CHANGES IN POPULATIONS OF WATERBIRDS ON A WETLAND FOLLOWING WATER STORAGE

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ABSTRACT

Tombullen was an intermittently flooded wetland near the Murrumbidgee River in southern inland New South Wales. In 1980 it was converted to an off-river storage. In the decade following impoundment, waterbirds at Tombullen showed a range of responses to permanent inundation. Abundances of Australian pelican, little pied cormorant, great cormorant, yellow-billed spoonbill, black swan, grey teal, maned duck, great crested grebe, Australasian grebe, freckled duck, Eurasian coot, great egret, little egret and intermediate egret decreased. Numbers of Pacific heron and straw-necked ibis increased, while Australian darter, little black cormorant, Pacific black duck, Australian white ibis and royal spoonbill did not show consistent trends in abundance. The death of permanently inundated red gums coincided with cessation of egrets breeding and enhanced breeding of Pacific herons. Permanent impoundment of water in Tombullen disadvantaged most species, did not affect a few, had positive impacts on two species of waterbird and reduced species diversity.

INTRODUCTION

Tombullen is an off-river storage used to adjust flows of water in the lower Murrumbidgee River. Before its conversion to a water storage in October 1980, Tombullen was an intermittently flooded wetland with river red gum *Eucalyptus camaldulensis* and open areas. It periodically filled overland from the Murrumbidgee River (Rankine and Hill 1977). Now, water levels in Tombullen rise with inputs from the Coleambally canal and fall with releases back to the Murrumbidgee River through a regulator.

Under its natural flooding and drying regime, Tombullen supported high numbers of waterbirds when flooded including, breeding populations of black duck, grey teal, Eurasian coot, little pied cormorant, great crested grebe and Australian shelduck (Frith 1957, 1959, Rankine and Hill 1977, B. Brown pers. comm.). Detailed information on waterbirds at Tombullen prior to its conversion to a water storage is not available. However, since impoundment, numbers of waterbirds and presence of breeding activity have been recorded several times per year at Tombullen by John Wilkinson of Coleambally. In the first few years after water storage, conditions at Tombullen were likely to have resembled a natural flood. As the duration of inundation increased, the red gums drowned and the storage increasingly resembled a permanent water body. Thus, the impacts on waterbirds of storing water in Tombullen can be investigated from trends in waterbird numbers and breeding in the decade following the change in hydrology.

STUDY AREA AND METHODS

Tombullen (350 ha at peak capacity; 34°39'S, 146°09'E) is beside the Sturt Highway 16 km east of Darlington Point in southern inland New South Wales (Figure 1). It is a depression which contains large numbers of dead river red gums and has artificial banks along the southern and western sides. The red gums died during the summer of 1983/84 and were leafless by 1986 (J. Wilkinson pers. comm.). Aquatic plants are rare in the basin now because the water level fluctuates too rapidly. Tombullen does not dry out entirely, although the water level fluctuates by about 3.5 m, from 1 m to 4.5 m.

The number of waterbirds and presence of nests or broods at Tombullen were recorded on two counting trips in 1981, and on three

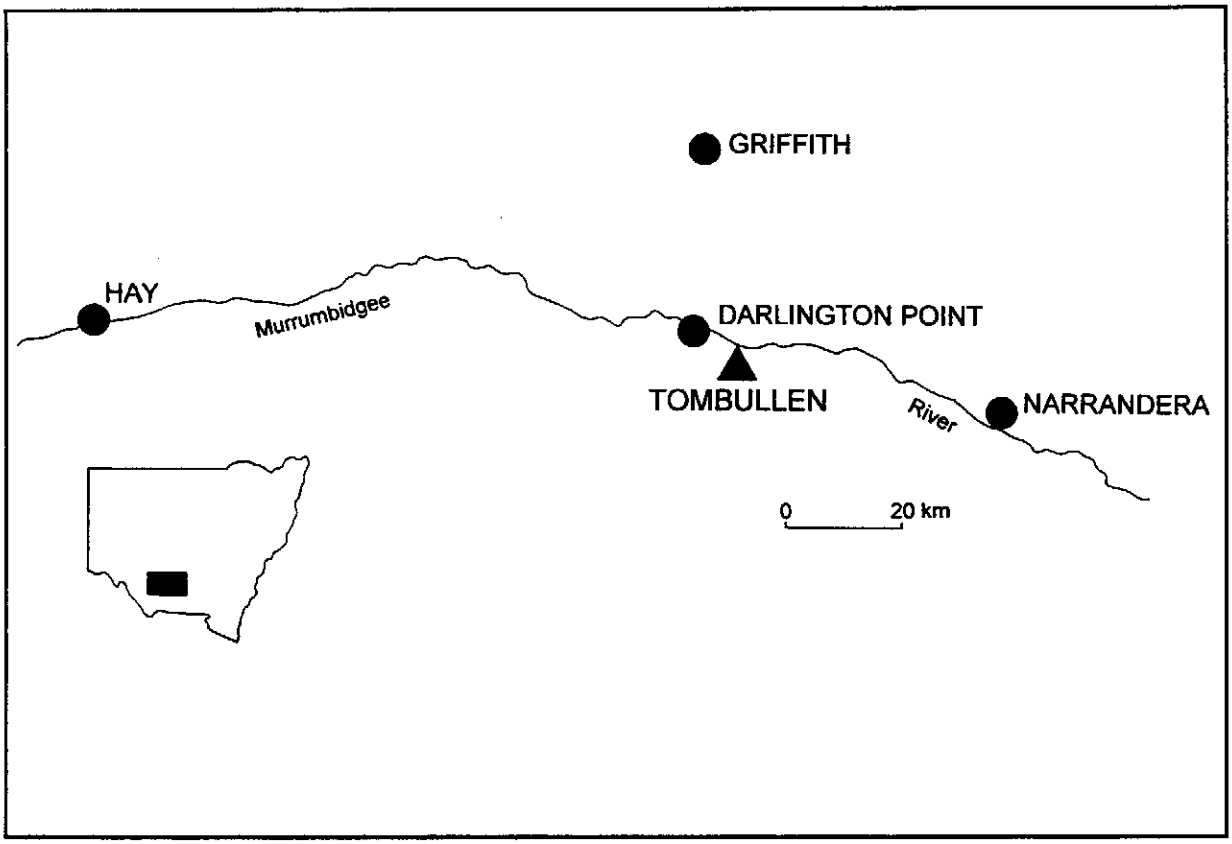

Figure 1 Location of study site.

to seven annual counts between 1982 and 1991. The mean numbers (± standard error) of visits per year were 5.4 ± 0.5 between 1982 and 1986 and 3.8 ± 0.2 between 1987 and 1991 (Table 1). The counts were usually made on one day in summer, autumn and spring. Access was by canoe or on foot depending on the water level. We used the highest count of each waterbird species in a year as its annual index of abundance. Rainfall data were obtained from the Bureau of Meteorology (district 74). Scientific names of waterbirds are listed in the Appendix. All means are reported with their standard errors.

RESULTS

Numbers of Australian darter, little black cormorant, Pacific black duck, white-faced heron, Australian white sacred ibis and royal spoonbill fluctuated with time (Figures 2, 3). Except for white-faced heron, these species bred repeatedly at Tombullen during the study period.

Australian pelican, little pied cormorant, great cormorant, yellow-billed spoonbill, black swan, grey teal and maned duck were present at Tombullen during the 1980s, but their abundances declined over the study period (great cormorant from one high year of abundance in 1982) (Figures 4, 5). Little pied cormorant, great cormorant and yellow-billed spoonbill nested frequently during the 1980s, grey teal and maned duck nested in some years, while Australian pelican and black swan did not breed at Tombullen during the study period. Medium to large numbers of great crested grebe, Australasian grebe, freckled duck, Eurasian coot, great egret, little egret and intermediate egret were present at Tombullen during the early to mid 1980s, but were rare or absent after 1986 or 1987 (Figures 6, 7). Great crested grebe and freckled duck were not recorded breeding during the study period. Australasian grebe, Eurasian coot, little egret and intermediate egret nested once before 1986 and great egret nested every year from 1982 to 1986. None of these species subsequently nested at Tombullen.

Abundances of both Pacific heron and straw-necked ibis at Tombullen have increased since impoundment (Figure 8). Pacific heron has bred at the site since 1984,

Table 1 Number of recording trips per year, maximum number of waterbirds, maximum number of species, and maximum number of breeding species of waterbirds at Tombullen, and annual rainfall in district 74 (1981-1991). The common species are shown in Figures 2-8, the uncommon species are listed in Table 2.

	Year										
	81	82	83	84	85	86	87	88	89	90	91
Number trips	2	5	6	4	7	5	4	3	4	4	4
Numbers											
Common species[1,2]	6000+	13500+	5600	3300	3300	5700	4100	3100	2100	6200	3900
Uncommon species[1]	265	22+	75	118	152	120	18	0	4	3+	54
All species[1,2]	6300+	13500+	5700	3400	3400	5800	4100	3100	2100	6200	4000
No. species											
Common species	18	19	21	21	21	19	16	17	15	19	20
Uncommon species	11	4	11	5	9	6	4	0	1	3	3
All species	29	23	32	26	30	25	20	17	16	22	23
No. breeding species											
Common species	*	9	10	13	13	11	5	8	7	6	6
Uncommon species	*	0	0	0	0	0	0	0	0	0	0
All species	*	9	10	13	13	11	5	8	7	6	6
Rainfall	442	180	489	437	388	366	280	433	470	403	327

[1] + complete count of some species not available in 1981, 1982 and 1990; [2] to nearest 100.

but straw-necked ibis did not nest there during the study period.

The uncommon species of waterbirds (< 10 individuals per year or present in < 5 years) did not show individual trends in numbers with time (Table 2). However, both annual abundance and diversity of the uncommon species decreased following impoundment, especially after 1986 (Tables 1, 2). None of the uncommon species of waterbirds bred at Tombullen during the study period.

Abundance of all waterbirds, number of species and number of breeding species diminished at Tombullen during the 1980s (Table 1). The fall in the number of breeding species was the most noticeable.

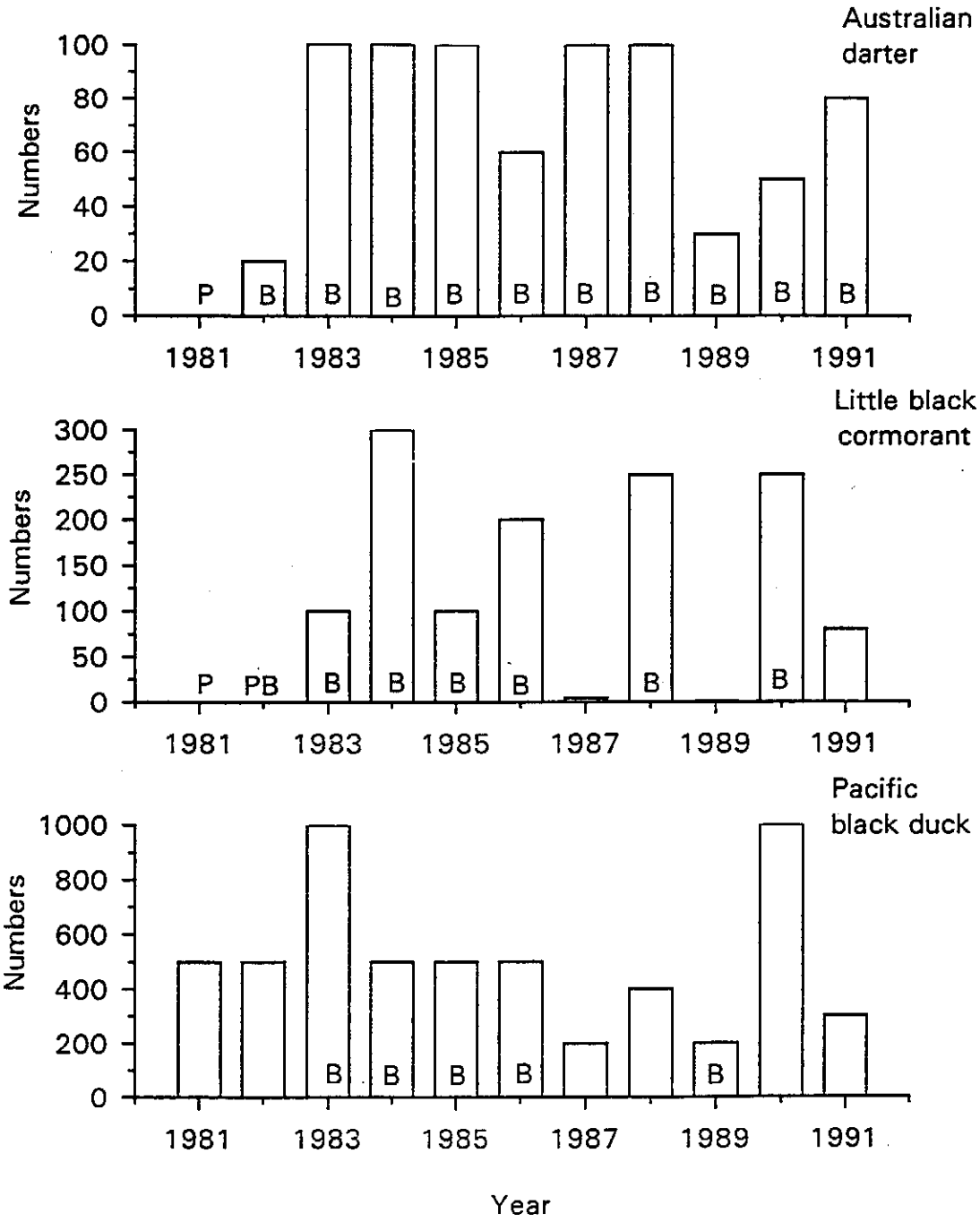

Figure 2 Species of waterbirds in the families Anhingidae, Phalacrocoracidae and Anatidae whose numbers did not show a consistent trend with time in the decade following impoundment of Tombullen. P, present; B, breeding.

From 1982 to 1986 an annual maximum of 6380 ± 1853 waterbirds was observed at the site, the maximum number of species observed annually was 27 ± 1.7 and the annual maximum number of breeding species was 11 ± 0.8. The equivalent yearly figures for the period from 1987 to 1991 were 3900 ± 679, 20 ± 1.4 and 6 ± 0.5 respectively. The mean annual abundance of waterbirds at Tombullen did not significantly differ between the early (1982-1986) and later time periods (1987-1991) (ANOVA, $p > 0.1$). However, the mean number of species and number of breeding species were both significantly lower in the period 1987 to 1991 than in the 1982 to 1986 period (ANOVAs, both $p < 0.01$).

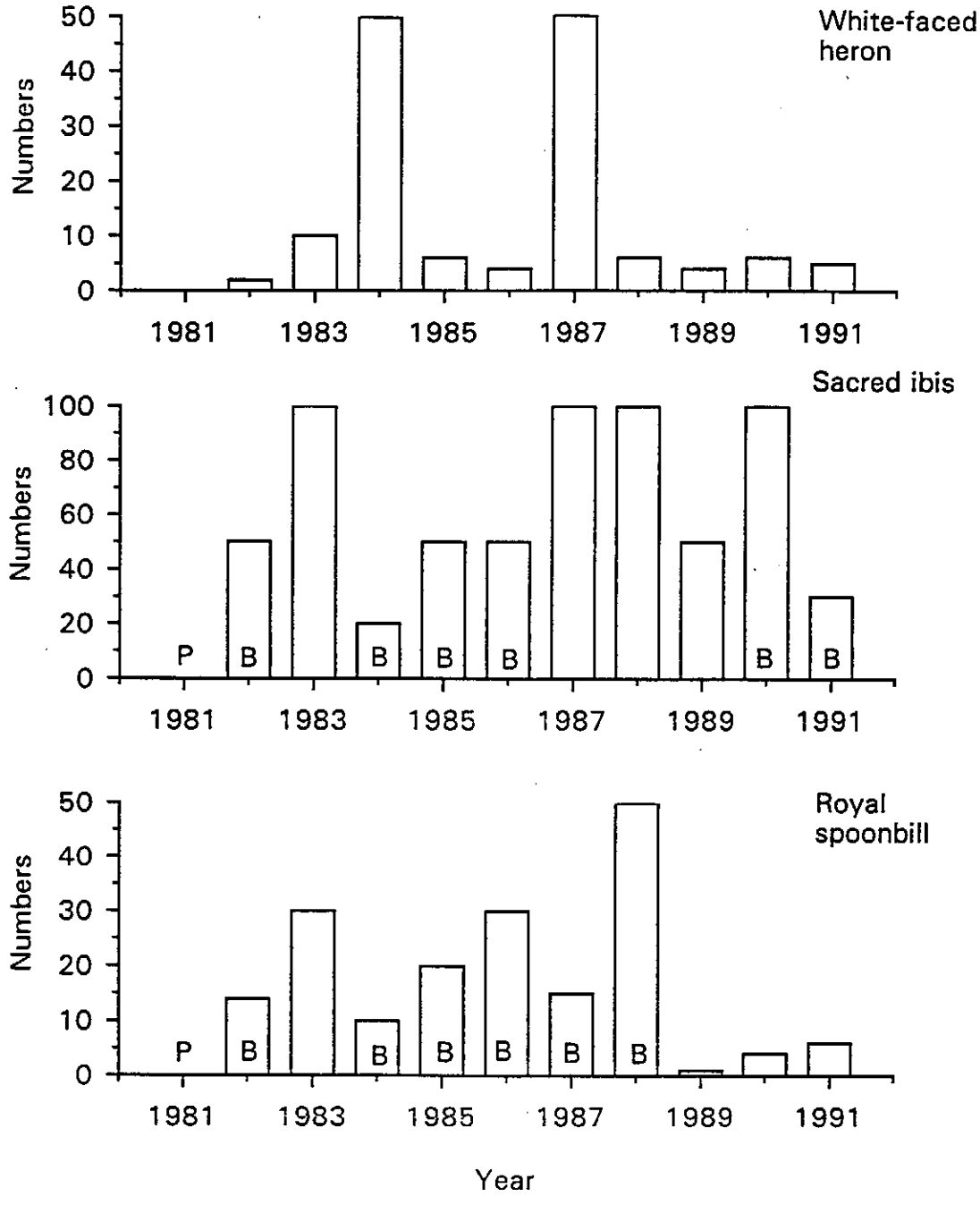

Figure 3 Species of waterbirds in the families Ardeidae and Plataleidae whose numbers did not show a consistent trend with time in the decade following impoundment of Tombullen. P, present; B, breeding.

Neither the annual abundance of waterbirds, nor the annual number of species at Tombullen between 1981 and 1991 was correlated with the number of counting trips per year to the site (regression analysis, $p > 0.1$). The number of breeding species (data only available for 1982-1991) showed a weak positive correlation with the annual number of counts (regression analysis, $r^2 = 0.27$, $p = 0.07$).

Annual rainfall in meteorological district 74 varied between 180 mm and 489 mm during the study period (Table 1). Annual average rainfall in the early and late 1980s was similar (372 ± 52 mm between 1982 and 1986; 383 ± 35 mm between 1987 and 1991).

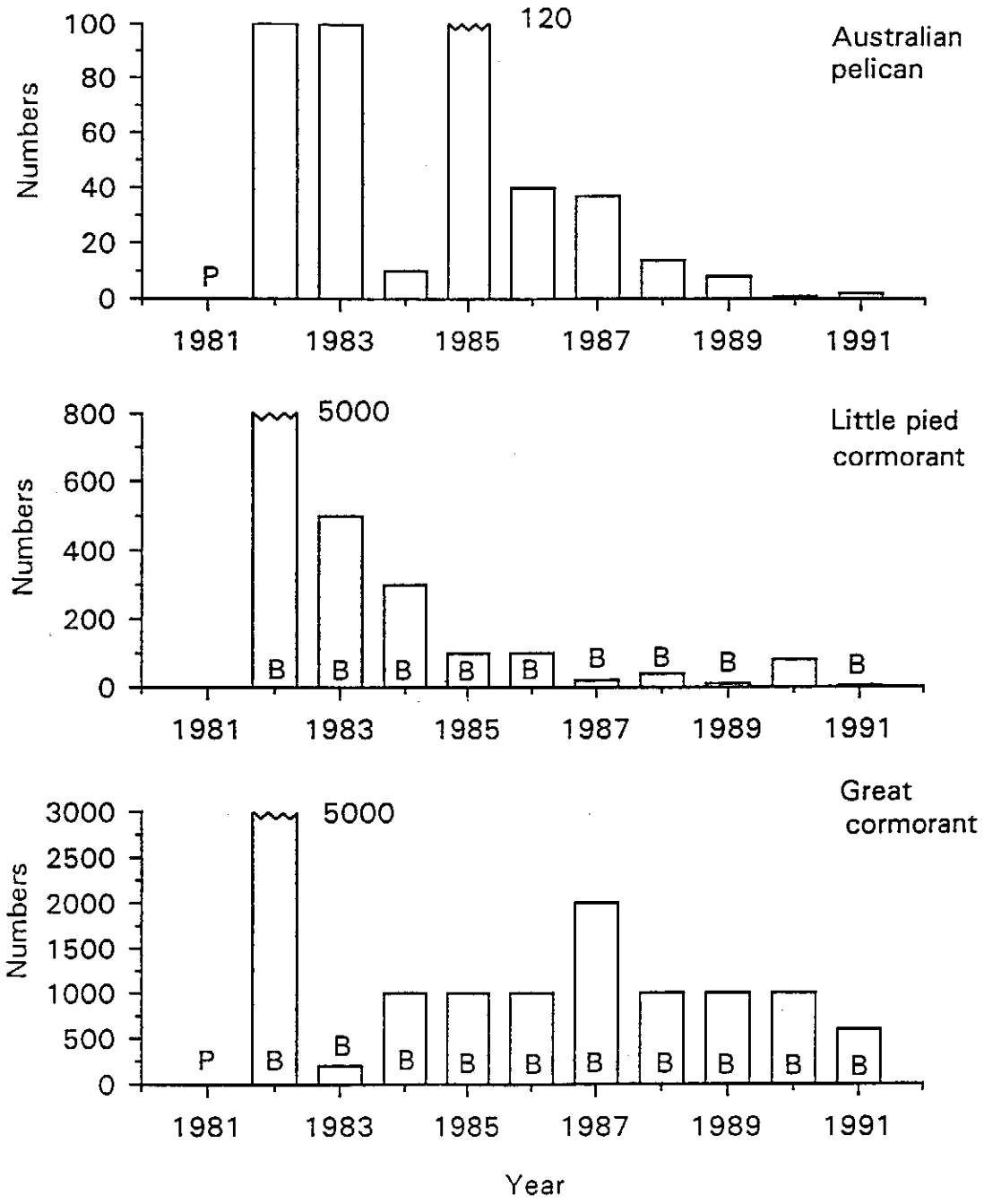

Figure 4 Species of waterbirds in the families Pelecanidae and Phalacrocoracidae whose numbers declined in the decade following impoundment of Tombullen. P, present; B, breeding.

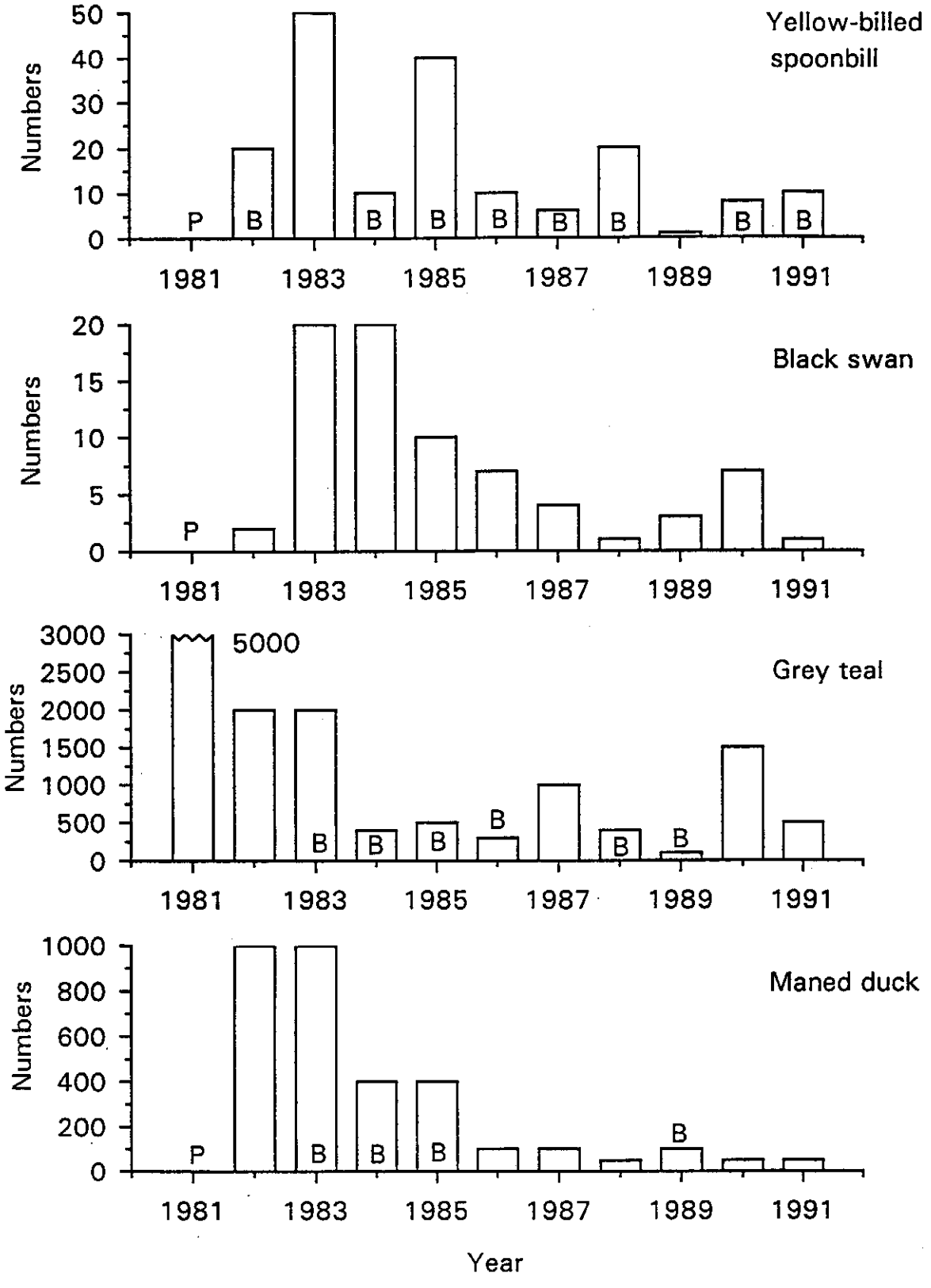

Figure 5 Species of waterbirds in the families Plataleidae and Anatidae whose numbers declined in the decade following impoundment of Tombullen. Figures are highest numbers seen per year.

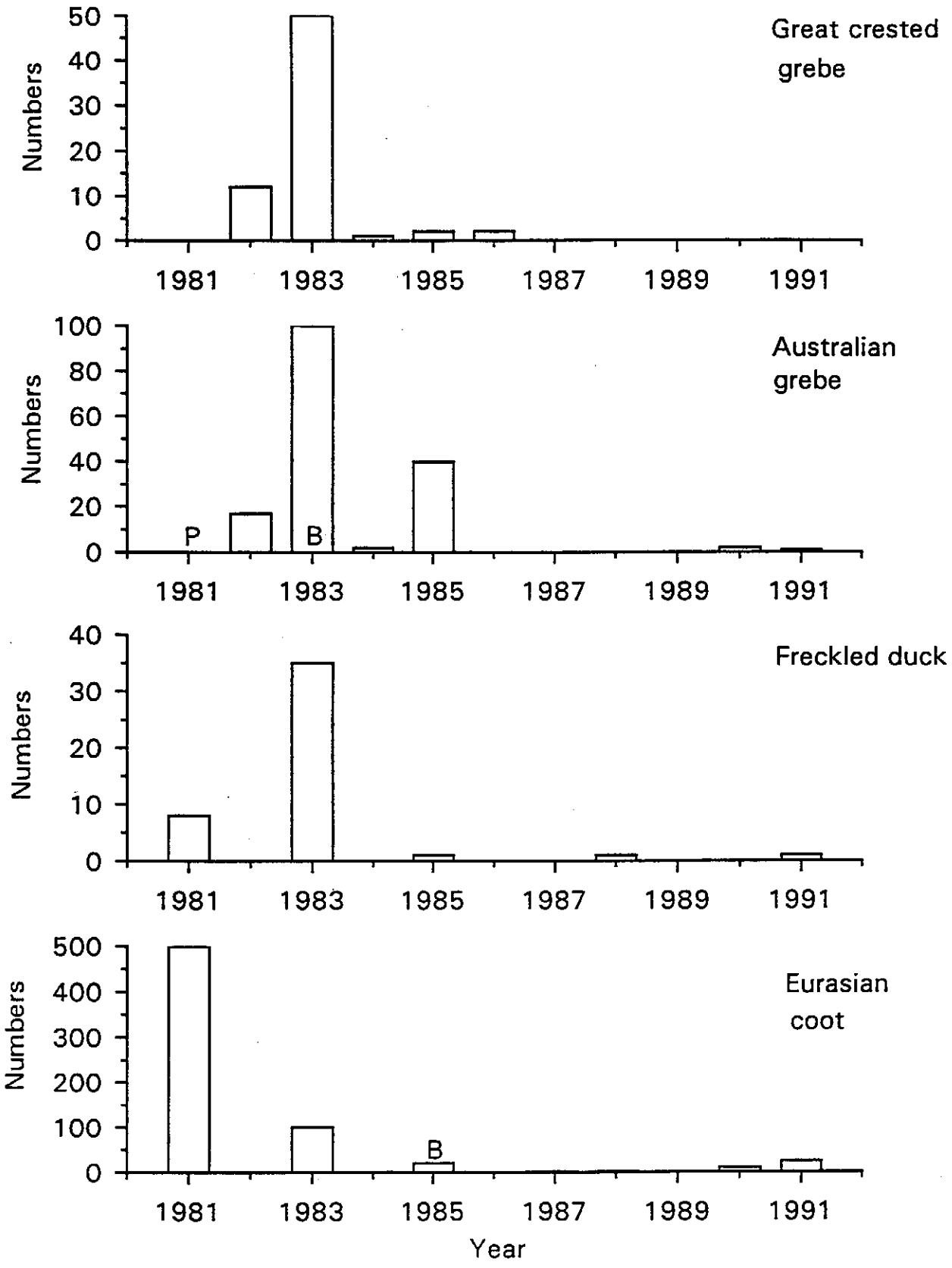

Figure 6 Species of waterbirds in the families Podicipedidae, Anatidae and Rallidae whose numbers declined in the decade following impoundment of Tombullen. P, present; B, breeding.

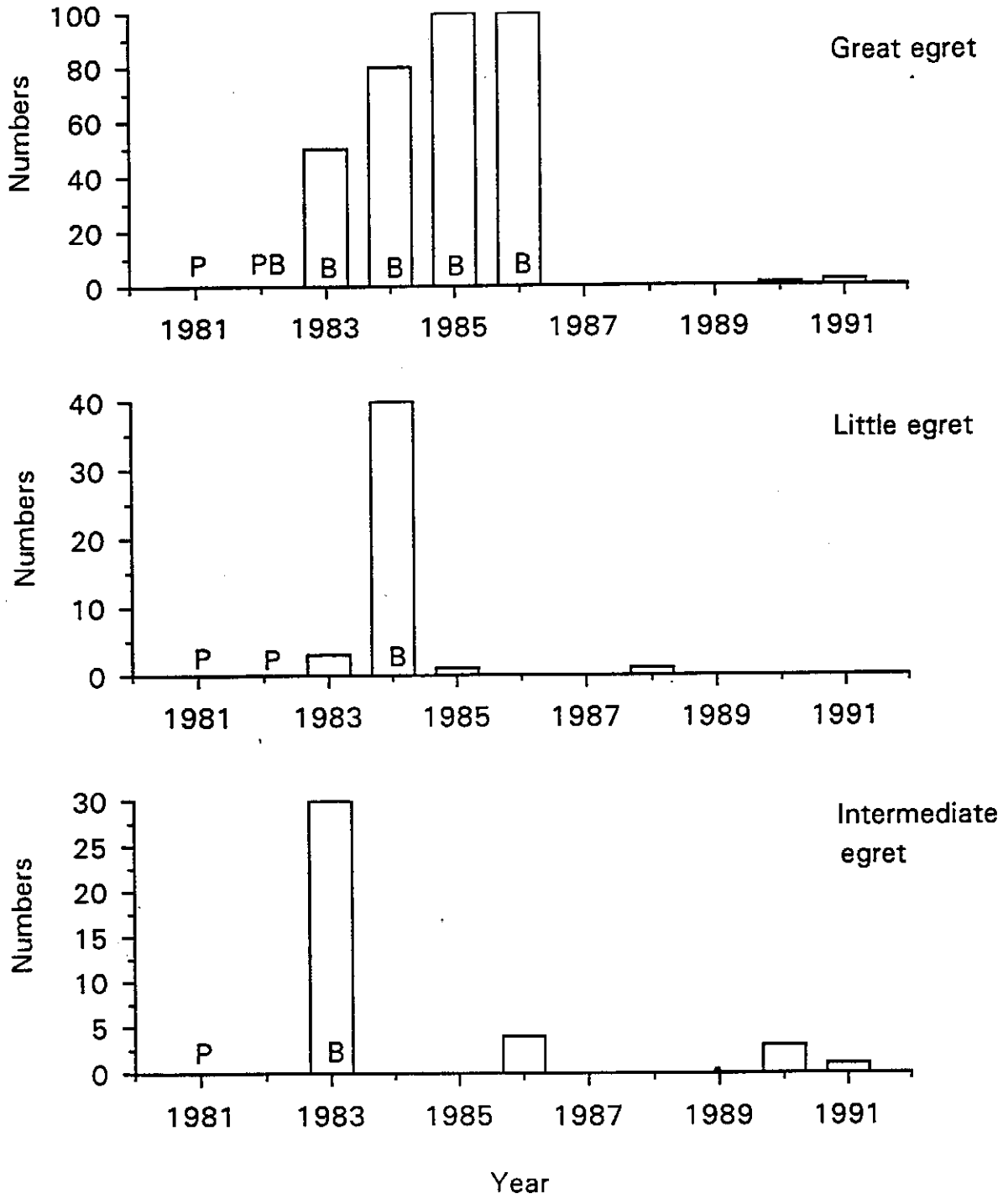

Figure 7 Reduction in numbers and breeding of egrets at Tombullen in the decade following impoundment. P, present; B, breeding.

DISCUSSION

The changes following the conversion of Tombullen to an off-river storage disadvantaged 13 to 14 species of waterbirds, did not obviously affect 6 to 7 and benefitted 2 species. Species diversity of waterbirds fell significantly after six or seven years of permanent inundation. The major reason for the fall in species diversity was fewer uncommon species. The number of breeding species also appeared to decline after six years, although this may have been influenced by observer effort. The total number of waterbirds decreased, but not significantly.

Egrets showed a strong negative response to regulation of water in Tombullen. Egrets

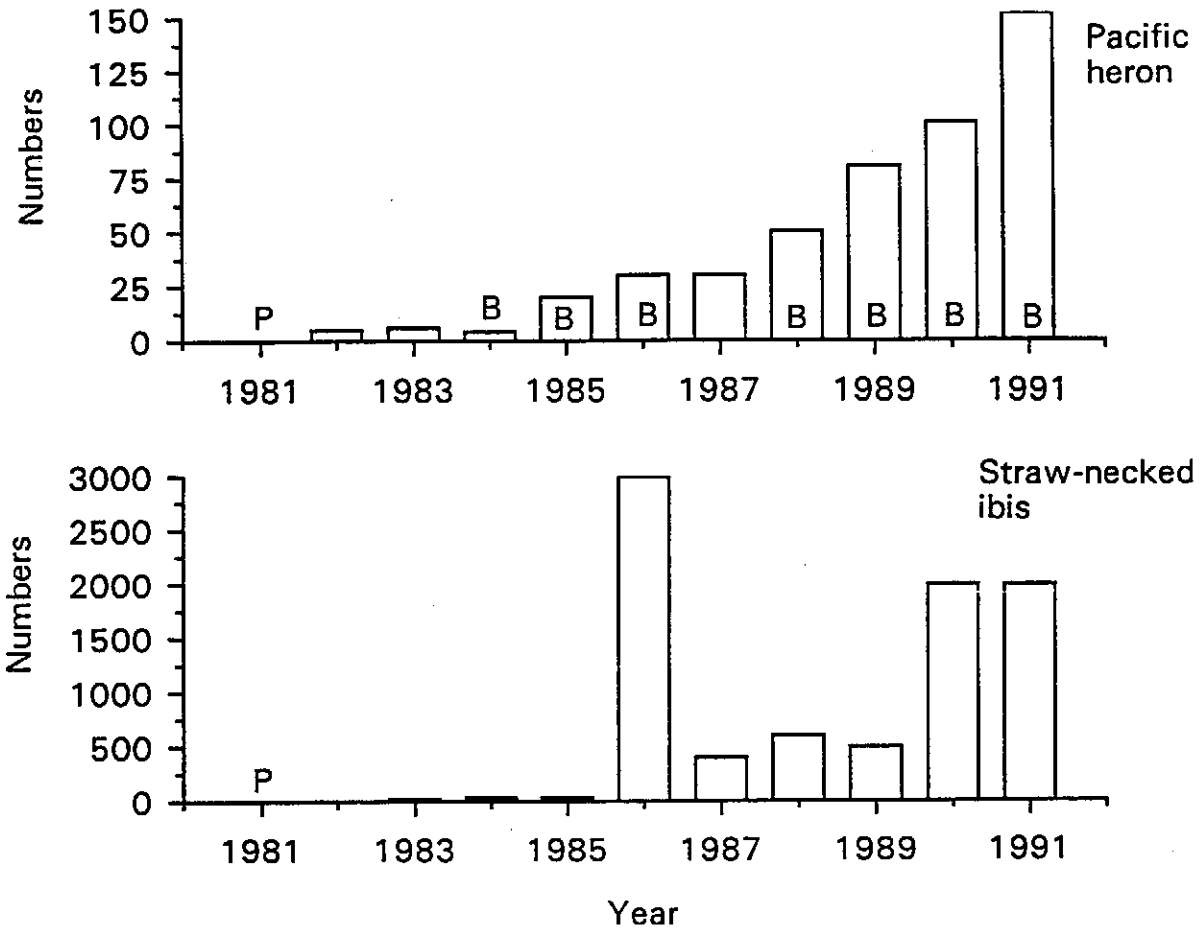

Figure 8 Species of waterbirds whose numbers increased in the decade following impoundment of Tombullen.

bred at Tombullen in the five years following impoundment but have not done so subsequently. Egrets breed in live trees with thick foliage within wetlands that are temporarily, but deeply, flooded (Chesterfield *et al.* 1984, Maher 1990, Magrath 1992). The death of red gums in Tombullen coincided with the cessation of breeding by egrets. Generally, egrets do not breed in dead trees. There is evidence from elsewhere (Chesterfield *et al.* 1984) that egrets have been adversely affected by changes in flood patterns caused by river regulation. The impacts on egrets of hydrological changes to wetlands warrant further, more detailed research.

Pacific heron and straw-necked ibis appear to have been favoured by storing water in Tombullen. Pacific heron bred consistently at the site, whereas straw-necked ibis used Tombullen for roosting. The increased use of Tombullen storage by Pacific heron during the 1980s correlates with increasing numbers of dead river red gums at the site. River red gums will only tolerate two to four years of continuous flooding (Briggs and Maher 1983, Bren 1990), consequently most were dead by mid 1984 and leafless by 1986 (J. Wilkinson pers. comm.). Pacific herons nest in both dead and live trees (Lowe 1989, K. Lowe pers. comm.). The results from Tombullen suggest that either Pacific herons are increasingly attracted to wetlands with longer duration of permanent flooding, or that nesting in this species is enhanced by large numbers of dead trees. Straw-necked ibis roosted at night in the dead trees at Tombullen and presumably fed during the day in the paddocks, rice fields and shallow wetlands in surrounding areas. Straw-necked ibis require a roosting site that is safe from predators and the dead trees in permanent water at Tombullen met this requirement.

Table 2 Number of uncommon species of waterbird (always < 10 individuals per year or present in < 5 years) at Tombullen 1981-1991.

Species	Year 81	82	83	84	85	86	87	88	89	90	91
Hoary-headed grebe	0	0	0	13	100	100	0	0	0	0	50
Pied cormorant	P	0	0	0	0	0	0	0	0	0	0
Rufous night heron	0	0	1	1	0	0	0	0	0	0	0
Glossy ibis	0	0	6	0	0	0	0	0	0	0	0
Australian shelduck	0	0	2	2	2	2	2	0	0	0	2
Mallard	0	0	1	0	0	0	0	0	0	0	0
Australasian shoveler	0	0	2	2	2	2	2	0	0	0	2
Pink-eared duck	25	0	2	0	3	0	0	0	0	0	0
Hardhead	6	1	12	0	22	0	0	0	0	0	0
Blue-billed duck	P	0	0	0	0	0	0	0	0	0	0
Musk duck	1	0	2	0	0	0	0	0	0	1	0
Black-tailed native hen	200	0	0	0	1	0	0	0	0	0	0
Dusky moorhen	0	0	0	100	0	0	0	0	0	2	0
Purple swamphen	P	0	0	0	2	0	0	0	0	0	0
Masked lapwing	P	0	1	0	0	0	0	0	0	0	0
Banded lapwing	P	0	0	0	0	0	0	0	0	0	0
Red-kneed dotterel	0	1	0	0	0	0	0	0	0	0	0
Black-fronted plover	10	0	0	0	0	0	0	0	0	0	0
Black-winged stilt	0	0	40	0	18	1	2	0	0	P	0
Red-necked avocet	23	0	0	0	0	0	0	0	0	0	0
Silver gull	0	P	0	0	2	12	12	0	0	0	0
Whiskered tern	0	20	4	0	0	3	0	0	4	0	0

Impacts of changed flood patterns on wetland flora and fauna have been neglected for many years. Some attention is now being focused on impacts of permanent inundation (Shepheard 1992, Roberts and Brickhill 1992). The results of the study at Tombullen show that changes following impoundment of water in wetlands can be

complex. Species of waterbirds showed a number of responses to hydrological change. A few benefitted, most did not and some species were apparently unaffected. The results of studies such as this one at Tombullen may enable water managers to predict effects of proposed hydrological changes to wetlands and avoid any adverse consequences.

ACKNOWLEDGEMENTS

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Appendix Scientific names of species of waterbirds at Tombullen.

Common name	Scientific name
Great crested grebe	*Podiceps cristatus*
Hoary-headed grebe	*Poliocephalus poliocephalus*
Australasian grebe	*Tachybaptus novaehollandiae*
Australian pelican	*Pelecanus conspicillatus*
Darter	*Anhinga melanogaster*
Great cormorant	*Phalacrocorax carbo*
Pied cormorant	*Phalacrocorax varius*
Little black cormorant	*Phalacrocorax sulcirostris*
Little pied cormorant	*Phalacrocorax melanoleucos*
Pacific heron	*Ardea pacifica*
White-faced heron	*Ardea novaehollandiae*
Great egret	*Egretta alba*
Little egret	*Egretta garzetta*
Intermediate egret	*Egretta intermedia*
Rufous night heron	*Nycticorax caledonicus*
Glossy ibis	*Plegadis falcinellus*
Australian white ibis	*Threskiornis aethiopica*
Straw-necked ibis	*Threskiornis spinicollis*
Royal spoonbill	*Platalea regia*
Yellow-billed spoonbill	*Platalea flavipes*
Black swan	*Cygnus atratus*
Freckled duck	*Stictonetta naevosa*
Australian shelduck	*Tadorna tadornoides*
Pacific black duck	*Anas superciliosa*
Mallard	*Anas platyrhynchos*
Grey teal	*Anas gibberifrons*
Australasian shoveler	*Anas rhynchotis*
Pink-eared duck	*Malacorhynchus membranaceus*
Hardhead	*Aythya australis*
Maned duck	*Chenonetta jubata*
Blue-billed duck	*Oxyura australis*
Musk duck	*Biziura lobata*
Black-tailed native hen	*Gallinula ventralis*
Dusky moorhen	*Gallinula tenebrosa*
Purple swamphen	*Porphyrio porphyrio*
Eurasian coot	*Fulica atra*
Masked lapwing	*Vanellus miles*
Red-kneed dotterel	*Erythrogonys cinctus*
Black-fronted plover	*Charadrius melanops*
Black-winged stilt	*Himantopus himantopus*
Red-necked avocet	*Recurvirostra novaehollandiae*
Silver gull	*Larus novaehollandiae*
Whiskered tern	*Chlidonias hybrida*