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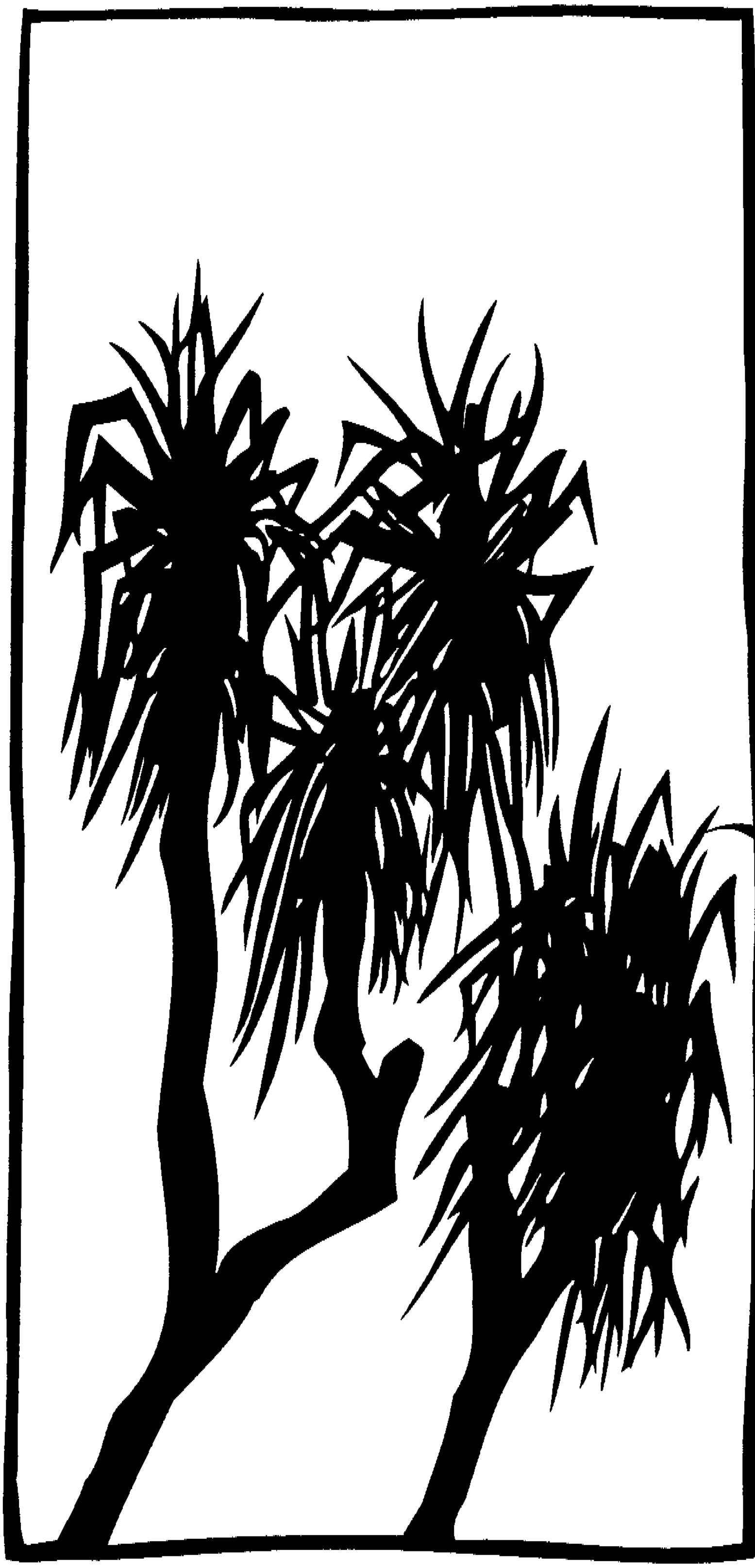

A survey of aquatic macroinvertebrates in lentic waterbodies of Magela and Nourlangie Creek catchments, Alligator Rivers Region, Northern Territory

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by

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Summary

Aquatic macroinvertebrates were sampled from the littora of seven lentic waterbodies of Magela and Nourlangie Creek catchments over a 5 week period from May to June 1995. 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. Waterbodies not directly draining the Ranger mine site had generally higher taxon (family) richness than those draining the mine site. Thus, greatest overall taxon richness was recorded in Georgetown Billabong in Magela Creek catchment whilst Buba and Sandy billabongs, control waterbodies in Nourlangie Creek catchment, had on average, the highest number of taxa per site. Least overall family richness was found in Djalkmara Billabong whilst, on average, this billabong together with Coonjimba Billabong (both in Magela Creek catchment and draining the mine site) shared the least number of taxa per site. Multivariate analysis of community structure ordinated waterbodies along a gradient that was significantly correlated with electrical conductivity. Taxa that were correlated with the ordination space, and lying in the same direction as electrical conductivity, were dytiscid Coleoptera and mesoveliid Hemiptera which may be tolerant of high conductivity, metal-enriched waters. Comparison of the ordination of species-level data for chironomids and that incorporating all macroinvertebrate families showed a similar gradient correlated with conductivity, overlain by differences among and within waterbodies most likely associated with physical features of the habitat. Collectively, these results may indicate that invertebrates have responded to mine-related disturbance though further studies are required to draw greater inferences from the data.

In a related study, patterns of microinvertebrates in the waterbodies were shown to be related to the 'physical type' of waterbody - artificial versus natural. This contrasts with the water quality gradient observed in the present study. Thus, if macroinvertebrate community structure is in fact altered by contamination arising from mine-waste waters, as suggested in our data, it would make this assemblage a useful one to monitor and assess mining impact upon aquatic ecosystems downstream of the Ranger mine.

1 Introduction

A number of workers have previously studied aquatic macroinvertebrates of billabongs of the Alligator Rivers Region (ARR). Two of the waterbodies sampled by earlier workers were also sampled in the present study. Thus, Marchant (1982) surveyed littoral macroinvertebrate communities of Georgetown and Coonjimba billabongs in 1979 whilst Outridge (1988) sampled benthic macroinvertebrate communities from Georgetown Billabong during the period 1980–81. Marchant (1982) and Outridge (1988) described similar patterns of species composition, structure and seasonal dynamics of littoral macroinvertebrate communities in billabongs of Magela Creek. Humphrey and Simpson (1985) studied freshwater mussels (*Velesunio angasi*) of Georgetown and Coonjimba billabongs from 1980 to 1982.

In 1995, CSIRO Division of Wildlife and Ecology contracted the ***eriss*** and a collaborative consultant (Mr Peter Dostine) to conduct surveys of aquatic macroinvertebrates in seven waterbodies of Magela and Nourlangie creeks during the early Dry season (1995). This study was part of a broader research program being conducted by CSIRO and consultants to assess the 'health' of biotic communities in waterbodies occurring in the Ranger Uranium Mine (RUM) project area. Four of the waterbodies were located on the RUM project area: three (natural) billabongs (Georgetown, Djalkmara, Coonjimba) and Retention Pond #1 (RP1), an artificial waterbody on the mine site (fig 1). Jabiru Lake, another artificial waterbody located within the boundary of Jabiru township (fig 1) and unaffected by mining activity (though subject to other types of disturbance), was sampled as a 'control' for RP1. Two Nourlangie Creek billabongs (Sandy and Buba - fig 1) were also sampled as control or reference sites, unaffected by mining.

Specific objectives of the study requested by CSIRO were:

- to describe the composition and structure of macroinvertebrate communities in the seven waterbodies;
- to describe the macroinvertebrate fauna of the RUM waterbodies; and
- to compare the macroinvertebrate fauna of RUM waterbodies with reference waterbodies.

2 Waterbodies studied

The seven waterbodies are shallow lowland billabongs (Humphrey & Simpson 1985) with maximum depth at the time of sampling of ~3.5 m. Georgetown, Djalkmara, Coonjimba, Sandy and Buba billabongs are of the 'backflow' type occurring at the confluence of small tributaries and the main stream (Magela or Nourlangie creeks). 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.

By the end of the Dry season in most years, all waterbodies except Jabiru Lake and RP1 dry to small pools. Djalkmara and Buba billabongs often dry out completely whilst Coonjimba Billabong dries less frequently; RP1 was emptied by Ranger in 1990. The order of average depth of the waterbodies is, from shallowest to deepest, Djalkmara, Buba, Coonjimba, Georgetown, Sandy, RP1 and Jabiru Lake (table 1).

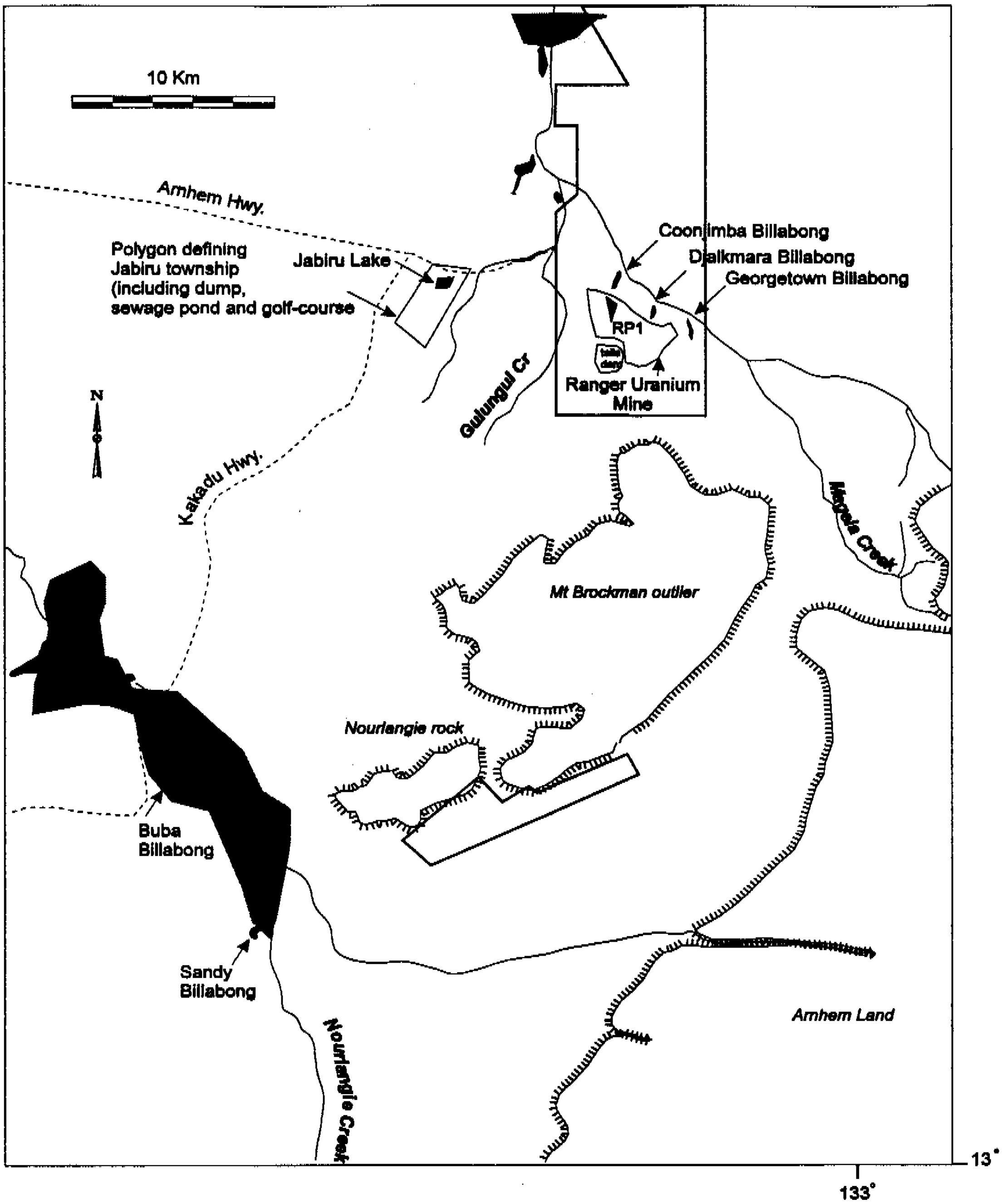

Figure 1 Study area showing the seven waterbodies and extent of the Ranger Uranium Mine project area

Table 1 Physical and chemical data from the seven waterbodies

	Georgetown	Coonjimba	Djalkmara	Jabiru Lake	Buba	Sandy	RP1
Maximum sampling depth (m)	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Depth ranking	4	3	1	7	2	5	6
Water temperature (°C)	25.1	25.7	25.2	27.0	25.8	26.2	26.5
Dissolved oxygen (mg L^{-1})	4.18	2.58	0.85	7.02	3.97	5.18	6.58
pH	7.1	7.3	6.9	7.3	5.8	5.6	7.5
Electrical conductivity (µS cm^{-1})	50	120	830	45	41	28	200

Water quality descriptions for backflow billabongs of Magela Creek in the early 1980s are given in Humphrey and Simpson (1985), Humphrey et al (1990) and ARRRI (1989). Since that period, some billabongs in the catchment have become slightly to highly contaminated by mine-waste waters (mostly magnesium sulphate) from Ranger (ARRRI 1989). This is mainly the result of Wet season overflow of water from retention ponds (RP1 and RP4) into billabongs. 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 (see OSS 1993). Electrical conductivity data reported in table 1 indicate the extent of such contamination occurring, from least to most affected, in Georgetown, Coonjimba and Djalkmara billabongs respectively.

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) and in the UK and USA. These methods maximize the number of different taxa collected and were therefore deemed useful for surveys of the type conducted here.

3.1 Field procedures

3.1.1 Sampling sites

Littoral (shallow margins) macroinvertebrates were sampled from ten sites in each waterbody. Each waterbody was sampled either on a single day or on two consecutive days. Sampling of the seven waterbodies was conducted over a 5 week period (10 May to 8 June).

Sites were generally spaced at 100 m intervals around the circumference of the waterbody. The first site was generally located at a fixed reference point such as a gauge board, where present. Details of the sampling sites are as follows:

Georgetown Billabong: site 1, gauge board on southern bank, sites 2-5 at 100 m intervals 'upstream' of site 1; sites 6–10 on opposite (northern) bank, site 6 located immediately opposite site 1 with sites 7–10 at 100 m intervals 'upstream' of site 6.

Coonjimba Billabong: site 1, gauge board on north-western bank, site 2 100 m 'downstream' (north) of site 1, site 3 100 m 'upstream' (south) of site 1, sites 4 and 5 at 100 m intervals 'upstream' of site 3; sites 6–10 in the same relative positions as sites 1–5 on the opposite (eastern) bank.

Djalkmara Billabong: site 1 at the north-west (downstream) end of the billabong at a position 20 m upstream (south) of the commencement of a discrete stand of fringing Melaleuca, sites 2–5 located at 100 m intervals 'upstream' of site 1; sites 6–10 located on opposite (eastern) bank, site 6 located opposite but 20 m downstream (north) of site 5, sites 7–10 at 100 m intervals downstream of site 6.

Jabiru Lake: site 1 at the south-east (downstream) end of the lake, 20 m from the lake wall, sites 2–10 at 100 m intervals from site 1, continuing clockwise away from the lake wall. (Sites 7–10 were located on the northern side of the lake.)

Buba Billabong: site 1 at the north-west end where a 3–km ANCA road leading from Kakadu Highway (just past the southern bridge over Nourlangie Creek) meets the billabong, sites 2–10 at 100 m intervals clockwise (south) from site 1. (Site 7 at ANCA steel pole denoting walking track), and 'opposite' site 6 located on other side of a tapering shallow end of the billabong.

Sandy Billabong: site 1, northern end, located immediately adjacent to the picnic table closest to the billabong edge, sites 2–7 at 100 m intervals anti-clockwise (upstream or south) from site 1. (Site 5 'opposite' site 4 located on other side of a tapering shallow arm of the billabong.) Sites 8–10 at 100 m intervals clockwise (downstream) of site 1.

Retention Pond #1: site 1 at the north-east (downstream) end, 50 m from pond wall, sites 2–6 located at 100 m intervals 'upstream' of site 1 (eastern bank); sites 7–10 on opposite (western) bank, site 7 located 40 m from upstream end of pond, sites 8–10 at 100 m intervals north (downstream) of site 7.

3.1.2 Sampling procedure

Samples were collected using a standard 250 µm mesh pond net (see 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 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.

3.1.3 Measurement of environmental variables

Information on macrophyte generic composition and relative abundance was collected at each site. 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). A further category, benthic 'algal floc' was also included. Percentage abundance values for the aquatic plant, Caldesia, were shared equally between FA and SNF categories rather than the EBL category of Sainty and Jacobs (1994) because the FA and SNF classes were 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 quality data for each waterbody were limited and were derived from a number of sources. Ranger provided data from the waterbodies as follows: (i) water temperature and dissolved oxygen concentrations for all waterbodies from sampling undertaken between 0850–0905 hrs on 8–9/6/1995; and (ii) pH and electrical conductivity of Coonjimba, Djalkmara and Georgetown billabongs (4/5/95) and RP1 (30/5/95). Conductivity and pH data for Buba and Sandy billabongs during May 1995 were obtained from ***eriss*** (Boyden & Pidgeon, unpublished data). Conductivity and pH data for Jabiru Lake were restricted to values derived from sampling undertaken by the NT Power and Water Authority in May 1986 and 1987. Although water clarity was not measured during the present study, this was visually assessed as 'high' in all waterbodies for the period of sampling.

Whilst the disparate spot readings of water quality variables are of limited value to the present study, the electrical conductivity data are regarded as the least variable and most conservative of the measured parameters. Importantly, conductivity data are believed to reflect the magnitude of human-related disturbance in the catchments.

3.2 Laboratory procedures

3.2.1 Sample processing

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 checked for invertebrates then discarded. Material retained in the 500 µm sieve was live-sorted for invertebrates no longer than 6 hours after field collection. Protocols for live-sorting were similar to those prescribed in the MRHI River Bioassessment Manual (Davies 1994) except live-sorting for 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.

Larvae of the family Chironomidae (non-biting midges) were identified to a lower level than any of the other invertebrate groups collected. Chironomids are characterised by high species richness and ecological diversity, extensive geographical range, and great abundance and biomass in aquatic systems. It is often the case, particularly in lotic systems, that the number of chironomid species equals or exceeds that of all other benthic macroinvertebrate groups combined (Coffman 1995). Chironomids, therefore, have potentially high ecological importance. This factor and the availability of a taxonomic key to the species of chironomids found in the Alligator Rivers Region (Cranston 1991) prompted their lower-level identification.

A maximum of 50 chironomids was identified from a given sample due to the time-consuming nature of the preparation process. Where greater than 50 chironomids were present in a sample, specimens for mounting were selected randomly. Clearing of the head capsules of chironomids and mounting on slides allows the examination at high magnification necessary for species and genus-level identification (Cranston 1991). Specimens were firstly cleared in 5% potassium hydroxide overnight at room temperature. The clearing process was then reversed by placing specimens in glacial acetic acid for at least 15 minutes. Specimens were then briefly immersed in propanol before mounting in Euparal on glass slides. Chironomid material was identified under a compound microscope to the lowest practical level.

Time and resource constraints meant that processing of non-chironomid material was restricted to five randomly-selected sites in each waterbody with specimens identified to family-level only. These invertebrates were identified using regional and in-house taxonomic keys. Specimens were identified and counted using Wild M8, MZ8 or M10 dissecting microscopes.

3.2.2 Data analysis

Species-level chironomid data from ten sites per waterbody were analysed separately from family-level macroinvertebrate data from five sites per waterbody. The proportional abundance of each chironomid species was scaled up to values equivalent to the total number in each sample to account for the fact that not all specimens were identified beyond family level. Both data sets were log-transformed before analysis as recommended for macroinvertebrate count data (Elliott 1977).

Multivariate ordination was used to explore variation in this large and complex data set. Ordination summarises 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, in the PATN statistical package (Belbin 1993), one of the most robust ordination methods available for analysing ecological data (Minchin 1987, Belbin 1993). Patterns of association amongst waterbodies were summarised by plotting the ordination scores of each axis against one another. The reduction of data to two or three axes that summarise 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). 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.

Pearson Product Moment correlations were calculated in the MINITAB (1995) statistical package to test for relationships between macroinvertebrate community structure and environmental variables.

4 Results

4.1 Environmental variables

Few major trends in macrophyte richness were apparent although the lowest taxon number in Djalkmara (4) and the highest richness in Buba (12) (table 2) is of interest. Both of these waterbodies are relatively shallow and prone to drying out, so the low macrophyte richness of Djalkmara may possibly be the result of contamination by mine-waste waters (table 1). Of the 22 plant taxa recorded, 50% were found in one waterbody only and no one taxon was recorded in all (although *Eleocharis*, *Pseudoraphis*, *Nymphaea* and *Nymphoides* were recorded in six of the seven waterbodies - table 2). Thus, the waterbodies had a varied flora which may translate to a broad suite of habitats available for macroinvertebrates. Macrophyte density was least in the artificial waterbodies (RP1 and Jabiru Lake, Appendix 1).

Few valid inferences can be drawn from single measurements of water quality parameters. Temperature and dissolved oxygen, for example, will change quite markedly on a diurnal and seasonal basis in open shallow waterbodies. Electrical conductivity reflected the order of human-related disturbance recorded previously (OSS 1993) with waterbodies subject to greatest disturbance having the highest electrical conductivity (table 1). Results from ongoing and previous studies suggest pH in the waterbodies does not fall outside the range 5.5–7.5 and that waterbodies contaminated by mine-waste waters, together with Jabiru Lake, are more consistently basic in nature.

4.2 Comparison of macroinvertebrate communities among waterbodies

The total number of macroinvertebrates live-sorted from each sample varied from 65 to 237 with the average being 157. All taxa except the Acarina or water mites were identified to family and the total number of families recorded across all seven waterbodies was 49 (Appendix 2). This included three coleopteran (beetle) families that had both larval and adult life stages present. Georgetown Billabong had the greatest total number of families recorded (36) but Buba Billabong had the highest average number of taxa per site (table 3). Djalkmara Billabong had the lowest overall number of macroinvertebrate taxa present (27) as well as the lowest average number per site (table 3). There were no significant correlations between macroinvertebrate family richness and environmental variables.

Table 2 Average cover of each macrophyte type for the ten sampling sites in the seven waterbodies

	Georgetown	Coonjimba	Djalkmara	Jabiru Lake	Buba	Sandy	RP1
Emergent broad leaf							
Dysophylla					*		
Emergent narrow leaf							
Commelina					**		
Cyperus sp.				**			
Eleocharis	**	**	***		***	*	**
Fimbristylis							*
Grasses indet.				*			
Leersia					*		
Pseudoraphis	*	**		***	*	***	*
Vetiveria	*	**					
Floating attached							
Ipomea				*			
Ludwigia		*					
Marsilea					*		
Nymphaea	***	***	***		*	*	**
Nymphoides		**	**	*	***	*	**
Free floating							
Azolla					*	*	
Submerged & emergent feathery							
Halagorocae	*						
Myriophyllum	*	*			***		
Najas	***	*	*				
Utricularia				*	*	***	**
Submerged not feathery							
Caldesia	*	*			***	***	*
Vallisneria							*
Algal floc				***			
Total no. taxa	8	9	4	7	12	7	8

(* <5%; ** 5-10%; *** >10%)

Table 3 Minimum, maximum and average number of macroinvertebrate taxa per site and total number found in each waterbody

	Georgetown	Coonjimba	Djalkmara	Jabiru Lake	Buba	Sandy	RP1
minimum no. taxa	19	13	14	14	20	13	16
maximum no. taxa	23	22	22	20	26	26	23
average no. taxa	20.6	17.4	17.4	18	22	19.6	19.8
total for waterbody	36	32	27	32	32	35	31

The total number of chironomid taxa identified in the study was 44 (Appendix 3). Retention Pond #1 had the highest number of chironomid types recorded (25) and the highest average number of taxa per site (table 4). Djalkmara had the lowest total number of chironomid taxa (15) but Coonjimba Billabong had the lowest number of types on average per site (table 4). Chironomid species richness was negatively correlated ($r = -0.281$; $p < 0.02$) with percentage macrophyte cover - RP1 had low plant cover and high chironomid species richness while Djalkmara had high plant cover and low chironomid species richness (Appendix 1). Three types of chironomid were found that had not been previously recorded in the ARR. These included two types of Chironominae of unknown genera (referred to as Types A and B) and a tanypod that may be a new species of *Larsia* (referred to as nr *Larsia*).

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

	Georgetown	Coonjimba	Djalkmara	Jabiru Lake	Buba	Sandy	RP1
minimum no. taxa	5	2	6	3	6	1	8
maximum no. taxa	14	11	11	10	11	13	15
average no. taxa	8.2	6.3	7.7	6.8	8.2	8.3	11.6
total for waterbody	22	23	15	24	22	23	25

4.2.1 Analysis of family-level macroinvertebrate data

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. Sites within waterbodies generally clustered together (fig 2) indicating each waterbody had distinct macroinvertebrate communities.

Djalkmara, Coonjimba and RP1 were generally separated from the other waterbodies in the ordination based on family-level macroinvertebrate data (fig 2). The location of these sites at one end of the ordination (ie negative values of vector 3, fig 2) was significantly correlated ($p < 0.001$) with four environmental variables - three related to aquatic plants (increasing *Eleocharis*, decreasing submerged and emergent feathery plant types - SEF, decreasing plant taxon richness) and one physico-chemical parameter (increasing electrical conductivity - fig 2). Whilst causal links cannot be inferred, there are indications from these analyses that the structure of macroinvertebrate communities in these RUM-lease waterbodies has been altered by a change in water quality resulting from mining activities (high conductivity) and/or low plant richness.

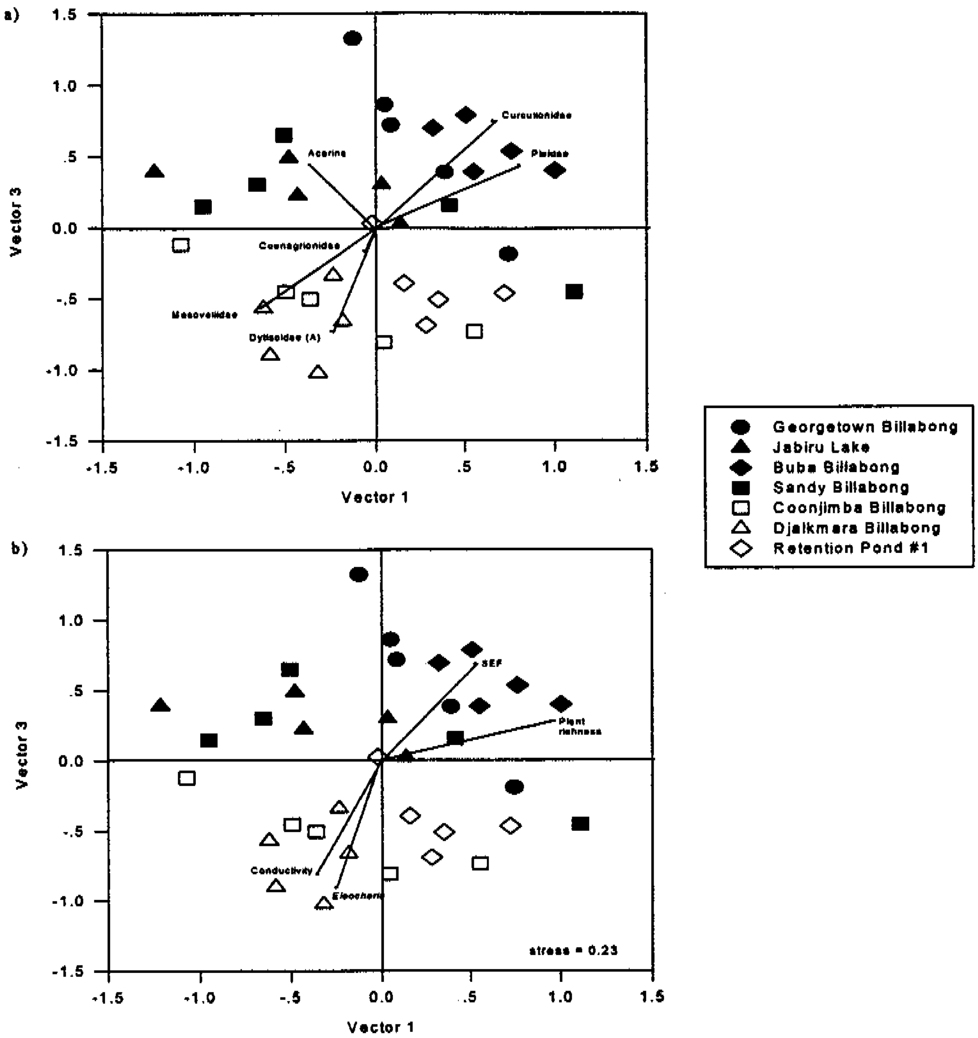

Figure 2 SSH ordination of sites based on macroinvertebrate families with:
a) Significant ($p < 0.001$) PCC correlation vectors for macroinvertebrate families overlain
b) Significant ($p < 0.001$) PCC correlation vectors for environmental variables overlain

The surface-dwelling hemipteran Mesoveliidae and adult beetles from the dytiscid family were significantly correlated in the same direction as the environmental gradient described above (fig 2). Dytiscid adults were found in highest numbers in RP1, Jabiru Lake, Djalkmara and Coonjimba Billabongs (table 5). In mine-polluted portions of Rockhole Mine Creek, a small tributary of the South Alligator River (ARR), dytiscid beetles were common in comparison to abundances in unpolluted portions of the creek (Dostine et al 1992, 1993), indicating a tolerance to, or preference for, high conductivity, metal-enriched waters. The Mesoveliidae were only found in high numbers in Djalkmara Billabong (table 5). Mesoveliidae are recorded as being associated with floating water plants (Carver et al 1991). This may partly explain the abundance of this taxon in Djalkmara which, on average, had 69% emergent and floating macrophyte cover in the transects sampled. Aerial breathing and predatory feeding habits of these organisms may also confer greater tolerances to degraded water quality and desiccation.

Table 5 Abundances of macroinvertebrate taxa that comprised greater than 0.05% of the total fauna collected

Taxa	Georgetown	Coonjimba	Djalkmara	Jabiru Lake	Buba	Sandy	RP1
Chrysomelidae (adult)	0	0	2	0	1	0	0
Curculionidae (adult)	8	1	0	2	12	3	2
Dytiscidae (adult)	3	32	33	34	13	6	49
Dytiscidae (larvae)	6	1	0	3	6	3	2
Hydrophilidae (adult)	10	30	69	17	28	15	23
Hydrophilidae (larvae)	3	8	30	1	5	9	12
Noteridae (adult)	4	4	0	2	0	2	0
Noteridae (larvae)	0	1	0	1	0	3	0
Ceratopogonidae	2	11	9	20	11	11	23
Chironomidae	192	294	201	115	124	277	434
Culicidae	0	2	4	2	0	14	2
Tabanidae	1	1	19	4	11	0	1
Baetidae	23	15	56	9	0	22	11
Caenidae	22	23	85	7	51	45	17
Belostomatidae	8	38	21	10	26	17	12
Corixidae	2	0	0	5	0	19	1
Gerridae	1	4	5	0	0	2	5
Hebridae	0	0	1	0	1	1	0
Mesoveliidae	0	4	41	0	0	2	0
Naucoridae	10	6	25	3	26	13	14
Notonectidae	0	0	0	0	0	1	9
Pleidae	55	9	17	23	48	22	68
Veliidae	3	8	1	2	1	0	3
Pyralidae	13	6	2	6	34	10	30
Sisyridae	2	0	0	0	0	1	0
Coenagrionidae	115	25	199	28	58	41	125
Gomphidae	5	1	0	3	3	0	8
Libellulidae	55	26	32	33	86	53	45
Ecnomidae	3	2	0	7	6	3	4
Hydroptilidae	2	1	0	1	3	4	0
Leptoceridae	24	3	4	23	11	9	83
Glossiphoniidae	5	0	0	0	0	0	0
Naididae	6	17	2	8	5	12	7
Tubificidae	1	0	0	0	3	0	1
Atyidae	25	1	0	0	2	13	0
Palaemonidae	20	0	0	7	7	9	0
Bithyniidae	37	0	1	0	1	0	0
Lymnaeidae	0	1	0	0	8	0	0
Planorbidae	6	1	4	2	28	3	2
Thiaridae	0	0	0	6	0	0	0
Viviparidae	25	0	0	0	54	0	0
Acarina	4	27	8	507	61	33	16

Other gradients from the ordination (fig 2) are more difficult to interpret. The location of the Jabiru Lake sites in the ordination was significantly correlated ($p < 0.001$) with the presence of Acarina (water mites). This group was often predominant in samples from Jabiru Lake and total numbers there were nearly ten times those collected in any of the other waterbodies (table 5). Little information is available about the ecology of these arachnids because work has only recently been published dealing with their taxonomy (Harvey, in press). Algae were only recorded from Jabiru Lake and were correlated with the ordination ($p < 0.05$) in a similar direction as Acarina (fig 2). Algae may have provided a unique food source for invertebrate fauna and may also represent slight eutrophication of this waterbody as a result of runoff from Jabiru township. Substratum may be another factor responsible for the high abundance of Acarina in Jabiru Lake as its substratum was visually assessed as being coarser (sand/fine gravel) than the other waterbodies studied here. High abundances of water mites have been associated with sandy substratum in the bed of Magela Creek (***eriss*** unpublished data).

4.2.2 Analysis of species-level chironomid data

Ordination of species-level chironomid data was carried out in three dimensions resulting in a stress level of 0.18 (82% of variation accounted for by three vectors). Sites within waterbodies did not cluster as discretely as in the ordination of macroinvertebrate family data (compare figs 2 & 3) possibly because analysis of species as opposed to family data provides extra information on environmental differences and, as a consequence, additional ecological gradients in ordination space. Plotting of twice the number of points in the chironomid ordination (70 versus 35 plotted in the macroinvertebrate family ordination - fig 2) may also hamper interpretation. In order to simplify the plot of ordination scores, the average score for each waterbody in each dimension was determined and this 'centroid' then plotted with the environmental and species vectors (fig 3).

From the MCAO analysis of chironomid species data, there was a higher number of invertebrate taxa and environmental variables significantly correlated with the ordination than in the ordination of macroinvertebrate family data (fig 3). This may be because sensitivity to environmental variation is most reliably recorded at species level (Resh & Unzicker 1975). In common with family-level analysis, electrical conductivity and cover of *Eleocharis* were significantly correlated with the ordination (fig 3). Unlike the ordination of family-level data, however, the environmental gradient represented by these parameters appeared mainly to represent the difference between Djalkmara Billabong (high conductivity and cover of *Eleocharis*) and the other waterbodies (fig 3). This idea is supported by the correlation values between electrical conductivity and the family and species ordinations. Although both were significant ($p < 0.001$) the correlation between electrical conductivity and the ordination of family data was higher ($r = 0.7360$) than the correlation between electrical conductivity and chironomid species data ($r = 0.5448$). The higher correlation value for the family data is indicative of a consistent progression of sites along a gradient rather than a cluster of sites from a single waterbody lying separately from another cluster consisting of all other sites, as characterised chironomid data (compare figs 2 & 3).

The position of some of the chironomid species that were significantly correlated with the ordination coincided with the conductivity gradient previously referred to (fig 3). In particular, high numbers of *Tanytarsus* were found in Djalkmara Billabong (table 6). Members of this genus were also more commonly encountered in mine-polluted portions of Rockhole Mine Creek (ARR) than in unpolluted portions (Dostine et al, 1992, 1993), indicating for the species concerned a tolerance to, or preference for, high conductivity, metal-enriched waters. Elsewhere in Australia, species of *Tanytarsus* have been recorded from saline lakes (Pinder 1995). The same environmental gradient also included depth, with the deepest waterbodies (Jabiru Lake and RP1) at the opposite extreme of the gradient to highest conductivity (fig 3). Depth may be a surrogate for a number of factors of ecological significance, such as frequency of desiccation, water temperature, macrophyte cover (the deepest waterbodies had the lowest overall percentage cover - Appendix 1) and a range of other physico-chemical variables.

Other environmental gradients represented by the ordination are more difficult to interpret, especially given the paucity of information on the ecology of many of the species. However, species-level chironomid data appear to indicate a gradient of mine-related disturbance overlain by differences among and within waterbodies most likely associated with habitat type, eg substratum, macrophyte type and density.

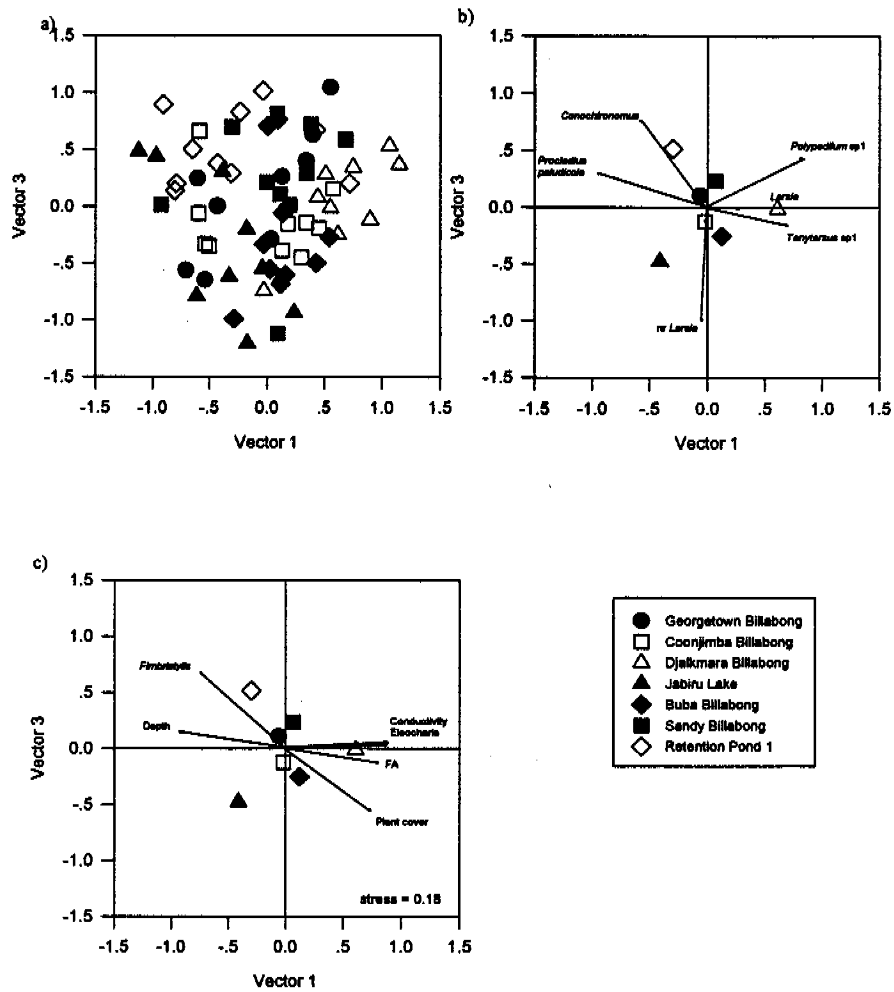

Figure 3 SSH ordination of sites based on chironomid taxa with
a) Ten samples for each site represented
b) Significant (p, 0.001) PCC correlation vectors for chironomid taxa overlaying centroids for each waterbody
c) Significant (p, 0.001) PCC correlation vectors for environmental variables overlaying centroids for each waterbody

Table 6 Abundances of chironomid taxa that comprise greater than 0.05% of the total fauna collected

	Georgetown	Coonjimba	Djalkmara	Jabiru Lake	Buba	Sandy	RP1
Chironomus	30	12	41	9	4	6	14
Cladopelma	4	0	0	0	7	4	10
Cladotanytarsus	7	1	22	9	8	5	22
Conochironomus	2	2	0	8	11	13	35
Cryptochironomus	0	0	0	0	0	2	0
Dicrotendipes sp.1	11	2	0	1	4	2	7
Dicrotendipes sp. 2	8	1	1	3	3	2	8
Dicrotendipes sp. 3	0	2	0	0	0	0	1
Kiefferulus	3	4	1	0	0	0	0
Polypedilum leei	5	3	11	2	1	0	14
Polypedilum sp. 1	16	12	76	1	16	19	36
Polypedilum sp. 2	2	0	0	1	7	0	9
Rheotanytarsus	2	0	0	2	0	3	3
Skusella	0	0	0	0	2	0	0
Stenochironomus	0	0	0	0	0	3	0
? Stictochironomus	0	0	0	0	6	0	0
Tanytarsus sp. 1	2	4	34	6	35	1	13
Tanytarsus sp. 2	0	0	3	0	0	0	2
Tanytarsus sp. 3	1	2	0	2	2	3	3
Tanytarsus sp. 4	0	0	0	6	0	0	5
Tanytarsus sp. 5	0	1	1	3	0	0	12
Zavreliella marmorata	0	1	0	1	1	4	0
Chironominae type A	1	1	0	0	0	2	0
Nanocladius OSS1L	0	0	0	1	0	2	0
Parakiefferiella OSS1L	0	2	0	0	0	8	2
Ablabesmyia sp. 1	11	3	12	19	0	12	13
Ablabesmyia sp. 2	1	0	0	0	0	2	0
Clinotanypus crux	1	1	0	1	7	3	7
Fittkauimyia disparipes	1	0	0	1	0	0	0
Larsia	156	253	76	71	138	201	189
nr *Larsia*	31	86	63	94	112	17	26
Paramerina	2	0	1	1	1	0	0
Procladius	11	9	4	25	8	43	18

5 Discussion and conclusions

5.1 Comparison of macroinvertebrate communities among waterbodies

The abundance and diversity of macroinvertebrates in Magela Creek waterbodies has previously been reported to vary markedly between seasons, with maxima recorded in the early Dry season (Marchant 1982) ie, the time of sampling for the present study. Such variation has been linked to differences in organic material required as a food source for macroinvertebrates (Outridge 1988). There is insufficient information available to determine the degree to which the differences in macroinvertebrates among waterbodies noted in this study are a result of natural variation in such environmental variables. Rather, an environmental gradient separating waterbodies was found to be significantly correlated with electrical conductivity in both family-level macroinvertebrate data and (to a lesser extent) species-level chironomid data (figs 2 & 3). Moreover, whilst the total number of taxa found in each waterbody did not vary greatly (tables 3 & 4) the billabong with poorest water quality (Djalkmara) did have the lowest number of macroinvertebrate (table 3) and chironomid (table 4) taxa.

The results from this study indicate that macroinvertebrates may serve as useful biological indicators of changes in the water quality of waterbodies occurring on the Ranger mine lease. Results need to be viewed with some caution, however, for several reasons. Firstly, there is a need for additional control waterbodies. In particular, future work would benefit by sampling waterbodies on the Magela Creek system that were not on the Ranger lease (eg Gulungul and Corndorl billabongs). This would allow stronger inferences to be made about the extent to which the high species richness and difference in community structure noted in control sites in the Nourlangie system (fig 2) are related to geographical separation and/or lack of anthropogenic impact.

Further, correlation analyses cannot be used to imply causation. While particular environmental parameters were found to be significantly correlated with the ordinations of sites in macroinvertebrate family and species space (figs 2 & 3) it cannot be implied that, for example, the high abundance of *Eleocharis* was responsible for the high numbers of Tanytarsus, only that they occurred in high numbers together. Nevertheless, such multivariate analyses do provide insight into potentially important environmental variables (Norris & Georges 1993) and future work can focus on processes associated with these elements so as to give definitive information on the significance of changes in macroinvertebrate community structure.

Debate still exists in limnology as to appropriate taxonomic levels to be used in invertebrate studies. Some authors have argued that species are the only biological units of any ecological significance and that higher taxonomic resolution gives ambiguous results and are used more for reasons of expediency rather than in response to definitive objectives (Resh & Unzicker 1975, Cranston 1990). However, many studies have been carried out using higher levels of identification, and have effectively detected impact (eg Chessman 1995). The current National River Health Program also uses the family level of identification to develop predictive models for detecting human impact (Davies 1994). Detection of subtle effects arising from anthropogenic disturbance may, however, not be possible without the use of species-level identification (Humphrey & Dostine 1994). A further often-cited justification for higher taxonomic resolution arises wherever the taxonomy of macroinvertebrate groups is poorly documented and species-level keys are either non-existent or require a high level of expertise to use. Resh and McElravy (1993) concluded that what constituted an appropriate taxonomic level would vary depending on the purpose of the study (eg biomonitoring, biodiversity for conservation status), the level of sensitivity required, the type of index or analysis used and the particular group of organisms of primary interest. It would appear from the present data that anthropogenic impact in lentic waterbodies near the Ranger mine site can be detected at the family level but interpretation of these results and assessment of their significance would still require a lower taxonomic resolution.

5.2 Macroinvertebrate vs microinvertebrate sensitivities

Data of B Timms (Univ Newcastle, submitted report) for microinvertebrates of the same seven waterbodies sampled in May 1995 showed an environmental gradient that matched *a-priori* expectations of water quality ie (poorest to highest quality) artificial waterbodies (Jabiru Lake, RP1) > RUM lease billabongs > Nourlangie Creek billabongs. Data from the present study are similar to Timm's (1995) data except that the macroinvertebrate community from Jabiru Lake was ordinated at the 'undisturbed' end of the environmental gradient referred to previously. The microinvertebrate ranking suggests that these organisms may be more responsive to the physical nature of the sites (natural vs artificial waterbody) than to water quality *per se* - the latter as suggested with macroinvertebrate data. If this result is confirmed in future studies, it would suggest that macroinvertebrate communities are more sensitive to chemical contamination, such as that resulting from mining impact, than microinvertebrates.

5.3 Comparison with other Australian data

Floodplain waterbodies (or billabongs) in Australia have been less well researched than lotic systems. Apart from studies already cited that have been carried out in the Alligator Rivers Region, most work in Australia has been carried out on the billabongs of the Murray River floodplain. These studies suggest that high macroinvertebrate diversity in billabongs is linked to high productivity (particularly primary productivity - macrophytes and algae) and environmental variability (Hillman 1986). Data collected over 8 years from five billabongs in the Murray River floodplain yielded 288 macroinvertebrate taxa (predominately species - Boon et al 1990). This included 56 chironomid taxa which compares with the 44 recorded here - Appendix 3). It has been suggested (Hillman 1986) that unpredictability of inundation may result in greater differences in community composition among billabongs. Greater predictability of inundation may, therefore, offer a possible explanation for lower species richness in billabongs of the Wet-Dry Tropics although lower sampling effort thus far in tropical billabongs may also be a factor.

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

	Georgetown Billabong									
Replicate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Date	10/5/95	10/5/95	10/5/95	10/5/95	10/5/95	11/5/95	11/5/95	11/5/95	11/5/95	11/5/95
(% cover)										
Dysophylla										
EBL										
Eleocharis	15.0	10.5	6.6	5.2	10.0	7.5	4.5	4.0	2.8	6.0
Pseudoraphis	3.0	3.5				7.5		13.5	11.0	6.0
Fimbristylis										
Cyperus sp.										
Grasses indet.										
Leersia										
Commelina										
Vetiveria									4.4	
ENL	18.00	14.00	6.60	5.20	10.00	15.00	4.50	17.50	18.15	12.00
Nymphaea	33.0	35.0	28.6	39.7	32.5	20.0	22.5	15.0	13.8	18.0
Nymphoides										
Ludwigia										
Ipomoea										
Marsilea										
FA	33.00	35.00	28.60	39.65	32.50	20.00	22.50	15.00	13.75	18.00
Azolla										
FF										
Najas		14.0	8.3	13.0	7.5	10.0	15.8	15.0	16.5	18.0
Myriophyllum			5.5	3.3						3.0
Utricularia										
Halagorocae sp.	9.0	3.5	5.5	3.3						
SEF	9.00	17.50	19.25	19.50	7.50	10.00	15.75	15.00	16.50	21.00
Vallisneria										
Caldesia		3.5	0.6	0.7		5.0	2.3	2.5	6.6	9.0
SNF		1.75	0.28	0.33		2.50	1.13	1.25	3.30	4.50
Algal floc										
Overall cover	60	70	55	65	50	50	45	50	55	60
Taxa richness	4	6	6	6	3	5	4	5	6	6
Days from day 1	1	1	1	1	1	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:

	Coonjimba Billabong									
Replicate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Date	12/5/95	12/5/95	12/5/95	12/5/95	12/5/95	12/5/95	12/5/95	12/5/95	12/5/95	12/5/95
(% cover)										
Dysophylla										
EBL										
Eleocharis	4.0	6.8	4.0	7.2	9.0	19.8	12.0	7.5	13.8	12.1
Pseudoraphis	4.0		16.0	7.2	4.5	5.0		15.0	16.5	11.0
Fimbristylis										
Cyperus sp.										
Grasses indet.										
Leersia										
Commelina										
Vetiveria	16.0	13.5	12.0	7.2	4.5					5.5
ENL	24.00	20.25	32.00	21.60	18.00	24.75	12.00	22.50	30.25	28.60
Nymphaea	12.0	24.5	15.7	25.8	16.3	10.0	10.1	7.5	7.6	10.8
Nymphoides			2.0	8.8	11.3	11.0	10.0	12.5	5.5	13.8
Ludwigia				5.6	2.3					
Ipomoea										
Marsilea										
FA	12.00	24.50	17.73	40.17	29.75	21.00	20.13	20.00	13.06	24.55
Azolla										
FF										
Najas	4.0	4.5			2.3			2.5		
Myriophyllum							2.0			
Utricularia										
Halagorocae sp.										
SEF	4.00	4.50			2.25		2.00	2.50		
Vallisneria										
Caldesia		0.9				2.8	3.2		2.8	
SNF		0.45				1.38	1.60		1.38	
Algal floc										
Overall cover	40	45	40	40	45	55	40	50	55	55
Taxa richness	5	5	5	6	7	5	5	5	5	5
Days from day 1	3	3	3	3	3	3	3	3	3	3

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:

	Djalkmara Billabong									
Replicate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Date	18/5/95	18/5/95	18/5/95	18/5/95	18/5/95	18/5/95	18/5/95	18/5/95	18/5/95	18/5/95
(% cover)										
Dysophylla										
EBL										
Eleocharis	42.0	27.5	26.0	32.5	72.3	30.0	42.0	41.3	48.0	75.0
Pseudoraphis										
Fimbristylis										
Cyperus sp.										
Grasses indet.										
Leersia										
Commelina										
Vetiveria										
ENL	42.00	27.50	26.00	32.50	72.25	30.00	42.00	41.25	48.00	75.00
Nymphaea	21.0	22.5	13.0	26.0	12.8	33.8	10.5	16.5	20.0	15.0
Nymphoides			19.5	6.5			10.5	17.3	12.0	5.0
Ludwigia										
Ipomoea										
Marsilea										
FA	21.00	22.50	32.50	32.50	12.75	33.75	21.00	33.75	32.00	20.00
Azolla										
FF										
Najas	7.0		6.5			11.3	7.0			
Myriophyllum										
Utricularia										
Halagorocae sp.										
SEF	7.00		6.50			11.25	7.00			
Vallisneria										
Caldesia										
SNF										
Algal floc										
Overall cover	70	50	65	65	85	75	70	75	80	90
Taxa richness	3	2	4	3	2	3	4	3	3	3
Days from day 1	9	9	9	9	9	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:

	Jabiru Lake									
Replicate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Date	23/5/95	23/5/95	23/5/95	23/5/95	23/5/95	23/5/95	23/5/95	23/5/95	23/5/95	23/5/95
(% cover)										
Dysophylla										
EBL										
Eleocharis										
Pseudoraphis	30.0		20.0	5.0	15.0	20.0	6.0	8.0		7.0
Fimbristylis										
Cyperus sp.	2.0	10.0	1.0			40.0	30.0	10.0		3.0
Grasses indet.						2.0	2.0		4.0	
Leersia										
Commelina										
Vetiveria										
ENL	32.00	10.00	21.00	5.00	15.00	62.00	38.00	18.00	4.00	10.00
Nymphaea										
Nymphoides	3.0	5.0	1.0	10.0			1.0		6.0	
Ludwigia										
Ipomoea	20.0									
Marsilea										
FA	23.00	5.00	1.00	10.00			1.00		6.00	
Azolla										
FF										
Najas										
Myriophyllum										
Utricularia							6.0			
Halagorocae sp.										
SEF							6.00			
Vallisneria										
Caldesia										
SNF										
Algal floc		50.0	20.0	10.0	60.0	13.0	15.0	12.0	2.0	
Overall cover	55	65	42	25	75	75	60	30	12	10
Taxa richness	4	3	4	3	2	4	6	3	3	2
Days from day 1	14	14	14	14	14	15	15	15	15	15

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:

	Buba Billabong									
Replicate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Date	26/5/95	26/5/95	26/5/95	26/5/95	26/5/95	26/5/95	26/5/95	26/5/95	26/5/95	26/5/95
(% cover)										
Dysophylla								1.5		10.0
EBL								1.50		10.00
Eleocharis	5.5	2.8	20.0	11.3	16.1	18.8	21.3	3.8		10.0
Pseudoraphis		3.5			2.1					
Fimbristylis										
Cyperus sp.										
Grasses indet.										
Leersia				17.3				21.8		
Commelina	4.4	16.8	16.0	7.5				6.8	33.8	10.0
Vetiveria										
ENL	9.90	23.10	36.00	36.00	18.20	18.75	21.25	32.25	33.75	20.00
Nymphaea	2.8	2.1	1.6	2.3	3.5	0.8	8.5	2.3		6.0
Nymphoides	7.2	21.0	9.6	3.0	17.5	17.3	17.0	12.0	41.3	24.0
Ludwigia										
Ipomoea										
Marsilea			4.8	7.5			4.3			
FA	9.90	23.10	16.00	12.75	21.00	18.00	29.75	14.25	41.25	30.00
Azolla		0.7								
FF		0.70								
Najas										
Myriophyllum	21.5		20.0	22.5	17.5	19.5	21.3	13.5		15.0
Utricularia		17.5								
Halagorocae sp.										
SEF	21.45	17.50	20.00	22.50	17.50	19.50	21.25	13.50		15.00
Vallisneria										
Caldesia	13.8	5.6	8.0	3.8	13.3	18.8	12.8	13.5		25.0
SNF	6.88	2.80	4.00	1.88	6.65	9.38	6.38	6.75		12.50
Algal floc										
Overall cover	55	70	80	75	70	75	85	75	75	70
Taxa richness	6	8	7	8	6	5	6	8	2	7
Days from day 1	17	17	17	17	17	17	17	17	17	17

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									
Replicate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Date	29/5/95	29/5/95	29/5/95	29/5/95	29/5/95	29/5/95	29/5/95	29/5/95	29/5/95	29/5/95
(% cover)										
Dysophylla										
EBL										
Eleocharis	6.5	2.5		2.0	2.0	1.2			3.8	2.8
Pseudoraphis	32.5	10.0	9.0	6.0	4.0	4.0	15.0	52.0	85.5	5.5
Fimbristylis										
Cyperus sp.										
Grasses indet.										
Leersia										
Commelina										
Vetiveria										
ENL	39.00	12.50	9.00	8.00	6.00	5.20	15.00	52.00	89.30	8.25
Nymphaea	3.3	2.5	6.8	2.0		0.4	3.0	6.5	2.9	
Nymphoides							3.0			
Ludwigia										
Ipomoea										
Marsilea										
FA	3.25	2.50	6.75	2.00		0.40	6.00	6.50	2.85	
Azolla								3.3		
FF								3.25		
Najas										
Myriophyllum										
Utricularia	13.0	15.0	22.5	20.0	18.0	14.4	9.0		2.9	5.5
Halagorocae sp.										
SEF	13.00	15.00	22.50	20.00	18.00	14.40	9.00		2.85	5.50
Vallisneria										
Caldesia	9.8	20.0	6.8	10.0	16.0	20.0		3.3		41.3
SNF	4.88	10.00	3.38	5.00	8.00	10.00		1.63		20.60
Algal floc										
Overall cover	65	50	45	40	40	40	30	65	95	55
Taxa richness	5	5	4	5	4	5	4	4	4	4
Days from day 1	20	20	20	20	20	20	20	20	20	20

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									
Replicate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Date	7/6/95	7/6/95	7/6/95	7/6/95	7/6/95	7/6/95	7/6/95	7/6/95	7/6/95	7/6/95
(% cover)										
Dysophylla										
EBL										
Eleocharis	1.1		1.1	3.0		1.8	12.0	4.5	3.0	65.0
Pseudoraphis	10.5	1.8		1.5			2.0			
Fimbristylis	5.3	7.0	3.5	3.0	3.0	7.0		4.5	4.5	10.0
Cyperus sp.										
Grasses indet.										
Leersia										
Commelina										
Vetiveria										
ENL	16.80	8.75	4.55	7.50	3.00	8.75	14.00	9.00	7.50	75.00
Nymphaea	5.3	3.5	3.5	3.0	3.0	5.3	12.0	9.0	9.0	20.0
Nymphoides		7.0	14.7	7.5	13.5	5.3	2.0	4.5	4.5	
Ludwigia										
Ipomoea										
Marsilea										
FA	8.75	14.53	18.20	12.00	18.75	13.13	14.00	13.50	13.50	20.00
Azolla										
FF										
Najas										
Myriophyllum										
Utricularia	6.0	7.7	12.3	6.0	6.0	10.5	12.0	7.5	9.0	5.0
Halagorocae sp.										
SEF	5.95	7.70	12.25	6.00	6.00	10.50	12.00	7.50	9.00	5.00
Vallisneria	7.0	8.1		3.0	4.5	5.3				
Caldesia				3.0						
SNF	7.00	8.05		4.50	4.50	5.25				
Algal floc										
Overall cover	35	35	35	30	30	35	40	30	30	35
Taxa richness	6	6	5	8	5	6	5	5	5	4
Days from day 1	29	29	29	29	29	29	29	29	29	29

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

		Georgetown Billabong					Coonjimba Billabong				
Replicate		**3**	**7**	**8**	**9**	**10**	**1**	**4**	**5**	**7**	**10**
Coleoptera	Chrysomelidae (adult)										
	Curculionidae (adult)	2	3	2		1				1	
	Dytiscidae (adult)			1		2	5	5	2	1	19
	Dytiscidae (larvae)	2		2	1	1	1				
	Elmidae (larvae)	1									
	Haliplidae (larvae)			1							
	Hydrophilidae (adult)	2	1		1	6	15	6	1	3	5
	Hydrophilidae (larvae)			2	1			1		7	
	Hygrobiidae (adult)										
	Limnichidae										
	Noteridae (adult)		4				1			2	1
	Noteridae (larvae)								1		
	Scirtidae										
Diptera	Ceratopogonidae			2				7	3		1
	Chironomidae	60	10	70	41	11	57	37	127	68	5
	Culicidae								1	1	
	Staphylinidae										
	Stratiomyidae										
	Tabanidae		1								1
	Tipulidae						1				
Ephemeroptera	Baetidae		2	15	1	5	1	10		3	1
	Caenidae	6	5		5	6		10		10	3
Hemiptera	Belostomatidae	1		2		5	8	8	14	1	7
	Corixidae		1	1							
	Gerridae			1				4			
	Hebridae										
	Mesoveliidae									4	
	Naucoridae		1	3	2	4	1	1	3		1
	Nepidae										
	Notonectidae										
	Pleidae	14	7	9	20	5	3	1	1		4
	Saldidae										
	Veliidae					3	4	3			1
Lepidoptera	Pyralidae	2		7	2	2	4	1			1
Neuroptera	Sisyridae	1			1						
Odonata	Coenagrionidae	15	18	22	40	20	6	8	2	5	4
	Gomphidae	1	4					1			
	Libellulidae	9	9	6	15	16	5	5	7	7	2
	Anisoptera (indet)			3				1			
	Zygoptera (indet)				8	6				1	1
Trichoptera	Ecnomidae	1			2					1	1
	Hydroptilidae	1			1					1	
	Leptoceridae	2	6	9	4	3	1	1		1	
Hirudinea	Glossiphoniidae	2			1	2					
Oligochaeta	Naididae	2	1		2	1		9	5	1	2
	Tubificidae			1							
	Oligochaeta (indet)										
Crustacea	Atyidae		5	2	10	8		1			
	Palaemonidae		1	5	6	8					
Gastropoda	Bithyniidae	2	9	5	21						
	Lymnaeidae							1			
	Planorbidae		1		5			1			
	Thiaridae										
	Viviparidae				1	24					
Acarina	Family indet.	3			1		2	6	1	12	6

Appendix 2:

		Djalkmara Billabong					Jabiru Lake				
Replicate		**2**	**3**	**4**	**5**	**7**	**2**	**4**	**5**	**6**	**10**
Coleoptera	Chrysomelidae (adult)					2					
	Curculionidae (adult)								1	1	
	Dytiscidae (adult)	1	3	10	15	4	4	6	12	2	10
	Dytiscidae (larvae)							3			
	Elmidae (larvae)										
	Haliplidae (larvae)										
	Hydrophilidae (adult)		14	23	12	20	1	3	2	11	
	Hydrophilidae (larvae)	5	8	13	2	2			1		
	Hygrobiidae (adult)										
	Limnichidae									1	
	Noteridae (adult)									2	
	Noteridae (larvae)									1	
	Scirtidae										
Diptera	Ceratopogonidae	1	3	3	1	1		3	3	11	3
	Chironomidae	69	43	30	26	33	36	31	5	30	13
	Culicidae				4		1		1		
	Staphylinidae					1					
	Stratiomyidae				1					1	
	Tabanidae			1		18	2	1	1		
	Tipulidae										
Ephemeroptera	Baetidae	10	7	4	30	5	2	1	2	1	3
	Caenidae	12	22	30	17	4	4	2			1
Hemiptera	Belostomatidae	2	8	3	6	2	1	3	1	5	
	Corixidae							2	1	1	1
	Gerridae	1			4						
	Hebridae				1						
	Mesoveliidae	10	4	9	1	17					
	Naucoridae	4	6		2	13		2	1		
	Nepidae										
	Notonectidae										
	Pleidae	2	6	5	2	2	2	3	6	12	
	Saldidae										
	Veliidae				1		2				
Lepidoptera	Pyralidae		1		1		4	1		1	
Neuroptera	Sisyridae										
Odonata	Coenagrionidae	33	26	96	22	22	10	1	7	3	7
	Gomphidae							1			2
	Libellulidae	7	11	6	1	7	4	2	5	20	2
	Anisoptera (indet)	1		1	4		1				1
	Zygoptera (indet)	4	1	5	3						1
Trichoptera	Ecnomidae						1				6
	Hydroptilidae						1				
	Leptoceridae		2	1		1	4	10	4	5	
Hirudinea	Glossiphoniidae										
Oligochaeta	Naididae		1	1			2		4	1	1
	Tubificidae										
	Oligochaeta (indet)										
Crustacea	Atyidae										
	Palaemonidae						1	1			5
Gastropoda	Bithyniidae			1							
	Lymnaeidae										
	Planorbidae	3	1				2				
	Thiaridae										6
	Viviparidae										
Acarina	Family indet.		2	1	4	1	79	67	165	68	128

Appendix 2:

		Buba Billabong					Sandy Billabong				
Replicate		**1**	**2**	**4**	**8**	**9**	**3**	**4**	**5**	**6**	**9**
Coleoptera	Chrysomelidae (adult)					1					
	Curculionidae (adult)	2	6	1	1	2		1		1	1
	Dytiscidae (adult)		1	3	8	1	1	3	1		1
	Dytiscidae (larvae)		2	1	2	1		1	1	1	
	Elmidae (larvae)										
	Haliplidae (larvae)										
	Hydrophilidae (adult)	6	1	7	13	1	3		2		10
	Hydrophilidae (larvae)		1	3	1						9
	Hygrobiidae (adult)						1				
	Limnichidae										
	Noteridae (adult)										2
	Noteridae (larvae)						1				2
	Scirtidae										
Diptera	Ceratopogonidae	3	4	1	2	1	1	1	2		7
	Chironomidae	9	38	11	31	35	61	64	79	53	20
	Culicidae						4		2		8
	Staphylinidae					1					
	Stratiomyidae										
	Tabanidae	4	2	4		1					
	Tipulidae										1
Ephemeroptera	Baetidae						5				17
	Caenidae	4	29		13	5	10	6	9	4	16
Hemiptera	Belostomatidae	10	3	4	4	5	2	2		8	5
	Corixidae							14	4	1	
	Gerridae						1			1	
	Hebridae				1						1
	Mesoveliidae						1		1		
	Naucoridae	10	3	3	5	5	1	1	1	3	7
	Nepidae										
	Notonectidae							1			
	Pleidae	8	5	8	11	16	4	5	2	3	8
	Saldidae										1
	Veliidae	1									
Lepidoptera	Pyralidae	10	2	6	9	7		2			8
Neuroptera	Sisyridae						1				
Odonata	Coenagrionidae	13	17	8	5	15	9	11	8	4	9
	Gomphidae	3									
	Libellulidae	17	18	11	20	20	14	10	2	9	18
	Anisoptera (indet)	1						1		1	
	Zygoptera (indet)	1		2						2	1
Trichoptera	Ecnomidae	4			1	1			1	2	
	Hydroptilidae		1		1	1	4				
	Leptoceridae	3		2	5	1	2	1	5		1
Hirudinea	Glossiphoniidae										
Oligochaeta	Naididae	1			4		1	3			8
	Tubificidae		1		2						
	Oligochaeta (indet)		1								
Crustacea	Atyidae	1			1		5	1			7
	Palaemonidae				2	5	1	1		1	6
Gastropoda	Bithyniidae			1							
	Lymnaeidae		5	2	1						
	Planorbidae	1	8	2	15	2	1				2
	Thiaridae										
	Viviparidae	12	9	13	20						
Acarina	Family indet.	8	4	18	26	5	8	8	3		14

Appendix 2:

		RP1				
Replicate		**1**	**5**	**8**	**9**	**10**
Coleoptera	Chrysomelidae (adult)					
	Curculionidae (adult)	1		1		
	Dytiscidae (adult)	9	7	2	19	12
	Dytiscidae (larvae)	2				
	Elmidae (larvae)					
	Haliplidae (larvae)		1			
	Hydrophilidae (adult)		6	5	12	
	Hydrophilidae (larvae)		2	7	2	1
	Hygrobiidae (adult)					
	Limnichidae					
	Noteridae (adult)					
	Noteridae (larvae)					
	Scirtidae				1	
Diptera	Ceratopogonidae	9	2	2	1	9
	Chironomidae	119	64	73	94	84
	Culicidae			2		
	Staphylinidae					
	Stratiomyidae					
	Tabanidae		1			
	Tipulidae					
Ephemeroptera	Baetidae	4	4	1	1	1
	Caenidae		13	2	1	1
Hemiptera	Belostomatidae	1	2		6	3
	Corixidae				1	
	Gerridae	2	2		1	
	Hebridae					
	Mesoveliidae					
	Naucoridae		7	4	2	1
	Nepidae					1
	Notonectidae		8		1	
	Pleidae	5	20	10	21	12
	Saldidae					
	Veliidae				3	
Lepidoptera	Pyralidae	1	19	8	1	1
Neuroptera	Sisyridae					
Odonata	Coenagrionidae	20	14	45	28	18
	Gomphidae	3	1	1	2	1
	Libellulidae	12	6	14	9	4
	Anisoptera (indet)		1	1		
	Zygoptera (indet)		17	2		
Trichoptera	Ecnomidae		1		2	1
	Hydroptilidae					
	Leptoceridae	30	36	4	8	5
Hirudinea	Glossiphoniidae					
Oligochaeta	Naididae	2		1	2	2
	Tubificidae			1		
	Oligochaeta (indet)					
Crustacea	Atyidae					
	Palaemonidae					
Gastropoda	Bithyniidae					
	Lymnaeidae					
	Planorbidae		1	1		
	Thiaridae					
	Viviparidae					
Acarina	Family indet.	5	8	1	1	1

Appendix 3: Abundance of chironomid taxa at each site

Georgetown Billabong

Replicate	1	2	3	4	5	6	7	8	9	10
Subfamily Chironominae										
Chironomus	13	1	5	7	3	1				
nr Chironomus										
Cladopelma	3		1							
Cladotanytarsus			2				1	3	1	
Conochironomus			1					1		
Cryptochironomus										
Dicrotendipes sp.1	1	1	2	1	1	1	2		1	1
Dicrotendipes sp. 2		1				4	2		1	
Dicrotendipes sp. 3										
Kiefferulus			1				1		1	
Microchironomus										
nr Microchironomus										
Parachironomus										
Paratanytarsus										
Paratendipes										
nr Paratendipes										
Polypedilum leei	2			1		1		1		
Polypedilum sp. 1	1	1				9	2		1	2
Polypedilum sp. 2									2	
Polypedilum sp. 3										
Rheotanytarsus									2	
Skusella										
Stenochironomus										
? Stictochironomus										
Tanytarsus sp. 1						1			1	
Tanytarsus sp. 2										
Tanytarsus sp. 3						1				
Tanytarsus sp. 4										
Tanytarsus sp. 5										
Tanytarsus sp. 6										
Zavreliella marmorata										
Chironominae type A			1							
Chironominae type B										
Subfamily Orthocladiinae										
Nanocladius OSS1L										
Parakiefferiella OSS1L										
Subfamily Tanypodinae										
Ablabesmyia sp. 1			1			6	1	1	1	1
Ablabesmyia sp. 2						1				
Clinotanypus crux		1								
Fittkauimyia disparipes						1				
Larsia	1	1	30	2	1	32		59	27	3
nr Larsia	1	1	12	4	2	4	1	4	1	1
Paramerina						1				1
Procladius	3	1	2		1	3			1	
Tanypus OSS1L										
Chiromonid (indet.)			2			1		1	1	2
richness	8	8	11	5	5	14	7	6	12	6
no. identified	25	8	58	15	8	66	10	69	40	9
total abundance	25	8	60	15	8	67	10	70	41	11

Appendix 3:

Coonjimba Billabong

Replicate	1	2	3	4	5	6	7	8	9	10
Subfamily Chironominae										
Chironomus		1		7					3	1
nr Chironomus									1	
Cladopelma										
Cladotanytarsus						1				
Conochironomus							2			
Cryptochironomus										
Dicrotendipes sp.1	1			1						
Dicrotendipes sp. 2						1				
Dicrotendipes sp. 3	2									
Kiefferulus						3			1	
Microchironomus										
nr Microchironomus										
Parachironomus										
Paratanytarsus							1			
Paratendipes										
nr Paratendipes										
Polypedilum leei	1			1			1			
Polypedilum sp. 1	4	1		2		1	3	1		
Polypedilum sp. 2										
Polypedilum sp. 3										
Rheotanytarsus										
Skusella										
Stenochironomus										
? Stictochironomus										
Tanytarsus sp. 1				1	1			1		1
Tanytarsus sp. 2										
Tanytarsus sp. 3				2						
Tanytarsus sp. 4										
Tanytarsus sp. 5									1	
Tanytarsus sp. 6										
Zavreliella marmorata									1	
Chironominae type A								1		
Chironominae type B										
Subfamily Orthocladiinae										
Nanocladius OSS1L										
Parakiefferiella OSS1L				1	1					
Subfamily Tanypodinae										
Ablabesmyia sp. 1	1			1						1
Ablabesmyia sp. 2										
Clinotanypus crux		1								
Fittkauimyia disparipes										
Larsia	37	29	32	18	35	12	48	13	28	1
nr Larsia	10	18	17	2	10	3	11	6	9	
Paramerina										
Procladius				1	2	1	2	1	1	1
Tanypus OSS1L										
Chiromonid (indet.)	1	60	66		78		1		1	
richness	7	5	2	11	5	7	7	6	8	5
no. identified	56	50	49	37	49	22	68	23	45	5
total abundance	57	110	115	37	127	22	69	23	46	5

Appendix 3:

	Djalkmara Billabong									
Replicate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Subfamily Chironominae										
Chironomus	2	6	5	8	3	10	2	3	1	1
nr Chironomus										
Cladopelma										
Cladotanytarsus			11	4	4	1				2
Conochironomus										
Cryptochironomus										
Dicrotendipes sp.1										
Dicrotendipes sp. 2	1									
Dicrotendipes sp. 3										
Kiefferulus		1								
Microchironomus										
nr Microchironomus										
Parachironomus			1							
Paratanytarsus										
Paratendipes										
nr Paratendipes										
Polypedilum leei	1		2		1	1		3	2	1
Polypedilum sp. 1	4		4	2	6	5	1	4	10	40
Polypedilum sp. 2										
Polypedilum sp. 3										
Rheotanytarsus										
Skusella										
Stenochironomus										
? Stictochironomus										
Tanytarsus sp. 1	3	4	6	9	2	3	1	2	1	3
Tanytarsus sp. 2					1	1	1			
Tanytarsus sp. 3										
Tanytarsus sp. 4										
Tanytarsus sp. 5			1							
Tanytarsus sp. 6										
Zavreliella marmorata										
Chironominae type A										
Chironominae type B										
Subfamily Orthocladiinae										
Nanocladius OSS1L										
Parakiefferiella OSS1L										
Subfamily Tanypodinae										
Ablabesmyia sp. 1	1	2	1	3	2	1				2
Ablabesmyia sp. 2										
Clinotanypus crux										
Fittkauimyia disparipes										
Larsia	21	26	2	1	5	1	10	7	1	2
nr Larsia	4	27	5		2		16	3	1	5
Paramerina						1				
Procladius			2	1						1
Tanypus OSS1L										
Chiromonid (indet.)	1	3	3	2			2			1
richness	8	6	11	7	9	9	6	6	6	9
no. identified	37	66	40	28	26	24	31	22	16	57
total abundance	38	69	43	30	26	32	33	22	16	58

Appendix 3:

Replicate	1	2	3	4	5	6	7	8	9	10
	Jabiru Lake									
Subfamily Chironominae										
Chironomus	5					2	1	1		
nr Chironomus										
Cladopelma										
Cladotanytarsus		2		1			6			
Conochironomus		1						1	6	
Cryptochironomus										
Dicrotendipes sp.1					1					
Dicrotendipes sp. 2				1					1	1
Dicrotendipes sp. 3										
Kiefferulus										
Microchironomus										
nr Microchironomus										
Parachironomus										
Paratanytarsus										
Paratendipes										
nr Paratendipes										
Polypedilum leei	1								1	
Polypedilum sp. 1							1			
Polypedilum sp. 2			1							
Polypedilum sp. 3			1							
Rheotanytarsus									1	1
Skusella										
Stenochironomus										
? Stictochironomus										
Tanytarsus sp. 1	3			1		1	1			
Tanytarsus sp. 2										
Tanytarsus sp. 3	2									
Tanytarsus sp. 4			1	2				3		
Tanytarsus sp. 5				2	1					
Tanytarsus sp. 6										
Zavreliella marmorata	1									
Chironominae type A										
Chironominae type B										
Subfamily Orthocladiinae										
Nanocladius OSS1L				1						
Parakiefferiella OSS1L										
Subfamily Tanypodinae										
Ablabesmyia sp. 1			2	2			5	4	2	4
Ablabesmyia sp. 2										
Clinotanypus crux			1							
Fittkauimyia disparipes						1				
Larsia	3	19	5	14		2	13	2	7	6
nr Larsia	12	12	11	5	3	20	26	1	3	1
Paramerina									1	
Procladius		2	1	1		2	5	4	10	
Tanypus OSS1L										
Chiromonid (indet.)			1	1		2	1			
richness	6	6	8	10	3	6	8	7	9	5
no. identified	27	36	23	30	5	28	58	16	32	13
total abundance	27	37	24	31	5	30	59	16	32	13

Appendix 3:

Buba Billabong

Replicate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Subfamily Chironominae										
Chironomus		1	1			1			1	
nr Chironomus										
Cladopelma					2		2	3		
Cladotanytarsus	1	1	2			2	1		1	
Conochironomus	1	1		4				5		
Cryptochironomus										
Dicrotendipes sp.1		1						3		
Dicrotendipes sp. 2		1							2	
Dicrotendipes sp. 3										
Kiefferulus										
Microchironomus										
nr Microchironomus						1				
Parachironomus										
Paratanytarsus										
Paratendipes										
nr Paratendipes										
Polypedilum leei					1					
Polypedilum sp. 1			2	2	1	1	1	4		5
Polypedilum sp. 2				1			5			1
Polypedilum sp. 3										
Rheotanytarsus										
Skusella				1						1
Stenochironomus										
? Stictochironomus									1	5
Tanytarsus sp. 1	2	1	6	1	3	2	3	2	6	9
Tanytarsus sp. 2										
Tanytarsus sp. 3			1					1		
Tanytarsus sp. 4										
Tanytarsus sp. 5										
Tanytarsus sp. 6										1
Zavreliella marmorata					1					
Chironominae type A										
Chironominae type B										1
Subfamily Orthocladiinae										
Nanocladius OSS1L										
Parakiefferiella OSS1L										
Subfamily Tanypodinae										
Ablabesmyia sp. 1										
Ablabesmyia sp. 2										
Clinotanypus crux	1					2	2		1	1
Fittkauimyia disparipes										
Larsia	1	6	43	1	3	2	36	7	12	27
nr Larsia	1	23	37	1	2	7	21	2	7	11
Paramerina									1	
Procladius					1	2	2			3
Tanypus OSS1L										
Chiromonid (indet.)	2	3			1			4	3	1
richness	6	8	7	7	8	9	9	8	9	11
no. identified	7	35	92	11	14	20	73	27	32	65
total abundance	9	39	93	11	15	20	75	31	35	66

Appendix 3:

Sandy Billabong										
Replicate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Subfamily Chironominae										
Chironomus				1	3	2				
nr Chironomus										
Cladopelma			1	2			1			
Cladotanytarsus	1		1				1		2	
Conochironomus	1		1	2	7	1	1			
Cryptochironomus				1			1			
Dicrotendipes sp.1	1	1								
Dicrotendipes sp. 2				1						1
Dicrotendipes sp. 3										
Kiefferulus										
Microchironomus									1	
nr Microchironomus										
Parachironomus										
Paratanytarsus										
Paratendipes										
nr Paratendipes										
Polypedilum leei										
Polypedilum sp. 1		1	4	4	8					2
Polypedilum sp. 2										
Polypedilum sp. 3										
Rheotanytarsus		1			1		1			
Skusella										
Stenochironomus		2								1
? Stictochironomus										
Tanytarsus sp. 1									1	
Tanytarsus sp. 2										
Tanytarsus sp. 3			1	1			1			
Tanytarsus sp. 4										
Tanytarsus sp. 5										
Tanytarsus sp. 6										
Zavreliella marmorata	1	1	1	1						
Chironominae type A			1	1						
Chironominae type B										
Subfamily Orthocladiinae										
Nanocladius OSS1L	1									1
Parakiefferiella OSS1L	1	1	1			1	1		2	1
Subfamily Tanypodinae										
Ablabesmyia sp. 1	2	2	2		4	1				1
Ablabesmyia sp. 2			1				1			
Clinotanypus crux	1					1	1			
Fittkauimyia disparipes										
Larsia	31	9	41	27	27	41	13	1	3	8
nr Larsia			2	1		1	4		9	
Paramerina										
Procladius	3		1	20		4	15			
Tanypus OSS1L										
Chiromonid (indet.)			3	2	29	1			2	1
richness	10	8	13	12	6	8	12	1	6	7
no. identified	43	18	58	62	50	52	41	1	18	15
total abundance	43	18	61	64	79	53	41	2	20	16

Appendix 3:

RP1										
Replicate	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Subfamily Chironominae										
Chironomus	4		2	3		1	2	1		1
nr Chironomus										
Cladopelma			4		1	2		3		
Cladotanytarsus	4	2	3	3	3	1		5		1
Conochironomus	1	18	16	4	1	5		2		3
Cryptochironomus										
Dicrotendipes sp.1			1			3			1	2
Dicrotendipes sp. 2						3		2	2	
Dicrotendipes sp. 3	1									
Kiefferulus										
Microchironomus										
nr Microchironomus										
Parachironomus										
Paratanytarsus										
Paratendipes							1			
nr Paratendipes			1							
Polypedilum leei	1		1	6	3	1			2	
Polypedilum sp. 1		1		8	8	2	9	5	3	
Polypedilum sp. 2	1	2	1	1		1			3	
Polypedilum sp. 3										
Rheotanytarsus		2		1						
Skusella										
Stenochironomus										
? Stictochironomus										
Tanytarsus sp. 1		1				5	3	1	1	2
Tanytarsus sp. 2	2									
Tanytarsus sp. 3	1				1				1	
Tanytarsus sp. 4		1			2	2				
Tanytarsus sp. 5		1	1	1	1	4		1	2	1
Tanytarsus sp. 6										
Zavreliella marmorata	1									
Chironominae type A										
Chironominae type B										
Subfamily Orthocladiinae										
Nanocladius OSS1L										
Parakiefferiella OSS1L				1	1					
Subfamily Tanypodinae										
Ablabesmyia sp. 1	1	1				1	1	1	1	7
Ablabesmyia sp. 2										
Clinotanypus crux			1					3	3	
Fittkauimyia disparipes										
Larsia	25	19	13	20	26	16	9	15	21	25
nr Larsia	5		4		1		3	6	3	4
Paramerina										
Procladius	3	2				4		2	6	1
Tanypus OSS1L							1			
Chiromonid (indet.)	69	61	23	45	16	3		26	45	37
richness	12	11	13	10	11	15	8	13	13	10
no. identified	50	50	48	48	48	51	29	47	49	47
total abundance	119	111	71	93	64	54	29	73	94	84