars, and the Blue-winged Kookaburra take prey similar to that of the Nankeen Kestrel, yet the former species breed in the wet season and the latter in the dry season. The Kestrel does, however, more closely approach the wet season in breeding than do the other Raptores.

IV. DISCUSSION

Several authors (Carter, 1899; Keast & Marshall, 1954; Carnaby, 1954; Robinson, 1955; Serventy & Marshall, 1957; Frith, 1957, 1959) have shown that in Australia the breeding seasons of birds are in general closely linked with rainfall or its effects.

One example of the effect of rainfall that may be quoted is that of rising water-level on the breeding seasons of wild ducks, and in this regard it is of interest to compare the breeding seasons of water-birds in the tropical north with those of inland New South Wales. In the latter semi-arid region the rainfall and flooding of the rivers are erratic, and it has been shown (Frith, 1957, 1959) that following a flood the water-birds breed in a definite sequence. The earliest are the nomadic species of ducks, next the more sedentary ducks, then the ibises and herons, followed by the Swamphehen, and finally the cormorants. Many of these breeding seasons were correlated with increases in abundance of food initiated by the changes in water-level.

In the Adelaide River district it has now been seen that a similar sequence of breeding seasons exists, beginning with the flooding of the swamps in the early wet season.

Serventy and Marshall (1957) have concluded that rainfall, acting as an initiating factor, and low temperature, acting as an inhibitor, are sufficient to explain the timing of the breeding seasons of birds generally in Western Australia, south of the Kimberley region. The present data, together

with those of Slater (1959) for the Kimberley region, permit this conclusion to be examined for the tropical north.

The general relationship shown by Serventy and Marshall to exist between the breeding season and the rainfall in southern regions is confirmed in the north. In the south-west, where winter rainfall is dominant, the main breeding season is in the spring and early summer. In the far north, where rainfall occurs only in the summer, the breeding is largely confined to the late summer and early autumn. The breeding seasons in other climatic zones of Western Australia have similar relationships to the annual distribution of rainfall.

The present authors are in agreement with this general conclusion that precipitation is the most likely proximate factor initiating breeding. It is difficult, however, to imagine low temperature acting as an inhibitor and preventing winter breeding, as it does in inland Western Australia, in a district where the temperature rarely falls below 60°F. It is suggested that in the tropical north the absence of rainfall is sufficient to prevent general winter breeding.

V. SUMMARY

The breeding seasons of birds in the coastal and near-coastal strip of the Northern Territory from Darwin to Arnhem Land are analyzed.

It is shown that forest-frequenting birds breed mainly during the wet season, and water-birds in the early dry season. The main breeding of the Raptores takes place in the middle of the dry season.

It is suggested that the absence of rain inhibits breeding in many species.

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TABLE 2
The Months in which Clutches were begun

Species	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Water-birds												
Crake		×	×		×							
Bushhen		×	×		×		×					
Eastern Swamphen		×	×	×	×							
Little Grebe			×	×								
Little Black Cormorant	×		×	×								
Australian Darter			×	×	×	×						
Masked Plover			×	×	×							
Lotus-bird	×	×		×	×							
Australian Pratincole				×	×							
Brolga			×						×			
White Ibis			×	×		×						
Straw-necked Ibis			×									
Yellow-billed Spoonbill												
Jabiru												
Great-billed Heron												
Little Egret												
Plumed Egret												
White Egret												
Cattle Egret			×	×	×						×	
White-faced Heron												
Pacific Heron	×	×										
Pied Heron												
Magpie-Goose			×	×								
Green Pigmy-Goose		×	×									
Whistling Tree-Duck		×	×	×	×							
Plumed Tree-Duck		×	×	×	×							
Burdekin Duck		×	×	×	×							
Black Duck		×	×	×	×							
Unidentified												
<i>Amaurornis ruficristus</i>												
<i>Porphyrion melanotos</i>												
<i>Podiceps ruficollis</i>												
<i>Phalacrocorax sulcirostris</i>												
<i>Anhinga novae-hollandiae</i>												
<i>Lobibyx miles</i>												
<i>Irediparra gallinacea</i>												
<i>Sillia isabella</i>												
<i>Grus rubicundus</i>												
<i>Threskiornis molucca</i>												
<i>T. spinicollis</i>												
<i>Platalea flavipes</i>												
<i>Xenorhynchus asiaticus</i>												
<i>Ardea sumatrana</i>												
<i>Egretta garzetta</i>												
<i>E. intermedia</i>												
<i>E. alba</i>												
<i>Ardeola ibis</i>												
<i>Ardea novae-hollandiae</i>												
<i>A. pacifica</i>	×	×										
<i>A. picata</i>												
<i>Anseranas semipalmata</i>												
<i>Nettion pulchellus</i>												
<i>Dendrocygna arcuata</i>												
<i>D. eytoni</i>												
<i>Tadorna radjah</i>												
<i>Anas superciliosa</i>												
Total Water-birds	6	9	14	16	15	4	1	0	1	1	1	3

TABLE 2 (continued)

Species	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
White-gaped Honeyeater	×								×	×	×	×
Blue-faced Honeyeater									×	×		
Silver-crowned Friar-bird									×			
Little Friar-bird												
Olive-backed Oriole	×											
Yellow Oriole	×											
Spangled Drongo	×											
Great Bower-bird	×											
<i>Stomiopera unicolor</i>												
<i>Entomyzon cyanotis</i>												
<i>Philemon argenticeps</i>												
<i>P. citreogularis</i>												
<i>Oriolus sagittatus</i>												
<i>O. flavocinctus</i>												
<i>Chibia bracteata</i>												
<i>Chlamydera nuchalis</i>												
Total frugivorous	13	3	2	1	0	0	0	0	4	6	12	11
Total Forest-birds	39	20	11	14	7	5	3	4	15	22	31	30
Raptors												
Grey Goshawk					×							
Australian Goshawk									×			
Wedge-tailed Eagle	×				×							
Australian Little Eagle						×	×					
White-breasted Sea-Eagle						×	×					
Red-backed Sea-Eagle						×	×					
Whistling Eagle						×	×					
Black Kite						×	×					
Square-tailed Kite						×	×					
Brown Hawk												
Nankeen Kestrel								×				
Northern Boobook Owl												
Barn Owl												
<i>Accipiter novae-hollandiae</i>												
<i>A. fasciatus</i>												
<i>Aquila audax</i>												
<i>Hieraaetus morphnoides</i>												
<i>Haliaeetus leucogaster</i>												
<i>Haliaeetus indus</i>												
<i>H. sphenurus</i>												
<i>Milvus migrans</i>												
<i>Lophoictinia isura</i>												
<i>Falco berigora</i>												
<i>F. cenchroides</i>												
<i>Ninox novae-seelandiae</i>												
<i>Tyto alba</i>												
Total Raptors	1	0	0	5	7	7	4	1	1	0	0	0