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CHANGES IN THE NUMBERS OF WATERBIRDS ON LLANGOTHLIN LAGOON, NSW, IN RELATION TO THE WATER LEVEL AND DISTANT FLOODING, 1981–84

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Waterbirds on Llangothlin Lagoon, New South Wales were counted regularly between 1981 and 1984 and their numbers related to water level and to the occurrence of floods on inland rivers. Some species responded differently to local conditions in a period of widespread drought than they did in times of average or above rainfall. The implications of these findings for future studies of the movements of waterbirds are discussed.

INTRODUCTION

An understanding of the environmental factors inducing the movement of waterbirds is crucial to their effective management. Changes in the numbers of waterbirds in south-eastern Australia are related to both regional and distant rainfall, water level, and/or season (Sharland 1960; Briggs 1977; Whyte 1981; Gosper *et al.* 1983; Norman 1983; Woodall 1985; Harper 1990; Norman and Nichols 1991).

There is some seasonal regularity in the mass movements of waterbirds in northern Australia (Lavery 1970) and in the south-west of Western Australia (Ford 1958; Beckle 1983; Gentilli and Beckle 1983; Hnatiuk 1987) but waterbirds in south-eastern Australia may move at any time of the year (Carrick 1962; Lamm 1965; McKilligan 1975; Frith 1982).

In this paper I relate changes in numbers of the ten most common waterbirds at Llangothlin Lagoon in the New England region of New South Wales between June 1981 and November 1984 to the depth of water in the lagoon and also to the flooding of inland rivers.

STUDY SITE

Llangothlin Lagoon (Lat: 30°5′S, Long: 151°45′E, altitude 1 360 m, surface area 400 ha) on the New England Tablelands of north-eastern New South Wales covers approximately 20 per cent of its catchment area when full. Depth of water (maximum approximately 2 m) is dependent solely on local rainfall (long-term annual mean 980 mm). The lagoon has a central area of emergent vegetation dominated by *Eleocharis sphacelata*. This is surrounded by shallow open water fringed by mud-flats and a grassy sward, much of it grazed by sheep and cattle. The lagoon is fully described in Briggs (1979).

During the first two years of the study (June 1981–May 1983) the New England region, together with much of south-eastern Australia, was in drought, but rainfall was generally average or above for the last 19 months of the study: the effect of the 1982–83 El Niño (Norman and Nicholls 1991). The lagoon was completely dry for some months in the summer and autumn of 1981 (just how many is unknown) but it began filling after local rain in early June 1981 and retained water throughout the study.

METHODS

The first of 63 'walk round' censuses of waterbirds was done ten days after the lagoon began to fill (White 1986a). Censuses were made every four weeks and approximately fortnightly during times of suspected rapid changes in numbers of birds after heavy local rain or at the onset of floods on the Upper

Darling System. (Weather conditions in May and July 1984 prevented access: no counts were made in these two months). The depth of water was measured at each census after the water reached permanent markers on the edge of the lagoon. Before that time the maximum depth was calculated from measurements taken as part of other studies at the lagoon (White 1986b). Records of floods in the Murray-Darling region were obtained from the Australian Bureau of Meteorology. Rainfall data was obtained from official records kept at Guyra Post Office NSW.

The Minitab statistical package (Ryan *et al.* 1976) was used to calculate Pearson's coefficient of correlation (r) between the number of waterbirds and the depth of water.

RESULTS

Black Swan *Cygnus atratus*, Pacific Black Duck *Anas superciliosa* and Maned Duck *Chenonetta jubata* arrived at Llangothlin Lagoon within 10 days of its receiving water in the first week of June 1981 after being completely dry for some months. Grey Teal *Anas gibberifrons* and Purple Swamphen *Porphyrio porphyrio* arrived within a month of the lagoon's receiving water. Australasian Shoveler *Anas rhynchotis* were first seen in August 1981 and Hardhead *Aythya australis* and Eurasian Coot *Fulica atra* arrived in September 1981. Australasian Grebe *Tachybaptus novaehollandiae* did not arrive until December 1981 and Musk Duck *Biziura lobata* were not seen until March 1982. Numbers of all species fluctuated widely throughout the study (Fig. 1).

Major floods occurred in the Paroo River in March 1983 and the drought broke with widespread rain in the autumn of 1983 with 380 mm of rain falling at the study site in April and May 1983 (N. Elphinston, pers. comm.). During this post-drought phase of the study further major flooding in the rivers of the Upper Darling System occurred in May and December 1983 and in January and July 1984 — weeks 88, 95, 125, 132, 161 of the study — (Australian Bureau of Meteorology). The onset of each flood is shown on Figure 1.

Declines in the numbers of Grey Teal from March 1983 to the end of the study followed major floods in the Upper Darling River system regardless of the depth of water or rainfall at Llangothlin. After these events numbers remained low for approximately six months, except during the spring of 1984. Hardhead appeared to behave similarly but the numbers were too low at the time of the first two inland floods to allow inferences to be made. The numbers of Pacific Black Duck also decreased after these inland floods but the initial fall in numbers was followed by a temporary increase after which the numbers more or less stabilized around a lower figure (Fig. 1). There was no coincidence with inland flooding with any other species. No seasonal variation in numbers was apparent for any species.

The numbers of most species appeared to be related to local rainfall or the depth of water (the two were indistinguishable) but their behaviour was not necessarily consistent during and after the drought. During the drought (June 1981 to May 1983) the numbers of Pacific Black Duck, Grey Teal, Eurasian Coot, Purple Swamphen and Australasian Grebe were positively correlated with the depth of water in the lagoon (Table 1). After the drought (June 1983 to November 1984) numbers of Eurasian Coot and Australasian Grebe remained positively correlated with the depth of water, but numbers of Pacific Black Duck were now negatively correlated with the depth of water. The numbers of Grey Teal and Purple Swamphen no longer showed any significant correlation with the depth of water. Combined figures from all censuses illustrate that the numbers of Pacific Black Duck and Australasian Shoveler were negatively correlated with the depth of water while the numbers of Hardhead, Maned Duck, Musk Duck, Eurasian Coot, and Australasian Grebe were positively correlated with the depth of water (Table 1).

TABLE 1

Correlation coefficients (Pearson's r) between the number of waterbirds and the depth of water at Llangothlin Lagoon.

Species	Drought n=39	Post-drought n=24	Whole study n=63
Black Swan	0.144	0.003	0.033
Pacific Black Duck	0.485**	−0.672**	−0.280*
Grey Teal	0.383*	−0.287	−0.119
Hardhead	0.099	0.341	0.385*
Australasian Shoveler	0.204	0.538**	−0.253*
Maned Duck	−0.109	0.132	0.284*
Musk Duck	0.256	0.744**	0.940**
Eurasian Coot	0.348*	0.657*	0.789**
Purple Swamphen	0.474**	−0.301	0.036
Australasian Grebe	0.373*	0.449*	0.701**

$**P < 0.01$; $*P < 0.05$; n = number of censuses.

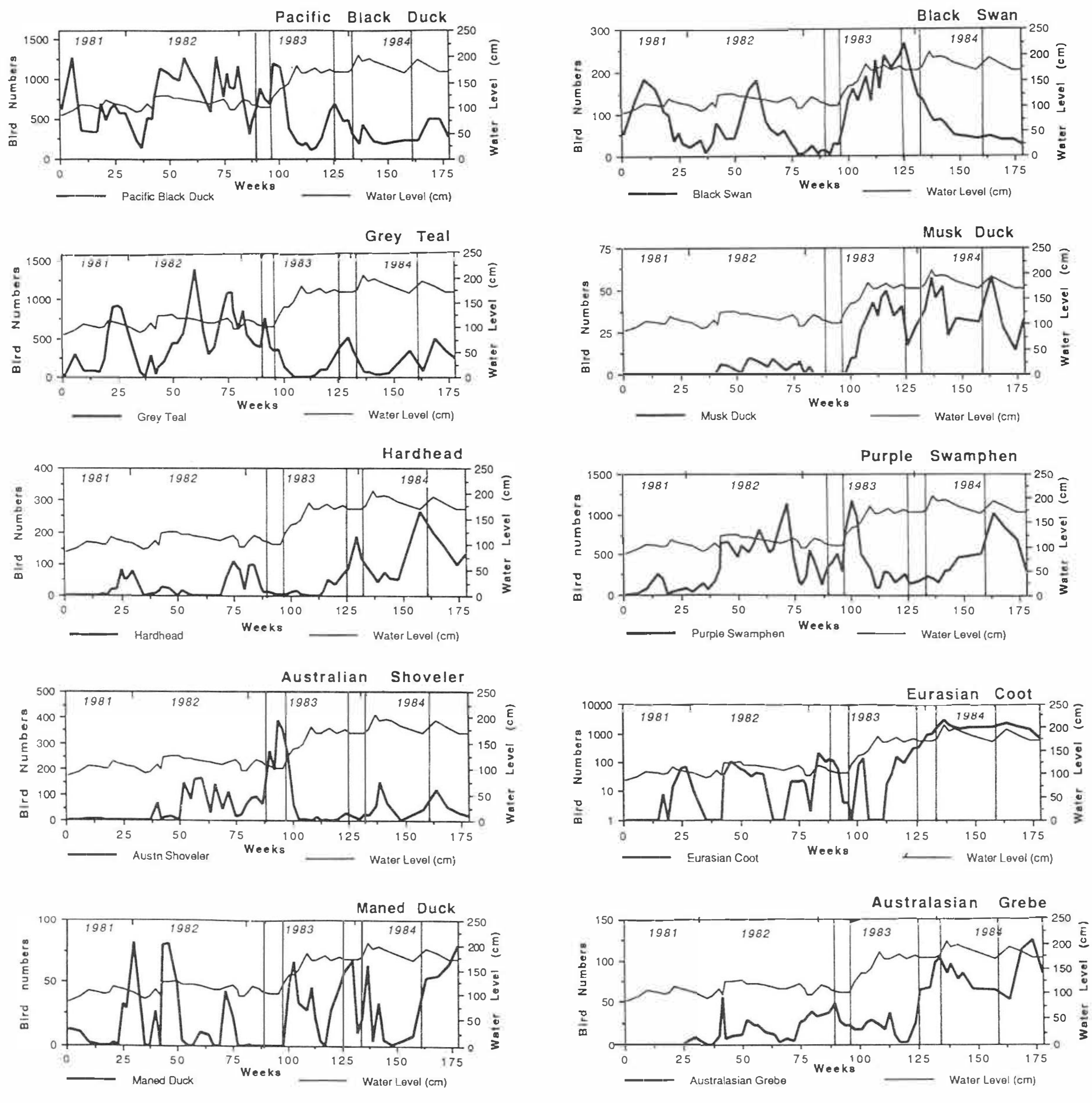

Figure 1. *The number of waterbirds and depth of water (cm) at each census between June 1981 and November 1984.*

Note: Vertical lines mark the onset of floods in the inland rivers: week 88 the Paroo; weeks 95; 125; 132; 161 the Upper Darling River System. Weeks 90–95 mark the end of the drought in the region.

DISCUSSION

The results of this study emphasize the need for long-term studies with frequent censuses. I also suggest that environmental factor remote from the study site should be considered if the movements of waterbirds in south-eastern Australia are to be fully understood.

The numbers of all species of waterbirds varied widely throughout the study. Some variations in numbers were apparently in relation to changes in water level due to local rainfall (and, by implication, its direct and indirect effects on the habitat and food supply), and some, I hypothesize, to distant floods.

Although the maximum depth of water was greater during the last 18 months of the study the nature of the lagoon is such that the ability to see birds did not differ to any marked degree except during the winter of 1983. Then birds were more readily seen because there was little emergent vegetation until late the following spring. Except for that period errors in censuses would have been reasonably consistent and any bias towards underestimation of numbers.

The relationship between Pacific Black Duck and the depth of water at Llangothlin Lagoon differed during and after the drought and there were indications that Grey Teal and Purple Swamphen showed a similar relationship. The numbers of these three species were positively correlated with the depth of water at Llangothlin Lagoon while there was widespread drought. However, after the drought, numbers of Pacific Black Duck were negatively correlated with depth of water, and even though there was no significant correlation between depth of water and numbers of both Grey Teal and Purple Swamphen after the drought, there was a change in the sign of the coefficient. In an earlier study on the same lagoon, when weather patterns were similar to those after the drought in my study, Briggs (1977) found a significant negative correlation of numbers of Grey Teal and Purple Swamphen with water level. Harper (1990), at Bool Lagoon in South Australia, found numbers of Pacific Black Duck to be influenced by local rainfall and water level but could find no correlation of numbers of either Grey Teal or Purple Swamphen and any local environmental factors.

I sugge t that the apparent change in response of Purple Swamphen at Llangothlin Lagoon to water level after the drought ended was due to the now generally deeper water causing the temporary flooding of their preferred habitat of reed swamp. I also suggest the hypothesis that the difference in the behaviour of Grey Teal is related to a response to inland flooding which might override any local stimulus.

Grey Teal left Llangothlin Lagoon in large numbers less than two weeks after the flooding of inland rivers. This rapid departure, possibly in response to distant events, has been reported by other authors (Ford 1958; Frith 1982; Beckle 1983; Gosper *et al.* 1983). Such behaviour underlines the need for frequent censuses in south-eastern Australia; annual censuses are inappropriate unless they include the far inland waters of the Cooper Basin and Darling River Systems.

There are indications that some species of waterbirds respond differently to seasons in different regions of south-eastern Australia. None of the ten species under discussion showed any regular seasonal changes in number at this lagoon (Briggs 1977) or Bool Lagoon (Harper 1990). However, Gosper *et al.* (1983) found evidence of seasonal variations in the numbers of Black Swan, Pacific Black Duck, Purple Swamphen, and Eurasian Coot on the north coast of New South Wales and Frith (1982) describes apparent seasonal movements of Black Swan in southern ew South Wales. It is possible that where seasonal changes in numbers are evident they reflect a regular pattern of rainfall. This warrants further investigation.

The positive correlation of numbers of Hardhead, Musk Duck, Eurasian Coot and Australasian Grebe and the depth of water is consistent with their habits of diving to feed.

This study throws no further light on the movements of Australasian Shoveler. The significant positive correlation with water level in the post-drought period of the study combined with the negative correlation overall — a function of the relative number of censuses in the two periods — emphasizes the lack of any detectable biological significance in these figures. Studies of the ecology of this species are urgently needed in the light of anecdotal evidence of a decline in its numbers.

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ERRATUM

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Brown, R. J., Brown, M. N. and Russell, E. M. (1990). The survival of four species of passerine in Karri forests in south-western Australia. *Corella* **14**(3): 69 78.

1. **In Appendix 1, page 78, line 6.**
   Years 1 7 should read Years 1–8.

2. **on pages 75 and 76.**
   The mean annual survival rate of the Red-winged Fairy Wren for years 1–8 after banding, derived from Table 6, should be 78% and not 67%.