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A survey of aquatic macroinvertebrates in lentic waterbodies of Magela and Nourlangie Creek catchments, Alligator Rivers Region, NT: Second year of data 1996

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Summary

Aquatic macroinvertebrates were sampled from the littoral zone of eleven lentic waterbodies of Magela and Nourlangie Creek catchments over a 3 week period in May 1996. Four of the waterbodies occurred on the project area of the Ranger Uranium Mine (RUM), three of which were contaminated to varying degrees by mine-waste waters. Differences in taxa richness were not marked between waterbodies on the mine lease and control waterbodies, with Gulungul Billabong having the highest average richness (25.4 taxa) and Jabiru Lake the lowest (18). However, some differences in the macroinvertebrate community of sites on the RUM lease from others was evident using multivariate ordination techniques. Environmental correlates of the ordination space included various features of aquatic macrophytes. In particular the amount of macrophyte cover at sites was a gradient that appeared particularly important in separating artificial waterbodies from natural billabongs. The absence or low abundance of palaemonid prawns and bithyniid snails from the waterbodies receiving mine waste waters was correlated with the environmental gradient separating these sites from control waterbodies within the Magela system which suggests their numbers were affected by mining activities. Impacts of mining on lentic waterbodies was generally less apparent in 1996 than it was in 1995.

1 Introduction

In 1995 the ***eriss*** surveyed seven lentic waterbodies within the Magela and Nourlangie Creek catchments for aquatic macroinvertebrates (O'Connor et al 1995). The survey was part of a broader research program conducted by CSIRO to assess the 'health' of biotic communities in waterbodies within the Ranger Uranium Mine (RUM) project area (Corbett 1996). The results from the 1995 study indicated that macroinvertebrate community structure changed along an environmental gradient correlated with electrical conductivity (O'Connor et al 1995). Release of mine waste waters from RUM retention ponds 1 and 4 result in an increase in solute concentrations in Coonjimba and Djalkmara billabongs respectively (ARRRI 1989). This and the greater incidence of invertebrate families likely to have a high tolerance to poor water quality in those waterbodies receiving mine waste waters, indicated that invertebrates were responding to mine-related disturbance.

It was recognised that the results from the 1995 survey needed to be viewed with some caution (O'Connor et al 1995) given that most of the control waterbodies were in a different catchment (Nourlangie) to those receiving mine waste waters (Magela). Differences between control waterbodies and those within the RUM lease may have been confounded by natural variability between catchments. It was decided, therefore, to repeat the study in 1996 with additional control waterbodies from within the Magela catchment. Repetition of the study in 1996 was also deemed worthwhile to investigate the interannual variability in macroinvertebrate community structure of these waterbodies, an aspect of temporal variability not covered in previous studies (Marchant 1982, Outridge 1988).

2 Waterbodies studied

The seven waterbodies sampled in 1995 were sampled again in 1996 as well as three additional waterbodies from the Magela catchment that don't receive mine waste waters and another control waterbody from Nourlangie (table 1). The nine natural waterbodies sampled were shallow lowland 'billabongs' (*sensu* Humphrey & Simpson 1985). Coonjimba, Djalkmara, Corndorl, Georgetown, Gulungul, Anbangbang, Buba and Sandy billabongs are of the 'backflow' type occurring at the confluence of small tributaries and the main stream (Magela or Nourlangie creeks - fig 1). Baralil Billabong is a waterbody lying in the main watercourse of Baralil Creek, and is only rarely backfilled by water from Gulungul Creek (fig 1). Humphrey and Simpson (1985) and Humphrey et al (1990) provide full morphological and hydrological descriptions of these waterbodies. At the time of sampling, immediately after Wet season flooding, waterbodies were at near-maximum depth with macrophytes fringing the margins up to depths of ~2 m. Some minor flow of water from the backflow-type waterbodies was evident.

Table 1 List of the waterbodies sampled in 1996 indicating whether they were also sampled in 1995, their location, whether they are natural or artificial and whether they receive mine waste water

	Sampled in 1995?	Catchment	Artificial or natural	Directly receives mine water
Coonjimba (CJ)	yes	Magela	natural	yes
Djalkmara (DJ)	yes	Magela	natural	yes
Retention Pond #1 (RP1)	yes	Magela	artificial	yes
Baralil (BA)	no	Magela	natural	no
Corndorl (CD)	no	Magela	natural	no
Georgetown (GT)	yes	Magela	natural	no
Gulungul (GU)	no	Magela	natural	no
Jabiru Lake (JL)	yes	Magela	artificial	no
Anbangbang (AN)	no	Nourlangie	natural	no
Buba (BU)	yes	Nourlangie	natural	no
Sandy (SY)	yes	Nourlangie	natural	no

Contamination of billabongs as a result of mining at RUM is predominantly in the form of elevated levels of magnesium sulfate (ARRRI 1989). Contamination occurs mainly as a result of Wet season overflow of water from retention ponds, although overland flow from the mine site and groundwater seepage are also contributing factors (ERA 1996a). Coonjimba Billabong receives overflows from Retention Pond #1 while Djalkmara Billabong receives overflow from Retention Pond #4. While mine waste rock occurs in the catchment of Georgetown Billabong, there are only isolated reports of runoff from the mine site leading to significant deterioration in water quality in the billabong (OSS 1993). In the month after sampling took place, the upstream water supply to Djalkmara Billabong was cut off by construction of a bund built to facilitate the development of a new orebody at Ranger. Gulungul and Corndorl billabongs, downstream of RUM on Magela Creek (fig 1) may receive mine waste water indirectly in the Wet season by way of backflow from Magela Creek. However, dilution of waste water in Magela Ck 2–3 km upstream of the confluence with Gulungul Creek (ERA 1996a) would suggest contamination of Gulungul and Corndorl billabongs via backflow would be minimal.

Jabiru Lake and Baralil Creek receive storm runoff from Jabiru township. Baralil Billabong is also located 3–4 km downstream of the domestic effluent discharge from Jabiru township (fig 1). Effluent is treated to a tertiary level before release into the creek. Baralil Creek then feeds into Gulungul Creek upstream of Gulungul Billabong (fig 1).

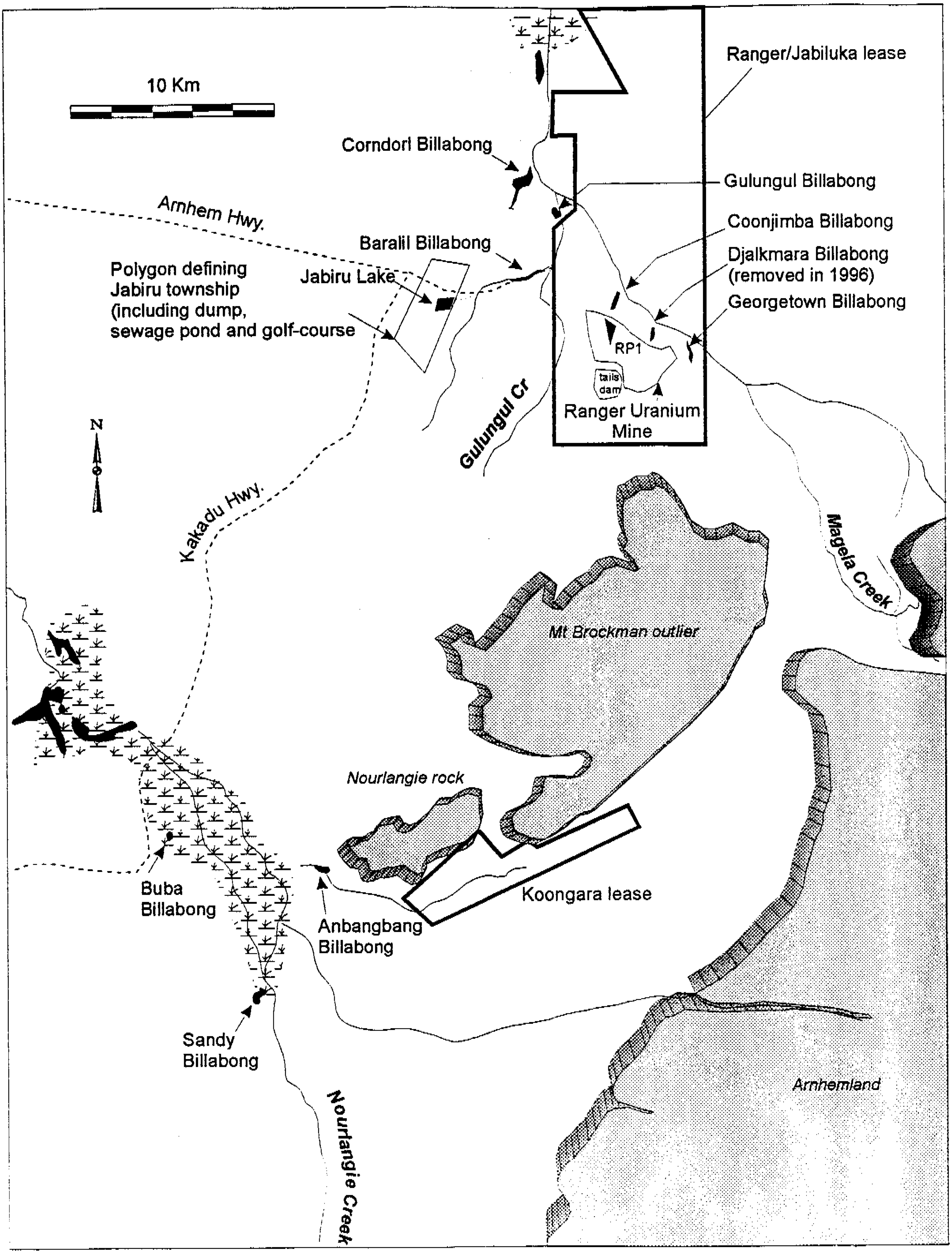

Figure 1 Study area showing the eleven waterbodies and extent of the Ranger Uranium Mine project area

3 Methods

Sampling and sorting of macroinvertebrates were conducted using standard rapid bioassessment techniques, as employed in the current national biological monitoring programs for river water quality in Australia (Davies 1994). Similar approaches are employed and in the UK and USA in their national river assessment programs. These methods aim to maximize the number of different taxa collected and were also used in the 1995 survey.

3.1 Field procedures

3.1.1 Macroinvertebrate sampling procedure

Five replicate samples were taken from the littoral zone (edge) of each waterbody. For the purpose of this study and for the sake of comparability with the 1995 survey, the littoral zone was defined as the area at the edge of the billabong of up to 0.7 m water depth. Samples were taken at regular intervals around the circumference of the waterbody, taking into account limitations of access (it was impossible to manoeuvre a boat through some thick stands of macrophyte) and habitat availability (steeply sloping edges were not sampled). Samples were collected using a standard 250 µm mesh pond net as described in Davies (1994) for specifications). Sampling of invertebrates in sediment and macrophytes was conducted along a 4 m wide transect perpendicular to the shoreline, from water depths of 0.1 m to 0.7 m. At each of the sites, two 1 m sweeps of the net were made through the top 2 cm of sediment. One of the sediment sweeps was made near the water's edge (depth of 0.1 m), the other in deeper water (0.3–0.4 m). Where the sediment was compacted, it was disturbed and broken up by hand before sampling. A further ten broad sweeps of the net were made through submerged (or submerged portions of) macrophytes over the depth range of the transect. The aim of this procedure was to include invertebrates from the broadest range of habitat types possible in each sample.

The fine fraction (<250 µm) of both the sediment and macrophyte samples was washed vigorously through the mesh of the pond net before the sample was emptied into a large plastic bag. Sediment and macrophyte samples were combined in the bag and water added to cover the sample so that invertebrates could be kept alive prior to sorting of specimens in the laboratory.

3.1.2 Measurement of environmental variables

Information on macrophyte generic composition and relative abundance was collected at each site using the same technique employed in the 1995 survey (O'Connor et al 1995). A visual assessment was made of the total percentage cover of macrophytes across the transect (surface and through the depth profile) as well as the percentage abundance of individual macrophyte species or 'types'. Total percentage cover was always less than 100% while percentage abundance of the different macrophyte species summed to total percentage cover. For further data analysis, structurally-similar plant forms were grouped and percentage abundance of these taxa summed as a sub-total of total percentage cover. This grouping was performed in order to determine whether gross morphological characteristics of the plants were the key features in possible plant-invertebrate relationships. Plant groupings were arranged according to the schema of Sainty and Jacobs (1994), ie 'floating attached' (FA), 'submerged not feathery' (SNF), 'submerged and emergent feathery' (SEF), 'free floating' (FF), 'emergent narrow leaf' (ENL) and 'emergent broad leaf' (EBL). Caldesia, was placed in the SNF category rather than the EBL category of Sainty and Jacobs (1994) because the

SNF class was deemed more relevant to the possible plant-invertebrate relationship of this species than the EBL class. All macrophyte data are shown in Appendix 1.

Water samples were taken prior to macroinvertebrate sampling at the same five locations. Results from the 1995 survey indicated that electrical conductivity was the only significant standard water quality variable measured that could be used to distinguish macroinvertebrate communities among billabongs so only it and pH were measured in the 1996 survey.

3.2 Laboratory procedures

3.2.1 Sample processing

Water samples were analysed on return to the laboratory. pH was measured using a Metrohm model 682 Titroprocessor while conductivity was measured using a Metrohm model E518 conductometer.

Macroinvertebrate samples were taken back to the laboratory and washed through nested 8 mm and 500 µm sieves. Material retained in the 8 mm sieve was coarsely sorted for invertebrates then discarded. Material retained in the 500 µm sieve was live-sorted for invertebrates within a period of 6 hours after field collection. Protocols for live-sorting were similar to those prescribed in the Australian Monitoring River Health Initiative River Bioassessment Manual (Davies 1994) except that live-sorting of each sample was carried out for 1 hour instead of 30 minutes. Live-sorting was carried out under constant light conditions in the laboratory using fluorescent desk or 'Magi' lamps. Invertebrates were preserved immediately after sorting using 70% ethanol.

3.2.2 Data analysis

Macroinvertebrate data were transformed to a presence-absence format unlike the 1995 survey which used quantitative data. Recent local and nation-wide information on rapid assessment techniques (***eriss*** unpublished data) suggests that the representativeness of community structure from live-sort samples compared to that in whole samples is highly variable. Conversion of data to presence-absence aimed to overcome possible bias in the retrieval of rank-order abundance (eg few individuals of a given cryptic taxon can be expected to be retrieved from samples with a high content of organic material).

Multivariate ordination was used to explore variation in this large and complex data set. Ordination summarizes data sets according to the similarity between the communities of different samples. The ordination method used in this study was semi-strong-hybrid (SSH) multidimensional scaling, available in the PATN statistical package (Belbin 1993), and one of the most robust ordination methods available for analysing ecological data (Minchin 1987, Belbin 1993). Patterns of association amongst waterbodies were summarized by plotting the ordination scores of each axis against one another. The reduction of data to two or three axes that summarize variation results in some distortion of the data. This distortion is measured in terms of 'stress' and the number of axes selected was determined on the basis of a plateau in the level of reduction in stress value as further dimensions were added.

The principal axis correlation (PCC) module in PATN was used to determine those environmental variables and invertebrate taxa that were correlated with the ordination space (see Faith et al 1995). Environmental variables used in addition to percentage cover of each macrophyte type were: total macrophyte cover, maximum depth at each site, number of days since the commencement of sampling, pH and electrical conductivity. The MCAO module in PATN (Monte Carlo Analysis) was then used to test the significance of the correlation coefficients. A series of 1000 simulations was run to determine the number of times the original PCC correlation for each variable was exceeded. If none of the simulated values exceeded the original PCC value, there was a 99.9% probability that the particular variable had explanatory value in the ordination.

4 Results

4.1 Environmental variables

Deterioration in water quality was evident in waterbodies directly receiving mine waste waters (Coonjimba, Djalkmara and Retention Pond #1). These waterbodies had electrical conductivities an order of magnitude higher than the others (table 2). Conductivity readings were also much more variable in Djalkmara than in the other waterbodies (table 2). High conductivity readings may also have been an indicator of some deterioration in water quality in Baralil Billabong and Jabiru Lake which had the next two highest recorded values (table 2). As discussed earlier (section 2), Jabiru Lake may potentially be contaminated by storm water runoff from Jabiru township while Baralil Billabong receives some domestic effluent in the Wet season, a source of contamination known to increase conductivity (Hynes 1960).

Table 2 pH and electrical conductivity of surface waters of the eleven waterbodies

		CJ	DJ	RP1	BA	CD	GT	GU	JL	AN	BU	SY
pH	- mean	6.18	6.92	6.81	6.81	6.16	6.21	6.38	7.30	6.33	6.44	5.98
std dev.		0.11	0.27	0.08	0.37	0.18	0.06	0.20	0.23	0.32	0.14	0.17
Electrical												
conductivity	- mean	104	646	159	67	27	33	28	87	29	50	15
std dev.		5.66	183.91	3.56	2.88	6.60	0.71	4.99	6.93	3.75	4.61	2.37

(see Table 1 for waterbody codes)

The lowest number of macrophyte taxa within a waterbody was recorded in RP1 and Georgetown Billabong (5) while the most diverse flora was recorded in Gulungul Billabong with 13 taxa (table 3). The aquatic grass, Pseudoraphis, was the only taxon found in all billabongs although the lilies Nymphaea and Nymphoides were also common (table 3). The three waterbodies receiving mine waste waters (Coonjimba, Djalkmara and RP1) had relatively low floral richness but some of the control waterbodies had a similar low diversity eg Georgetown and Anbangbang billabongs (table 3). There is no relationship evident in these data, therefore, between the water quality of waterbodies and floral taxa richness.

Table 3 Average cover of each macrophyte type over the five sampling sites at each of the eleven waterbodies (* <5%; ** 5–10%; *** >10%)

	CJ	DJ	RP1	BA	CD	GT	GU	JL	AN	BU	SY
Emergent broad leaf											
Dysophylla							**			*	
Persicaria	***						*				
Emergent narrow leaf											
Commelina				*			*			**	
Eleocharis	**	***		***		***	*	*	*	***	
Leersia											*
Oryza										*	
Paspalum distictium							**				
Pseudoraphis	***	*	*	**	***	***	***	**	***	***	***
Undentif. grasses				*				***			
Floating attached											
Ipomea					*						
Ludwigia					*					*	
Nymphaea	***	***	***	***	**	***	**		**	*	**
Nymphoides	**	**		***	***	*	***	***		***	**
Free floating											
Azolla					*				*	*	**
Salvinia molesta					***						
Submerged and emergent feathery											
Myriophyllum				***			*			***	
Najas		*	***	*			*				**
Utrichularia			***	***	**		*		***	***	***
Submerged not feathery											
Caldesia	*	*		**		*	***		*	**	**
Limnophila								*			
Vallisneria								**			
Xyris			**				*				
TOTAL RICHNESS	6	6	5	10	8	5	13	6	6	12	8
AVERAGE COVER (% of area sampled)	66	83	50	76	92	89	86	46	90	78	86

4.2 Macroinvertebrate communities

The total number of macroinvertebrates live-sorted from each sample varied from 94 to 362 with the average being 206. Data of higher taxonomic level than family were eliminated from the data set, with the exception of Acarina (mites) and Oligochaeta (aquatic worms) to give a total number of 68 taxa recorded across the eleven waterbodies (Appendix 2). This included six coleopteran (beetle) families in which both larval and adult life stages were recorded separately. The highest overall number of taxa from a waterbody occurred in the two Magela controls, Corndorl and Gulungul, while the lowest number of taxa was recorded in the Nourlangie control Anbangbang Billabong (table 4). Gulungul Billabong also had the highest number of taxa on average for the five replicates while Jabiru Lake had the lowest (table 4). These summary statistics, therefore, do not in themselves give a clear indication of effects of mining because the waterbodies directly receiving mine waste waters have taxonomic richness within the range of that found in the other waterbodies.

Table 4 Minimum, maximum and average number of macroinvertebrate taxa per site and total number of taxa found in each waterbody

	CJ	DJ	RP1	BA	CD	GT	GU	JL	AN	BU	SY
minimum no. taxa	13	22	16	19	18	20	21	13	14	19	17
maximum no. taxa	24	24	25	26	27	28	30	23	22	27	29
average no. taxa	19.8	22.8	20.6	22.8	23.2	22.8	25.4	18.0	19.6	23.2	23.0
total no. taxa for waterbody	38	41	35	34	43	39	43	31	30	34	40

Ordination of family-level macroinvertebrate data was carried out in three dimensions resulting in a stress level of 0.23. This represents a reasonably high level of distortion (Belbin 1993) but interpretation of a greater number of dimensions is problematic. A stress level of 0.23 means that 77% of the variation in community structure amongst waterbodies and sites was accounted for by their ordination in three dimensions.

There was some separation of natural waterbodies receiving mine waste water (Coonjimba and Djalkmara billabongs) in vector 2 of the ordination (fig 2) while the artificial waterbody receiving mine waste water (RP1) was positioned at one extreme of the gradient represented by vector 1 (fig 2). Also evident in the ordination was a separation along vector 2 of control waterbodies in the Nourlangie catchment from control waterbodies in the Magela catchment (fig 2). The Bithyniidae (operculate gastropods) was the only taxon with a significant correlation to the ordination whose distribution was likely to have been related to differences in water quality (fig 2 and table 5). Electrical conductivity was not as highly correlated with the 1996 ordination of sites based on macroinvertebrate community structure ($p = 0.033$) as it was with the 1995 ordination ($p < 0.001$) indicating water quality was not the overriding factor in determining macroinvertebrate community structure in the waterbodies in 1996.

Some of the environmental gradients represented in the ordination may represent geographical differences between waterbodies or differences related to the physical nature of the waterbodies. For example, differences in overall macrophyte cover were correlated with the ordination (fig 2b). This probably reflects the lower cover present in the artificial waterbodies RP1 and Lake Jabiru (table 3) which may in turn have influenced macroinvertebrate community structure. The predominance of the Palaemonidae (freshwater prawns) and Atyidae (freshwater shrimps) in control waterbodies of the Magela catchment (table 5) may also reflect geographical differences between waterbodies in the Magela catchment and the Nourlangie catchment although specifying what this difference might be is difficult given these decapod families were found in the two Nourlangie waterbodies sampled in 1995 (O'Connor et al 1995).

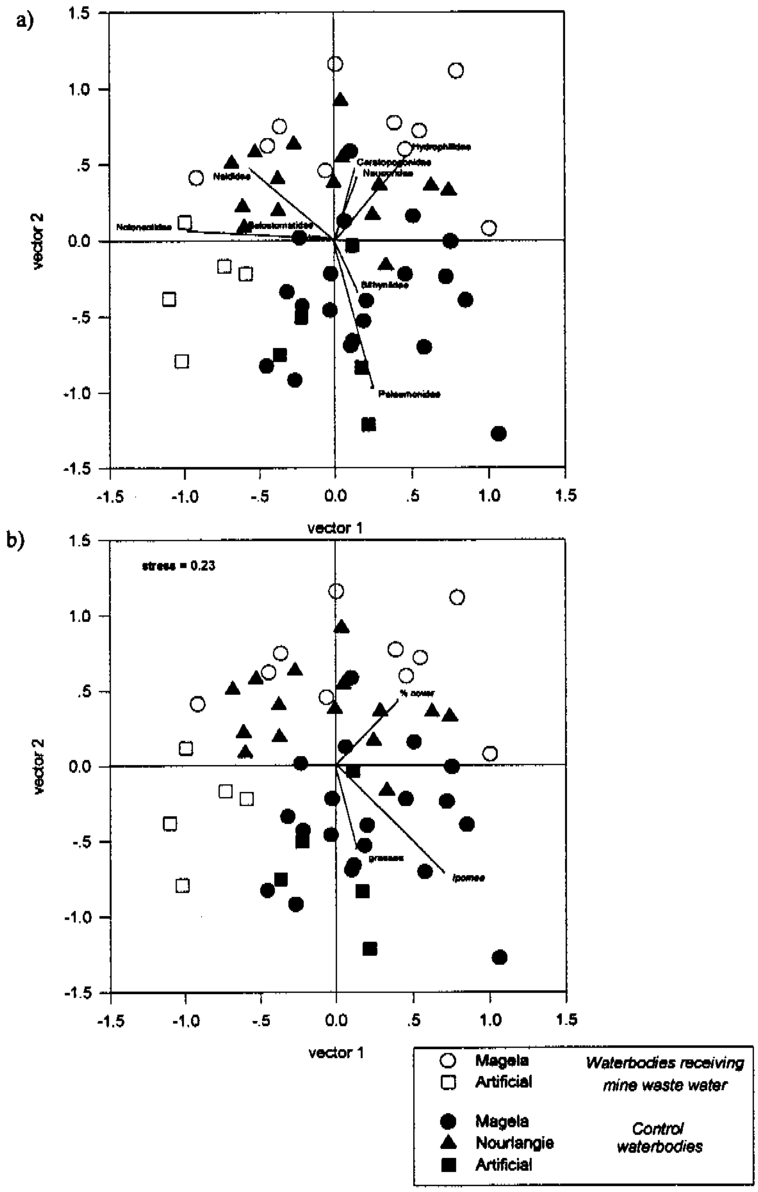

Figure 2 SSH ordination of sites based on macroinvertebrate families with:
a) Eight most highly correlated and significant ($p < 0.001$) PCC correlation vectors for macroinvertebrate families overlain
b) Significant ($p < 0.001$) PCC correlation vectors for environmental variables overlain

Corndorl Billabong was the only waterbody in the study in which Ipomea and the invasive macrophyte Salvinia molesta were recorded (table 3). Salvinia was at peak cover at site 1 (Appendix 1) which was positioned at the extreme positive end of vector 1 and the extreme negative end of vector 2 in the ordination of sites by macroinvertebrate community structure (fig 2). This positioning is noteworthy in that it was separated from the other Corndorl sites and represented an extreme in the environmental gradients represented by the ordination. The positioning of Corndorl Billabong site 1 in the ordination was most likely due to a low richness of macroinvertebrates and in particular the absence of some hemipteran families (notably Belostomatidae and Naucoridae) and larvae of the beetle family Dytiscidae.

Table 5 Distribution of macroinvertebrate taxa having a significant ($p < 0.001$) correlation with the SSH ordination of sites

	CJ	DJ	RP1	BA	CD	GT	GU	JL	AN	BU	SY
Curculionidae (A)	**	*****	*	***	*****	**	***		***	****	**
Dytiscidae (L)	**	****	***	*****	****	*****	****	**	**	*****	**
Hydrophilidae (A)	*****	*****	***	*****	*****	*****	*****	*	*****	*****	*****
Hydrophilidae (L)	****	*****	***	****	*****	***	***	*	***	****	****
Ceratopogonidae	*****	***	*****	**	*	***	****	*****	****	***	*****
Belostomatidae	***	*****	***	*****	****	*****	*****	**	****	*****	*
Corixidae			**				*	****	*	*	*****
Naucoridae	**	*****	*	*****	****	*****	*****		*****	*****	*****
Notonectidae	*	*	*****		**		*		*	**	*
Veliidae	*	****			**			*		****	**
Gomphidae	**		*****	**	**	***	*	***	*		**
Ecnomidae			*****	***		***	**	**	*		
Naididae	**	*	*****	*	*			**	****	**	****
Atyidae				*****	***	****	*****				***
Palaemonidae			**	*****	***	*****	****	****			***
Bithyniidae				*****	*****	***	****		****	*****	

note: number of asterisks indicates number of waterbodies a taxon occurs in, (A) indicates adult life stage and (L) larval

5 Discussion and conclusions

5.1 Comparison of macroinvertebrate communities among waterbodies

Some difference between waterbodies on the RUM lease and other waterbodies of the region was evident in a multivariate ordination of their macroinvertebrate fauna (fig 2) but not in summary statistics of community structure (table 4). Differences in macroinvertebrate community structure amongst the waterbodies appeared to be related more to the type and amount of vegetative cover in the waterbodies than to differences measured in water quality variables (fig 2). The percentage of sampling area covered with macrophyte, in particular, appeared to be an important factor separating natural and artificial waterbodies (fig 2). It cannot be deduced from these data whether low macrophyte cover in the artificial waterbodies (Retention Pond # 1 and Jabiru Lake) affected macroinvertebrate community structure directly or whether it was a surrogate for other environmentally significant factors (eg limnological features of the waterbodies) because correlation analyses cannot be used to imply causation.

In the conclusions of the report for the 1995 survey a concern was expressed that differences in community structure noted between control sites in the Nourlangie system and waterbodies receiving mine waste waters in the Magela catchment were related to the geographical separation of the two catchments rather than indicating differences attributable to mining (O'Connor et al 1995). Results from the 1996 survey indicate, however, that billabongs in the Nourlangie catchment were more similar to waterbodies receiving mine waste waters than control waterbodies located in the Magela catchment (fig 2, table 5). These data indicate, therefore, that waterbodies in the Nourlangie catchment were valid controls to detect impact of mining in the Magela catchment for the 1995 study.

Results from this study also provide preliminary insight into the ecological significance of Salvinia molesta infestations in lentic waterbodies of the region. While this study was not designed specifically to investigate this issue, results indicate that monocultures of Salvinia support macroinvertebrate communities with lower richness than those found in areas with native vegetation (fig 2). The implications of these results for conservation and management of lentic ecosystems merit further investigation.

5.2 Comparison of macroinvertebrate communities between 1995 and 1996

The 1995 survey of seven of the same waterbodies sampled in 1996 found greater evidence for impact of waste waters released from the Ranger mine on macroinvertebrate communities (O'Connor et al 1995). Previous studies assessing the temporal variability of billabongs in the region have recorded marked seasonal changes in abundance and diversity of macroinvertebrates, with maxima recorded in the early Dry season (Marchant 1982). This study is the first to report on interannual variability in the macroinvertebrate community structure of billabongs. Use of presence-absence rather than quantitative macroinvertebrate data in the 1996 analysis would have obscured any gradients manifested by changes in relative abundances and may have contributed to the differences observed. Differences in the macroinvertebrate community structure of lentic waterbodies between years may also be related to variation in limnological and hydrological conditions.

There was higher rainfall in the 1994/95 Wet season (1737 mm) than in the 1995/96 Wet season (1440 mm) (ERA 1995, 1996b). High rainfall in 1994/95 resulted in greater production and release of waste water from the Ranger mine into Coonjimba and Djalkmara billabongs via Retention Ponds #1 and #4 respectively. In 1995, 1,889,400 m^3 of water was released from Retention Pond #1 compared to 913,000 m^3 in 1996 (ERA 1995, 1996b). Similarly, discharge from Retention Pond #4 was 478,600 m^3 in 1995 and 318,000 m^3 in 1996 (ERA 1995, 1996b). Water quality monitoring of retention ponds 1 and 4 indicated that concentrations of solutes were lower in 1994/95 because of greater dilution (ERA 1996a). Maximum solute concentration in Djalkmara Billabong, however, was higher in 1995 (ERA 1996a) - an observation which corresponds with the conductivity readings taken in this and the previous study (O'Connor et al 1995). These water quality results indicate that larger volumes of waste waters released in 1994/95 resulted in a greater solute load entering the billabongs. Exposure of billabong communities to mine waste waters for longer periods in 1995 (particularly Djalkmara Billabong), may be another factor in the greater influence of water quality on macroinvertebrate community structure in 1995 than 1996.

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7 References

ARRRI 1989. Alligator Rivers Region Research Institute Annual Research Summary 1988–1989. Supervising Scientist for the Alligator Rivers Region. - AGPS, Canberra.

Belbin L 1993. *PATN - Pattern Analysis Package*. CSIRO Division of Wildlife and Rangelands Research, Canberra.

Corbett L 1996. Aquatic studies at Ranger Mine: a whole ecosystem approach - Final report. CSIRO Division of Wildlife and Ecology, Darwin.

Davies PE 1994. River Bioassessment Manual, version 1.0. National River Processes and Management Program, Monitoring River Health Initiative. Joint EPA-LWRRDC publication.

ERA 1995. Ranger Environmental Monitoring Program - Non-Restricted Release Zone Water Release Report 1994–1995. Energy Resources of Australia.

ERA 1996a. Ranger Environmental Monitoring Program - Environmental Annual Report 1996. Energy Resources of Australia.

ERA 1996b. Ranger Environmental Monitoring Program - Non-Restricted Release Zone Water Release Report 1995–1996. Energy Resources of Australia.

Faith DP, Dostine PL & Humphrey CL 1995. Detection of mining impacts on aquatic macroinvertebrate communities: results of a disturbance experiment and the design of a multivariate BACIP monitoring program at Coronation Hill, N.T. *Australian Journal of Ecology* 20, 167–180.

Humphrey CL, Bishop KA & Brown VM 1990. Use of biological monitoring in the assessment of effects of mining wastes on aquatic ecosystems of the Alligator Rivers Region, tropical northern Australia. *Environmental Monitoring and Assessment* 14, 139–181.

Humphrey CL & Simpson RD 1985. The biology and ecology of *Velesunio angasi* (Bivalvia: Hyriidae) in Magela Creek, Northern Territory. Open file record 38, Supervising Scientist for the Alligator Rivers Region, Canberra. Unpublished paper.

Hynes HBN 1960. *The biology of polluted waters*. Liverpool University Press, Liverpool.

Marchant R 1982. The macroinvertebrates of Magela Creek, Northern Territory. Research Report 1, Supervising Scientist for the Alligator Rivers Region, AGPS, Canberra.

Minchin PR 1987. An evaluation of the relative robustness of techniques for ecological ordination. *Vegetatio* 69, 89–107.

O'Connor R, Humphrey C, Dostine P, Lynch C & Spiers A 1995. A survey of aquatic macroinvertebrates in lentic waterbodies of Magela and Nourlangie Creek catchments, Alligator Rivers Region, Northern Territory. Internal report 225, Supervising Scientist for the Alligator Rivers Region, Canberra. Unpublished paper.

OSS 1993. Office of the Supervising Scientist for the Alligator Rivers Region, Annual Report 1992-93, AGPS, Canberra.

Outridge PM 1988. Seasonal and spatial variations in benthic macroinvertebrate communities of Magela Creek, Northern Territory. *Australian Journal of Marine and Freshwater Research* 39, 211–223.

Sainty GR & Jacobs SWL 1994. *Waterplants in Australia*. Sainty & Associates, Sydney.

Appendix 1: Percentage cover of each macrophyte taxon and group, and overall macrophyte cover and richness.

	Coonjimba Billabong					Djalkmara Billabong				
Date collected	**15/5/96**					**13/5/96**				
Site	**Site1**	**Site2**	**Site3**	**Site4**	**Site5**	**Site1**	**Site2**	**Site3**	**Site4**	**Site5**
Sample no.	**1469**	**1470**	**1471**	**1472**	**1473**	**1269**	**1270**	**1271**	**1272**	**1273**
(% cover)										
Nymphaea	5	0	16	36	52	4.5	4	30	4.5	4.75
Nymphoides	5	2	8	8	12	0	8	6	4.5	0
Ludwigia	0	0	0	0	0	0	0	0	0	0
Ipomea	0	0	0	0	0	0	0	0	0	0
FA	10	2	24	44	64	4.5	12	36	9	4.75
Dysophylla	0	0	0	0	0	0	0	0	0	0
Persicaria	10	36	0	0	0	0	0	0	0	0
EBL	10	36	0	0	0	0	0	0	0	0
Eleocharis	5	2	8	8	12	85.5	68	15	72	87.4
Pseudoraphis	25	0	48	24	0	0	0	6	4.5	2.85
Unidentif. grasses	0	0	0	0	0	0	0	0	0	0
Leersia	0	0	0	0	0	0	0	0	0	0
Oryza	0	0	0	0	0	0	0	0	0	0
Paspalum distictium	0	0	0	0	0	0	0	0	0	0
Commelina	0	0	0	0	0	0	0	0	0	0
ENL	30	2	56	32	12	85.5	68	21	76.5	90.25
Myriophyllum	0	0	0	0	0	0	0	0	0	0
Utrichularia	0	0	0	0	0	0	0	0	0	0
Maidenia-like?	0	0	0	0	0	0	0	3	0	0
SEF	0	0	0	0	0	0	0	3	0	0
Azolla	0	0	0	0	0	0	0	0	0	0
Salvinia molesta	0	0	0	0	0	0	0	0	0	0
FF	0	0	0	0	0	0	0	0	0	0
Caldesia	0	0	0	4	4	0	0	0	4.5	0
Limnophila	0	0	0	0	0	0	0	0	0	0
Vallisneria	0	0	0	0	0	0	0	0	0	0
Xyris	0	0	0	0	0	0	0	0	0	0
SNF	0	0	0	4	4	0	0	0	4.5	0
Overall cover	50	40	80	80	80	90	80	60	90	95
Maximum depth (cm	70	70	50	40	60	70	70	30	70	70
pH	6.03	6.1	6.24	6.21	6.31	6.57	7	7.3	6.77	6.95
EC (uS / cm)	106	98	98	108	110	525	689	750	401	865
days from day 1	3	3	3	3	3	1	1	1	1	1

EBL: emergent broad leaf; ENL: emergent narrow leaf; FA: floating attached; FF: free floating; SEF: submerged and emergent feathery; SNF: submerged not feathery.

Appendix 1:

	RP1					Baralil Billabong				
Date collected	**20/5/96**					**21/5/96**				
Site	**Site1**	**Site2**	**Site3**	**Site4**	**Site5**	**Site1**	**Site2**	**Site3**	**Site4**	**Site5**
Sample no.	**1504**	**1505**	**1506**	**1507**	**1508**	**1,539.00**	**1,540.00**	**1,541.00**	**1,542.00**	**1,543.00**
(% cover)										
Nymphaea	8	12	42	24	56	8	24.5	21	16	16
Nymphoides	0	0	0	0	0	32	14	7	0	8
Ludwigia	0	0	0	0	0	0	0	0	0	0
Ipomea	0	0	0	0	0	0	0	0	0	0
FA	8	12	42	24	56	40	38.5	28	16	24
Dysophylla	0	0	0	0	0	0	0	0	0	0
Persicaria	0	0	0	0	0	0	0	0	0	0
EBL	0	0	0	0	0	0	0	0	0	0
Eleocharis	0	0	0	0	0	0	14	31.5	8	0
Pseudoraphis	0	0	0	0	16	16	3.5	0	0	8
Unidentif. grasses	0	0	0	0	0	0	0	0	8	0
Leersia	0	0	0	0	0	0	0	0	0	0
Oryza	0	0	0	0	0	0	0	0	0	0
Paspalum distictium	0	0	0	0	0	0	0	0	0	0
Commelina	0	0	0	0	0	4	0	3.5	0	0
ENL	0	0	0	0	16	20	17.5	35	16	8
Myriophyllum	0	0	0	0	0	0	7	0	24	16
Utrichularia	8	9	21	6	0	4	7	0	24	16
Maidenia-like?	24	6	0	0	0	0	0	0	0	16
SEF	32	15	21	6	0	4	14	0	48	48
Azolla	0	0	0	0	0	0	0	0	0	0
Salvinia molesta	0	0	0	0	0	0	0	0	0	0
FF	0	0	0	0	0	0	0	0	0	0
Caldesia	0	0	0	0	0	16	0	7	0	0
Limnophila	0	0	0	0	0	0	0	0	0	0
Vallisneria	0	0	0	0	0	0	0	0	0	0
Xyris	0	3	7	0	8	0	0	0	0	0
SNF	0	3	7	0	8	16	0	7	0	0
Overall cover	40	30	70	30	80	80	70	70	80	80
Maximum depth (cm	30	30	30	30	70	70	70	40	70	70
pH	6.87	6.85	6.68	6.79	6.85	6.49	6.56	6.61	7.31	7.1
EC (uS / cm)	160	163	162	155	156	69	69	68	64	63
days from day 1	8	8	8	8	8	9	9	9	9	9

EBL: emergent broad leaf; ENL: emergent narrow leaf; FA: floating attached; FF: free floating; SEF: submerged and emergent feathery; SNF: submerged not feathery.

Appendix 1:

	Corndorl Billabong					Georgetown Billabong				
Date collected	27/5/96					14/5/96				
Site	Site1	Site2	Site3	Site4	Site5	Site1	Site2	Site3	Site4	Site5
Sample no.	1623	1624	1625	1626	1627	1464	1465	1466	1467	1468
(% cover)										
Nymphaea	0	9	4.5	9	4.5	9	54	38.25	36	27
Nymphoides	0	0	0	4.5	45	0	0	4.25	0	0
Ludwigia	2	9	0	0	0	0	0	0	0	0
Ipomea	2	0	0	0	0	0	0	0	0	0
FA	4	18	4.5	13.5	49.5	9	54	42.5	36	27
Dysophylla	0	0	0	0	0	0	0	0	0	0
Persicaria	0	0	0	0	0	0	0	0	0	0
EBL	0	0	0	0	0	0	0	0	0	0
Eleocharis	0	0	0	0	0	54	36	0	9	45
Pseudoraphis	2	13.5	67.5	63	36	27	0	38.25	36	18
Unidentif. grasses	0	0	0	0	0	0	0	0	0	0
Leersia	0	0	0	0	0	0	0	0	0	0
Oryza	0	0	0	0	0	0	0	0	0	0
Paspalum distictium	0	0	0	0	0	0	0	0	0	0
Commelina	0	0	0	0	0	0	0	0	0	0
ENL	2	13.5	67.5	63	36	81	36	38.25	45	63
Myriophyllum	0	0	0	0	0	0	0	0	0	0
Utrichularia	2	9	9	9	0	0	0	0	0	0
Maidenia-like?	0	0	0	0	0	0	0	0	0	0
SEF	2	9	9	9	0	0	0	0	0	0
Azolla	2	4.5	4.5	4.5	0	0	0	0	0	0
Salvinia molesta	90	45	4.5	0	4.5	0	0	0	0	0
FF	92	49.5	9	4.5	4.5	0	0	0	0	0
Caldesia	0	0	0	0	0	0	0	4.25	9	0
Limnophila	0	0	0	0	0	0	0	0	0	0
Vallisneria	0	0	0	0	0	0	0	0	0	0
Xyris	0	0	0	0	0	0	0	0	0	0
SNF	0	0	0	0	0	0	0	4.25	9	0
Overall cover	100	90	90	90	90	90	90	85	90	90
Maximum depth (cm	70	70	30	30	30	70	50	70	70	70
pH	6.12	6.03	6.14	6.47	6.04	6.17	6.17	6.29	6.16	6.24
EC (uS / cm)	22.9	21.5	25.2	26	38.1	33	32	32	33.5	32
days from day 1	15	15	15	15	15	2	2	2	2	2

EBL: emergent broad leaf; ENL: emergent narrow leaf; FA: floating attached; FF: free floating; SEF: submerged and emergent feathery; SNF: submerged not feathery.

Appendix 1:

	Gulungul Billabong					Jabiru Lake				
Date collected	**16/5/96**					**17/5/96**				
Site	**Site1**	**Site2**	**Site3**	**Site4**	**Site5**	**Site1**	**Site2**	**Site3**	**Site4**	**Site5**
Sample no.	**1474**	**1475**	**1476**	**1477**	**1478**	**1,479.00**	**1,480.00**	**1,481.00**	**1,482.00**	**1,483.00**
(% cover)										
Nymphaea	12	8	4.5	4.5	9	0	0	0	0	0
Nymphoides	28	24	27	22.5	9	21	6	0	15	18
Ludwigia	0	0	0	0	0	0	0	0	0	0
Ipomea	0	0	0	0	0	0	0	0	0	0
FA	40	32	31.5	27	18	21	6	0	15	18
Dysophylla	4	0	4.5	13.5	0	0	0	0	0	0
Persicaria	0	4	0	0	0	0	0	0	0	0
EBL	4	4	4.5	13.5	0	0	0	0	0	0
Eleocharis	4	0	0	0	0	1.5	0	0	0	0
Pseudoraphis	16	16	0	0	27	0	0	7	10	0
Unidentif. grasses	0	0	0	0	0	4.5	10	63	25	39
Leersia	0	0	0	0	0	0	0	0	0	0
Oryza	0	0	0	0	0	0	0	0	0	0
Paspalum distictium	4	8	0	0	18	0	0	0	0	0
Commelina	0	0	0	0	9	0	0	0	0	0
ENL	24	24	0	0	54	6	10	70	35	39
Myriophyllum	0	0	0	9	0	0	0	0	0	0
Utrichularia	0	12	0	0	0	0	0	0	0	0
Maidenia-like?	0	0	0	9	9	0	0	0	0	0
SEF	0	12	0	18	9	0	0	0	0	0
Azolla	0	0	0	0	0	0	0	0	0	0
Salvinia molesta	0	0	0	0	0	0	0	0	0	0
FF	0	0	0	0	0	0	0	0	0	0
Caldesia	12	8	45	31.5	9	0	0	0	0	0
Limnophila	0	0	0	0	0	0	0	0	0	3
Vallisneria	0	0	0	0	0	3	4	0	0	0
Xyris	0	0	9	0	0	0	0	0	0	0
SNF	12	8	54	31.5	9	3	4	0	0	3
Overall cover	80	80	90	90	90	30	20	70	50	60
Maximum depth (cm	60	70	50	50	30	70	70	70	70	50
pH	6.19	6.2	6.41	6.66	6.44	6.95	7.21	7.37	7.51	7.45
EC (uS / cm)	24.5	22.8	34	32.2	25.4	84.5	82	99	86	83
days from day 1	4	4	4	4	4	5	5	5	5	5

EBL: emergent broad leaf; ENL: emergent narrow leaf; FA: floating attached; FF: free floating; SEF: submerged and emergent feathery; SNF: submerged not feathery.

Appendix 1:

	Anbangbang Billabong					Buba Billabong				
Date collected	**28/5/96**					**30/5/96**				
Site	**Site1**	**Site2**	**Site3**	**Site4**	**Site5**	**Site1**	**Site2**	**Site3**	**Site4**	**Site5**
Sample no.	**1628**	**1629**	**1630**	**1631**	**1632**	**1683**	**1684**	**1685**	**1686**	**1687**
(% cover)										
Nymphaea	7.6	7.2	7.2	5.95	4.5	0	0.85	0.85	3.85	0
Nymphoides	0	0	0	0	0	5.6	18.7	12.75	7.7	2.25
Ludwigia	0	0	0	0	0	0	0.425	0	0	0
Ipomea	0	0	0	0	0	0	0	0	0	0
FA	7.6	7.2	7.2	5.95	4.5	5.6	19.975	13.6	11.55	2.25
Dysophylla	0	0	0	0	0	3.5	0.85	0	0	1.5
Persicaria	0	0	0	0	0	0	0	0	0	0
EBL	0	0	0	0	0	3.5	0.85	0	0	1.5
Eleocharis	0	0	0	0	7.2	6.3	8.5	21.25	16.94	0
Pseudoraphis	49.4	50.4	63.9	57.8	60.3	0	25.5	15.3	16.94	18.75
Unidentif. grasses	0	0	0	0	0	0	0	0	0	0
Leersia	0	0	0	0	0	0	0	0	0	0
Oryza	0	0	0	0	0	11.9	0.425	4.25	0	0
Paspalum distictium	0	0	0	0	0	0	0	0	0	0
Commelina	0	0	0	0	0	9.8	5.95	0.85	0	3.75
ENL	49.4	50.4	63.9	57.8	67.5	28	40.375	41.65	33.88	22.5
Myriophyllum	0	0	0	0	0	2.1	0	18.7	23.1	0
Utrichularia	38	31.5	18	21.25	18	8.4	15.3	5.95	6.93	48
Maidenia-like?	0	0	0	0	0	0	0	0	0	0
SEF	38	31.5	18	21.25	18	10.5	15.3	24.65	30.03	48
Azolla	0	0	0.9	0	0	0	0	0	0	0.75
Salvinia molesta	0	0	0	0	0	0	0	0	0	0
FF	0	0	0.9	0	0	0	0	0	0	0.75
Caldesia	0	0.9	0	0	0	22.4	8.5	5.1	1.54	0
Limnophila	0	0	0	0	0	0	0	0	0	0
Vallisneria	0	0	0	0	0	0	0	0	0	0
Xyris	0	0	0	0	0	0	0	0	0	0
SNF	0	0.9	0	0	0	22.4	8.5	5.1	1.54	0
Overall cover	95	90	90	85	90	70	85	85	77	75
Maximum depth (cm	70	70	70	70	70	70	70	70	70	40
pH	6.42	5.95	6.06	6.75	6.45	6.43	6.28	6.34	6.62	6.51
EC (uS / cm)	34.9	26	30.09	28.4	25.7	49.1	53.5	50.2	55.1	43.2
days from day 1	16	16	16	16	16	19	19	19	19	19

EBL: emergent broad leaf; ENL: emergent narrow leaf; FA: floating attached; FF: free floating; SEF: submerged and emergent feathery; SNF: submerged not feathery.

Appendix 1:

	Sandy Billabong				
Date collected	**22/5/96**				
Site	**Site1**	**Site2**	**Site3**	**Site4**	**Site5**
Sample no.	**1583**	**1584**	**1585**	**1586**	**1587**
(% cover)					
Nymphaea	16	4.5	4.5	4.5	4
Nymphoides	4	18	0	0	8
Ludwigia	0	0	0	0	0
Ipomea	0	0	0	0	0
FA	20	22.5	4.5	4.5	12
Dysophylla	0	0	0	0	0
Persicaria	0	0	0	0	0
EBL	0	0	0	0	0
Eleocharis	0	0	0	0	0
Pseudoraphis	24	0	63	63	40
Unidentif. grasses	0	0	0	0	0
Leersia	4	0	0	0	0
Oryza	0	0	0	0	0
Paspalum distictium	0	0	0	0	0
Commelina	0	0	0	0	0
ENL	28	0	63	63	40
Myriophyllum	0	0	0	0	0
Utrichularia	20	9	13.5	18	24
Maidenia-like?	8	27	0	0	0
SEF	28	36	13.5	18	24
Azolla	4	4.5	4.5	4.5	4
Salvinia molesta	0	0	0	0	0
FF	4	4.5	4.5	4.5	4
Caldesia	0	27	4.5	0	0
Limnophila	0	0	0	0	0
Vallisneria	0	0	0	0	0
Xyris	0	0	0	0	0
SNF	0	27	4.5	0	0
Overall cover	80	90	90	90	80
Maximum depth (cm	70	70	70	70	70
pH	5.88	5.89	6.24	6.07	5.82
EC (uS / cm)	17.5	14.5	13	18	13.2
days from day 1	10	10	10	10	10

EBL: emergent broad leaf; ENL: emergent narrow leaf; FA: floating attached; FF: free floating;
SEF: submerged and emergent feathery; SNF: submerged not feathery.

Appendix 2: Abundance of macroinvertebrate families from each site

	Coonjimba Billabong					Djalkmara Billabong				
Site	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Coleoptera										
Brentidae (larvae)	0	0	0	0	0	0	0	0	0	0
Carabidae (adult)	0	0	0	0	0	0	0	0	0	1
Chrysomelidae (adult)	0	1	0	0	0	0	0	0	0	0
Chrysomelidae (larvae)	0	1	0	0	0	0	0	0	0	0
Curculionidae (adult)	2	0	2	0	0	6	1	1	7	6
Curculionidae (larvae)	0	0	0	0	0	0	0	0	0	0
Dytiscidae (adult)	3	9	8	7	1	9	5	7	11	1
Dytiscidae (larvae)	0	0	4	0	1	3	0	2	4	1
Elmidae (adult)	0	0	0	0	0	1	0	0	0	0
Elmidae (larvae)	0	0	0	0	0	0	0	0	0	0
Haliplidae (adult)	0	0	0	0	0	0	0	0	0	0
Haliplidae (larvae)	0	0	1	0	0	0	0	0	0	0
Hygrobiidae (adult)	0	0	0	0	0	0	0	0	0	0
Hydraenidae (adult)	0	0	0	0	0	0	0	0	0	0
Hydrophilidae (adult)	1	8	9	4	8	135	27	11	60	21
Hydrophilidae (larvae)	0	1	2	1	3	9	4	2	20	11
Limnichidae (adult)	0	0	0	0	0	0	0	0	0	1
Noteridae (adult)	0	0	1	1	0	0	0	0	1	0
Noteridae (larvae)	0	0	0	1	0	0	0	0	0	0
Scirtidae (larvae)	0	0	0	0	0	16	1	0	0	3
Staphylinidae (adult)	0	0	0	0	0	1	0	0	0	1
Diptera										
Ceratopogonidae	1	1	10	5	6	1	0	1	0	2
Chironomidae	95	108	105	59	91	47	33	52	41	31
Culicidae	0	0	6	2	1	2	0	0	1	0
Stratiomyidae	0	0	0	0	0	0	1	0	0	0
Tabanidae	0	0	1	0	0	2	3	2	1	0
Thaumeleidae	0	0	0	0	0	0	0	0	0	14
Tipulidae	0	0	0	0	3	1	0	0	0	6
Ephemeroptera										
Baetidae	1	11	2	7	4	0	6	5	0	1
Caenidae	0	3	3	1	21	8	7	17	8	3
Hemiptera										
Belostomatidae	0	0	2	1	2	13	8	5	4	3
Corixidae	0	0	0	0	0	0	0	0	0	0
Gerridae	0	0	0	0	0	0	0	1	1	1
Hebridae	0	0	0	0	0	0	0	0	0	0
Mesoveliidae	0	0	0	0	0	0	1	2	0	0
Naucoridae	0	0	1	2	0	4	13	7	4	10
Notonectidae	0	0	1	0	0	0	1	0	0	0
Nepidae	0	0	0	0	0	0	0	1	1	1
Pleidae	1	2	4	5	0	4	13	0	4	0
Veliidae	0	0	0	0	1	1	1	1	0	2
Lepidoptera										
Pyralidae	0	0	1	1	10	0	0	3	3	0
Neuroptera										
Sisyridae	0	0	0	0	0	0	0	0	0	0

Appendix 2: Abundance of macroinvertebrate families from each site

	Coonjimba Billabong					Djalkmara Billabong				
Site	1	2	3	4	5	1	2	3	4	5
Odonata										
Aeshnidae	0	0	0	0	0	0	0	0	1	0
Coenagrionidae	2	6	13	10	15	9	35	25	30	59
Corduliidae	0	0	0	0	0	0	0	0	0	0
Gomphidae	2	0	0	0	1	0	0	0	0	0
Libellulidae	46	17	20	17	15	7	17	4	17	9
Protoneuridae	0	0	0	0	0	0	0	0	0	0
Trichoptera										
Ecnomidae	0	0	0	0	0	0	0	0	0	0
Hydroptilidae	1	0	0	0	1	0	1	0	0	0
Leptoceridae	0	3	1	2	15	2	6	3	0	0
Philopotamidae	0	0	0	0	1	0	0	0	0	0
Hirudinea										
Glossiphoniidae	0	1	0	0	1	0	0	0	0	0
Ornithobdellidae	0	0	0	0	0	0	0	0	0	0
Richardsonianidae	0	0	1	0	5	0	0	0	0	0
Oligochaeta										
Naididae	0	0	0	2	1	0	0	0	3	0
Tubificidae	17	24	5	11	5	1	0	0	2	0
Oligochaeta indet.	0	0	0	0	0	0	0	0	0	0
Crustacea										
Atyidae	0	0	0	0	0	0	0	0	0	0
Palaemonidae	0	0	0	0	0	0	0	0	0	0
Sundatelphusidae	0	0	0	0	0	0	0	0	0	0
Gastropoda										
Bithyniidae	0	0	0	0	0	0	0	0	0	0
Hyriidae	0	0	0	0	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0	0	0
Planorbidae	0	3	0	6	0	7	4	7	14	0
Thiaridae	0	0	0	0	0	0	0	0	0	0
Viviparidae	0	0	0	0	0	0	0	0	0	0
Acarina										
Acarina indet.	15	27	34	13	9	6	2	2	2	5
Nematoda										
Nematoda	0	0	0	0	0	0	0	0	0	0

Appendix 2:

	RP1					Baralil Billabong				
Site	1	2	3	4	5	1	2	3	4	5
Coleoptera										
Brentidae (larvae)	0	0	0	0	0	0	0	0	0	0
Carabidae (adult)	0	0	0	0	0	0	0	0	0	0
Chrysomelidae (adult)	0	0	0	0	0	0	0	0	0	0
Chrysomelidae (larvae)	0	0	0	0	0	0	0	0	0	0
Curculionidae (adult)	0	0	0	0	3	0	1	2	0	1
Curculionidae (larvae)	0	0	0	0	0	0	0	0	0	0
Dytiscidae (adult)	10	9	28	5	25	1	14	4	7	9
Dytiscidae (larvae)	2	0	2	0	1	7	11	2	3	3
Elmidae (adult)	0	0	1	0	0	0	0	0	0	0
Elmidae (larvae)	0	0	0	0	0	0	0	0	0	0
Haliplidae (adult)	1	0	0	1	0	0	0	0	0	0
Haliplidae (larvae)	0	0	0	0	0	0	0	0	0	0
Hygrobiidae (adult)	0	0	0	0	0	0	0	0	0	0
Hydraenidae (adult)	0	0	0	0	0	0	0	0	0	0
Hydrophilidae (adult)	1	0	1	0	6	15	5	12	4	7
Hydrophilidae (larvae)	0	1	2	1	0	2	1	3	3	0
Limnichidae (adult)	0	0	0	0	0	0	0	0	0	0
Noteridae (adult)	0	0	0	0	0	0	0	0	0	0
Noteridae (larvae)	0	0	0	0	0	0	0	0	0	0
Scirtidae (larvae)	0	0	0	0	0	0	0	0	0	0
Staphylinidae (adult)	0	0	0	0	0	0	0	0	0	0
Diptera										
Ceratopogonidae	6	1	5	5	13	2	0	0	0	1
Chironomidae	126	69	105	92	37	55	8	90	9	0
Culicidae	2	0	0	0	0	0	0	0	0	0
Stratiomyidae	0	0	0	0	0	0	0	0	0	0
Tabanidae	1	0	0	2	1	0	0	0	0	0
Thaumeleidae	0	0	0	0	0	0	0	0	0	0
Tipulidae	0	0	4	0	0	0	0	1	0	0
Ephemeroptera										
Baetidae	6	0	2	0	1	0	0	0	1	2
Caenidae	19	25	4	4	13	25	3	24	11	10
Hemiptera										
Belostomatidae	3	1	0	3	0	7	13	6	5	3
Corixidae	0	0	1	0	1	0	0	0	0	0
Gerridae	0	0	0	0	0	1	0	0	0	0
Hebridae	0	0	0	0	0	0	0	0	0	0
Mesoveliidae	0	0	1	0	0	0	0	0	0	0
Naucoridae	0	0	0	0	3	11	4	6	3	3
Notonectidae	1	4	1	1	1	0	0	0	0	0
Nepidae	0	0	0	0	0	1	0	0	0	0
Pleidae	3	0	3	9	5	8	5	2	8	9
Veliidae	0	0	0	0	0	0	0	0	0	0
Lepidoptera										
Pyralidae	5	1	1	0	0	7	0	4	2	1
Neuroptera										
Sisyridae	0	0	0	0	0	0	0	1	0	0

Appendix 2:

	RP1					Baralil Billabong				
Site	1	2	3	4	5	1	2	3	4	5
Odonata										
Aeshnidae	0	0	1	0	0	0	0	0	0	0
Coenagrionidae	12	4	15	6	13	13	4	8	26	13
Corduliidae	0	0	0	0	0	0	0	0	0	2
Gomphidae	3	2	1	3	4	0	0	1	4	0
Libellulidae	14	13	15	17	9	5	5	1	10	6
Protoneuridae	0	0	1	0	0	0	0	0	0	0
Trichoptera										
Ecnomidae	3	1	5	4	1	0	0	2	1	1
Hydroptilidae	0	0	0	0	0	1	0	1	0	0
Leptoceridae	13	3	5	7	9	3	2	8	15	2
Philopotamidae	0	0	0	0	0	0	0	0	0	0
Hirudinea										
Glossiphoniidae	0	0	0	0	0	0	0	0	0	0
Ornithobdellidae	0	0	0	0	0	0	0	0	0	0
Richardsonianidae	0	0	0	0	0	0	0	0	0	0
Oligochaeta										
Naididae	5	2	1	2	6	0	0	0	0	1
Tubificidae	0	0	0	0	0	1	1	0	0	6
Oligochaeta indet.	0	0	0	0	0	0	0	0	0	0
Crustacea										
Atyidae	0	0	0	0	0	1	28	18	69	9
Palaemonidae	0	0	0	1	1	4	8	7	29	8
Sundatelphusidae	0	0	0	0	0	0	0	0	0	1
Gastropoda										
Bithyniidae	0	0	0	0	0	18	12	6	28	20
Hyriidae	0	0	0	0	1	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	1	0	2	0	0
Planorbidae	3	1	2	0	0	27	3	18	3	27
Thiaridae	0	0	0	0	0	0	0	0	0	0
Viviparidae	0	0	0	0	0	0	0	1	0	0
Acarina										
Acarina indet.	5	7	15	17	7	1	1	1	6	4
Nematoda										
Nematoda	0	0	0	0	0	0	0	0	0	0

Appendix 2:

	Corndorl Billabong					Georgetown Billabong				
Site	1	2	3	4	5	1	2	3	4	5
Coleoptera										
Brentidae (larvae)	0	0	0	0	1	0	0	0	0	0
Carabidae (adult)	0	0	0	0	0	0	0	0	0	1
Chrysomelidae (adult)	2	4	0	0	0	0	0	0	0	0
Chrysomelidae (larvae)	0	0	0	0	0	0	0	0	0	0
Curculionidae (adult)	1	2	1	9	20	0	0	0	1	17
Curculionidae (larvae)	0	0	0	0	0	0	0	0	0	0
Dytiscidae (adult)	1	7	3	3	2	9	18	5	5	4
Dytiscidae (larvae)	0	3	6	7	9	3	3	3	1	2
Elmidae (adult)	0	0	0	0	0	0	0	0	0	0
Elmidae (larvae)	0	0	0	0	0	0	0	0	0	0
Haliplidae (adult)	0	0	0	0	0	1	0	0	0	0
Haliplidae (larvae)	0	0	0	0	0	0	3	0	0	3
Hygrobiidae (adult)	0	0	0	0	0	1	0	0	0	0
Hydraenidae (adult)	0	0	0	0	0	0	0	0	0	0
Hydrophilidae (adult)	14	9	14	16	7	4	4	2	3	24
Hydrophilidae (larvae)	2	6	1	2	10	0	1	1	0	12
Limnichidae (adult)	0	0	0	0	0	0	0	0	0	0
Noteridae (adult)	0	2	0	0	0	0	3	0	0	2
Noteridae (larvae)	0	0	0	0	0	0	0	0	0	0
Scirtidae (larvae)	0	0	0	0	0	0	0	0	0	0
Staphylinidae (adult)	0	1	0	0	0	0	0	0	0	1
Diptera										
Ceratopogonidae	0	0	0	0	1	0	5	0	1	12
Chironomidae	12	57	13	15	43	6	62	55	54	63
Culicidae	0	3	0	2	6	0	0	0	0	1
Stratiomyidae	0	0	0	0	0	0	0	0	0	0
Tabanidae	0	0	1	0	1	0	1	0	0	0
Thaumeleidae	0	0	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0	0	1
Ephemeroptera										
Baetidae	1	0	0	1	7	0	0	3	0	0
Caenidae	0	1	1	5	8	6	2	2	11	10
Hemiptera										
Belostomatidae	0	1	20	6	2	5	6	3	17	6
Corixidae	0	0	0	0	0	0	0	0	0	0
Gerridae	0	0	0	1	0	0	0	0	0	0
Hebridae	0	0	0	1	0	0	0	0	0	0
Mesoveliidae	0	0	0	0	0	0	0	0	0	0
Naucoridae	0	3	8	6	4	1	1	23	12	5
Notonectidae	0	0	1	1	0	0	0	0	0	0
Nepidae	0	0	0	0	0	0	0	0	0	1
Pleidae	0	9	21	13	7	7	11	9	8	7
Veliidae	0	0	0	1	2	0	0	0	0	0
Lepidoptera										
Pyralidae	0	2	10	1	15	1	0	0	2	2
Neuroptera										
Sisyridae	0	0	0	1	0	0	0	0	0	0

Appendix 2:

	Corndorl Billabong					Georgetown Billabong				
Site	1	2	3	4	5	1	2	3	4	5
Odonata										
Aeshnidae	0	0	0	0	0	0	0	0	0	0
Coenagrionidae	5	6	1	2	4	12	7	8	6	6
Corduliidae	3	0	0	0	0	0	1	0	0	0
Gomphidae	1	1	0	0	0	2	1	0	4	1
Libellulidae	40	24	12	9	7	21	8	11	11	19
Protoneuridae	0	0	0	0	0	0	0	0	0	0
Trichoptera										
Ecnomidae	0	0	0	0	0	0	2	1	1	0
Hydroptilidae	0	0	0	1	1	0	0	0	0	0
Leptoceridae	0	1	2	0	0	1	3	5	4	2
Philopotamidae	0	0	0	0	0	0	0	0	0	0
Hirudinea										
Glossiphoniidae	0	0	0	0	2	1	0	1	0	0
Ornithobdellidae	0	0	0	0	0	0	0	0	0	0
Richardsonianidae	0	1	0	0	0	0	0	0	0	0
Oligochaeta										
Naididae	0	0	0	0	1	0	0	0	0	0
Tubificidae	1	0	3	15	8	3	7	0	6	3
Oligochaeta indet.	1	0	0	0	0	0	0	0	0	0
Crustacea										
Atyidae	10	4	0	1	0	0	2	18	1	2
Palaemonidae	13	6	0	1	0	7	2	8	7	11
Sundatelphusidae	0	0	0	0	0	0	0	0	0	0
Gastropoda										
Bithyniidae	22	7	144	24	4	0	1	8	24	0
Hyriidae	0	0	0	0	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	0	0	0	0	0
Planorbidae	4	9	6	13	3	2	0	0	5	3
Thiaridae	0	0	0	0	0	0	0	0	0	0
Viviparidae	0	0	0	0	0	0	1	1	0	0
Acarina										
Acarina indet.	8	13	1	10	21	1	4	1	0	1
Nematoda										
Nematoda	0	0	0	0	0	0	0	0	0	0

Appendix 2:

	Gulungul Billabong					Jabiru Lake				
Site	1	2	3	4	5	1	2	3	4	5
Coleoptera										
Brentidae (larvae)	0	0	0	0	0	0	0	0	0	0
Carabidae (adult)	0	0	0	0	0	0	0	0	0	0
Chrysomelidae (adult)	0	0	0	2	0	0	0	0	0	0
Chrysomelidae (larvae)	0	0	0	0	0	0	0	0	0	0
Curculionidae (adult)	0	5	1	3	1	0	0	0	0	0
Curculionidae (larvae)	0	0	0	0	0	0	0	0	0	0
Dytiscidae (adult)	0	3	1	1	1	7	10	38	15	8
Dytiscidae (larvae)	5	0	1	2	1	1	1	0	0	0
Elmidae (adult)	0	0	0	0	0	0	0	0	0	0
Elmidae (larvae)	0	0	0	0	0	0	0	0	0	0
Haliplidae (adult)	0	0	3	0	0	0	0	0	0	0
Haliplidae (larvae)	0	1	0	1	0	0	0	0	0	0
Hygrobiidae (adult)	0	0	0	0	0	0	0	0	0	0
Hydraenidae (adult)	0	0	0	0	0	0	0	0	0	0
Hydrophilidae (adult)	6	4	5	10	1	0	0	0	0	4
Hydrophilidae (larvae)	0	0	1	3	2	0	0	0	14	0
Limnichidae (adult)	0	0	0	0	0	0	0	0	0	0
Noteridae (adult)	0	0	1	0	0	0	0	0	0	0
Noteridae (larvae)	0	0	3	0	0	0	0	0	0	0
Scirtidae (larvae)	0	0	0	0	0	0	0	0	0	0
Staphylinidae (adult)	0	0	0	0	0	0	0	0	0	0
Diptera										
Ceratopogonidae	1	4	0	1	5	1	2	2	2	1
Chironomidae	38	88	36	110	59	17	55	11	20	8
Culicidae	1	3	1	0	5	8	1	0	0	0
Stratiomyidae	0	0	0	0	0	0	0	0	2	3
Tabanidae	2	1	2	1	0	0	0	0	0	3
Thaumeleidae	0	0	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0	3	0
Ephemeroptera										
Baetidae	3	1	0	2	4	5	41	1	0	0
Caenidae	1	17	4	15	23	1	1	0	1	0
Hemiptera										
Belostomatidae	2	3	3	1	8	3	0	0	1	0
Corixidae	0	1	0	0	0	17	17	28	2	0
Gerridae	0	0	0	1	0	0	0	0	0	0
Hebridae	0	0	1	0	0	0	0	0	1	0
Mesoveliidae	0	0	1	1	1	0	0	0	0	0
Naucoridae	2	2	7	1	8	0	0	0	0	0
Notonectidae	0	0	0	0	1	0	0	0	0	0
Nepidae	0	0	0	0	0	0	0	0	0	0
Pleidae	1	0	4	6	2	14	14	3	7	2
Veliidae	0	0	0	0	0	0	0	0	1	0
Lepidoptera										
Pyralidae	21	3	9	19	1	2	1	0	7	9
Neuroptera										
Sisyridae	0	0	0	0	0	0	0	0	0	0

Appendix 2:

	Gulungul Billabong					Jabiru Lake				
Site	1	2	3	4	5	1	2	3	4	5
Odonata										
Aeshnidae	0	0	0	0	0	0	0	0	0	0
Coenagrionidae	13	3	11	13	6	33	24	11	4	6
Corduliidae	0	0	0	0	0	0	0	0	0	0
Gomphidae	0	0	0	0	1	1	1	0	1	0
Libellulidae	16	11	5	22	7	3	4	1	1	3
Protoneuridae	0	0	1	0	0	0	0	0	0	0
Trichoptera										
Ecnomidae	0	4	0	3	0	1	3	0	0	0
Hydroptilidae	1	2	1	1	0	0	2	0	0	0
Leptoceridae	2	7	1	3	1	0	0	1	6	11
Philopotamidae	0	0	0	0	0	0	0	0	0	0
Hirudinea										
Glossiphoniidae	0	0	1	1	1	0	0	0	0	0
Ornithobdellidae	0	0	0	0	0	0	0	0	0	0
Richardsonianidae	0	0	0	0	0	0	0	0	0	0
Oligochaeta										
Naididae	0	0	0	0	0	0	0	1	2	0
Tubificidae	7	0	4	0	4	0	0	7	9	3
Oligochaeta indet.	0	0	0	0	1	0	0	0	0	0
Crustacea										
Atyidae	18	5	2	0	2	0	0	0	0	0
Palaemonidae	0	1	4	3	6	1	2	0	2	2
Sundatelphusidae	0	0	0	0	0	0	0	0	0	0
Gastropoda										
Bithyniidae	1	0	32	7	10	0	0	0	0	0
Hyriidae	0	0	0	0	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	2	0	0	7	14
Planorbidae	2	1	8	2	0	1	1	3	5	1
Thiaridae	0	0	0	0	0	1	0	0	0	0
Viviparidae	0	0	0	0	0	0	0	0	0	0
Acarina										
Acarina indet.	1	0	5	0	7	243	69	189	57	126
Nematoda										
Nematoda	0	0	0	0	0	0	0	0	0	0

Appendix 2:

	Anbangbang Billabong					Buba Billabong				
Site	1	2	3	4	5	1	2	3	4	5
Coleoptera										
Brentidae (larvae)	0	0	0	0	0	0	0	0	0	0
Carabidae (adult)	0	0	0	0	0	0	0	0	0	0
Chrysomelidae (adult)	0	0	0	0	0	0	0	0	0	0
Chrysomelidae (larvae)	0	0	0	0	0	0	0	0	0	0
Curculionidae (adult)	3	0	5	0	2	2	0	5	3	6
Curculionidae (larvae)	0	0	0	0	0	1	8	3	0	0
Dytiscidae (adult)	28	17	28	20	24	15	4	2	1	4
Dytiscidae (larvae)	1	0	1	0	0	1	8	6	6	5
Elmidae (adult)	0	0	0	0	0	0	0	0	0	0
Elmidae (larvae)	0	0	0	0	0	1	0	0	0	0
Haliplidae (adult)	0	0	0	0	0	0	0	0	0	0
Haliplidae (larvae)	0	0	0	0	0	0	0	0	0	0
Hygrobiidae (adult)	0	0	0	0	0	0	0	0	0	0
Hydraenidae (adult)	0	0	0	0	0	0	0	0	0	0
Hydrophilidae (adult)	7	40	10	8	21	28	16	6	8	12
Hydrophilidae (larvae)	3	0	4	0	1	3	5	0	1	1
Limnichidae (adult)	0	0	1	0	0	0	0	0	0	0
Noteridae (adult)	2	0	4	2	2	0	0	0	0	0
Noteridae (larvae)	0	1	1	0	0	0	0	0	0	0
Scirtidae (larvae)	0	0	0	0	0	0	0	0	0	0
Staphylinidae (adult)	0	0	0	0	0	0	0	1	0	0
Diptera										
Ceratopogonidae	0	1	2	2	2	2	2	0	1	0
Chironomidae	48	19	55	9	22	28	16	41	25	16
Culicidae	6	0	1	0	2	0	0	0	0	0
Stratiomyidae	0	0	0	0	0	0	0	0	0	0
Tabanidae	0	0	0	0	0	0	0	1	3	0
Thaumeleidae	0	0	0	0	0	0	0	0	0	0
Tipulidae	0	0	0	0	0	0	0	0	0	0
Ephemeroptera										
Baetidae	1	2	3	0	0	0	0	1	0	2
Caenidae	17	0	14	8	17	37	44	24	30	25
Hemiptera										
Belostomatidae	6	6	0	12	14	5	4	2	3	7
Corixidae	0	0	0	2	0	0	0	0	0	2
Gerridae	0	0	0	0	0	0	0	0	2	0
Hebridae	0	0	0	0	0	0	0	2	2	0
Mesoveliidae	0	0	0	0	0	0	0	0	0	0
Naucoridae	9	24	15	23	10	6	12	26	46	7
Notonectidae	1	0	0	0	0	1	0	0	0	1
Nepidae	0	0	0	0	0	0	0	0	0	0
Pleidae	14	9	6	8	16	8	10	7	10	5
Veliidae	0	0	0	0	0	4	1	2	1	0
Lepidoptera										
Pyralidae	1	2	2	1	3	1	1	0	2	2
Neuroptera										
Sisyridae	0	0	0	0	0	0	0	0	0	0

Appendix 2:

	Anbangbang Billabong					Buba Billabong				
Site	1	2	3	4	5	1	2	3	4	5
Odonata										
Aeshnidae	0	0	0	0	0	0	0	0	0	0
Coenagrionidae	10	3	7	9	3	10	11	14	4	3
Cordullidae	0	0	2	0	0	0	0	0	0	0
Gomphidae	0	0	1	0	0	0	0	0	0	0
Libellulidae	20	24	23	33	25	22	10	14	9	13
Protoneuridae	0	0	0	0	0	0	0	0	0	0
Trichoptera										
Ecnomidae	1	0	0	0	0	0	0	0	0	0
Hydroptilidae	0	0	1	0	0	1	0	2	2	0
Leptoceridae	0	0	2	2	0	1	0	1	1	0
Philopotamidae	0	0	0	0	0	0	0	0	0	0
Hirudinea										
Glossiphoniidae	0	0	0	0	0	4	0	0	0	0
Ornithobdellidae	0	0	0	0	0	5	0	0	0	2
Richardsonianidae	0	0	0	0	0	0	0	0	0	0
Oligochaeta										
Naididae	1	1	2	1	0	6	0	0	2	0
Tubificidae	0	0	0	0	0	0	0	0	2	0
Oligochaeta indet.	0	0	0	0	0	0	0	0	0	0
Crustacea										
Atyidae	0	0	0	0	0	0	0	0	0	0
Palaemonidae	0	0	0	0	0	0	0	0	0	0
Sundatelphusidae	0	0	0	0	0	0	0	0	0	0
Gastropoda										
Bithyniidae	1	0	1	26	7	10	15	30	14	16
Hyriidae	0	0	0	0	0	0	0	0	0	0
Lymnaeidae	0	0	0	0	0	8	5	8	5	2
Planorbidae	3	0	3	3	6	6	7	8	13	14
Thiaridae	0	0	0	0	0	0	0	0	0	0
Viviparidae	0	0	0	0	0	0	0	0	0	0
Acarina										
Acarina indet.	68	4	49	8	123	5	17	26	17	21
Nematoda										
Nematoda	0	0	0	0	0	0	0	0	0	0

Appendix 2:

	Sandy Billabong				
Site	1	2	3	4	5
Coleoptera					
Brentidae (larvae)	1	0	0	0	0
Carabidae (adult)	0	0	0	0	0
Chrysomelidae (adult)	0	0	0	0	0
Chrysomelidae (larvae)	0	0	0	0	0
Curculionidae (adult)	1	1	0	0	0
Curculionidae (larvae)	0	0	0	0	0
Dytiscidae (adult)	2	6	0	5	13
Dytiscidae (larvae)	0	1	0	1	0
Elmidae (adult)	0	0	0	0	0
Elmidae (larvae)	0	0	0	0	0
Haliplidae (adult)	0	0	0	0	0
Haliplidae (larvae)	0	0	0	0	0
Hygrobiidae (adult)	1	1	0	0	0
Hydraenidae (adult)	0	1	0	0	1
Hydrophilidae (adult)	4	17	6	23	17
Hydrophilidae (larvae)	4	3	1	0	1
Limnichidae (adult)	0	0	0	0	0
Noteridae (adult)	3	3	0	0	0
Noteridae (larvae)	0	0	0	0	1
Scirtidae (larvae)	0	0	0	0	0
Staphylinidae (adult)	1	0	0	0	0
Diptera					
Ceratopogonidae	5	1	8	5	4
Chironomidae	35	70	63	18	25
Culicidae	1	4	0	0	0
Stratiomyidae	0	0	0	0	0
Tabanidae	0	0	0	0	0
Thaumeleidae	0	0	0	0	1
Tipulidae	0	0	0	0	0
Ephemeroptera					
Baetidae	6	5	6	2	5
Caenidae	19	5	30	9	4
Hemiptera					
Belostomatidae	0	0	1	0	0
Corixidae	28	2	7	5	3
Gerridae	0	0	0	0	0
Hebridae	0	0	0	0	0
Mesoveliidae	2	0	0	0	0
Naucoridae	4	3	11	3	9
Notonectidae	0	1	0	0	0
Nepidae	0	0	0	0	0
Pleidae	9	5	5	24	10
Veliidae	3	0	0	0	1
Lepidoptera					
Pyralidae	3	8	1	0	3
Neuroptera					
Sisyridae	0	0	0	0	0

Appendix 2:

Sandy Billabong					
Site	1	2	3	4	5
Odonata					
Aeshnidae	0	0	0	0	0
Coenagrionidae	38	12	52	24	18
Corduliidae	8	0	11	0	0
Gomphidae	3	0	5	0	0
Libellulidae	50	7	25	16	19
Protoneuridae	0	0	0	0	0
Trichoptera					
Ecnomidae	0	0	0	0	0
Hydroptilidae	0	0	1	0	1
Leptoceridae	3	1	5	7	4
Philopotamidae	0	0	0	0	0
Hirudinea					
Glossiphoniidae	0	0	0	0	0
Ornithobdellidae	0	0	0	0	0
Richardsonianidae	0	0	0	0	0
Oligochaeta					
Naididae	10	0	6	1	14
Tubificidae	0	0	0	0	0
Oligochaeta indet.	0	0	0	0	0
Crustacea					
Atyidae	1	0	0	6	1
Palaemonidae	1	0	0	2	1
Sundatelphusidae	0	0	0	0	0
Gastropoda					
Bithyniidae	0	0	0	0	0
Hyriidae	0	0	0	0	0
Lymnaeidae	0	0	0	0	0
Planorbidae	1	2	2	0	1
Thiaridae	0	0	0	0	0
Viviparidae	0	0	0	0	0
Acarina					
Acarina indet.	89	17	91	32	30
Nematoda					
Nematoda	0	0	1	0	1