

## SHORT COMMUNICATIONS

### SPECIES DIVERSITY OF WATERBIRDS ON LAKE ILLAWARRA, COOMADITCHY LAGOON AND THE CORDEAUX STORAGE DAMS, NEW SOUTH WALES

The amount of shallow water in a lake or pondage strongly influences its carrying capacity for waterbirds, and frequent fluctuations in water level, resulting from reservoir operations, lessen the value of man-made lakes as waterbird habitat (Bardach & Dussart 1973). Frith (1977) has indicated that deep storage dams generally provide limited waterfowl habitat.

This brief study was conducted as part of an undergraduate biology project at the University of Wollongong, and its aim was to assess the value of the man-made storage dams of the Cordeaux system as waterbird habitat. For comparison a large shallow estuarine lake (Lake Illawarra) and a small freshwater wetland (Coomaditchy Lagoon) were studied. According to Goodrick's (1970) classification of New South Wales coastal wetlands, these two areas can be classed as medium and good waterfowl habitat respectively.

#### STUDY AREAS

##### *Lake Illawarra and Coomaditchy Lagoon*

Lake Illawarra is situated on the Illawarra coastal plain south of Wollongong, and consists predominantly of shallow estuarine waters, whose levels are influenced by tidal movements. The greatest depth of Lake Illawarra seldom exceeds 4 m, and about 10% of the lake is less than 1 m in depth. The shallow waters and saline conditions allow plants such as the aquatic angiosperms *Zostera* sp and *Ruppia* sp to thrive. These seagrasses provide food for waterfowl in the shallows. Swans and ducks in particular are known to feed on the starch-rich tubers of these plants (Frith *et al.* 1969; Braithwaite 1970). Lake Illawarra is approximately 4,000 ha in area and the adjacent freshwater Coomaditchy Lagoon is about 2 ha in area.

Coomaditchy Lagoon is a shallow area of water, with a maximum depth of approximately 3 m. The area surrounding the lagoon has largely been cleared of vegetation. However, several grass species, *Juncus* sp and the Common Reed *Phragmites australis* are still found around the lagoon.

##### *Cordeaux Dams*

The Cordeaux reservoir system is situated NNW of Lake Illawarra at 302 m above sea level, and consists of three dams. The Main Dam (Dam 3) covers about 800 ha, while each of the other dams is about 25 ha in area. The two smaller dams constitute the dams of the Upper Cordeaux and are referred to as Dam 1 and Dam 2 respectively.

The tall spike rush *Eleocharis sphacelata* lines most of the edge of the dams and their major creeks. The rushes seldom extend further than 2 to 3 m from the water's edge due to the steep gradient of the dam floor. The maximum depth of the Main Dam is 47 m, and only about 5% of the

total area would be less than 4 m in depth. Dams 1 and 2 have a maximum depth of approximately 35m, and also have a small proportion of their total area less than 4m in depth.

#### METHODS AND MATERIALS

The study was conducted between 1 March and 17 June 1979. After preliminary observations the sampling sites were selected as being those sites that consistently permitted observation of both the greatest number of birds and the greatest number of species. One site was chosen at each of the Cordeaux Dams, and one each at Coomaditchy Lagoon and Lake Illawarra.

At each site birds were counted and identified. Censuses were performed in sixty degree sectors defined from fixed compass readings. Each site on the three dams was an area of water, usually near the mouth of a large creek, with boundaries identified by landmarks on the horizon. Similarly, on Lake Illawarra and Coomaditchy Lagoon sampling sites were areas of open water. All sites were sampled on six occasions over four months (March to June), at approximately two week intervals.

The Shannon-Wiener Index ( $H'$ ) was used to compare diversity at each site.  $H'$  was calculated thus:

$$H' = \sum_{i=1}^s (P_i) (\log_2 P_i)$$

where  $s$  is the number of species in the community and  $P_i$  is the proportional abundance of the  $i_{th}$  species. The greater the diversity, the larger the  $H'$  value, such that the probability of picking the next individual in the sample decreases. This index of diversity takes into account the number of species, and the equitability, or evenness of allotment of individuals among the species (Krebs 1978).

#### RESULTS

A total of twenty-seven species of waterbirds was recorded during the study. Of these, twenty-four were seen on Lake Illawarra and nineteen species were recorded on Coomaditchy Lagoon. The maximum numbers of species for the three storage dams were found to be nine, ten and fourteen respectively (Table I). The families represented and the number of species in each are shown for each study site in Figure 1.

A Chi-square test of homogeneity showed no significant difference between  $H'$  values of samples from the three Cordeaux Dams, and so a mean was calculated for the whole eighteen counts made on the dams.

This mean  $H'$  value, and those calculated for Coomaditchy Lagoon and Lake Illawarra are given in Table I. A significant difference was found between

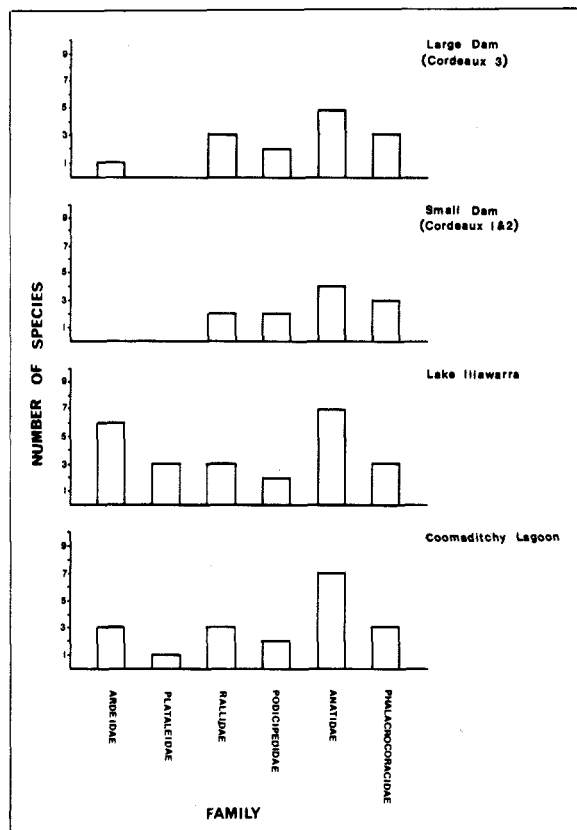


Figure 1 The number of waterbird species per family recorded on Lake Illawarra, Coomaditchy Lagoon and each of the Cordeaux Dams.

the mean  $H'$  value for Coomaditchy Lagoon and Lake Illawarra ( $p < 0.05$ , t-test). Both of these coastal wetland areas had  $H'$  values significantly different from that of the three storage dams ( $p < 0.01$ , t-test).

The White-faced Heron *Ardea novaehollandiae* was the only wading bird seen on the dams, while nine species of waders from the families Ardeidae and Plataleidae were recorded on Lake Illawarra (Fig. 1). However, diving birds such as cormorants, grebes and the Musk Duck *Biziura lobata* were frequently observed on both Lake Illawarra and the Cordeaux Dams. The Pacific Black Duck *Anas superciliosa* was one of the few dabbling species that was often seen on the dams, but it was confined to the shallower creeks, rather than the deep open water.

During this study certain itinerant visitors to Lake Illawarra, Coomaditchy Lagoon and the Cordeaux Dams were observed. Two Mountain Ducks *Tadorna tadornoides* remained on Lake Illawarra for several days, as did two Pink-eared Ducks *Mala-*

*corhynchus membranaceus* on Coomaditchy Lagoon. This small area of freshwater also supported twelve Hardheads *Aythya australis* for several weeks. Chestnut Teal *Anas castanea* were seen only once on Dam 3 of the Cordeaux system, while large numbers were frequently observed on both Lake Illawarra and Coomaditchy Lagoon.

## DISCUSSION

The paucity of wading birds on the dams was probably because there were few shallow areas of water less than 1 m in depth. Fewer wading birds were recorded on Coomaditchy Lagoon than Lake Illawarra, which again probably reflects the absence of adequate shallow water required by these species.

The study areas had equal numbers of species of grebes and cormorants. This indicates that all areas provided adequate habitat for these birds. Apparently the depth of the dams has little effect on the bottom-feeding diving birds such as the Musk Duck. These birds were regularly observed diving in the dams.

The rushes on the dams, and the reeds on Lake Illawarra and Coomaditchy Lagoon provided the necessary protection for edge-feeding species, such as the Purple Swamphen *Porphyrio porphyrio*, the Dusky Moorhen *Gallinula tenebrosa* and the Eurasian Coot *Fulica atra*. However, there was generally a notable absence of edge-feeding waterfowl on the dams, compared to the large number of birds found on the edges of Lake Illawarra and Coomaditchy Lagoon. These included such species as the Grey Teal *Anas gibberifrons* and the Chestnut Teal *A. castanea*. The dams, unlike Lake Illawarra, do not provide areas of shallow water for large numbers of edge-feeders.

Although conclusions about species diversity are difficult to make when comparing habitats of quite different area and location, it can be noted that species diversity on the man-made lakes was considerably lower than that on both larger and smaller areas of coastal wetlands.

Lake Illawarra and Coomaditchy Lagoon are better habitats for waterbirds than the dams of the Cordeaux system, and are better refuges for nomadic species like *A. gibberifrons*. However, these dams were used by a number of waterbird species, and it can be concluded that the Cordeaux water storage areas have a value as waterbird habitats, although they cannot be considered as a good alternative to natural wetland areas such as Coomaditchy Lagoon.

TABLE I

The species recorded at the five study sites. Values of the Shannon-Wiener Index of Diversity ( $H'$ ) for the three study areas are shown. All  $H'$  values are expressed as means  $\pm$  standard error of the mean.

Species	Number Recorded in Six Visits				
	Cordeaux 1	Cordeaux 2	Main Dam	Lake Illawarra	Coomaditchy Lagoon
White-faced Heron <i>Ardea novaehollandiae</i>	0	0	3	2	3
White-necked Heron <i>A. pacifica</i>	0	0	0	1	0
Mangrove Heron <i>Butorides striatus</i>	0	0	0	1	0
Little Egret <i>E. garzetta</i>	0	0	0	2	1
White Egret <i>E. alba</i>	0	0	0	3	2
Cattle Egret <i>Ardeola ibis</i>	0	0	0	12	0
White Ibis <i>Threskiornis molucca</i>	0	0	0	4	0
Royal Spoonbill <i>Platalea regia</i>	0	0	0	2	1
Yellow-billed Spoonbill <i>P. flavipes</i>	0	0	0	1	0
Purple Swampphen <i>Porphyrio porphyrio</i>	0	0	4	4	2
Dusky Moorhen <i>Gallinula tenebrosa</i>	4	2	10	6	20
Eurasian Coot <i>Fulica atra</i>	27	8	52	16	75
Australasian Little Grebe <i>Podiceps novaehollandiae</i>	3	12	22	40	19
Hoary-headed Grebe <i>P. poliocephalus</i>	10	6	46	10	5
Pacific Black Duck <i>Anas superciliosa</i>	2	10	4	22	8
Hardhead <i>Aythya australis</i>	0	0	0	0	12
Musk Duck <i>Biziura lobata</i>	2	0	6	6	0
Maned Duck <i>Chenonetta jubata</i>	0	10	10	8	0
Grey Teal <i>Anas gibberifrons</i>	0	0	0	97	34
Chestnut Teal <i>A. castanea</i>	0	0	3	74	5
Pink-eared Duck <i>Malacorhynchus membranaceus</i>	0	0	0	0	2
Mountain Duck <i>Tadorna tadornoides</i>	0	0	0	2	0
Mallard <i>Anas platyrhynchos</i>	0	0	0	0	2
Black Swan <i>Cygnus atratus</i>	2	2	2	42	12
Little Black Cormorant <i>Phalacrocorax sulcirostris</i>	5	6	15	8	2
Little Pied Cormorant <i>P. melanoleucos</i>	3	6	15	5	3
Black Cormorant <i>P. carbo</i>	0	4	6	12	2
Total Number of Species	9	10	14	24	19
$H' \pm S.E.$		0.56 $\pm$ 0.10		1.63 $\pm$ 0.11	2.04 $\pm$ 0.13

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