Wetland Survey of the Lake Bryde Natural Diversity Recovery Catchment: Waterbirds, Aquatic Invertebrates and Water chemistry

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Summary
A summer rainfall event in January 2006 presented an opportunity to collect baseline data for wetlands of the Lake Bryde Natural Diversity Recovery Catchment. Water chemistry, Waterbirds and invertebrates were sampled at seven wetlands in March 2006, October 2006 and March 2007.

Immediately after flooding all wetlands recorded their lowest salinities, however, three detention lakes and Lake Janet were above thresholds believed to limit the richness of freshwater invertebrates. Only four wetlands held water 12 months after flooding and only East Lake Bryde and Yate Swamp were fresh.

25 species of water bird were recorded including 7 species which bred on Recovery Catchment wetlands in response to the high water levels. Recorded water birds were generally ubiquitous species although the relatively uncommon Freckled Duck was also recorded.

Three previously undescribed species of micro-invertebrates were collected from Recovery Catchment wetlands. These were the rotifers; *Lecane* sp. nov, collected from Lake Bryde and *Brachionus* sp. *nov.* [plicatilis complex] from East Lake Bryde. The third species, a conchostracan, *Limnadopsis* sp. *nov.* (type 'paradoxa') was collected from both Lake Bryde and East Lake Bryde.

A total of 186 distinct invertebrate taxa were collected from the seven studied wetlands. In conjunction with data from monitoring at Lake Bryde between 1997 and 2003, observed species richness for the Recovery Catchment reached 221 species. A statistical estimate (ICE) of total species richness for these wetlands was 313 species which fits with published data suggesting that the sampling protocol collects 60-70% of species within a wetland.

Half of the invertebrate species recorded in the current study may be considered uncommon or difficult to collect since they were not collected or were collected only once in a previous survey of 223 wheatbelt wetlands.

Lake Bryde was a major repository of the observed biodiversity. A total of 140 invertebrate species have been identified for this wetland alone. The current study collected 30 invertebrate species not previously recorded at Lake Bryde and there were 68 species collected previously and not on this occasion. 58% of the total species pool collected within the recovery catchment has been collected at least once at Lake Bryde. Lake Bryde was also the most important wetland for both waterbird richness and abundance in March 2007.

The three freshest wetlands Lake Bryde, Yate Swamp and East Lake Bryde supported 67% of the invertebrate species richness in March 2006,

including a high proportion of micro-invertebrate species. At this time other wetlands were also at their most species rich, but supported a diverse fauna dominated by insects. It is likely that salinization has a negative impact on the richness of micro-invertebrate species in particular and that flood events are important in the long term maintenance of populations of these species.

Introduction

The Lake Bryde Recovery Catchment was established in 1999 as one of the Natural Biodiversity Recovery Catchments managed by the Department of Environment and Conservation (Wallace 2001). The Recovery Catchment includes many fresh and naturally saline wetlands and lies in the headwaters of the Lockhart catchment, a sub-catchment of the Swan-Avon basin.

Lake Bryde is a focal point of the Recovery Catchment and has been monitored for; water level and water chemistry since the 1970's (Lane and Munroe 1983, Lane et al. 2004), aquatic invertebrates and waterfowl since 1998 (Cale et al 2004) and fringing vegetation since 1998 (Ogden and Froend 1998, Gurner et al 1999, Gurner et al 2000, Mike Lyons unpublished data). Lake Bryde and East Lake Bryde were surveyed for waterbirds between 1981 and 1985 (Jaensch et al 1985). However, little or no data for other wetlands within the Recovery Catchment are available and no data are available for these wetlands immediately following a flood event.

In January 2006 a high rainfall event across the South-west land division resulted in the flooding of valley floors and the associated wetland chains throughout the Lake Bryde Recovery Catchment. This event provided an opportunity to collect baseline data for water chemistry, aquatic invertebrates and waterbirds in selected wetlands under high water level (and low salinity) conditions.

Methods

Rainfall event

A major driver of this study was the filling of the wetlands which resulted from a summer rainfall event. During January 2006 the remains of Tropical Cyclone Clare crossed through the south-west land division and caused widespread rains over a period of days. Lake Grace to the east of the recovery catchment recorded 268mm of rainfall while Katanning to the west received 61mm. The average rainfall for the district was 98mm (Bureau of Meteorology 2006).

Farmer et al (2002) suggested that rainfall events of greater than 70-80mm will cause widespread inundation of the recovery catchment wetlands (see also Watkins and McNee 1987) and that six such events had occurred since 1925. Prior to the event in Jan 2006, the most recent event was in Jan 2000 and was at least superficially similar.

It is likely that the frequency of these flooding events is greater than was historically the case, as increased runoff resulting from land clearing has resulted in a reduction of the threshold rainfall required to flood wetlands (Farmer et al 2002).

Study sites

The seven wetlands (Fig. 1,Table 1) sampled in this investigation were selected by Recovery Catchment managers.

All wetlands lay within the valley floor (V) landscape unit described by Farmer et al (2002). While these wetlands receive water seasonally from surrounding landscapes, it is likely they only fill to capacity or overflow when the valley floor floods. The Yate Swamp (Bryde 5) is an exception in that a drainage line from the north east provides its primary inflow. Volumes flowing into the Yate Swamp from this path are probably greater than historically and inflow from the valley floor may now occur as water impounded by the adjacent Pingrup-Newdegate Rd infiltrates into the wetland (Farmer et al 2002).

Field observation suggests that except for East Lake Bryde and Yate Swamp all wetlands have some degree of secondary salinization. Detention Lake LLS1 and Lake Janet may have been naturally saline but also suffer from secondary salinization.

Geographically the wetlands lie in a chain in relatively close proximity to each other. From south east to north west the wetland chain is no longer than 25km. Within the study area several wetlands were grouped i.e. Detention Lake D5 and D1 lay within several hundred metres of each other and Lake Bryde, Yate Swamp and Lake Janet lay within a circle of approximately 1km radius. This meant that only Detention Lake LLS1 and East Lake Bryde were separated from other sample wetlands by more than 1km.

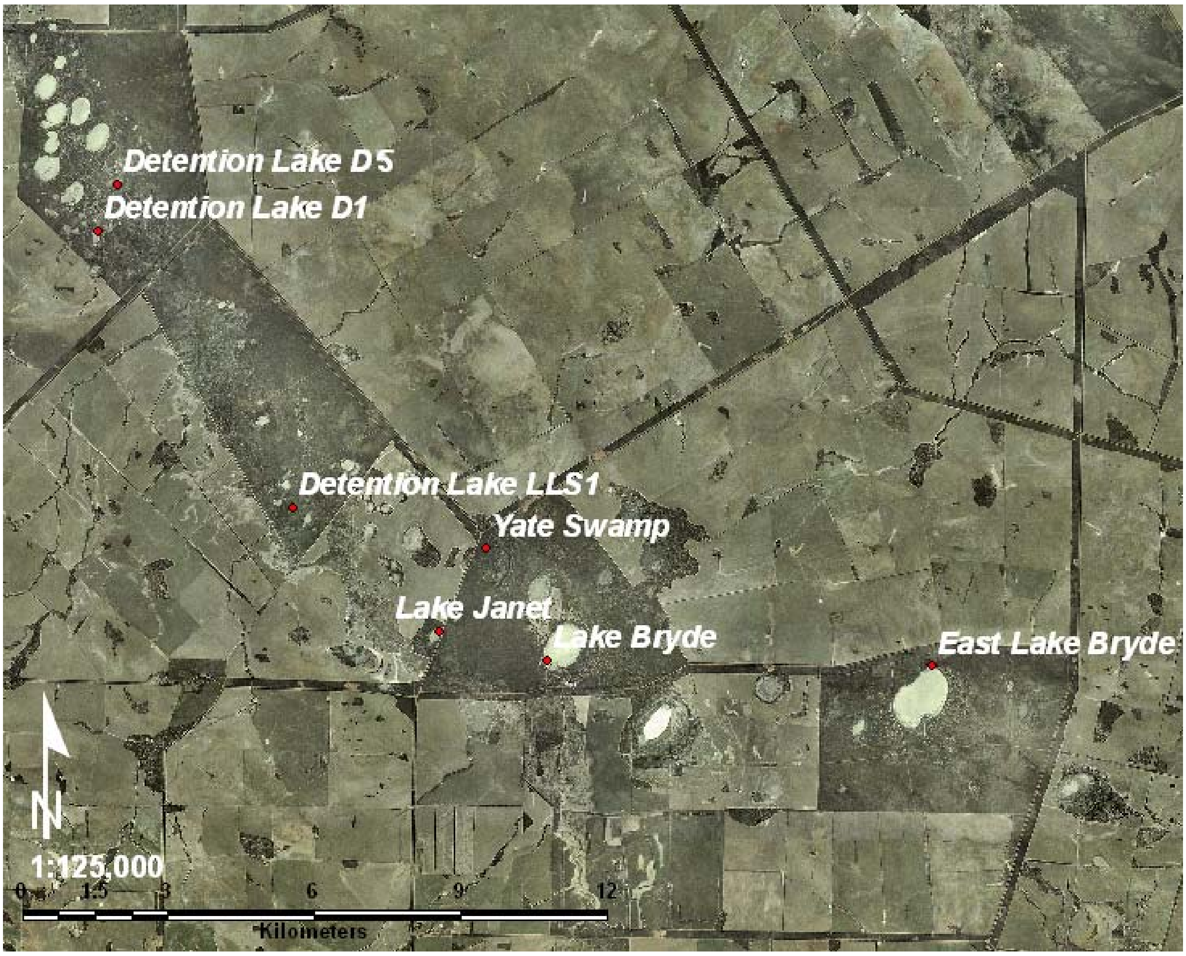

Figure 1 The seven sampled wetlands of the Lake Bryde Recovery Catchment. Red markers are approximate location of invertebrate sampling site. *Aerial photography courtesy of Landgate. Contact phone 9273 7373, website*: http://www.landgate.wa.gov.au/corporate.nsf/web/contact+us#map

TABLE 1 Sampling Site Data

Recovery Catchment Wetland	Sample Site name	Sample site Coordinates	Sample Id'	Sampling date
Detention Lake D5	Bryde 1	33°16'01"S 118°43'38"E	B1Y06MAR B1Y06OCT B1Y07MAR	22/03/2006 31/10/2006 20/03/2007
Detention Lake D1	Bryde 2	33°16'32"S 118°43'23"E	B2Y06MAR B2Y06OCT B2Y07MAR	22/03/2006 31/10/2006 20/03/2007
Detention Lake LLS1	Bryde 3	33°19'35"S 118°46'02"E	B3Y06MAR B3Y06OCT B3Y07MAR	22/03/2006 31/10/2006 20/03/2007
Lake Janet	Bryde 4	33°20'56"S 118°48'00"	B4Y06MAR B4Y06OCT B4Y07MAR	21/03/2006 1/11/2006 21/03/2007
Yate Swamp	Bryde 5	33°20'00"S 118°48'36"E	B5Y06MAR B5Y06OCT B5Y07MAR	22/03/2006 1/11/2006 21/03/2007
Lake Bryde	Bryde 6	33°21'14"S 118°49'26"E	B6Y06MAR B6Y06OCT B6Y07MAR	21/03/2006 31/10/2006 20/03/2007
East Lake Bryde	Bryde 7	33°21'13"S 118°54'32"E	B7Y06MAR B7Y06OCT B7Y07MAR	21/03/2006 1/11/2006 21/03/2007

Sampling Protocol

Wetlands were surveyed in March 2006 (20-22/3/2006), October 2006 (30-31/10/2006 and 1/11/2006) and in March 2007 (20-21/3/2007). At each wetland data were collected for water chemistry, waterbirds and aquatic invertebrates. The sampling protocol has been described in detail elsewhere (Cale et al 2004), but is summarized here.

Waterbirds were surveyed on each occasion using binoculars and spotting scope to identify all species, count all individuals and count the number of broods of breeding species. No attempt was made to search for nests; consequently breeding records are likely to be an underestimate, at least of numbers and possibly of breeding species. For larger wetlands (e.g. Bryde and East Lake Bryde) a boat was used to gain better access to all parts of the wetland. On smaller wetlands the wetted perimeter of the lake was traversed on foot.

A list of the parameters measured to elucidate wetland water chemistry is provided in Appendix 1. These parameters were measured at each wetland on each sampling occasion. At Lake Bryde and East Lake Bryde the DEC maintained depth gauge was used to record depth. At Detention Lake D1 a depth gauge associated with a single piezometer was used. In other wetlands maximum depth was estimated. Field measurement of pH, electrical conductivity, temperature and dissolved oxygen were made using a WTW 340i Multimeter. Water samples for the laboratory determination of other parameters were collected in acid washed bottles and either frozen or refrigerated until transported to The Chemistry Centre (WA) for processing. Water samples for total nitrogen and phosphorus were filtered through 0.45μm filters prior to freezing and chlorophyll samples were collected by filtering known volumes through Whatman glass microfibre filter papers. For analysis, ion concentrations were converted to milliequivalents.

Aquatic invertebrates were sampled in a benthic sample collected using a 250μm mesh D-net and a plankton sample using a 50μm mesh D-net. Both comprised a broken transect of approximately 50m aimed at sampling all habitats within an area of about 200m. Plankton samples were preserved in 5% formalin while benthic samples were preserved in ethanol. Both invertebrate samples were sorted in the laboratory under a dissecting microscope to extract all species and to estimate their abundance on a log scale. Taxa collected from benthic and plankton samples were combined to provide the total sample species list. Taxa were identified to the lowest level possible. For most groups this was species, however some dipterans could not be identified beyond family, and Ostracoda and some minor phyla (eg Nematoda and Turbellaria) were not identified below class. Rotifera were identified by Dr R. Shiel of the University of Adelaide.

Lake Bryde has been sampled, on a number of occasions, as part of the Wheatbelt Wetlands Monitoring Programme (Cale et al 2004). While using the same protocol, these samples included two sub-sites within the wetland. For use in the present study, data for a single sub-site (sub-site A) were extracted from these samples for October 1997, 1999, 2001 and 2003. These data have equivalent sampling effort to those of the current project and are included for comparison.

Analysis

Ordination and classification were used to compare the species assemblages across sites and seasons. Ordinations were carried out using the Semi-strong Hybrid multidimensional scaling (SSH) algorithm of the PATN ecological software package (Belbin 2006). Presence-absence data and Bray-Curtis association measures were used for both ordination and classification analyses. Classification analysis was performed using the Un-weighted Pair Group Mean Averaging (UPGMA) algorithm of the PATN software (Belbin 2006) with the default beta value of -0.1.

For multivariate analyses species lists were modified to ensure consistent identification of taxa across sites. Some specimens identified to species at one site could only be identified to a higher taxon at another, e.g. some beetle larvae could only be identified to genus at one site while adults of the same genus could be identified to species at another site. Taxa were reassigned by either deleting or combining them so as to lose as little information from a site as possible.

Species accumulation across wetland samples was investigated by scoring the richness of all possible wetland combinations using the EstimateS software (Colwell, R. K. 2005). This calculates the expected number of species given the observed richness. Species accumulation curves are estimates of total richness calculated using the Incident-based Coverage estimator (ICE) (Chao 2005) provided in the EstimateS software. These curves are plotted with 95% confidence limits.

Results

Water chemistry

Each wetland showed an expected decrease in depth and increase in salinity over the twelve month study period as evaporation reduced lake volumes and concentrated dissolved solids. In March 2007 Detention lake D1, Detention Lake LLS1 and Lake Janet were dry.

A classification of all samples using all environmental parameters listed in Appendix 1- 1A, defined 5 groups (Fig. 2) which can be seen to form a series on a salinity gradient (Fig. 3).

Group 1 included samples from March 2006 for Detention Lakes 5, 1 and LLS1 and Janet Lake. Salinity in these samples was between 2870µS/cm and 5150µS/cm. Whilst brackish this range represented the lowest salinity for these wetlands during the study period. Group 1 also included the March 2007 sample from Lake Bryde which by contrast was the highest salinity this wetland experienced during the study period.

Group 2 included samples with a sub-brackish salinity range of 1068-2540µS/cm. The March 2007 sample from Yate Swamp lies in this group. At this time Yate Swamp was almost dry having been reduced to a series of pools and super saturated sediments. The two other samples in this group are from Lake Bryde firstly in October 2006 and secondly from a sample collected in October 1997. Interestingly at this lake, depth in October 1997 was greater (1.74m), but associated with a higher salinity (2540µS/cm) than was recorded in October 2006 (depth 1.47, Ec 1445µS/cm) suggesting that the lake had been flushed of salt by a flood event in the intervening period.

Group 3 comprised all freshwater samples with an upper salinity boundary of 540µS/cm for the group. East Lake Bryde samples from all sample dates and Yate Swamp samples from March 2006 and October 2006 belonged to this group and also shared higher "Colour" and lower pH (6.49-7.79).than other wetlands. East Lake Bryde samples displayed much higher turbidity (1200-1800 NTU) than any other wetland. The March 2006 sample from Lake Bryde also fitted into this group and represented the lowest salinity recorded for this lake during the study period.

Group 4 included samples from October 2006 for Detention Lakes 5, 1 and LLS1 and Janet Lake. These samples were saline with Ec values between

9510µS/cm and 20100µS/cm and indicate significant evapo-concentration of lake waters as they dried. Lake Bryde in October 2001 and 2003 experienced similar salinities and samples collected on these occasions also belonged to this group.

Group 5 was represented by only two samples. Both Detention Lake 5 in March 2007 and Lake Bryde in October 1999 were hypersaline (79100mS/cm and 53700mS/cm respectively) and represented the final stages of drying of these wetlands.

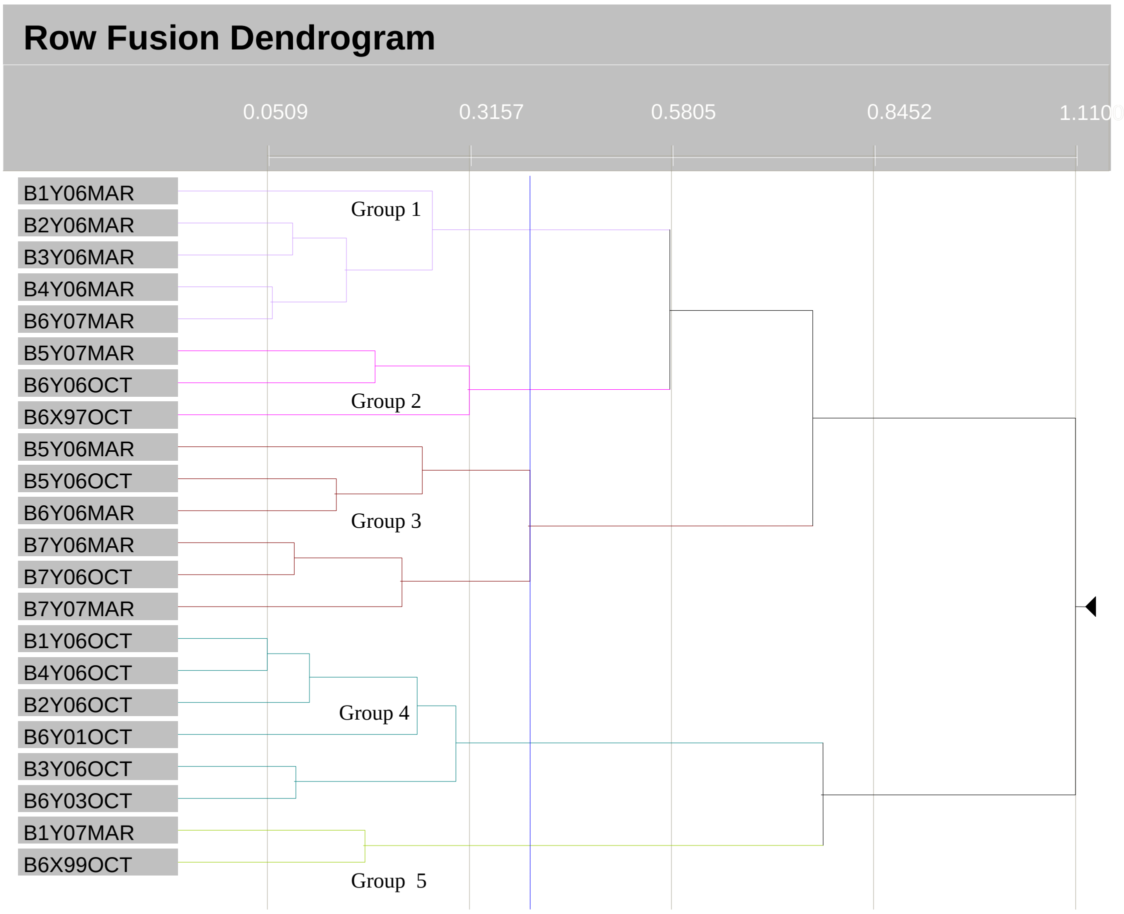

Figure 2 Dendogram output for UPGMA Classification of all samples and all environmental parameters.

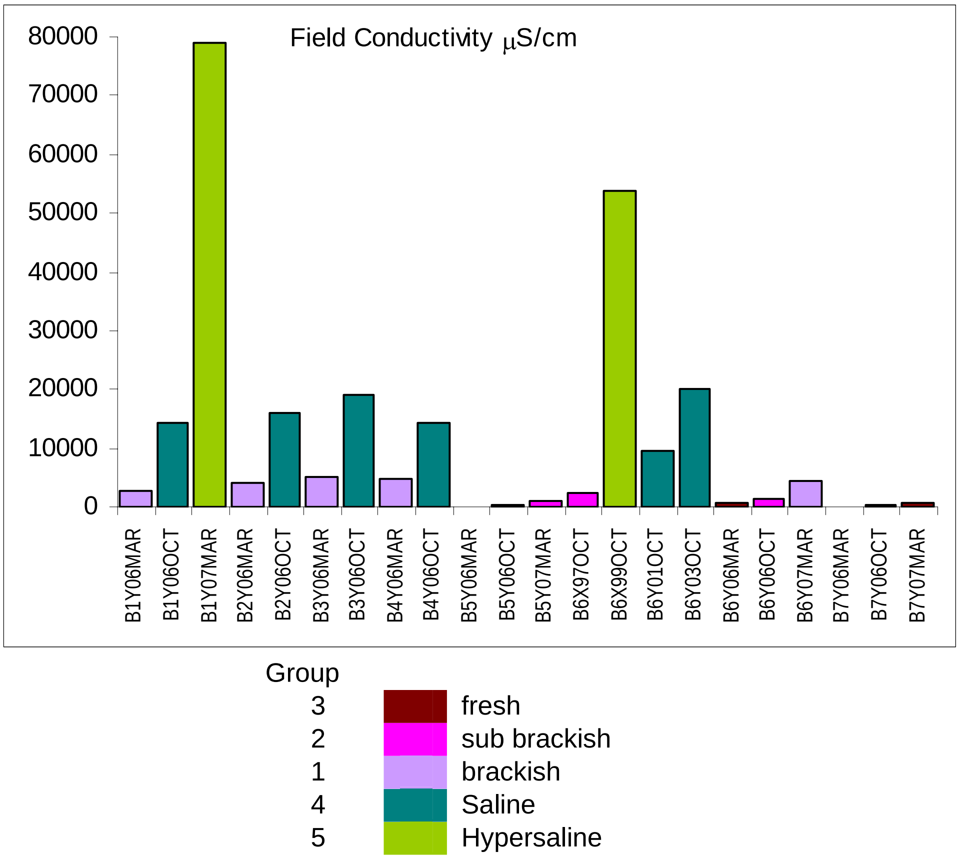

Figure 3 Electrical conductivity of each sample, colour coded by group membership from a UPGMA classification of all samples using all water chemistry variables (see also Fig. 2).

Waterbirds

A total of 25 waterbird species (Table 2) were recorded from the study area. Twelve of these occurred in all sampled seasons compared with 7 species which occurred in one season only. This suggests a relatively high level of residency over the study period.

Waterbird usage of the wetlands was strongly seasonal and dependent on wetland with three patterns observed. In the three detention lakes (Bryde 1- 3) and Lake Janet species richness of waterbirds declined over the study period and was exaggerated by the drying of these wetlands in March 2007. By contrast, in the two fresh wetlands, Yate Swamp and East Lake Bryde, species richness peaked in October 2006. Lastly, at Lake Bryde, species richness declined to October 2006 but was the highest recorded in March 2007. In this latter case Lake Bryde was clearly the favoured loafing wetland, concentrating the majority of species and individuals recorded in the study area at this time. This may be, at least in part, a response to the favourable depth of Lake Bryde which enabled ducks, particularly Grey Teal, to feed on benthic macrophyte beds.

Seven species bred within the study area in March and October 2006. Breeding was most common in March 2006, after the summer rainfall event, in line with studies that have suggested rainfall is a proximal trigger, initiating gonad development and the onset of breeding, in waterfowl (Halse and Jaensch 1989). While all wetlands supported breeding species, Lake Bryde and Detention Lakes D5 and D1 experienced the longest period of breeding activity and D5 the greatest number of broods recorded (10 broods from 5 species). Despite their presence on all wetlands except Lake Janet, Hoary-headed Grebe were only recorded breeding on the three Detention Lakes. These lakes were in close proximity and generally more secluded from traffic and visitors. Other waterbird species were recorded breeding across a range of wetlands.

Detention lake LLS1 was used by just four waterbird species. This lake was relatively small and shallow.

A classification of the waterbird data as occurrences at each wetland over the three sampling visits (Table 2) indicated 5 groups of birds that used wetlands in a similar pattern (Fig. 4). A core group of waterfowl species were found in most wetlands during the study (Group 2 of Fig. 4). These are species such as the Grey Teal and Eurasian Coot, which are generally ubiquitous. The presence of these species at any particular wetland in any particular season did not follow a pattern detectable by the three sampling visits. Group 1 of the classification was closely aligned to group 2 with a wide distribution across the study site, but differed in that species of this group were absent from Detention Lake D5 and Detention Lake LLS1.

The remaining groups of this classification included a number of species which were rarely encountered and probably required particular wetland conditions. For example the Little Grassbird (group 5, Fig. 4) was only encountered on Detention lakes D5 and D1 where it utilized the dense fringing Melaleuca habitat. Three shorebird species (Black-fronted Dotterel, Black-winged Stilt and Red-kneed Dotterel- Group 5) were only recorded at Detention Lakes D5 and LLS1 where they were dependent on areas of shoreline and mudflats as these wetlands dried in March 2007. Shorebird species were present at Lake Bryde in March 1998, 1999 and throughout 2001 when lake levels were low enough to expose areas of shoreline, but not during the present study. The Nankeen Night-heron (Groups 3, Fig. 4) was only observed at Yate Swamp where their preferred habitat of dense almost closed canopy was present. Group 4 included the Freckled Duck which is one of the most uncommon waterfowl in the south west region and was only recorded at East Lake Bryde during this study.

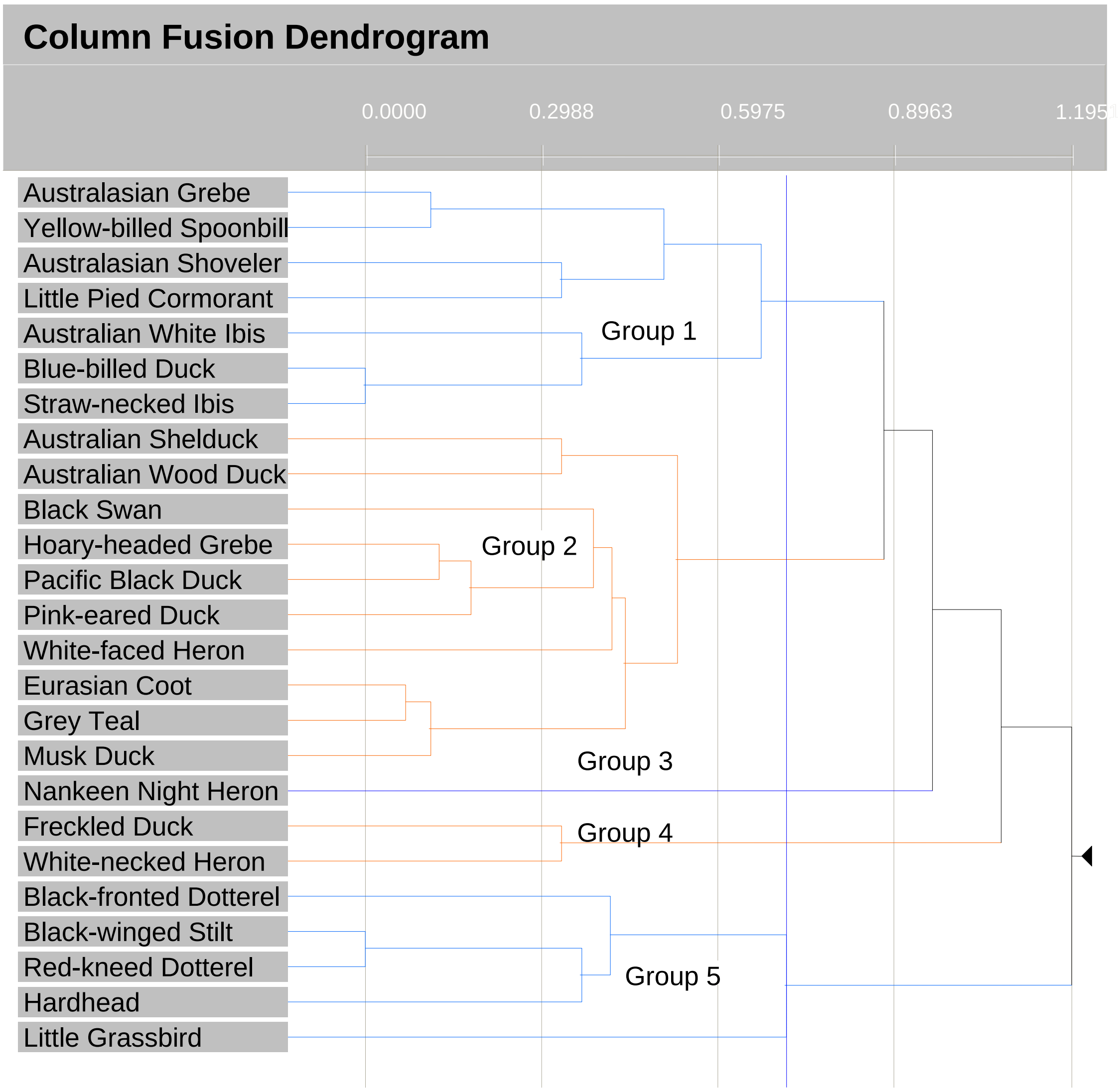

Figure 4 Waterbird species classification showing groups of species based on the similar patterns of occurrence at the 7 study wetlands. Classification based on the data reported in Table 2.

Table 2. Waterbird Species found on the seven study wetlands as the number of occurrences between March 2006 and March 2007. (* breeding observed.)

Waterbird	Detention Lake			Lake Janet	Yate Swamp	Lake Bryde	East Bryde
	D5	D1	LLS1				
Eurasian Coot	2	2*	1*	2*	2*	3*	3*
Grey Teal	3*	2	1*	2*	1	3*	3*
Musk Duck	2	1		2	2	3*	3
Hoary-headed Grebe	1*	2*	1*		2	2	1
Pink-eared Duck	1*	1*		1	2*	2	2
Australian Wood Duck				1	1	2	3*
Pacific Black Duck	1	1			2	2	1
Black Swan	1	1	1	1		2	
White-faced Heron		2				2	2
Australian Shelduck	1*					1	3
Yellow-billed Spoonbill		1		1	1	1	1
Australasian Grebe		1		1	1	1	
Australasian Shoveler	2				1	1	
Little Grassbird	2	2					
Australian White Ibis						1	1
Black-fronted Dotterel	1		1				
Freckled Duck							2
Hardhead	1					1	
Little Pied Cormorant					1	1	
Nankeen Night Heron					2		
Black-winged Stilt	1						
Blue-billed Duck						1	
Red-kneed Dotterel	1						
Straw-necked Ibis						1	
White-necked Heron							1

A classification of wetlands (including older Lake Bryde data) based on waterbird presence/absence (Fig. 5) showed little concordance with the groups established for water chemistry parameters (i.e. Fig. 2). In this analysis, wetland survey events tended to group by season and anomalous survey events were obvious. For example, Detention Lake D1 in March 2006 and Lake Bryde in October 1999 and 2003 which were very species poor and showed no similarity to other wetlands of similar water chemistry. Species richness of waterbirds from individual surveys of this study and additional Lake Bryde data was negatively correlated with salinity (as electrical conductivity) over the whole recorded range of 130-79100µS/cm ($r=-0.44$ $p<.001$, $df=23$), however this correlation was strongly influenced by the two highest salinity values and the correlation over the narrower range of 130-20100µS/cm was not significant ($r=-0.29$, $p>0.1$, $df=21$).

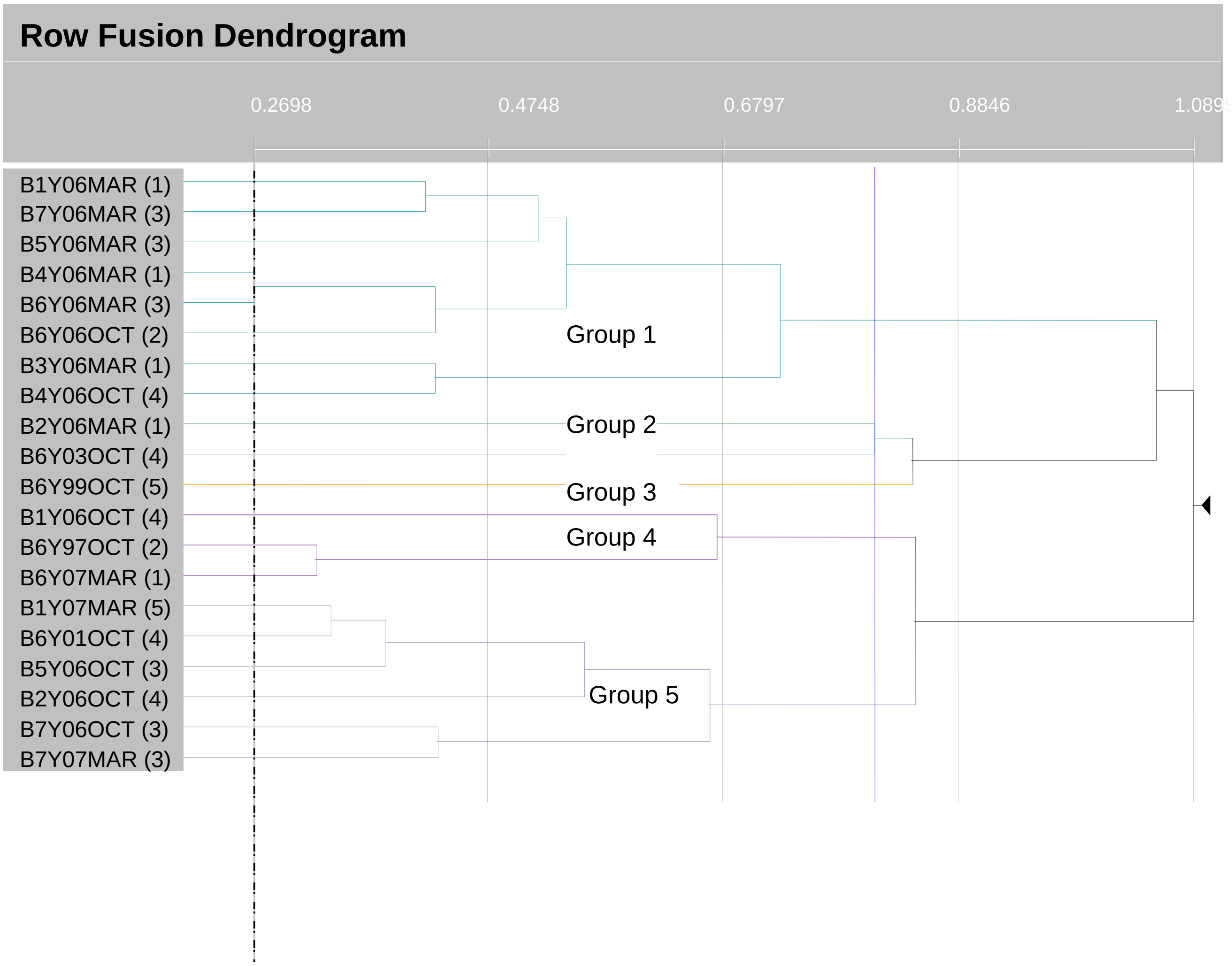

Figure 5 Classification of sites using waterbird presence/absence at the seven study wetlands and additional surveys from Lake Bryde between 1997 and 2003. Values in parenthesis are group membership from the environmental parameters classification (Fig. 2).

Aquatic invertebrates

A total of 186 distinct invertebrate taxa (Appendix 2) were recorded for the seven wetlands. Of these, 137 were used in analyses for comparison of wetlands, the difference being species dropped as single occurrences or recombined because of differences in taxonomic resolution across sites. The total observed species richness from all Lake Bryde samples and samples of the current study was 221 species.

Three taxa are believed to be currently undescribed species and are being further investigated by specialist taxonomists. These included two rotifers; *Lecane* sp. *nov*, collected from Lake Bryde and *Brachionus* sp. *nov* [plicatilis complex] from East Lake Bryde (Dr R.Sheil University of Adelaide). The third species was the conchostracan, *Limnadopsis* sp. *nov.* (type 'paradoxa'), collected from both Lake Bryde and East Lake Bryde in March 2006 shortly after the filling of the wetlands. It is believed this latter species has since been collected from the Esperance region following a similar summer rainfall event (Prof. B. Timms University of Newcastle.).

Some species while widespread in other regions have rarely been collected in the wheatbelt. For example *Branchinella occidentalis* was collected at East Lake Bryde in March 2006. This large fairy shrimp is more commonly collected in the Carnarvon Basin (Halse et al. 2000) and Pilbara (Pinder unpublished data) regions. Similarly, the clam shrimp *Eocyzicus* sp., collected at Detention Lake LLS1 in March 2006, has frequently been collected from the Pilbara region (Pinder unpublished data), but not from the south west.

The total species pool was dominated by insects (Fig. 6) with 82 species. Most aquatic insect orders were represented, however larvae of Diptera (flies and midges) and particularly of Chironomidae (non-biting midges) were the single richest group. Within wetlands, insects comprised a larger proportion of the fauna at Detention Lake D5, D1 and LLS1 and Lake Janet where they ranged between 55-81% of richness compared to 35 -57% of the fauna at Yate Swamp, Lake Bryde and East Lake Bryde (Fig. 7). However, there was no consistent seasonal difference in insect richness either within or across wetlands.

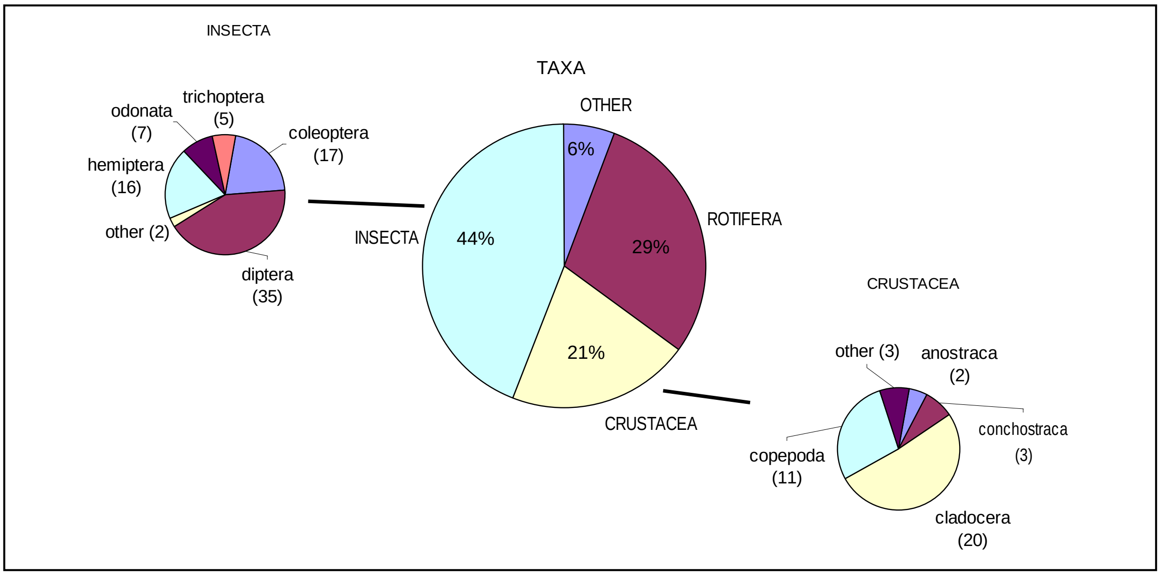

Figure 6 Species richness as distributed amongst various higher taxa

Rotifera contributed 54 species (29%) to the total species pool and in conjunction with the crustacean orders Ostracoda, Cladocera and Copepoda comprised the micro-invertebrate sub group of the total fauna. Micro-invertebrates accounted for 45% of the total species pool which is comparable to the 44% recorded by Halse et al (2002) and affirms the importance of these rarely sampled taxa as a component of total biodiversity. Since ostracods were not identified to species the total number of micro-invertebrate taxa is underestimated. Ten species of ostracod were identified from Lake Bryde between 1997 and 2003 (Cale unpublished data). The addition of ten species of microinvertebrates to the current study would raise their proportion of the total fauna to over 50%.

In contrast to the distribution of insects microinvertebrates comprised the greater proportion of total richness in Yate Swamp (39.6-50%), Lake Bryde (34-37.2%) and East Lake Bryde (35.4-42.3%). As with insects the proportion of the fauna comprised of micro-invertebrates did not show a clear seasonal pattern.

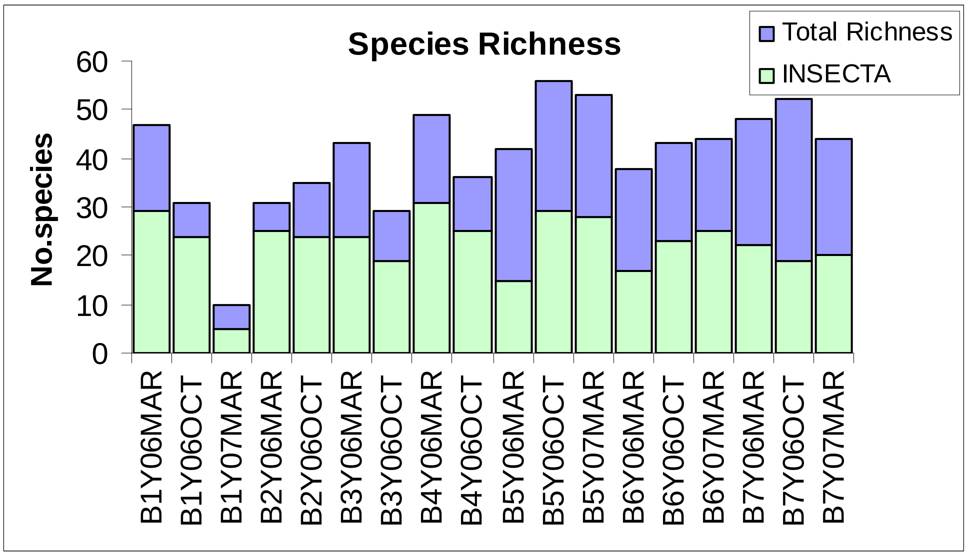

Figure 7 Species richness at each wetland for each sampling occasion showing also the contribution of insects to the total richness.

Invertebrate Community Structure

Classification of invertebrate communities across all samples created 5 groups, one of which contained only the single assemblage from Detention Lake D5 for March 2007. This assemblage showed little similarity to any other wetland (Fig 8). The remaining four groups split communities by season and wetland as described below.

Group 1 comprised samples from March 2006 for Detention Lake D5 and D1, Lake Janet and Lake Bryde. With the exception of Lake Bryde these samples belong to group 1 of the environmental parameters classification (Fig. 2) which indicates these assemblages tolerated brackish conditions.

Group 2 comprised all assemblages from Yate Swamp. This group was most similar to Group 1 and difficult to separate in ordination space but formed a distinct group within the classification. Only five taxa included in the analysis; two Rotifera, (Floscularidae spp and *Lepadella* sp.), the beetle *Enochrus maculiceps* and two chironomids, *Kiefferulus martini* and *Paralimnophyes* sp. 1 were unique to Yate Swamp samples. These species are widely distributed outside the study site. The distinctiveness of the Yate Swamp invertebrate assemblages arises because many taxa were only found in this wetland and either Lake Bryde (5 species) or East Lake Bryde (6 species). Yate Swamp also supported 16 singleton species (collected only once during the study) which were eliminated from the analysis, but would reinforce the distinctiveness of these assemblages.

Group 3 includes the March 2007 community for Lake Bryde plus all communities from October 2006 except for Yate Swamp and East Lake Bryde. Both increased salinity and seasonal factors influenced the composition of these assemblages. Except for the Lake Bryde samples members of this group belonged to Group 4 of the environmental parameters classification. Average salinity for this group was 11589µS/cm although both Bryde samples were from lower salinity.

Group 4 included all assemblages from East Lake Bryde and reflected the uniqueness of invertebrate communities from this wetland. Also included in Group 4 is the community from Detention Lake LLS1 for March 2006. While this assignment seems anomalous it arises at least in part because of three species; Daphnia cephalata, Eocyzicus sp. and Branchinella halsei which were only found at East Lake Bryde and Detention Lake LLS1. Five taxa were unique to East Lake Bryde i.e. N*otomata cerberus* (Rotifera), N*eothrix armata* (Cladocera), A*graptororixa hirtifrons* (Hemiptera), *Glyptophysa* sp. (Gastropoda) and *Boeckella robusta* (Copepoda).

Group 5 contained only the invertebrate assemblage from Detention Lake D5 in March 2007 when salinity had risen to 79100µS/cm. This community was species poor with only 10 taxa recorded. The species included were a subset of those found in Group 1 and Group 3 or were collected in most samples.

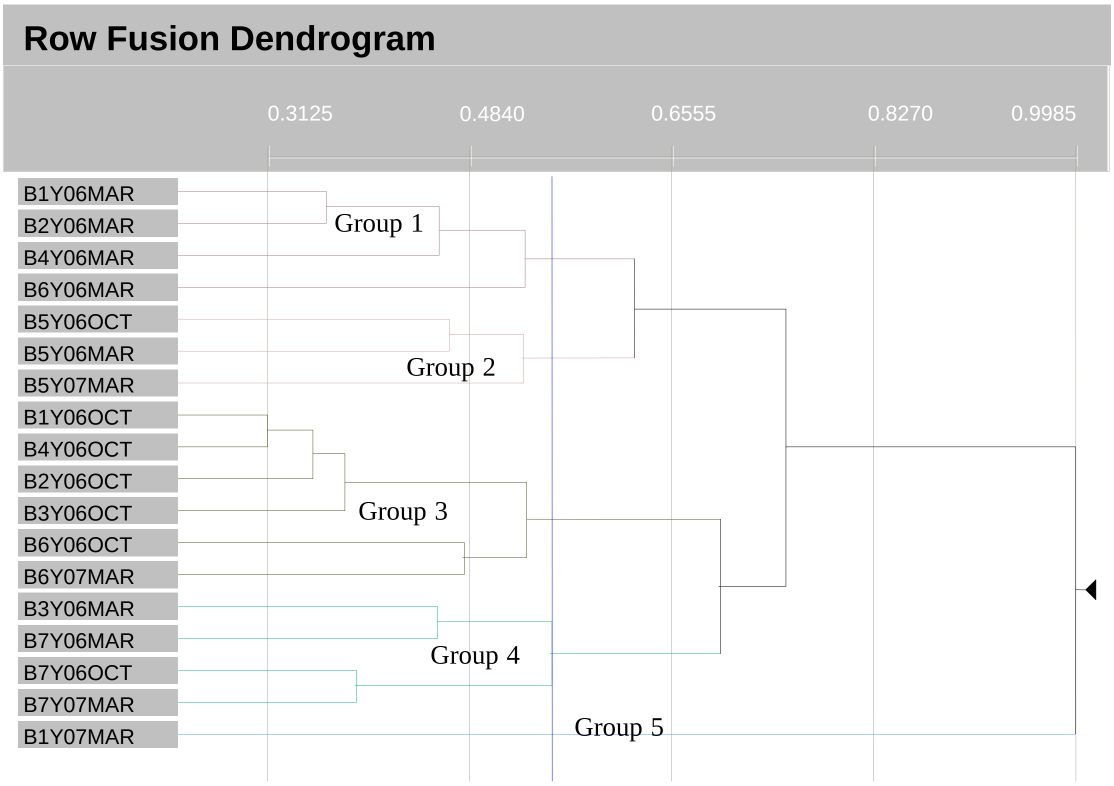

Figure 8 UPGMA Classification of the invertebrate communities for all sites in all seasons.

Table 3 The eight invertebrate assemblages described by Pinder et al. 2004 and collected in the present study. Shown for each wetland are; 1) the number of species 2) the proportion of total wetland richness attributable to each assemblage. For each assemblage the richness in this study as a proportion of the total number of species in the assemblage is shown.

Assemblage (after Pinder et al. 2004)	Det LK5		Det LK1		Det Lk3		Janet		Yate		Bryde		East Bryde				
	No. Species	% of S	No. Species	% of S	No. Species	% of S	No. Species	% of S	No. Species	% of S	No. Species	% of S	No. Species	% of S	Tot. No. Spp	% of AS	Assemblage Richness(AS)
A	4	6	0	0	0	0	2	3	5	5	4	4	2	2	12	8	148
B	0	0	0	0	1	2	0	0	0	0	0	0	0	0	1	3	33
C	1	1	1	2	2	4	1	2	4	4	1	1	5	6	9	47	19
D	1	1	2	4	2	4	1	2	4	4	6	7	4	4	8	14	56
E	37	54	33	63	34	60	38	58	32	32	37	41	35	39	56	62	91
F	9	13	7	13	3	5	8	12	20	20	14	16	14	16	31	37	83
H	3	4	1	2	2	4	1	2	0	0	4	4	1	1	6	24	25
J	0	0	0	0	0	0	0	0	1	1	3	3	1	1	3	9	34
unassigned	13	19	8	15	13	23	14	22	33	33	21	23	28	31	61		
richness(S)	68		52		57		65		99		90		90				

Invertebrates and broader Wheatbelt Assemblages

Pinder et al (2004) identified 10 assemblages of invertebrate species based on their patterns of occurrence across 223 wheatbelt wetlands. Species belonging to 8 of these assemblages were found during this survey (Table 3). At any single site between 14 and 40% of species could not be assigned to an assemblage because they were not recorded by Pinder et al (2004) either because they were not collected or were only collected once and thus dismissed from their analysis.

Three assemblages D, E and F are considered widespread in the wheatbelt and prefer fresh to sub-saline wetlands. Assemblage E is dominated by insects which are able to rapidly disperse and colonize wetlands. Assemblage F includes a disproportionate number of rotifers and D a predominance of rotifers and micro-crustacea (Pinder et al 2004), the re-colonization of which rely on resting stages held in the lake for long periods of time. Assemblages D, E and F were the most commonly recorded in this study and accounted for most taxa at each wetland. They represent the core group of species across the study site.

Assemblages A and C show a preference for freshwater swamps and were represented by only 12 and 9 species respectively in the current study. Whilst most common in March 2006 when salinities were at their lowest these assemblages were only absent from Detention Lakes D1 and LLS1.

Assemblage B is believed to have strong affinities with the unique granite rock pool habitat (Pinder et al 2004). It was represented in the Lake Bryde recovery catchment only by the beetle *Berosus nutans* which was collected at Detention Lake LLS1. While this would appear to be anomalous this beetle is highly mobile; able to fly in and out of wetlands as conditions change and was probably an opportunistic user of the wetland.

The only collected assemblage with a preference for saline or mildly saline waters was assemblage H (assemblage G was not collected here). This group of species was only absent from Yate Swamp but was only a minor contributor to total species richness at all wetlands.

Assemblage J was represented by three dipterans; *Harrisius* sp. *Cricotopus parbinctus* and Forcipomyinae sp. 3. These species are more typical of saline flowing waters, however adults are winged and may have some dispersal capability and it is possible that flow conditions during filling of the wetlands mimicked conditions suitable for their colonization. These species were only found in Yate Swamp, Lake Bryde and East Lake Bryde.

Wetland and Catchment Diversity

Individual wetlands only supported a fraction of the total species pool. During March 2006 single wetlands had a mean species richness of 42.5 species (SD= 6.4, range 31-49) or 22.8% of the total fauna. In October 2006 single wetlands had a mean species richness of 40.28 species (SD= 10.4, range 29-56) or 21.6% of the total fauna. For these two seasons the seasonal species pool remained constant at 128 and 124 species with 87 species (49%) common to both seasons. Species richness accumulated similarly in both seasons (Fig. 9a-b) and the Incidence-based estimator of total species richness (ICE) was 203 and 204 for the 7 wetlands in Mar-06 and Oct-06 respectively. These values are entirely consistent with estimates (Halse et al. 2004) that 60% of species richness is collected by the sampling protocol. Estimated total richness for the recovery catchment was 313 species and is based on the ICE value for the 22 samples from the current study and monitoring at Lake Bryde (Fig. 9d).

A total of 140 species were identified from 14 samples collected from Lake Bryde during this study and monitoring between 1997 and 2003. Of these, 72 species were collected in the current study including 30 species not collected previously and 110 were collected during monitoring including 68 not collected in this study. One hundred and eight species or 58 % of the fauna collected from recovery catchment wetlands was also collected at least once in Lake Bryde samples. Conversely, 32 species or 23% of the fauna collected at Lake Bryde was not collected elsewhere in the recovery catchment. Of the 78 species (42%) comprising the fauna of the recovery catchment that was not collected at Lake Bryde, 19 species were unique to Yate Swamp and 18 were unique to East Lake Bryde with an additional 5 species found in only these two lakes.

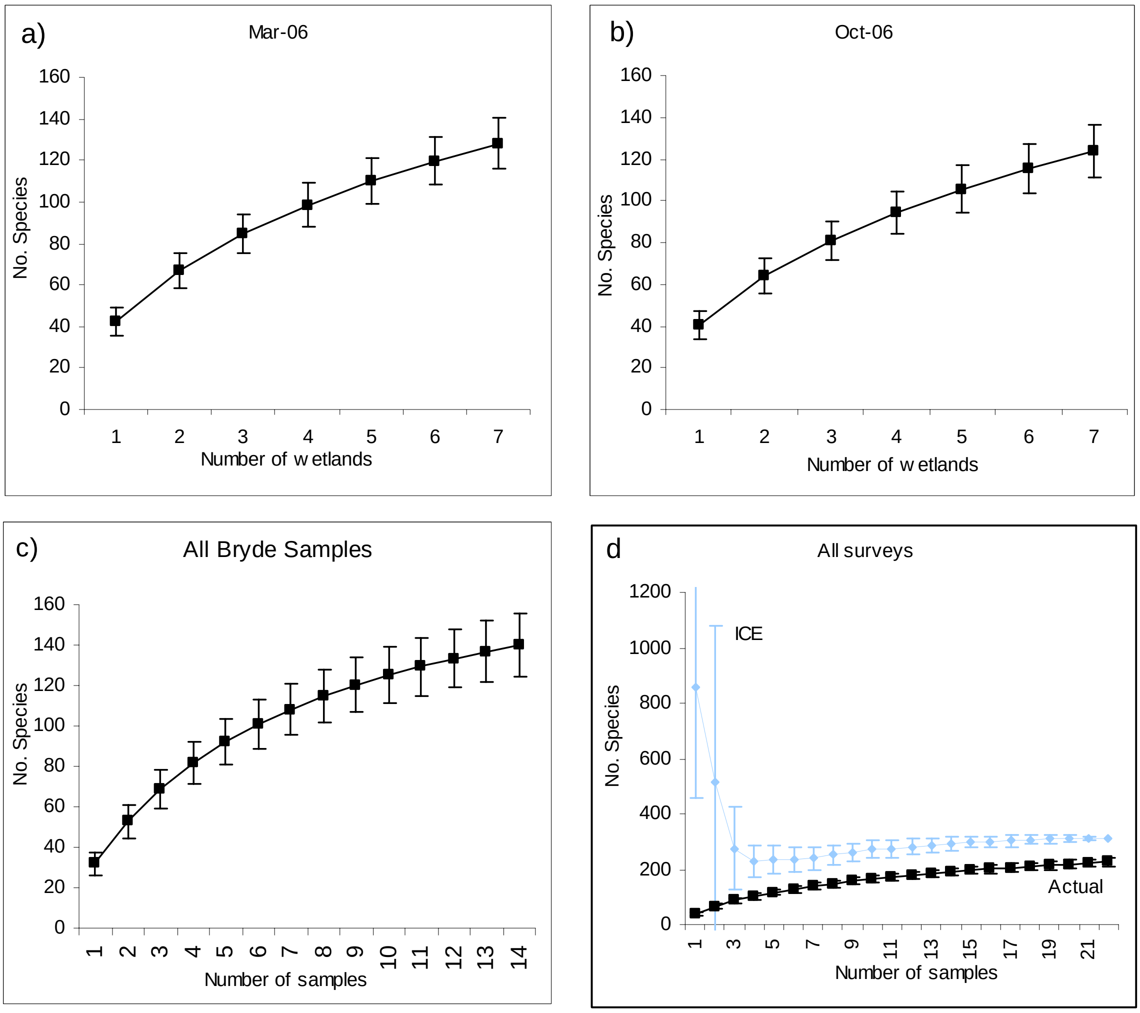

Figure 9 Species accumulation curves calculated for a) study wetlands in Mar-06, b) in Oct-06 and c) all 14 Lake Bryde samples between 1997 and 2007 d) all samples from the recovery catchment and Lake Bryde as actual richness and as incident-based estimator of richness (ICE).

Invertebrates and salinity

There was a negative correlation between salinity at each wetland and; total species richness ($r=-0.73$, $p<0.001$), the number of species of Rotifera ($r=-0.74$, $p<0.001$) and Crustacea ($r=-0.59$, $p<0.05$) (Fig 10). Richness of insect species and salinity were not correlated ($r=0.03$, $p>0.5$) despite insect richness showing a positive correlation with total richness. Data for Detention Lake D5 in March 2007 were not included in this correlation analysis because the single high salinity value represented by this wetland exaggerated the relationship between salinity and species richness. The relationship between richness and salinity was not an artefact of season since these same relationships occurred when only October data were investigated (i.e. correlation coefficient for total richness $r=-0.93$, $p<0.01$, Rotifera $r=-0.89$, $p<0.01$ and Crustacea $r=-0.85$, $p<0.01$).

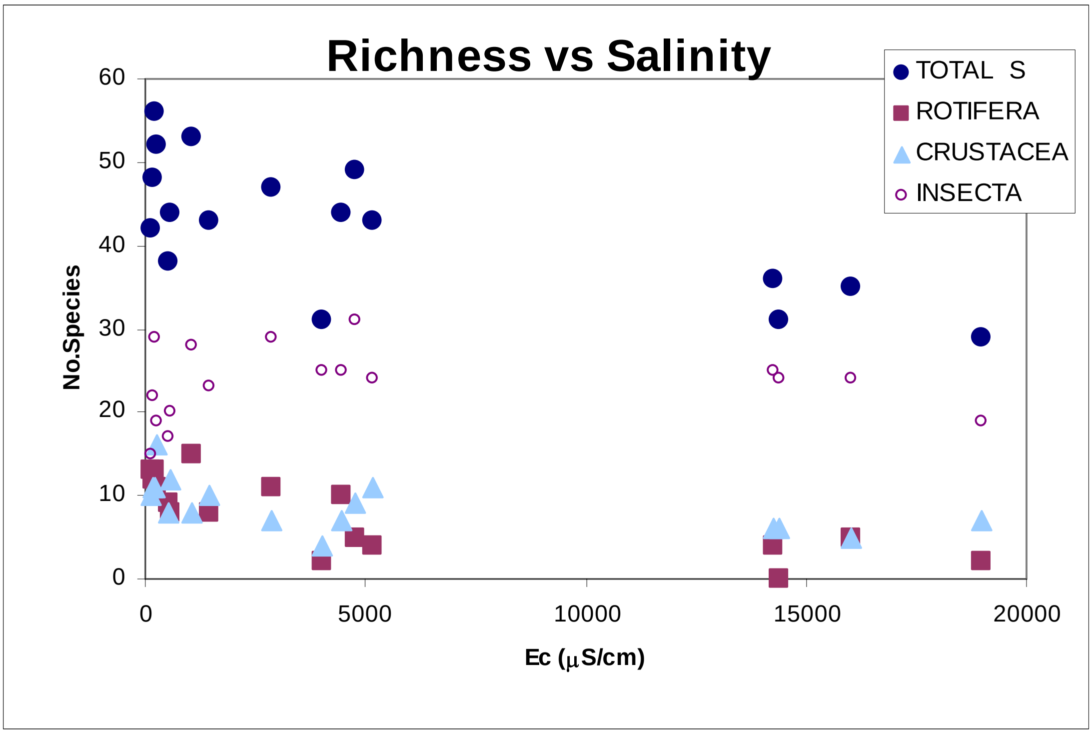

Figure 10 Relationship between Salinity (µS/cm) and Species richness of several higher taxa. Except for Insecta relationships are significant at $P<0.05$ or less (see text).

Discussion

The fauna sampled from the seven wetlands of the Lake Bryde Recovery Catchment was diverse and included a mix of common and less common taxa. Overall, the waterbird community was comprised of common ubiquitous species with broad habitat requirements. However, some species such as waders and the Little Grassbird have specific habitat requirements best met at only a few wetlands. Waders feed on exposed shorelines, which restricted their distribution to Detention Lakes D5 and LLS1 during the study period; however they would become more widely distributed as other wetlands dried, particularly large wetlands like Lake Bryde and East Lake Bryde. The Hoary-headed Grebe while widespread across the study area only bred at the three detention lakes showing a preference for secluded nesting sites.

The collection of 3 new species of aquatic invertebrates is an important contribution to our knowledge of the regional diversity of aquatic invertebrates. Pinder et al (2004) collected at least 957 invertebrate species from a survey of wheatbelt wetlands of which 10% were previously un-described (i.e. new species) and a further 7% were first records for Western Australia. The current rate of discovery of new species in the south west is in part a function of the quantity and detail of survey work being conducted in the region by various authors (e.g. Horwitz 1997 , Storey 1998, Halse et al 2000 and Pinder et al 2004) and part the increased taxonomic knowledge and expertise available.

Beyond new species, the invertebrate fauna was roughly divided into halves, the first of which (with 49 % of species) could be assigned to the assemblages defined by Pinder et al (2004) from wheatbelt wetlands. This portion of the fauna represents a core of common species which were widespread across the study site and probably across the region. Assemblages E, F and D (in that order) were best represented by the recovery catchment fauna and are the most common assemblages found across fresh to sub-saline wetlands of the wheatbelt. Many species in these assemblages have considerable tolerance of salinity.

The remaining 51% of the invertebrate fauna was either not collected or was collected on only single occasions by Pinder et al. (2004) or has insufficient taxonomic resolution to compare with that dataset. Some of these species must be considered uncommon or of low abundance, but with caution, since the sampling protocols used both in this study and in the survey of Pinder et al (2004) are known to collect only 60-70% of the taxa present at a wetland (Halse et al 2002, Pinder unpublished data).This leaves open the possibility that these "uncommon' taxa while difficult to collect are actually widespread. Some of these uncommon taxa while rarely collected in the wheatbelt may be widely distributed in other regions. At least two taxa collected in this study, *Brachinella occidentalis* and *Eocyzicus* sp. are uncommon in the wheatbelt but have been collected in the Carnarvon Basin and Pilbara.

Over the three seasons, species richness averaged between 38 and 42 species per wetland. As an overall measure of diversity these values indicate a similar diversity (Pinder et al 2004) or slightly higher diversity (Halse et al 2000, Storey 1998) than that recorded in other regional surveys. Using, species accumulation curves and the incident-based estimate of species richness (Chao 2005) total species richness from the recovery catchment is estimated at 313 species (compare to 221 species observed to date). This is likely to be an underestimate since it assumes; 1) that all major wetland types within the recovery catchment have been represented and 2) all seasonal and temporal conditions have been encountered. Neither assumption is realistic since most of the data collected are from Lake Bryde and fresh wetlands such as Yate Swamp and East Lake Bryde have been sampled under only a limited range of conditions. Similarly, the early drying of salinized wetlands such as Lake Janet prevented sampling these during hypersaline conditions when halophilic species might be expected.

Not all wetlands contributed equally to the observed diversity of invertebrates. Rather, the bulk of the invertebrate fauna was found at Yate Swamp, Lake Bryde and East Lake Bryde. These wetlands collectively contained 67% of the total fauna in March 2006, 82% in October 2006 and 97% in March 2007. Fifty eight percent of all species collected from the recovery catchment were collected at least once at Lake Bryde. While this highlights the importance of this wetland in terms of maintaining invertebrate diversity it is partly a function of the sampling effort at this wetland and it is likely that both Yate Swamp and East Lake Bryde would show similar patterns given the same sampling effort. The invertebrate communities of the three detention lakes and Lake Janet were subsets of the Lake Bryde communities and contained relatively few unique species. These four lakes were most diverse in March 2006 shortly after the wetlands filled. At this time small closely located wetlands like these are probably important to the recolonization of the wetland chain as they provide stepping stones for both dispersing insects and water birds.

Salinity and Diversity

Wetland groups based on water chemistry were dominated by the effects of salinity, and had little relationship to wetland classifications based on water bird or invertebrate species occurrences across wetlands. This lack of correspondence fits with the hypothesis that while wetland salinity is a constraint on species richness other considerations such as micro-habitat availability are more important in determining which species use a wetland, at least over the narrow ranges of salinity observed (e.g. Williams 1998). In the case of water birds, this is particularly plausible given the heterogeneity of wetland salinity over the study area at any one time and, to a highly mobile bird population, the close proximity of wetlands which allowed free movement between them.

Salinity had a greater impact on invertebrate diversity, with particular taxonomic groups such as the Rotifera and Crustacea showing lower richness with increasing salinity. Freshwater invertebrates generally, show a decline in species richness above salinities of 2- 3g l^{-1} (roughly 3000- 5000μS/cm). Of 752 species, defined as occurring in freshwater in the Wheatbelt region, only 46% occurred at salinities > 3g l^{-1} and 17% at salinities > 10 g l^{-1} (Pinder et al. 2005). Conversely this range of salinity may see an increased richness of halophilic species. The three detention lakes and Lake Janet were always above this lower threshold value and depressed species richness was observed in conjunction with a strong predominance of insects.

While some insect species are relatively tolerant to salinity, others are able to avoid saline conditions. Insect species are highly mobile (winged adults) and may occupy wetlands until conditions (e.g. salinity) become unfavourable, at which time they move to another wetland. By contrast, micro-crustaceans are largely immobile with limited dispersal between wetlands. Many of these species have a resting egg stage which may persist for many years in dry wetlands and have particular requirements, e.g. of low salinity, to hatch (Nielsen et al 2003). Rotifers as a group are sensitive to salinity with only 9 species collected in the wheatbelt at salinities >10 g l^{-1} (Pinder et al. 2005). The Rotifera were a significant portion of the fauna collected in this study but 70% of the 54 species collected occurred only at salinities <3000µS/cm. This restricted the bulk of species to Lake Bryde, Yate Swamp and East Lake Bryde. While salinity remains low in both Yate Swamp and East Lake Bryde, salinity may reach 56 450µS/cm at Lake Bryde at low water levels (Cale et al. 2004). The high water level/ low salinity conditions presenting following a flood event are probably critical to the hatching of resting egg stages and to the establishment of populations essential for the long term persistence of these species.

At Lake Bryde the rare conditions of high water level and low salinity observed after flooding are important to overall diversity as shown by the collection of an additional 30 species of invertebrates not previously collected, despite a ten year history of sampling. Species only rarely encountered in the Lake Bryde Recovery Catchment, for example after a flooding event, would be affected by changes in the hydrological regime. Any combination of increased salt load, reduced maximum water level or altered frequency of flooding is likely to have an impact on the diversity of wetlands by preventing species (e.g. Rotifera) from maintaining propagules which would re-establish populations in the future. Such wetlands would become increasingly dominated by species such as insects which have a dispersal stage capable of re-colonizing a wetland. Fresh wetlands would be most at risk and secondarily salinized wetlands such as the Detention Lakes and Lake Janet are probably already displaying reduced species richness.

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Appendix 1

Parameter	Chem Centre Methodology	Units
Field Depth		metre
Field Conductivity		mS/cm
Field pH		pH units
Field Dissolved Oxygen (General or surface)		% saturation
Field Temperature		^{o} Celsius
TN	iNP1WTFIA	µg/L
TP	iPP1WTFIA	µg/L
Chlorophyll-a	iCHLA1WACO	µg/L
Chlorophyll-b	iCHLA1WACO	µg/L
Chlorophyll-c	iCHLA1WACO	µg/L
Phaeophytin-a	iCHLA1WACO	µg/L
Turbidity	iTURB1WCZZ	NTU
Colour	iCOL1WACO	TCU
TDS	iSOL1WDGR	mg/L
Alkalinity	iALK1WATI	mg/L
Hardness	iHTOT2WACA	mg/L
Silica	iSI1WCICP	mg/L
Sodium	iMET1WCICP	mg/L
Calcium	iMET1WCICP	mg/L
Magnesium	iMET1WCICP	mg/L
Potassium	iMET1WCICP	mg/L
Manganese	iMET1WCICP	mg/L
Chloride	iCL1WAAA	mg/L
Bicarbonate	iALK1WATI	mg/L
Carbonate	iALK1WATI	mg/L
Nitrate	iNTAN1WFIA	mg/L
Sulphate	iMET1WCICP	mg/L
Iron	iMET1WCICP	mg/L

Appendix 1A Complete list of Water chemistry parameter values against sites and dates collected.

SiteCode	Date	SampleID	Field Depth	Field Conductivity	Field pH	TN	TP	Chlorophyll-a	Chlorophyll-b	Chlorophyll-c	Phaeophytin-a	Field Temperature	Field Dissolved Oxygen	Turbidity	Colour
BRY001	22/03/2006	B1Y06MAR	0.8	2870	7.56	4800	70	0.5	0.5	1	3	22.3	82	7.2	98
BRY001	31/10/2006	B1Y06OCT	0.75	14380	9.24	1400	5	1	1	1	2	19.7	111.8	2.2	21
BRY001	20/03/2007	B1Y07MAR	0.3	79100	8.52	6000	30	6	6	9	11	28.9	72.3	18	40
BRY002	22/03/2006	B2Y06MAR	0.9	4000	7.7	3500	30	0.5	1	2	11	23.4	93.4	5.2	110
BRY002	31/10/2006	B2Y06OCT	0.54	16020	8.52	3000	5	0.5	1	2	2	22.6	97.7	1.1	32
BRY002	20/03/2007	B2Y07MAR	dry												
BRY003	22/03/2006	B3Y06MAR	0.6	5150	8.13	3600	50	0.5	0.5	9	8	22.9	92.7	4.8	80
BRY003	31/10/2006	B3Y06OCT	0.17	18970	8.77	9900	20	2	2	2	3	15.1	97.8	1.6	39
BRY003	20/03/2007	B3Y07MAR	dry												
BRY004	21/03/2006	B4Y06MAR	1.2	4750	8.05	2200	20	2	0.5	6	1	25.3	111.4	4.1	59
BRY004	1/11/2006	B4Y06OCT	0.8	14240	10.11	3000	5	0.5	1	1	2	22.4	1233.7	8.7	11
BRY004	21/03/2007	B4Y07MAR	dry												
BRY005	22/03/2006	B5Y06MAR	2.2	130	6.49	1400	30	4	2	0.5	0.5	20.8	10.6	15	210
BRY005	1/11/2006	B5Y06OCT	1.8	232	7.04	2000	60	5	1	2	3	22.1	37.3	5.4	230
BRY005	21/03/2007	B5Y07MAR	0.02	1068	8.38			0.5	1	1	2	22.6	114.4	5.5	220
BRY006	21/03/2006	B6Y06MAR	1.82	549	7.81	2100	130	6	1	6	3	21.6	88.3	31	75
BRY006	31/10/2006	B6Y06OCT	1.47	1445	10.6	1100	10	1	0.5	1	1	20.6	100.4	2.1	20
BRY006	20/03/2007	B6Y07MAR	0.61	4480	9.41	2200	10	1	1	3	5	22.9	88.2	0.8	21
BRY007	21/03/2006	B7Y06MAR	2.15	168	6.91	1800	70	2	0.5	1	0.5	25.8	80.5	1200	110
BRY007	1/11/2006	B7Y06OCT	1.75	262	7.63	2000	260	1	1	1	1	15.3	84.4	1200	150
BRY007	21/03/2007	B7Y07MAR	0.95	584	7.79	2700	340	1	1	2	1	19.6	85.3	1800	150

Appendix 1A Complete list of Water chemistry parameter values against sites and dates collected.														
SiteCode	Date	SampleID	TDS	Alkalinity	Hardness	Silica	Sodium	Calcium	Magnesium	Potassium	Manganese	Chloride	Bicarbonate	Carbonate
BRY001	22/03/2006	B1Y06MAR	1.9	105	480	8.7	452	104	53.2	19		879	128	1
BRY001	31/10/2006	B1Y06OCT	8.7	55	1800	0.2	2280	296	264	38.8	0.015	4440	67	0.5
BRY001	20/03/2007	B1Y07MAR	54	135	13000	5	16500	2040	1990	251	0.15	33800	165	0.5
BRY002	22/03/2006	B2Y06MAR	2.7	115	790	0.9	613	188	76.5	22		1210	128	6
BRY002	31/10/2006	B2Y06OCT	11	83	3300	3.9	2400	836	296	43.1	0.016	4820	101	0.5
BRY002	20/03/2007	B2Y07MAR												
BRY003	22/03/2006	B3Y06MAR	3.3	190	650	3	922	78.7	110	23.4		1500	195	18
BRY003	31/10/2006	B3Y06OCT	11	263	1900	0.5	3490	99	409	55.5	0.034	6090	247	36
BRY003	20/03/2007	B3Y07MAR												
BRY004	21/03/2006	B4Y06MAR	2.7	70	640	1.8	870	85.2	104	22.5		1590	85	1
BRY004	1/11/2006	B4Y06OCT	8.5	78	1700	0.5	2380	177	309	39.8	0.018	4370	82	6
BRY004	21/03/2007	B4Y07MAR												
BRY005	22/03/2006	B5Y06MAR	0.15	40	30	4.5	17.5	6.9	3.1	5.9		22	49	1
BRY005	1/11/2006	B5Y06OCT	0.16	45	38	0.1	27.6	7.9	4.3	5.6	0.028	35	55	0.5
BRY005	21/03/2007	B5Y07MAR	0.77	118	150	7.7	146	30	18.2	21.2	0.007	249	143	0.5
BRY006	21/03/2006	B6Y06MAR	0.37	100	87	0.5	87	20	9	8.9		129	122	1
BRY006	31/10/2006	B6Y06OCT	0.73	100	100	0.4	213	12.8	17.6	10.3	0.002	342	122	0.5
BRY006	20/03/2007	B6Y07MAR	2.3	173	240	0.5	665	21.2	44.5	24.3	0.003	1210	210	0.5
BRY007	21/03/2006	B7Y06MAR	0.22	35	44	7.8	33.9	3.5	8.6	16.8		32	43	1
BRY007	1/11/2006	B7Y06OCT		53	18	97	50.4	2.8	2.6	5.2	0.038	45	64	0.5
BRY007	21/03/2007	B7Y07MAR		95	25	110	111	3.9	3.7	8	0.05	110	116	0.5

Appendix 1A Complete list of Water chemistry parameter values against sites and dates collected.														
SiteCode	**Date**	**SampleID**	**Nitrate**	**Sulphate**	**Iron**									
BRY001	22/03/2006	B1Y06MAR	0.6	171	-9999									
BRY001	31/10/2006	B1Y06OCT	0.005	892	0.008									
BRY001	20/03/2007	B1Y07MAR	0.005	5280	0.073									
BRY002	22/03/2006	B2Y06MAR	0.02	340										
BRY002	31/10/2006	B2Y06OCT	0.01	2350	0.023									
BRY002	20/03/2007	B2Y07MAR												
BRY003	22/03/2006	B3Y06MAR	0.01	183										
BRY003	31/10/2006	B3Y06OCT	0.005	776	0.01									
BRY003	20/03/2007	B3Y07MAR												
BRY004	21/03/2006	B4Y06MAR	0.05	237	-9999									
BRY004	1/11/2006	B4Y06OCT	0.005	855	0.008									
BRY004	21/03/2007	B4Y07MAR												
BRY005	22/03/2006	B5Y06MAR	0.01	3.4	-9999									
BRY005	1/11/2006	B5Y06OCT	0.02	3.9	0.5									
BRY005	21/03/2007	B5Y07MAR	0.05	6.3	0.085									
BRY006	21/03/2006	B6Y06MAR	0.44	37.4										
BRY006	31/10/2006	B6Y06OCT	0.005	23.7	0.015									
BRY006	20/03/2007	B6Y07MAR	0.005	59.3	0.0025									
BRY007	21/03/2006	B7Y06MAR	0.41	7	-9999									
BRY007	1/11/2006	B7Y06OCT	0.35	7.8	0.36									
BRY007	21/03/2007	B7Y07MAR	0.5	14.4	1									

Appendix 2 Complete list of Invertebrate species against sites and dates collected.

		Det LK5	Det LK5	Det LK5	Det LK1	Det LK1	Det LLS1	Det LLS1	Janet	Janet	Yate	Yate	Yate	Bryde	Bryde	Bryde	East Bryde	East Bryde	East Bryde
TAXA	Authority	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-06	Oct-06	Oct-06	Mar-06	Oct-06	Yate	Mar-07	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-07
TURBELLARIA (flatworms)						1		1		1	1	1	1			1	1	1	
NEMATODA (roundworms)							1			1	1	1		1	1	1	1	1	1
ROTIFERA																			
Habrotrocha sp.											1								
Rotaria sp.											1	1		1					
Floscularid sp.											1	1							
indet. Bdelloid		1											1					1	
Conochilus natans	(Seligo, 1900)												1						
Synantherina sp.												1							
Lacinularia sp.		1																	
Hexarthra mira	Hudson													1				1	1
Hexarthra intermedia	(Wiszniewski, 1929)	1																	
Hexarthra fennica	(Levander, 1892)							1		1					1	1			
Testudinella patina	(Hermann, 1783)								1	1	1	1							
Testudinella emarginula																		1	
Horaella sp.												1							
Filinia sp.												1							
Brachionus plicatilis s.l.	Müller, 1786					1	1	1								1			
Brachionus quadridentatus	Hermann, 1783					1	1			1		1	1			1			
Brachionus lyratus	Shephard, 1911				1						1			1					
Brachionus angularis	Gosse, 1851	1										1				1	1	1	
Keratella australis	Berzins, 1963													1			1		1
Platyais quadricornis	(Ehrenberg, 1832)										1						1		
Lepadella ovalis	(Müller. 1786)																	1	
Lepadella discoidea									1										

		Det LK5	Det LK5	Det LK5	Det LK1	Det LK1	Det LLS1	Det LLS1	Janet	Janet	Yate	Yate	Yate	Bryde	Bryde	Bryde	East Bryde	East Bryde	East Bryde
TAXA	Authority	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-06	Oct-06	Oct-06	Mar-06	Oct-06	Yate	Mar-07	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-07
Lepadella oblonga		1																	
Lepadella pattela	(Müller. 1773)															1			
Lepadella sp.											1	1	1						
Dicranophorus epicharis																	1		
Euchlanis sp.										1	1	1	1	1					
Lecane bulla	Gosse, 1851	1									1	1	1	1			1	1	1
Lecane closterocerca	Schmarda	1											1						
Lecane flexilis	(Gosse, 1886)												1		1				1
Lecane hamata	Stokes, 1896	1									1		1		1		1	1	1
Lecane ludwigii	(Eckstein, 1883)	1				1	1		1	1			1	1		1	1		
Lecane luna	(Müller, 1776)														1				
Lecane lunaris	(Ehrenberg, 1832)	1																	
Lacane ichthyoura															1		1	1	
Lecane signifera	(Jennings, 1896)																		1
Lecane thalera	(Harring & Myers, 1926)					1	1						1						
Lecane halsei	Seger & Shiel 2003														1				
Lecane paradoxa									1										
Lecane (M) sp.												1				1	1		
Lecane sp. nov.																1			
Lophocaris sp.											1	1	1	1			1		
Cephalodella gibba	(Ehrenberg, 1832)					1											1		
Cephelodella forficula	(Ehrenberg, 1832)												1						
Cephelodella ventripes	Dixon-Nuttall, 1901										1		1						
Taphrocampa selenura	(Gosse, 1887)																		1
Notomata cerberus	Gosse 1886																	1	1
Eosphora najas	Ehrenberg, 1830																	1	
Proales kostei																	1		
Polyarthra dolichoptera	(Idelson, 1925)	1			1									1		1			
Trichocera similis	(Wierzejski, 1893)										1							1	

		Det LK5	Det LK5	Det LK5	Det LK1	Det LK1	Det LLS1	Det LLS1	Janet	Janet	Yate	Yate	Yate	Bryde	Bryde	Bryde	East Bryde	East Bryde	East Bryde
TAXA	Authority	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-06	Oct-06	Oct-06	Mar-06	Oct-06	Yate	Mar-07	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-07
Machrochaerus altamiria	(Arevalho, 1918)															1			
Macrochaetus subquadratus	(Perty)														1				
Scaridium longicaudum	(Müller, 1786)												1						
GASTROPODA (snails)																			
Ferrissia petterdi	(Johnson, 1897)											1	1	1					1
Glyptophysa sp.																	1	1	1
Gyraulus sp.							1												
OLIGOCHAETA (worms)																			
Tubificidae																		1	1
Dero nivea	Aiyer, 1929						1												
Enchytraeidae				1			1		1	1									
ACARINA (water mites)																			
Acercella falcipes	Lundblad, 1941										1				1			1	
Arrenurus balladoniensis	Halik, 1940		1							1									
Mesostigmata														1				1	
ANOSTRACA (fairy shrimps)																			
Branchinella occidentalis	(Dakin, 1914)																1		
Branchinella halsei	Timms 2002						1										1	1	1
Branchinella sp.														1					
CONCHOSTRACA (clam shrimps)																			
Caenestheriella packardi										1		1		1			1	1	
Eocyzicus sp.							1										1	1	
Limnadopsis sp.nov. 'type paradoxa'														1			1		
CLADOCERA (waterfleas																			
Diaphanosoma unguiculatum	Gurney, 1927																		1
Alona nr *affinis*																		1	
Alona longinqua	(Smirnov, 1971)																	1	

		Det LK5	Det LK5	Det LK5	Det LK1	Det LK1	Det LLS1	Det LLS1	Janet	Janet	Yate	Yate	Yate	Bryde	Bryde	Bryde	East Bryde	East Bryde	East Bryde
TAXA	Authority	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-06	Oct-06	Oct-06	Mar-06	Oct-06	Yate	Mar-07	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-07
Alona clathrata	Sars 1888										1								
Alona rigidicaudis	(Smirnov, 1971)			1						1						1			
Alona cf. *rectangula* (> 1 spp.)						1				1	1	1					1	1	
Dunhevedia crassa	King, 1853			1					1							1			
Leberis cf. *diaphanus*	King, 1853								1								1		
Leydigia cf. *leydigii* (SAP)	Schoedler, 1863											1			1			1	1
Plurispina cf. *chauliodis* (SAP)	Frey, 1991													1					
Pleuroxus foveatus	Frey, 1991															1			
Pleuroxus inermis	Sars, 1896						1				1		1		1				
Rak sp.													1						
Pseudomonospilus diporus	Smirnov & Timms, 1983																		1
Daphnia carinata	King, 1853	1			1					1				1					
Daphnia cephalata	King, 1853						1				1						1	1	1
Simocephalus victoriensis	Dumont, 1983	1			1					1	1	1	1						
Macrothrix breviseta	Smirnov, 1976		1			1		1	1	1					1				
Macrothrix sp.(*Echinisca* sp.)								1					1						
Neothrix armata																		1	1
OSTRACODA (seed shrimps)																			
Ostracoda (Unident.)		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
COPEPODA																			
Boeckella triarticulata	(Thompson, 1883)	1					1			1	1	1		1	1		1	1	1
Boeckella robusta	Sars, 1896																1	1	1
Boeckella sp.													1						
Calamoecia sp. 342 (ampulla variant)			1					1		1	1			1	1			1	1
Metacyclops sp. 442 (CB)								1	1						1	1			
Metacyclops sp. 434 (arnaudi sensu Sars) (CB)							1												
Australocyclops australis	(Sars, 1855)	1			1		1				1	1	1		1			1	1

		Det LK5	Det LK5	Det LK5	Det LK1	Det LK1	Det LLS1	Det LLS1	Janet	Janet	Yate	Yate	Yate	Bryde	Bryde	Bryde	East Bryde	East Bryde	East Bryde
TAXA	Authority	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-06	Oct-06	Oct-06	Mar-06	Oct-06	Yate	Mar-07	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-07
Mesocyclops brooksi	De Laurentiis et al, 1996		1			1									1	1			
Eucyclops australiensis	Morton						1												
Paracyclops ?chiltoni (SAP)											1							1	
Apocyclops dengizicus	(Lepesckin, 1900)		1																
Harpacticoida spp								1			1	1							
AMPHIPODA (shrimps)																			
Austrochiltonia subtenuis	(Sayce, 1902)		1	1		1	1	1	1				1		1	1		1	1
DECAPODA																			
Cherax destructor	Clark, 1936						1												
COLEOPTERA (beetles)																			
Haliplus sp.			1				1	1	1										
Hyphydrus elegans	(Montrouzier, 1860)	1			1					1			1			1			
Allodessus bistrigatus	(Clark, 1862)	1			1	1	1	1	1								1		
Antiporus gilberti	(Clark, 1862)	1			1	1	1	1		1				1			1		1
Sternopriscus multimaculatus	(Clark, 1862)	1	1		1		1	1	1	1	1				1	1	1	1	1
Necterosoma penicillatus	(Clark, 1862)				1	1		1	1	1									
Megaporus howitti	(Clark, 1862)		1		1	1	1				1		1		1				
Rhantus suturalis	(W.S.MacLeay, 1825)	1			1														
Lancetes lanceolatus	(Clark, 1866)					1					1								1
Hyderodes crassus	Sharp, 1882	1																	
Onychohydrus scutellaris	(Germar, 1848)				1						1						1		
Berosus munitipennis	Blackburn, 1895													1					
Berosus nutans	(Macleay, 1873)							1											
Berosus sp.		1	1		1	1	1		1	1	1	1	1		1				
Enochrus eyrensis	(Blackburn, 1894)									1									
Enochrus maculiceps	(MacLeay, 1873)										1	1							
Limnoxenus zelandicus	(Broun)	1											1	1					
Hydraena luridipennis	Macleay, 1873									1									
LEPIDOPTERA (moths)																			

TAXA	Authority	Det LK5 Mar-06	Det LK5 Oct-06	Det LK5 Mar-07	Det LK1 Mar-06	Det LK1 Oct-06	Det LLS1 Mar-06	Det LLS1 Oct-06	Janet Oct-06	Janet Mar-06	Yate Oct-06	Yate Yate	Yate Mar-07	Bryde Mar-06	Bryde Oct-06	Bryde Mar-07	East Bryde Mar-06	East Bryde Oct-06	East Bryde Mar-07
lepidoptera larvae									1		1					1	1		
DIPTERA (true flies)																			
Anopheles sp.		1								1		1	1						
Culex (Culex) annulirostris													1						
Bezzia sp.										1					1			1	
Culicoides sp.							1												
Monohelea sp.				1															
Nilobezzia sp.			1	1		1	1	1	1	1			1		1	1			1
Atrichopogon sp. 3 (SAP)											1								1
Forcypomyia sp. 3 (SAP)														1					
Stratiomyidae		1	1		1	1	1	1		1	1	1	1	1	1		1	1	
Muscidae															1			1	
Coelopynia pruinosa	Freeman, 1961																		1
Procladius paludicola	Skuse, 1889	1	1	1			1	1	1						1	1	1		1
Procladius villosimanus	Kieffer, 1917		1		1	1				1	1		1				1	1	
Ablabesmyia notabilis										1			1		1	1	1	1	1
Paramerina levidensis	(Skuse, 1889)										1	1			1			1	
Cricotopus albitarsus	Hergstrom																1		
Cricotopus 'parbicinctus'	Hergstrom											1		1					
Limnophyes sp. A (SAP)																		1	
Orthocladiinae sp. A (?VSC11)											1								
Paralimnophyes sp. 1 *(pullulus)*											1		1						
Tanytarsus barbitarsis	Freeman, 1961			1															
Tanytarsus bispinosus													1		1	1			
Tanytarsus fuscithorax	Skuse, 1889/Glover, 1973	1	1			1	1	1	1		1						1		
Harrisius sp.															1			1	
Chironomus occidentalis	Skuse, 1889	1			1							1							
Chironomus tepperi	Skuse, 1889		1			1			1						1		1		
Chironomus aff. *alternans* (V24)	Walker, 1856	1			1					1	1	1	1	1			1		

		Det LK5	Det LK5	Det LK5	Det LK1	Det LK1	Det LLS1	Det LLS1	Janet	Janet	Yate	Yate	Yate	Bryde	Bryde	Bryde	East Bryde	East Bryde	East Bryde
TAXA	Authority	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-06	Oct-06	Oct-06	Mar-06	Oct-06	Yate	Mar-07	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-07
Dicrotendipes conjunctus	(Walker, 1856)		1			1	1	1	1	1	1				1	1		1	1
Dicrotendipes 'CA1'													1			1			
Kiefferulus intertinctus	(Skuse, 1889)				1		1				1					1			
Kiefferulus martini	Freeman, 1961										1		1						
Polypedilum nubifer	(Skuse, 1889)	1	1			1	1		1	1	1				1	1			1
Cryptochironomus griseidorsum		1			1		1			1				1	1		1	1	1
Cladopelma curtivalva	(Kieffer, 1917)		1	1							1		1						
Harnischia sp.																			1
EPHEMEROPTERA (mayflies)																			
Tasmanocoenis tillyardi	(Lestage)																	1	
HEMIPTERA (bugs)																			
Saldula brevicornis	Rimes, 1951	1																	
Diaprepacauris barycephalus																1			
Sigara truncatipala	(Hale, 1922)	1								1	1	1	1						
Sigara mullaka	Lansbury, 1970				1	1		1	1						1	1			
Agraptocorixa parvipunctata	(Hale, 1922)	1					1			1		1	1				1		
Agraptocorixa hirtifrons	(Hale, 1922)																	1	1
Agraptocorixa sp.			1		1						1								
Micronecta robusta	Hale, 1922	1						1	1	1			1	1				1	
Micronecta gracilis	Hale, 1922	1			1		1			1	1					1			1
Anisops thienemanni	Lundblad, 1933	1	1		1			1	1	1	1	1	1	1	1	1			
Anisops hyperion	Kirkaldy, 1898				1					1									
Anisops gratus	Hale, 1923						1							1		1	1	1	1
Anisops baylii	Lansbury, 1995										1								
Anisps hackeri													1						
Anisops sp.						1													
Microvelia sp													1						
Mesoveliidae sp													1						
Hydrometra strigosa													1						

		Det LK5	Det LK5	Det LK5	Det LK1	Det LK1	Det LLS1	Det LLS1	Janet	Janet	Yate	Yate	Yate	Bryde	Bryde	Bryde	East Bryde	East Bryde	East Bryde
TAXA	Authority	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-06	Oct-06	Oct-06	Mar-06	Oct-06	Yate	Mar-07	Mar-06	Oct-06	Mar-07	Mar-06	Oct-06	Mar-07
ODONATA (dragonflies, damselflies)																			
Xanthagrion erythroneurum	(Selys, 1876)		1						1							1			1
Austrolestes analis	(Rambur, 1842)	1	1		1	1	1		1	1	1	1		1		1	1		
Austrolestes annulosus	(Selys, 1862)	1	1		1	1	1	1	1	1		1		1	1	1	1	1	
Austrolestes io	(Selys, 1862)	1	1		1	1	1	1	1	1				1			1		
Hemianax papuensis	(Burmeister, 1839)	1	1		1	1	1		1	1	1	1	1				1		
Orthetrum caledonicum	(Brauer)					1			1	1			1			1			
Hemicordulia tau	Selys, 1871	1	1		1	1		1	1	1		1	1	1	1	1	1	1	1
TRICHOPTERA (caddisflies)																			
Ecnomus pansus/turgidus																1			
Notalina spira	St Clair		1			1		1	1						1	1			1
Oecetis sp.		1	1			1	1		1	1	1			1	1	1	1	1	1
Triplectides australis	Navas, 1934	1	1			1	1	1	1	1	1			1	1	1	1	1	1

Front cover; Yate swamp. Back cover; Lake Bryde. Photos by Natalie Nicholson 2007