RIPARIAN HABITATS ON THE CHOWILLA FLOODPLAIN OF THE RIVER MURRAY, SOUTH AUSTRALIA

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INTRODUCTION

For most of its length, the River Murray is a floodplain river with only 350 out of 2560 km, a mere 14%, being headwaters (Walker 1986). The floodplain of the River Murray is large; approximately 10000 km^2. It spans a wide climatic range and has a varied geomorphology and thus is not uniform in character. To date, scientific research has focused on the upper and middle floodplains, notably on billabongs (Hillman 1986) and red gum forests (Bren & Gibbs 1986, Chesterfield 1986). Although wetlands on the Murray floodplain have been mapped and classified using categories based on geomorphology and hydrology (Pressey 1986), their aquatic plant communities remain poorly documented. Descriptions and maps of floodplain vegetation have focused almost exclusively on woody dominants (Chesterfield 1986, NEC 1987, MPPL 1989) and specifically excluded hydrophytes (Moore 1953). Wetland inventories have given only cursory descriptions of vegetation (Thompson 1986).

The aim of this study was to gain further knowledge about aquatic habitats on the Chowilla floodplain on the lower Murray by describing the riparian vegetation in terms of plant species and vegetation structure, and relating these to environmental factors. Chowilla is part of a larger floodplain between Wentworth in New South Wales and Renmark in South Australia (Fig. 1). This larger floodplain is 5-10 km broad and comprises 1515 km^2 along 358 km of river. Wetlands are numerous and occupy nearly 10% of the floodplain area. The most common geomorphic types are lentic channel forms, such as anabranches and shallow depressions, of which 70% are connected to the river at pool level (Pressey 1986). The prevalence of this hydrological category reflects the dominating effect of regulation. Lock 6, constructed during 1927-30 at Murtho, upstream of Renmark (Fig. 1), creates a pool 77 km long up the main river channel. This pool provides a hydraulic head at weirs at the head of two anabranches, Pipeclay and Slaney Creeks, therefore both have rapid flow and are fast anabranches. At low flow, approximately half of the River Murray flow is into the Chowilla Creek anabranch via Pipeclay Creek (NEC 1987).

In South Australia, conservation of River Murray wetlands has been "inadequate" (Lothian & Williams 1988). None of the Chowilla wetlands is conserved, yet six out of thirteen wetlands inspected upstream of the Chowilla Creek-River Murray junction were given a high conservation ranking for their value as a feeding and breeding habitat for waterbirds (Thompson 1986). It has been proposed that the entire floodplain from Renmark to Wentworth be conserved as a tri-state National Park. Inventories and assessment such as Pressey (1986) and Thompson (1986) have laid a solid base for selecting individual wetlands for conservation, but ultimately resource management can only be effective if backed by research (DEP 1983). Habitat requirements are known for only a few wetland groups, notably waterfowl (Braithwaite 1976) and mussels (Walker 1981), whilst the distribution of non-game freshwater fish has only recently been documented for the River Murray in South Australia (Lloyd & Walker 1986).

The use of anabranches in the north-eastern Chowilla floodplain as salt retention ponds has been identified as a component of one of three cost-effective schemes available to the Government of South Australia for reducing river salinity by intercepting saline groundwater accessions (EWS 1987). The preferred option (NEC 1987) will hydrologically isolate those anabranches used as retention ponds. The possibility of such a scheme, which also threatens the viability of a proposed tri-state park in the area, gives some urgency to the study of floodplain habitats in South Australia.

METHODS

Sampling sites were pre-selected to cover a range of Chowilla floodplain wetlands (Fig. 1): two each of fast anabranch and main river channel (both upstream of Lock 6), three slow anabranches, four backwaters, and one billabong. Another billabong site was pre-selected but was excluded from analyses because it was likely that a road embankment had altered the water regime and affected the vegetation. At each site, the sampling area was a 100 m straight section of shoreline typical of that location. Because water levels change seasonally, the shoreline is not fixed in space, thus the sampling area was a narrow strip from approximately 0.5 m below water to the top of the river bank and included plants growing on the bank but not on the level floodplain above. This sampling area was sub-sectioned into visually homogeneous habitats by consensus with colleagues investigating fish and macro-invertebrates, based on vegetation structure, species and ground cover; a total of 31 habitats were delineated.

For each habitat, the abundance of plant species, ground cover and snags was estimated using an abundance rating ranging from 0 = absent to 5 = very abundant or continuous dense cover. Ground cover was divided into five size classes; bark, leaf litter, twigs, branches and boles, and debris was the sum of all ground cover classes. There were two types of snags; tree roots from the bank into the water, and fallen branches or trees emerging from the water.

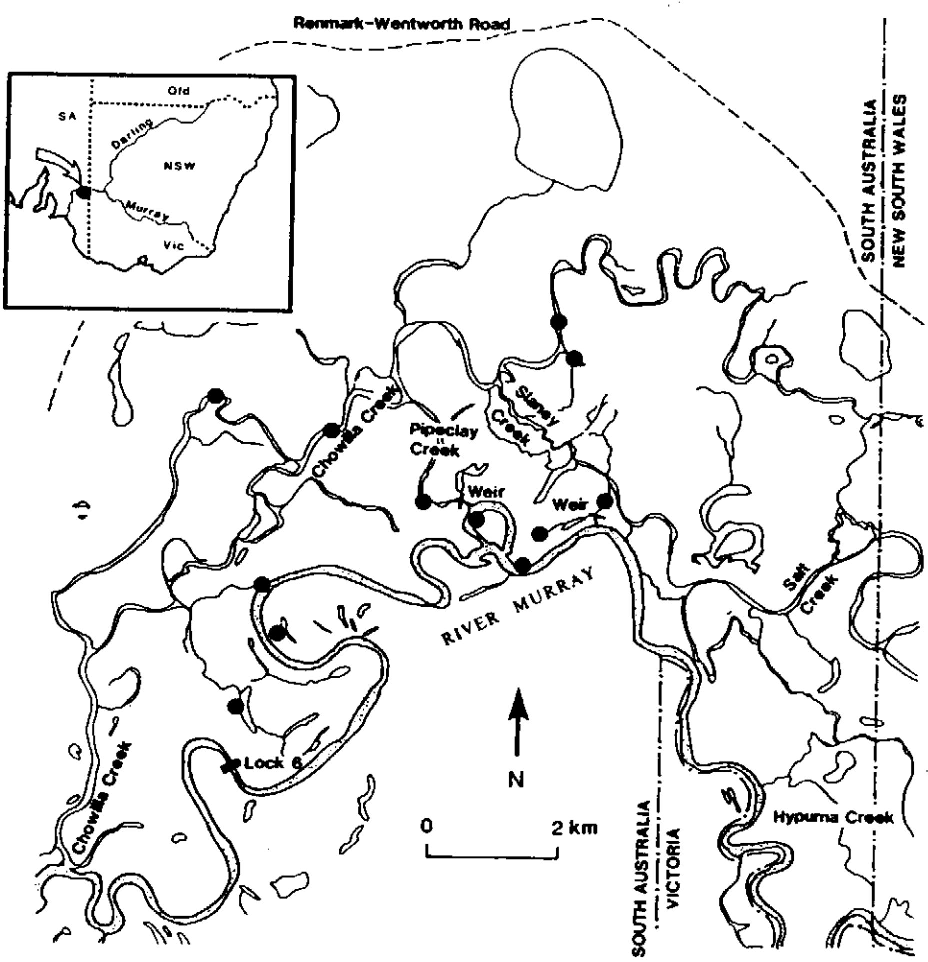

Figure 1. Riparian sites sampled on the Chowilla floodplain of the River Murray, South Australia.

Slope was estimated by drawing a cross-section of the bank in the field and measuring the angle between bank top and water level. Wave action was estimated using a five point scale and was based on fetch at right angles to sampling area allowing for the protective effects of adjacent riparian trees and channel incision. Exposure was computed as wave action modified by roots and snags:

$$\text{exposure} = \text{wave action} * [1-(\text{roots}+\text{snags}/10)].$$

Estimates of current were made within 1 m of the bank, on a five point scale (provided by A.J. Boulton, *pers. comm.* 1989). All fieldwork was done in October 1988.

Vegetation types were identified by numerical classification using a hierarchical cluster analysis based on species abundances and chord distances between habitats or sampling units (Ludwig & Reynolds 1988). The significance of mean differences in environmental factors between vegetation types was examined using analysis of variance followed by Tukey's honestly significant difference procedure when differences were indicated. The SYSTAT package for microcomputers was used (Wilkinson 1987).

RESULTS

A total of 29 plant species was collected (Appendix I) of which four were too young to identify to species level. Three species, *Cotula coronopifolia, Callitriche stagnalis* and *Ludwigia peploides*, are considered naturalised (Jessup & Toelken 1986), having been introduced into South Australia in the last century (Kloot 1986).

Cluster analysis resulted in the recognition of four vegetation types (Fig. 2). River red gum, *Eucalyptus camaldulensis*, was typical of habitats placed in vegetation types 1 and 2 but completely absent from vegetation types 3 and 4 (Table 1). Vegetation type 1 was characterised by reeds, *Phragmites australis*, with grasses and other emergent monocots being infrequent or absent. Reeds were absent to rare in vegetation type 2 which had a mixture of grasses and emergent monocots; typically either a sedge, *Eleocharis actua*, or a grass, *Cynodon dactylon*, was abundant. Spiny

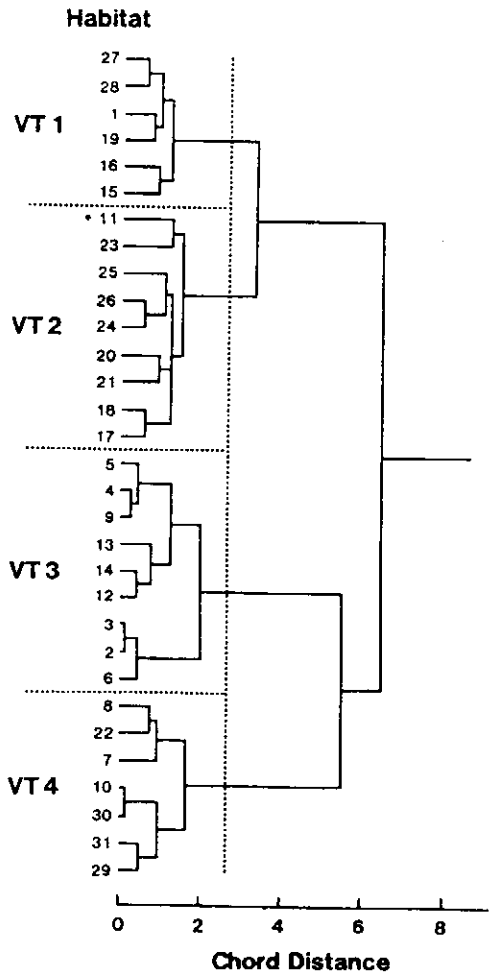

Figure 2. Cluster analysis of 31 Chowilla floodplain riparian habitats. Cluster analysis misclassified habitat 11 (starred) into vegetation type 2; based on species abundance and environmental data it belongs in vegetation type 3 where it was placed for all data analyses.

sedge, *Cyperus gymnocaulos*, and/or tussock rush, *Juncus aridicola*, were also common. Neither common spikerush, *E. acuta*, nor tussock rush occurred in other vegetation types. Vegetation type 3 was characterised by spiny sedge with infrequent grass, *Cynodon dactylon* or *Paspalidium jubiflorum* or traces of both. Vegetation type 4 was characterised by having both grasses present with spiny sedge in trace amounts or absent. The four vegetation types (VT1 to VT4) are named for their dominant or distinctive plant species as follows: river red gum and reed (VT1), river red gum and sedge-rush (VT2), spiny sedge and grass (VT3), and riparian grasses (VT4).

Vegetation types with trees had greater structural diversity; eight lifeforms were represented in river red gum + sedge-rush community (VT2), and six in river red gum + reed (VT1), whereas the open communities had only five each. Only VT2 had emergent dicots; submerged herbs were not represented in VT1 and VT4, and floating-leafed plants were not represented in VT3 (Table 1). Lifeforms such as shrubs, emergent monocots and free-floating plants occurred in all vegetation types but not always in equal richness or abundance. Thus in VT3 and VT4, the open communities, free-floating plants were found only occasionally, always in low abundance and usually represented by *Azolla filiculoides*, whereas in VT1 and VT2 the free-floating form was recorded frequently, and *Azolla filiculoides* was always present, often common to abundant with up to three other species present.

Species richness was higher in vegetation types with trees. Mean species richness for river red gum + reed and river red gum + sedge-rush community was 6.5 and 10.4 respectively, compared with 2.7 and 3.3 for the two open communities, spiny sedge with grass, and riparian grasses.

In terms of environmental characteristics, river red gum + sedge-rush (VT2) was distinct from the other three vegetation types (Table 2). It comprised riparian habitats where the current was slow and where the bank was not subject to strong wave action (i.e., protected from high exposure) and was gently sloping. In contrast, habitats characterised by riparian grasses (VT4) had the fastest currents and the steepest banks. These habitats were not subject to strong wave action. River red gum + reed habitats also had relatively fast currents and steep banks, but were exposed to strong wave action. Spiny sedge + grass habitats were intermediate relative to current swiftness, bank steepness and exposure, but were very open as indicated by having low amounts of debris from trees. The distribution of vegetation types in different kinds of wetlands is shown in Table 3.

LIFE FORM	SPECIES	VEGETATION TYPES (1) Red gum + reed	(2) Red gum + sedge-rush	(3) Spiny sedge + grass	(4) Riparian grasses
Trees	*Eucalyptus camaldulensis*	1.83 ±0.70	3.38 ±0.18	0	0
	Eucalyptus largiflorens	0.33 ±0.33	0.50 ±0.50	0	0
	Exocarpos strictus	0.83 ±0.54	0	0	0
Shrubs	*Muehlenbeckia cunninghamii*	0.33 ±0.33	0.62 ±0.38	0.30 ±0.30	0.43 ±0.20
Grasses	*Cynodon dactylon*	0.50 ±0.34	3.00 ±0.60	0.80 ±0.39	1.57 ±0.43
	Paspalidium jubiflorum	0.83 ±0.40	0.50 ±0.27	0.70 ±0.26	2.29 ±0.36
Emergent monocots	*Bolboschoenus spp.*	0.83 ±0.40	0.25 ±0.25	0	0.29 ±0.29
	Cyperus gymnocaulos	0.33 ±0.33	2.00 ±0.32	2.70 ±0.45	0.14 ±0.14
	Eleocharis acuta	0	1.88 ±0.64	0	0
	Juncus aridicola	0	1.62 ±0.38	0	0
	Phragmites australis	4.83 ±0.17	0.50 ±0.32	0	0
	Typha domingensis	0.67 ±0.67	1.50 ±0.80	0	0
Floating-leaved plants	*Ludwigia peploides*	0	0.38 ±0.26	0	0.29 ±0.29
	Rumex bidens	1.00 ±0.45	0.50±0.33	0	0
Submerged plants	*Myriophyllum papillosum*	0	1.62 ±0.71	0	0
Free-floating plants	*Azolla filiculoides*	2.17 ±0.54	2.75 ±0.53	0.30 ±0.15	0.43 ±0.30
	Azolla pinnata	0.83 ±0.31	1.62 ±0.53	0	0.43 ±0.30
	Ricciocarpus natans	0.33 ±0.33	0.50 ±0.33	0	0
	Spirodela punctata	0.67 ±0.42	0.88 ±0.35	0	0

Table 1. Mean abundances (± standard error) for 19 plant species (by life form) within the four riparian vegetation types. Only species found in at least two habitats, and common in at least one, are shown.

ENVIRONMENTAL FACTOR	VEGETATION TYPES (1) Red gum + reed	(2) Red gum + sedge-rush	(3) Spiny sedge + grass	(4) Riparian grasses
Slope of the bank (deg.)	25.2^{b}	4.9^{a}	21.5^{ab}	33.7^{b}
Swiftness rating for the current (0-5)	2.2^{b}	0.3^{a}	1.6^{b}	2.6^{b}
Exposure to wave action (0-5)	2.2^{c}	0.4^{a}	1.4^{bc}	1.1^{ab}
Surface debris on the bank (0-25)	3.2^{a}	9.9^{b}	2.7^{a}	3.9^{ab}

Table 2. Mean values for four environmental factors of the four vegetation types. For each factor, vegetation types with different superscript letters (a<b<c) are significantly different ($P<0.05$) based on Tukey's honestly significant difference procedure.

DISCUSSION

While some wetlands were a mosaic of differents vegetation types, for example backwaters and slow anabranches, in general there was a strong association between vegetation type and wetland type. This has important implications for the distribution of aquatic animals. River red gum + sedge-rush was exclusively found in backwaters and billabongs, not main river channels or anabranches. Billabongs rather than river channels are habitat for the freshwater mussel, *Velusunio ambigua* (Walker 1981) and within billabongs plants have distinctive zooplankton communities (Shiel 1976). The riparian grasses vegetation type was exclusively found along anabranch channels at sites with protection from strong wave action due to narrow fetch and, at some sites, exposed and submerged roots and snags.

WETLAND	VEGETATION TYPES (1) Red gum + reed	(2) Red gum + sedge-rush	(3) Spiny sedge + grass	(4) Riparian grasses
Main river channel	4	0	0	0
Fast anabranch	0	0	0	4
Slow anabranch	1	0	7	3
Backwater	1	5	3	0
Billabong	0	3	0	0
	6	8	10	7

Table 3. Frequency table showing the four vegetation types from 31 habitats in five wetlands typical of the Chowilla floodplain on the River Murray.

Submerged wood, plants, and mud are distinct habitats for benthic macro-invertebrates (Maher 1984). River red gum + reed was mostly found along the main River Murray channel. Small freshwater fish are most diverse in the main River Murray channel, less so in backwaters, and least in billabongs (Lloyd & Walker 1986).

Obviously the study would have benefited if the number of sites had been larger and a greater area covered because delineation and description of vegetation types would have been more precise. However descriptions provided by Thompson (1986) and observations made during field work suggest the vegetation types described here are reasonably typical of most shorelines in the Chowilla region. Three of them correspond closely with communities described for the Chowilla floodplain (MPPL 1989) but VT2 which is strongly associated with backwaters and billabongs (Table 3) has no direct equivalent as wetland vegetation was not specifically included.

A broader survey could expect to find additional vegetation types downstream of Lock 6, along parts of Salt Creek, Hypurna Creek, and on islands within Chowilla Creek because in these areas the dominant environmental factor appears to be extreme water level fluctuations (Thoms & Walker, *pers. comm.* 1989), brackish-saline water, shallow fast flow over sand or absence of grazing, respectively (*pers. obs.*). These areas comprise only a small part of the total riparian habitat on the Chowilla floodplain.

Fieldwork for this study was done early in the growing season, and only shortly after recession of winter floods, consequently the spectrum of lifeforms is incomplete and biased towards more robust perennials. Mudflat annuals such as *Centipeda cunninghamii* and *Epaltes australis*, common at the end of summer (*pers. obs.*), were completely absent in October. Lifeforms such as submerged plants and emergent dicots are probably under-represented.

The Chowilla floodplain contains examples of most westerly distribution of several aquatic or semi-aquatic species (NEC 1987). This can be explained by its position in the lower part of a large riverine system. This downstream position means it is a recipient of water-dispersed propagules, thus is unlikely to have endemic or rare species. Records of *Zannichellia palustris* and *Glossostigma* sp. A from the Chowilla floodplain (NEC 1987) are unusual, but probably because of collector bias against submerged and inconspicuous aquatic plants.

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APPENDIX I

Plant species collected from Chowilla floodplain, River Murray, South Australia, in October 1988. Nomenclature follows Aston (1973) for liverworts and ferns, and Jessup and Toelken (1986) for Angiosperms. Species naturalised in South Australia denoted by *.

BRYOPHYTA	
RICCIACEAE	
Ricciocarpus natans L.	
PTERIDOPHYTA	
AZOLLACEAE	
Azolla filiculoides Lam.	Pacific azolla
Azolla pinnata R.Br.	ferny azolla
MAGNOLIOPHYTA	
ASTERACEAE	
**Cotula coronopifolia* L.	water buttons
CALLITRICHACEAE	
**Callitriche stagnalis* Scop.	common starwort
CYPERACEAE	
Bolboschoenus sp.	
Cyperus gymnocaulos Steudel	spiny sedge
Cyperus sp.	
Eleocharis acuta R.Br.	common spikerush
Schoenoplectus validus (Vahl) A.Love & D.Love	river club rush
FABACEAE	
Acacia stenophylla Cunn. ex Benth.	river coobah
HALORAGACEAE	
Myriophyllum papillosum Orch.	milfoil
Myriophyllum verrucosum Lindley	red milfoil
HYDROCHARITACEAE	
Vallisneria spiralis L.	ribbon weed
JUNCACEAE	
Juncus aridicola L.A.S.Johnson	tussock rush
LEMNACEAE	
Spirodela punctata (G.Meyer)C.Thompson	duckweed
MYRTACEAE	
Eucalyptus camaldulensis Dehnh.	river red gum
Eucalyptus largiflorens F.Muell.	black box
ONAGRACEAE	
**Ludwigia peploides* (Kunth) Raven	water primrose
POACEAE	
Cynodon dactylon (L.)Pers.	swamp grass
Paspalidium jubiflorum (Trin.)Hughes	Warrego grass
Phragmites australis (Cav.)Trin. ex Steudel	common reed
POLYGONACEAE	
Muehlenbeckia cunninghamii (Meisn.)F. Muell.	lignum
Polygonum sp.	
Rumex bidens R.Br.	swamp dock
POTAMOGETONACEAE	
Potamogeton crispus L.	curly pondweed
RANUNCULACEAE	
Ranunculus sp.	
SANTALACEAE	
Exocarpos strictus R.Br.	dwarf cherry
TYPHACEAE	
Typha domingensis Pers.	cumbungi