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WATERBIRDS AT MINDEN DAM, SOUTH-EAST QUEENSLAND, 1979 TO 1987, AND FACTORS INFLUENCING THEIR ABUNDANCE

G. J, LEACH[1] and H.B. HINES[2]

[1] P.O. Box 568, Kenmore. Old 4069
[2]42 Pangeza Street, Stafford Heights, Qld 4053

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Waterbirds were monitored at approximately three-week intervals from June 1979 through May 1987 at Minden Dam, south-east Queensland. Thirty-four species were observed, 3 to 19 species in each count. Mean counts were highest for Dusky Moorhen, followed by Eurasian Coot, Little Black Cormorant, Pacific Black Duck, Cattle Egret and Australasian Grebe. These species, except the Cattle Egret and Eurasian Coot, were present in 75 per cent of counts, as were also Purple Swamphen and Little Pied Cormorant.

Total numbers of birds and numbers of seven species (Plumed Whistling-Duck, Pacific Black Duck, Grey Teal, Hardhead, Masked Lapwing, Black-fronted Plover and Black-winged Stilt) increased significantly as the water level in the dam fell. Numbers of ten species were inversely correlated with rainfall in the preceding 100 days. In contrast, numbers of Little Black Cormorant and Little Pied Cormorant decreased as water level fell and as rainfall in the preceding 100 days was lower. Numbers of Australasian Grebe, White-faced Heron, Intermediate Egret, Pacific Black Duck and Dusky Moorhen were highest in winter, while those of Little Black Cormorant, Little Pied Cormorant, Cattle Egret, Plumed Whistling-Duck and Black-winged Stilt were highest in summer.

Minden is rich in waterbird species because of its permanence and the diverse range of habitats. The predominantly inverse correlations with depth suggest that it was a local refuge as nearby habitats diminished during dry periods. The diversity and functioning of the dam is threatened by introduced water weeds and rural residential development so careful management is required to maintain its attractiveness to waterbirds.

INTRODUCTION

There have been few published long-term studies on waterbird populations in Australia. In Queensland, such monitoring has been confined to the north-east from 1958 to 1964 (Lavery 1966, 1970a and b) and one day counts by the Queensland Ornithological Society (QOS) in the Moreton Region of the south-east in each October between 1972 and 1983 (Woodall 1985, 1986, 1988).

Analyses of the QOS counts showed numbers of several species to be inversely correlated with changes in winter rainfall of the Moreton Region (Woodall 1985, 1986, 1988). Numbers of some other species, e.g. Grey Teal†, were inversely correlated with changes in inland rainfall (Woodall 1985). Only Darter and Pied Cormorant were positively correlated with the Moreton Region and inland rainfall, respectively.

†Vernacular names follow Schodde *et al.* (1978).

Waterbirds were monitored for several years in the Richmond River Valley (Gosper 1981; Gosper *et al.* 1983), which is located east of the Great Divide in northern New South Wales and has similar waterbirds to south-east Queensland. Numbers of abundant species such as Black Swan, Pacific Black Duck and Dusky Moorhen were strongly influenced by season (Gosper *et al.* 1983). Numbers of some other species, such as Pacific Heron, Straw-necked Ibis and Grey Teal, were inversely related to wetland availability inland of the Great Divide.

In the present study, changes in waterbird numbers were intensively monitored over an eight-year period on Minden Dam in south-east Queensland. The intensity of monitoring enabled the influence of seasonal factors within years to be analysed as well as factors that vary between years; some of the latter can be determined from one day per year counts like those of QOS (Woodall 1985). Counts from the first four years overlap part of the period analysed by Woodall (1985), enabling some comparisons between our frequent monitoring of a single dam and the once-a-year regional counts.

METHODS

Site

Minden Dam, 27°33'S, 152°33'E, is 80 m above sea level and comprises three bodies of water separated by low walls/causeways (Fig. 1). Floods flow from south to north, but at other times the sections are discrete. The catchment is mainly improved grassland on the alluvial plain of the Minden Valley, with run-off from Minden.

The northern section (N, Fig. 1) has held water continuously since at least 1900 (V. E. Millewski, pers. comm.). When full, it covers approximately 1.2 ha and has a perimeter of about 900 m. Originally more than 6 m deep, subsequent silting has reduced the maximum depth to about 2 m. The central section (C, Fig. 1) is shallow, seldom with more than 0.5 m depth of water and sometimes with none. When full, it covers approximately 0.2 ha and has a perimeter of about 250 m. The southern section (S, Fig. 1) has an area of approximately 0.2 ha, a perimeter of about 300 m, a maximum depth of about 1 m, and is also virtually permanent.

Some mature Blue Gum *Eucalyptus tereticornis*, patches of Brigalow *Acacia harpophylla*, Tea Tree *Melaleuca bracteata*, Pepperina *Schinus molle*, *Acacia* spp and a few exotic species occurred around the perimeter of the northern section (Fig. 1). During the warmer months, a floating foliage of aquatic species such as *Ludwigia*, *Nymphaea* and *Nymphoides* spp extended about 2 m from the margin when water levels were high, becoming more prominent over the last 4 years. Occasionally, free-floating *Azolla* and *Lemna* spp spread over the surface.

A muddy shoreline was available around the northern section through much of 1979, 1980 and in 1986/1987, but at most other times rank vegetation reached to the edge of the water. A 1 m wide band of Bulrush *Typha* sp., and some Common Reed *Phragmites australis*, surrounded about half the perimeter of this section (Fig. 1) and grazed or mown grassland surrounded the remainder. *Eleocharis* sp. occurred over the whole of the central section, which was surrounded by closely grazed grassland. The southern section supported a band of floating aquatic species and was bordered by *Eleocharis* sp. A muddy shoreline habitat was absent from the southern section, but available for long periods around the central section.

Depth of water, rainfall and temperature

The depth of water in the northern section was monitored by noting the level on a post in the dam. It was almost full when observations began in 1979 (Fig. 2). The depth was lowest in December 1980, highest in the following summer and near its maximum for the three years from April 1983. The water was generally clear, except when the level was low in the latter half of 1980 and when the dams were flooded in June–July 1983.

Daily rainfall was recorded at Marburg Post Office (Table 1), about 5 km east, and temperatures at Lawes, about 20 km west. Approximately equal numbers of seasons and years with rainfall above- or below-average were encountered, although the summer rainfall was below average over the six years.

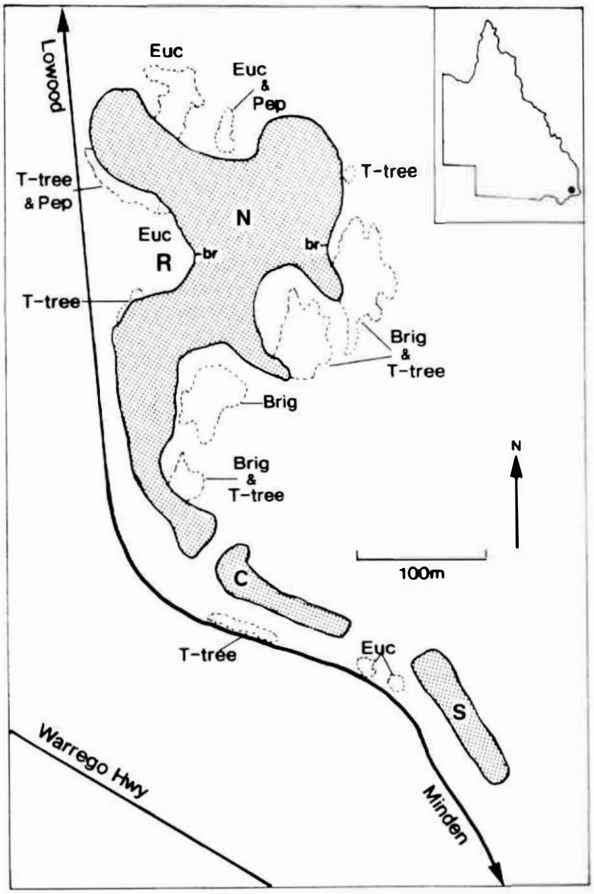

Figure 1. *Minden Dam, showing location of the northern* (**N**), *central* (**C**) *and southern* (**S**) *sections and the former refuse dump* (**R**). *Principal woody vegetation around the perimeter is Blue Gum (Euc.), Brigalow (Brig.), Tea-tree (T-tree) and Pepperina (Pep.). Bulrush extended around the southern portion of the northern section between the two points labelled "br". Inset shows location of Minden in south-east Queensland.*

Waterbird observations

Waterbirds were counted on 128 days from June 1979 through May 1987, i.e. at approximately three-week intervals (range 1 to 10 weeks). The number of counts per year ranged from 11 in 1985-86 to 24 in 1981–82. Most counts (10 to 35 mins) were made between 1300 and 1600 h, with a few earlier in the day.

Counts of the northern section were made from the former dump site (R, Fig. 1) and from the road near the southern end. The central and southern sections were counted from the road. Some birds within the bulrushes on the eastern side would not have been detected, but those in the bulrushes near the dump site usually flushed while counting was in progress.

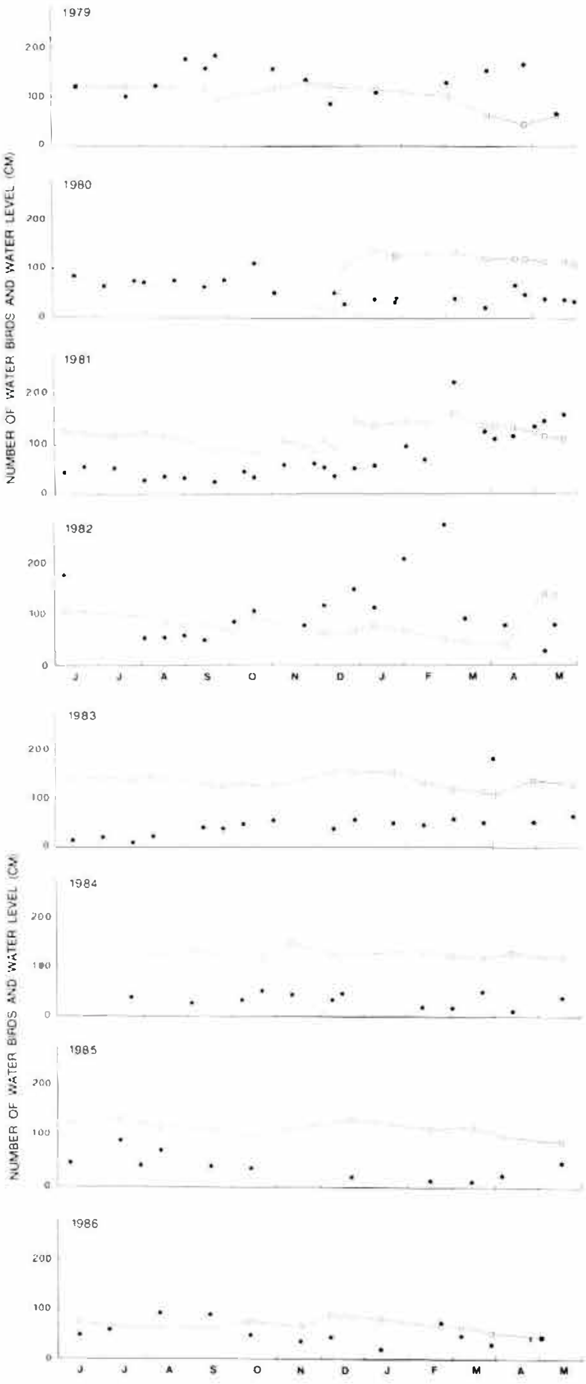

Figure 2. *The height of water (open symbols joined by line) and the total number of birds on the northern section of the dam (closed symbols).*

TABLE 1

Rainfall at Marburg from 1979 to 1987 (mm).

Year	June–Aug.	Sept.–Nov.	Dec.–Feb.	Mar.–May	Total
1979	130	187	216	208	741
1980	40	163	368	188	759
1981	121	238	516	141	1 016
1982	9	125	195	364	693
1983	267	255	222	197	941
1984	195	251	175	200	821
1985	96	212	297	60	666
1986	61	206	253	147	666
Long-term means:					
Amberley	128	194	373	187	882
Lawes	115	181	313	175	784

Note: Records provided by the Brisbane Office of the Bureau of Meteorology. Long-term means are unavailable for Marburg; Amberley is 20 km east of Minden and Lawes 20 km west.

Data analyses

Correlations were calculated between waterbird numbers and eight variables: (1) number of days elapsed since the study commenced (Day), (2) time of day, (3) duration of counting, (4) water depth, (5) total rainfall for the day of the count, (6) cumulative rainfall total for the preceding 20 days and (7) for the preceeding 100 days, and (8) mean daily temperature for the 20 days preceding each count as an index of season. Analyses were confined to the counts from the northern section because it was largest, had most habitat diversity and supported many more birds and species than other sections. Only the 17 species observed on the northern section on 20 or more days were included in correlation analyses for individual species.

Counts of one species, the Hardhead, were significantly lower later in the day ($P < 0.01$), while counts of the Dusky Moorhen increased marginally ($P < 0.05$) as the duration of counting increased (G. J. Leach and H. B. Hines, unpubl. data). The absence of other significant effects of time of day or duration of counting indicates that they were not important confounding factors and we do not consider them further in this paper.

RESULTS

Waterbird species and numbers

Mean number of species ranged from 5.9 ± 0.59 (n=17) in 1983 to 11.4±0.78 (n=14) in 1979, with a range from 3 to 19 in individual counts.

Thirty-four species were observed (Table 2). The Dusky Moorhen was nearly always present. Five other species (Australasian Grebe, Eurasian Coot, Little Pied Cormorant, Pacific Black Duck and Little Black Cormorant) were observed on

TABLE 2

The maximum and mean numbers of birds of each species, and the number of days on which a species was observed, on the northern (N) and central (C) plus southern (S) sections of the dam from 1979 to 1987.

	Section							
	N				C+S			
		Mean[a]				Mean		
Species	Max.	All	Pr.	(Days)	Max.	All	Pr.	(Days)
Australasian Grebe	28	5.9	6.6	(115)	7	1.1	2.1	(65)
Australian Pelican	1	0.0	1.0	(1)	0	0.0	0.0	
Darter	2	0.2	1.1	(24)	0	0.0	0.0	
Great Cormorant	2	0.0	1.5	(2)	0	0.0	0.0	
Pied Cormorant	2	0.0	2.0	(1)	0	0.0	0.0	
Little Black Cormorant	47	9.5	12.5	(98)	1	0.0	1.0	(1)
Little Pied Cormorant	29	4.6	5.3	(111)	1	0.0	1.0	(3)
Pacific Heron	1	0.0	1.0	(6)	1	0.0	1.0	(6)
White-faced Heron	2	0.3	1.1	(30)	2	0.2	1.2	(18)
Cattle Egret	150	6.2	23.2	(34)	49	1.0	14.9	(9)
Great Egret	2	0.1	1.1	(16)	2	0.0	2.0	(1)
Little Egret	1	0.1	1.0	(9)	1	0.0	1.0	(1)
Intermediate Egret	3	0.3	1.1	(35)	2	0.2	1.0	(26)
Glossy Ibis	1	0.0	1.0	(3)	1	0.0	1.0	(4)
Sacred Ibis	4	0.2	1.5	(19)	1	0.0	1.0	(3)
Straw-necked Ibis	9	0.3	4.4	(8)	2	0.1	1.1	(12)
Royal Spoonbill	1	0.0	1.0	(7)	1	0.0	1.0	(1)
Yellow-billed Spoonbill	6	0.1	2.1	(7)	0	0.0	0.0	
Plumed Whistling-Duck	149	4.6	20.2	(29)	0	0.0	0.0	
Black Swan	2	0.0	1.7	(3)	0	0.0	0.0	
Pacific Black Duck	46	8.1	9.4	(111)	8	0.7	2.7	(32)
Grey Teal	23	2.2	8.9	(32)	6	0.1	3.7	(3)
Australasian Shoveler	0	0.0	0.0		1	0.0	1.0	(1)
Hardhead	52	3.4	7.1	(61)	2	0.1	1.1	(7)
Maned Duck	20	0.3	3.3	(11)	0	0.0	0.0	
Dusky Moorhen	48	10.0	10.2	(126)	19	3.8	5.2	(93)
Purple Swamphen	5	0.3	1.5	(24)	4	0.1	1.8	(5)
Eurasian Coot	77	10.7	12.2	(112)	9	0.5	3.2	(20)
Comb-crested Jacana	3	0.1	1.6	(11)	2	0.1	1.7	(10)
Masked Lapwing	25	0.8	3.1	(32)	4	0.5	2.0	(33)
Red-kneed Dotterel	3	0.0	1.5	(4)	0	0.0	0.0	
Black-fronted Plover	3	0.3	1.9	(20)	1	0.0	1.0	(3)
Black-winged Stilt	10	0.8	4.5	(23)	2	0.1	1.8	(6)
Latham's Snipe	3	0.0	1.7	(3)	0	0.0	0.0	

Note: [a]Mean for all 128 counts (All) and for days when the species was present (Pr.).

over 75 per cent of visits. Nine species were observed on less than 5 per cent of visits; three on only one occasion. Thirty-three species were observed on the northern section and 23 of these, as well as the Australasian Shoveler, were also observed on the central and southern sections. Cormorants, in particular, were absent from the latter sections.

Six species (Australasian Grebe, Little Black Cormorant, Cattle Egret, Pacific Black Duck, Dusky Moorhen and Eurasian Coot) had a mean of five or more birds in counts on the northern section (Table 2). On the other sections, the mean was 3.8 for the Dusky Moorhen, but for the other five species it was less than one-fifth of the number on the northern section even though there was only a three-fold difference in area of water when the dam was full. Means, for only those days when the species was present, exceeded 10 for five species on the northern section and for one on the other sections. Cattle Egrets, when present, were usually the most abundant species.

Largest concentrations on the northern section were Cattle Egrets (150), followed by Plumed Whistling-Duck (149), Eurasian Coot (77) and Hardhead (52) (Table 2). Counts of only Cattle Egret (49) and Dusky Moorhen (19) ever exceeded 10 on the other sections.

Mean number of birds ranged from 41 ± 4.5 (n=12) in 1984 to 137 ± 9.9 (n=14) in 1979, with a minimum count of 15 in 1983 and a maximum of 315 in 1982. Relative fluctuations in bird numbers (range/mean) were much higher from 1981 to 1983 than in other years.

Cormorants were most numerous from December 1981 through March 1984, with highest counts (Little Black Cormorant: 47; Little Pied Cormorant: 29) in late summer and autumn. The build-up in numbers of the Little Pied Cormorant in summer was about a month earlier than that of the Little Black Cormorant, while dispersal was up to two months earlier. Numbers of Pacific Black Duck reached their highest peak (46) in the first year. Usually there was one peak each year, although not always at the same time of year. In contrast, fluctuations in numbers of the other two principal ducks, Grey Teal (max. 23) and Hardhead (max. 52), were more irregular. Numbers of Dusky Moorhen (max. 48) and Eurasian Coot (max. 77) were high through the first year, especially from September through November. Shore-feeding birds, i.e. herons, egrets, dotterels and Black-winged Stilt, were most numerous (max. total of all species — 14) from March through April and September through December 1980 and from December 1982 through April 1983.

Relations between numbers of birds on the northern section, water depth, preceding rainfall and season

The total number of birds declined significantly with the number of days that had elapsed since counts began (Day, Table 3). Counts of seven species were inversely correlated with Day. In contrast, counts of the White-faced Heron increased as the study progressed.

The depth of water in the dam was positively correlated with rainfall in the preceding 20 days ($P < 0.01$) and 100 days ($P < 0.001$), but not significantly with either mean temperature in the preceding 20 days or Day.

The total number of birds was inversely correlated with depth of water (Table 3). Little Black Cormorant increased significantly as the depth of water increased, but Plumed Whistling-Duck, Pacific Black Duck, Grey Teal, Hardhead, Masked Lapwing, Black-fronted Plover and Black-winged Stilt increased as the water level fell. Numbers of Dusky Moorhen, Purple Swamphen and Eurasian Coot were not significantly correlated with depth of water.

The total number of birds was not correlated with preceding rainfall (Table 3). However, when counts for Cattle Egrets, Plumed Whistling-Ducks and Masked Lapwings were excluded, because each species was probably as dependent on adjacent grasslands, the total number of all remaining species was inversely correlated with rainfall in the preceding 100 days.

Numbers of Australasian Grebe and Pacific Black Duck were inversely, and Little Pied Cormorant positively, correlated with rainfall in the 20 days preceding each count (Table 3). The numbers of nearly all species were inversely correlated with rainfall in the 100 days preceding each count: the two cormorants and the Cattle Egret were exceptions with positive correlations. Numbers of the relatively numerous Eurasian Coot were not correlated with rainfall in either the preceding 20 or 100 days.

Counts of Australasian Grebe, White-faced Heron, Intermediate Egret, Pacific Black Duck and Dusky Moorhen were inversely correlated with mean temperature in the preceding 20 days, while numbers of Little Black Cormorant, Little Pied Cormorant, Cattle Egret, Plumed Whistling-Duck and Black-winged Stilt were positively correlated (Table 3). This indicates lower numbers of the former, and higher numbers of the latter, in summer than in winter.

DISCUSSION

Species richness

Our survey, over a range of seasons (Table 1), shows that Minden has a rich waterbird community, with 34 of the 49 species that Leach and Hines (1987) observed and about one-third of those listed for the whole of south-east Queensland (Roberts 1979). Another four species (Rufous Night Heron, Little Bittern, Magpie Goose and Musk Duck), which were not observed in the present survey, have been seen at Minden (Leach and Hines 1987; G. J. Leach and H. B. Hines, unpubl. data). The Minden waterbird community also compares favourably with the 52 species reported in surveys of a 15 000 km^2 area in south-east Queensland (Woodall 1985). The species of freshwater habitats that Woodall (1985) observed with a frequency greater than 10 per cent but, which we did not observe, included Rufous Night Heron, Black-necked Stork, Chestnut Teal and Buff-banded Rail.

We are not aware of other information on the species richness of individual wetlands in the sub-coastal lowlands of southern Queensland and northern New South Wales. On the New England Tablelands of New South Wales, species richness for small wetlands was no greater, and sometimes much less, than for Minden even though the smallest wetland monitored had five times the surface area of Minden (Briggs 1977; White 1987; Ambrose and Fazio 1989). The Minden community is much richer than the community on large, deep reservoirs near Wollongong in New South Wales (Howarth and Grant 1982).

Minden was consistently used by waterbirds with never less than three species or 15 individuals in counts. The diverse range of more or less permanent aquatic and shoreline habitats enhances its attractiveness to a range of waterbirds (e.g. see Braithwaite 1975). Fluctuations in water levels produce a diversity of temporary habitats for waterbirds (Braithwaite 1975; Weller 1978; Briggs 1981) and production of food organisms is likely to mimic, albeit on a small scale, that described by Crome (1986, 1988) even though the dam never empties between replenishments. The

TABLE 3

Correlations between waterbird numbers, day of observation, depth of water, preceding rainfall and mean temperature.

	Correlation coefficients[a]				
			Rainfall		
Species	Day	Depth	20-day	100-day	Temp.
All[b]	−.367***	−.210*	−.126	−.123	.103
Principal[c]	−.506***	−.210*	−.169	−.230**	−.041
Australasian Grebe	−.048	−.173	−.298***	−.500***	.420***
Darter	.116	.089	.022	−.025	−.041
Little Black Cormorant	−.077	.235**	.079	.373***	.356***
Little Pied Cormorant	−.064	.169	.243**	.359***	.232**
White-faced Heron	.243**	.002	−.160	−.180*	.262**
Cattle Egret	−.028	.082	.047	.189*	.181*
Intermediate Egret	.114	−.077	−.116	−.222*	−.203*
Plumed Whistling-Duck	.066	−.217*	−.033	−.049	.184*
Pacific Black Duck	−.408***	−.474***	−.307***	−.414***	.228**
Grey Teal	−.196*	−.613***	−.165	−.285**	−.126
Hardhead	−.313***	−.200*	−.033	−.226*	−.052
Dusky Moorhen	−.281***	.054	−.108	−.183*	−.176*
Purple Swamphen	−.272***	−.009	−.114	−.207*	−.015
Eurasian Coot	−.578***	.046	−.084	−.168	−.039
Masked Lapwing	.134	−.192*	−.102	−.157	−.042
Black-fronted Plover	−.288***	−.519***	−.130	−.252**	.061
Black-winged Stilt	−.159	−.650***	−.142	−.253**	.196*

Notes: [a]Pearson correlation coefficients are significant at: * P = <0.05; **P = <0.01; ***P = <0.001; (n = 128). [b]All — all waterbirds. [c]Principal — principal waterbirds, i.e. excluding Cattle Egret, Plumed Whistling-Duck and Masked Lapwing.

dam also has a moderate amount of shelter, with surrounding mature trees partially screening nearby residential development and providing roosting and nesting sites.

Factors influencing waterbird numbers

An explanation for the decline in numbers of waterbirds during this study is not obvious. Rainfall at Marburg (Table 1) averaged 77 per cent (range 73–84%) of the annual rainfall for the South Coast-Moreton Region (Bureau of Meteorology 1979–1987) during the first four years and 72 per cent (range 67–77%) during the last four, indicating that other parts of south-east Queensland may have provided alternative wetland habitat in the latter period. Waterbird numbers may also respond to inland rainfall (Goddard *et al.* 1983; Woodall 1985). Annual (June to May) rainfall for Warrego, used by Woodall (1985) to represent inland Queensland, increased progressively from 51 per cent to 127 per cent of its long-term mean over the first five years of our survey and was about 15 per cent greater in the last four years than in the first four (Bureau of Meteorology 1979–87). A key factor could have been the doubling of inland rainfall in the year following drought-breaking rain in autumn 1983, enhanced by above-average winter rainfall in the following four years (Bureau of Meteorology 1979–87) and, especially, the persistence of the effects of rainfall on some waterbird populations into the following year (Briggs and Holmes 1988).

Fluctuations in the depth of water at Minden influenced numbers of waterbirds with numbers of most species decreasing, and a few increasing, with increase in depth. Woodall (1985) found no significant correlations between dam levels and numbers of waterbirds in south-east Queensland. The difference may arise because our correlations were derived from counts and levels at a single dam, whereas Woodall (1985) correlated counts from a large survey area with levels at four major irrigation/urban water supply dams within that area as indicators of regional water availability. Fluctuations in levels at Minden were determined by rainfall, run-off accession and evaporation, but irrigation and urban demand were major additional factors for the indicator dams used by Woodall (1985).

Correlations of numbers of waterbirds with preceding rainfall largely agree with conclusions of Woodall (1985). He found that only Darter and Pied Cormorant numbers were positively correlated with preceding rainfall, whereas we found significant positive correlations only for two other cormorants. However, we found stronger inverse correlations for Australasian Grebe and Pacific Black Duck with preceding rainfall, possibly because they could use smaller and shallower nearby wetlands — a dispersal which would not be evident in a regional count.

Correlations with season are weaker than those found by Gosper *et al.* (1983) for the Richmond Valley. Whereas habitat availability for waterbirds, i.e. water depth, was strongly determined by season in the Richmond Valley, it was independent of season at Minden during this study, in part because seasonal rainfall varied severalfold between years (Table 1). While species such as Australasian Grebe, White-faced Heron and Pacific Black Duck are more numerous in winter, and the cormorants in summer, the numbers of remaining species are relatively independent of season at Minden. This implies that correlations of numbers of waterbird species with season at Minden may be influenced by local movement in response to seasonal flooding and drying of nearby temporary wetlands as discussed in the previous paragraph.

Minden is suitable for cormorants only when it is close to full and they were never able to use the shallow central and southern sections. Shore feeders, e.g. herons, egrets, dotterels and Black-winged Stilt, are dependent on receding water levels to create feeding habitat. In contrast, the Dusky Moorhen and Eurasian Coot were able to use the dam through the full range of conditions observed.

Changes in numbers of Cattle Egrets in south-east Queensland were analysed by Woodall (1986); the population has expanded rapidly since they first bred in 1963 (Condon 1975). Numbers around Brisbane changed little from 1972 to 1983, but further inland, e.g. in the area around Minden, numbers increased exponentially (Woodall 1986). In contrast, our results for 1979 to 1987 (Table 2) suggest numbers at Minden were relatively stable. This difference may arise because Woodall (1986) based his conclusions on one-day counts when the egrets were moving to established breeding grounds whereas the Minden counts encompassed a secondary roost 20 km east of a stable breeding colony (McKilligan 1987).

Implications

The survey results reflect conditions in the surrounding district as well as at Minden dam. We suggest that the many inverse correlations between waterbird numbers and depth imply that Minden is functioning as a district refuge as well as primary habitat. It becomes more attractive to those birds that need moderate water depth as water levels recede in nearby shallow dams and temporary swamps. While the dual role ensures that the waterbird population is diverse, the role will only continue as long as the diversity of aquatic habitat at Minden and nearby is retained.

Since this study was completed, colonization of the main dam by Water Hyacinth *Eichhornia crassipes* has excluded nearly all waterbird species (G. J. Leach and H. B. Hines, unpubl. data). Once the Water Hyacinth is controlled, the aquatic and shoreline habitats could be enhanced. Planting additional local native trees would help to screen/shelter the dam and replace existing mature trees as they disappear. Rural residential development in the vicinity will increase disturbance and accentuate predation from domestic animals. Management to maintain habitat diversity and decrease predation of shoreline species will become increasingly important as human visitation and residential development increase.

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