Aquatic Invertebrate Diversity in Drummond Natural Diversity Recovery Catchment Wetlands, 2004-2010.

Adrian Pinder, David Cale and Anna Leung

DEC, Science Division

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Background

The two claypans in Drummond Nature Reserve were first sampled for aquatic invertebrates by Cale (2005) to assess aquatic fauna biodiversity in the newly established Drummond Natural Diversity Recovery Catchment (DNDRC). The same wetlands were sampled for the Avon Baselining Project (Jones *et al.* 2009) and the wetlands have now been incorporated into the State Salinity Strategy wetland monitoring project. The first sampling event for the latter was in August 2010, although only one of the two wetlands had water.

The wetland located at the south-west corner of the reserve (off Old Plains Road) is herein referred to as the 'south-west' wetland and the wetland accessed off Bulligan Road is referred to as the 'north-east' wetland. In the State Salinity Strategy monitoring these will be sites SPM030A and SPM030B respectively.

On each sampling occasion a sample of the zooplankton was taken with a net with 50 µm mesh and a sample of the benthos and zooplankton was taken using a net with mesh 250 µm. An exception was an ad-hoc collection of zooplankton in August 2004 taken using a 100um mesh net. In-situ measurements of pH, conductivity and temperature were taken and water samples were collected for measurement of total dissolved solids, ionic composition, turbidity, hardness, alkalinity and total filterable nutrients.

Water chemistry

Table 1 lists all of the water chemistry data for the three sampling rounds, except that the 2010 water samples have not yet been analysed. Both wetlands have been fresh (TDS <500 mg/L) and clear (turbidity ≤2 NTU) when sampled, with moderate colour present at times (up to 140 TCU). Phosphorus concentrations are as low as can be detected (10 µg/L total filterable phosphorus) but nitrogen concentrations can be moderately high (1000 to 2300 µg/L total filterable nitrogen). The TFN concentrations are at or above the Australian Water Quality Guidelines for total (unfiltered) nitrogen (<1500 µg/L) for south-western Australian wetlands (Australian and New Zealand Environment and Conservation Council *et al.* 2000). The pH is variable, with lower values recorded in 2007 (5.39 and 6.82) than in 2004 (8.08 to 8.51). The water is normally well saturated with oxygen. Chlorophyll concentrations are generally low and not of concern at this stage, although they were somewhat higher (13 mg/L) in the south-west wetland in 2004.

Table 1. Surface water physico-chemical data for the Drummond Nature Reserve claypans.

	South-west wetland				North-east wetland		
Project	**Cale (2005) Drummond Survey**	**Cale (2005) Drummond Survey**	**Jones et al. (2009) Avon Baselining Project**	**State Salinity Strategy Monitoring**	**Cale (2005) Drummond Survey**	**Cale (2005) Drummond Survey**	**Jones et al. (2009) Avon Baselining Project**
Sample Code	**ADS002A**	**ADS002**	**ABP032**	**SPM030**	**ADS002B**	**ADS002B**	**ABP030**
Date	**Aug 2004**	**Oct 2004**	**Sep 2007**	**Aug 2010**	**Aug 2004**	**Oct 2004**	**Sep 2007**
Depth (cm)	25	15	20	6	30	30	20
Field Conductivity (uS/cm)	189		177	205	227	531	350
Field pH	8.51		5.39	8.67	8.08	8.16	6.82
TN (ug/L)	2300		1000			1800	1700
TP (ug/L)	10		10			10	10
Total chlorophyll	5		2			13	2
Temperature (^{o}C)	17.4	24.3	13.3	15.9	17.1	24.3	18.5
Oxygen (%)	128.1				124.1	124.4	
Turbidity (NCU)			2			0.6	0.9
Colour (TCU)			4			140	84
Total Dissolved Solids (TDS g/L)			99			460	160
Alkalinity (mg/L)			5			29	25
Hardness(mg/L)			8			31	14
Silica (mg/L)			3.5			2.3	2.4
Sodium (mg/L)			28.6			121	53.7
Calcium(mg/L)			1.3			5.2	2.9
Magnesium (mg/L)			1.2			4.5	1.5
Potassium (mg/L)			4.9			10.9	5.9
Manganese (mg/L)			0.022			0.003	0.002
Chloride (mg/L)			44			210	67
Bicarbonate (mg/L)			6			35	31
Carbonate (mg/L)			0.5			1	0.5
Nitrate (mg/L)	0.02		0.02		0.02	0.01	0.02
Sulphate (mg/L)			2.8			7.9	4.8
Iron (mg/L)			0.049			0.038	0.1

Aquatic invertebrates

Richness

The aquatic invertebrate data is provided in Appendix 1. A total of 151 species has been recorded, with an average of 59 ± 12 per sample. About half of these species have only been recorded in one of the six samples. Richness per sample at Drummond is comparable to that of other clay-based wetlands (Fig. 1) but seems to be particularly variable, with the 2007 and 2010 richness (39 to 45) being only about half that recorded in 2004 (78 and 93). The lower richness in 2007, compared to 2004, is not obviously related to water depth (since depth was about as high in Sep 2007 (20cm) as it was in Oct 2004 (15 to 30cm) but the period since flooding may have been different. pH was lower in 2007 but not sufficiently so to have influenced the fauna. Invertebrates 'missing' in 2007 but present in one or both samples in 2004 included about equal numbers of aerially dispersing species and those with drought resistant propagules, indicating that the reduced diversity could have been due

to a combination of reduced hatching and colonization success. Richness in the single 2010 sample was about the same as in 2007, despite water depths being much lower (6cm).

Composition

The fauna includes some rare and/or interesting elements, as previously discussed by Cale (2005). However, some of the species flagged as new by Cale (2005) have since turned out not to be. In particular, the *Cephalodella* rotifer mentioned remains of uncertain identity while the *Lepadella* rotifer from the north-west wetland has been tentatively identified as *L. acuminata* by Russell Shiel (University of Adelaide). Russell Shiel has suggested that the unidentified *Lecane* rotifer from the south-west wetland may be a new species. There is a great deal of taxonomic work required on Australian rotifers and significant cryptic diversity is being revealed. Moreover, south-western Australia seems to be a 'hotspot' for rotifer (and other microinvertebrate) diversity (Segers *et al.* 2003), so regular collection of new species is expected. The ostracods *Lacrimicypris* n.sp. and *Newnhamia* sp. DR4 are likely to be new but require further work by specialists. Cale (2005) also suggested that the mosquito *Aedes* (*Och*.) nr *stricklandi* may be undescribed. This has since been collected from Drummond wetlands in 2007 and 2010 and from Dobaderry Swamp, about 30km west of the town of Beverley (Jones *et al.* 2009), but it has not been collected during any other DEC project. It is listed in Table 2 as *Aedes* sp. 5 (Dobaderry).

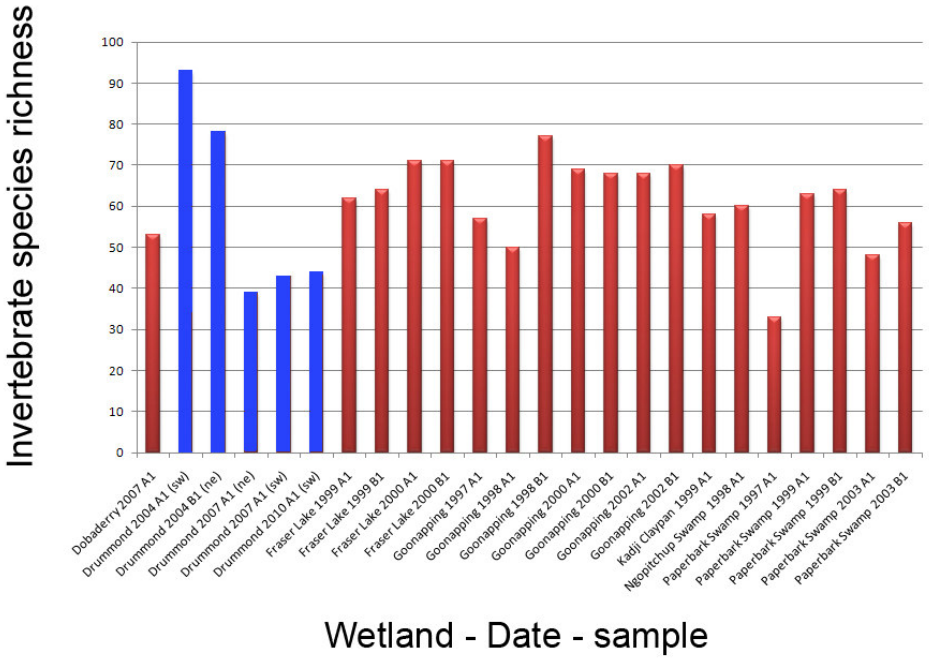

Fig. 1. Invertebrate species richness in Drummond NDRC wetlands (blue columns) and a range of other clay-based wetlands (red columns) in the south-west of Western Australia.

Cale (2005) listed several additional species that have otherwise rarely been collected, at least in the inland south-west: *Gyraulus* snails, rotifer *Lecane hornemanni*, ostracod *Plesiocypridopsis* sp., water mite *Arrenurus* (*Micruracarus*) sp. 1 and the beetle *Hydaticus* sp. (as larvae). Additionally, the calanoid copepod *Boeckella geniculata*, a south-west WA endemic, recorded in the south-west Drummond wetland in 2007 and 2010, has also rarely been collected (from a few fresh, mostly temporary, wetlands in the far south-west and south-coast). A species of cladoceran collected in 2010 has been tentatively identified as *Alona kendallensis*. This is a rarely collected species, with the only other inland south-west record being Yorkrakine Rock in 2007 (Jones *et al.* 2009), although it appears to be more common on the Swan Coastal Plain and is widely distributed in southern and eastern Australia. Most records of the chironomid Pentaneurini sp. A have been from the Drummond wetlands (2004, 2007 and 2010) and Dobaderry Swamp (2007), but there are a few records further south (Ngopitchup Swamp, Cairn Rock and Noobijup Swamp – which are also temporary freshwater wetlands).

In August 2004 David Cale collected a plankton sample from the south-west wetland just in case the wetland dried before the scheduled October invertebrate sampling. This sample has only recently been processed. This was an opportunistic collection and the only net on hand was a 110 um mesh net, so some rotifers would not have been collected. A benthic sample was not collected so overall richness of this collection is not considered. Twenty five species were collected, of which eleven were not collected from the same wetland in the following October, suggesting that there was significant turnover in species between sampling events. Three of these species were not present in any of the five subsequent samples from either of the Drummond wetlands: mesoveliid hemipterans, lepidopteran larvae (possibly terrestrial) and the non-biting midge Pentaneurini sp. F. Three of the seven indicator species (see below) were collected.

Significant compositional change over a period of 2 months is expected in seasonally inundated wetlands and stage of the hydrological cycle can be a source of variation in community composition. This is especially true during the period following flooding and during the drying period if water quality declines. Sampling at a consistent stage of the hydrological cycle is difficult to achieve where there is no real time monitoring of hydrology and budget constraints mean that geographically disparate wetlands need to be sampled during a single field trip. Nonetheless, the community is probably sufficiently well developed by about 6 to 8 weeks after flooding for timing of sampling not to significantly affect monitoring against proposed biodiversity targets. That is, sampling undertaken after this lag should adequately represent the community and allow the full range of indicator species to be collected.

Sampling every year, rather than biennially, and considering monitoring results over several years will also help to smooth out interannual differences caused by inconsistent timing of sampling (and other factors). The Installation of a depth logger (planned for 2011) will allow better interpretation of invertebrate data.

Draft biodiversity targets set for the Drummond wetlands by the Recovery Catchment suggest the following triggers for management action:

1. Community composition should not differ significantly from baseline data over a 5 year timeframe.

2. No less than four indicator species should be present in any one wetland and no less than six indicator species should be present across both wetlands on any one sampling occasion.

Many wetlands in south-western Australia vary substantially in physical and chemical characteristics from year to year and this leads to variability in faunal composition. This biological variability makes establishment of baseline community composition difficult when there is little data. The first of the above targets is tentatively based on the 2004 and 2007 data but this may need to be revisited as we undertake more sampling. Further years with similar wetland conditions may need to be included in the baseline to account for the range of natural variation in composition. In 2010 there was only a minor filling of the south-west wetland and the north-east wetland was dry when visited. Since climate change is considered a significant threat to these wetlands, the 2010 data was used as a test of the current baseline.

Fig. 2 is an ordination of invertebrate communities in all five of the 2004 to 2010 Drummond samples, together with data from a selection of other clay-based wetlands for context. This is a non-metric multidimensional scaling produced using Primer v6 (Primer-E Ltd. 2008). In this analysis the two 2004 Drummond samples grouped separately from the two 2007 samples and the 2010 sample was placed outside of the range of the earlier samples (2004 and 2007). The Drummond samples are aligned along a time (year) gradient in this ordination, but with only three sampling occasions it may be too early to suggest that this is a temporal trend in composition. The community composition target above is for no change from baseline composition over a five year period, so additional sampling in coming years is required to assess this target. Moreover, the gradient is also a seasonal one, with the 2004 collections made in October, the 2007 samples collected in September and the 2010 samples collected in August (because of the risk of complete drying by delaying sampling).

The second target refers to a list of seven species closely associated with seasonal clay-based wetlands in inland south-western Australia. These species are:

- clam shrimp (*Lynceus* sp.)
- ostracod (*Bennelongia australis*)
- beetle (*Paroster* couragei)
- beetle (*Berosus approximans*)
- copepod (*Calamoecia attenuata*)
- phantom midge (*Promochlonyx australiensis*)
- cladoceran (*Latonopsis brehmi*)

Table 2 shows the number of claypan specialists recorded in each of the five 2004 to 2010 samples. The target is for at least six of the seven species to be present across both wetlands and for at least 4 to be present in any one wetland. In 2010 only 3 species were recorded in the south-west wetland and the north-east wetland was dry so the combined wetland measure was not possible.

Table 2. Richness of the suite of species associated with seasonal clay-based wetlands of the inland south-west of Western Australia.

		Number of species typically occurring in clay-based seasonal wetlands in south-west WA.	
Date	Sample	Per wetland (1 sample)	Per year (2 samples)
Oct 2004	South-west	6	7
Oct 2004	North-east	7	
Sep 2007	South-west	6	7
Sep 2007	North-east	5	
Oct 2010	South-west	3	-

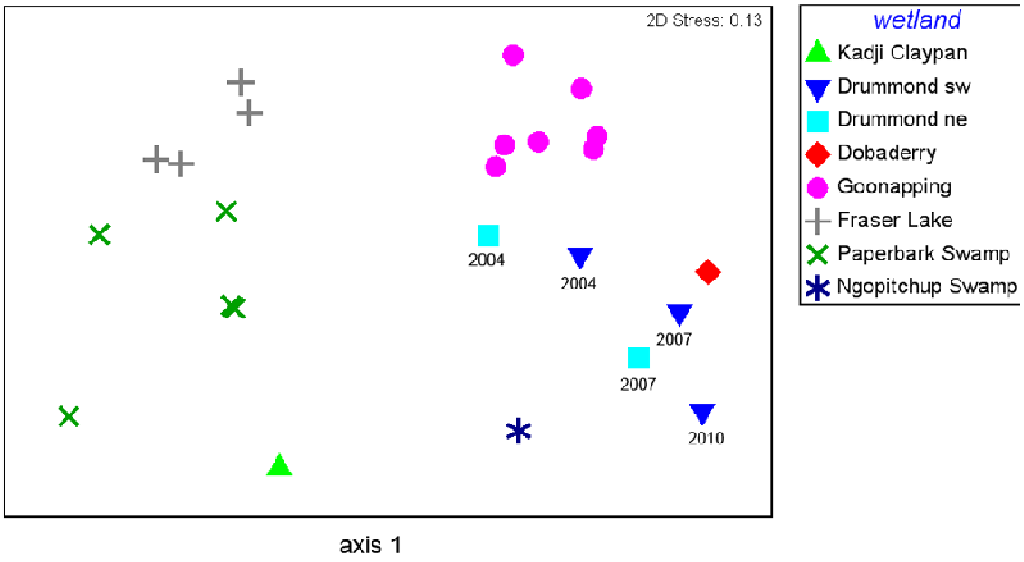

Fig. 2. Two-dimensional ordination of invertebrate communities in the Drummond wetlands (in blue) and other clay-based wetlands of the south-west.

Summary

Aquatic invertebrate richness was much higher in 2004 than in either 2007 or 2010. Without knowledge of the timing and duration of the flood event prior to sampling it is difficult to comment on the reason for the low 2007 richness. In 2010 it is probably due to the very small amount of water present prior to, and during, sampling. To allow better interpretation of aquatic invertebrate data in such a seasonal wetland it is recommended that a depth logger be installed. There is a suggestion in the data of a temporal trend in community composition, though it is difficult to say whether this represents a seasonal effect or a trend over the years of data collected. Further years of data are required and it is likely that a good filling event in the next couple of years will see the wetland community return to the 2004 to 2007 composition, providing there are no major changes in water quality. The number of seasonal clay-pan specialists was much lower in 2010 than in previous years

so that in 2010 the target of at least 4 species per wetland and 6 species across both wetlands was not met. We recommend sampling both wetlands each year to collect sufficient data to assess the invertebrate communities against the proposed biodiversity targets.

References

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Jones S, Collins M, Francis C & Halliday D 2009 Stage 3 evaluations of 28 wetlands in the Avon Natural Resource Management region, spring 2008. Department of Environment and Conservation, Perth.

Primer-E Ltd. 2008 Primer v6.1.11. Primer-E Ltd, Plymouth, UK.

Segers H & Shiel R J 2003 Microfaunal biodiversity in a biodiversity hotspot: new rotifers from southwestern Australia. Zoological Studies 42: 516-521.

Appendix 1 (following pages). All aquatic invertebrate data for the Drummond wetlands for 2004 to 2010.

			Cale et al. (2005)			Jones et al. (2009)		State Salinity Strategy
		Sample code	ADS002	ADS002	ADS002	APB030	APB032	SPM030
		Date	26/08/2004	15/10/2004	15/10/2004	11/09/2007	11/09/2007	23/08/2010
		wetland	SW ***	SW	NE	NE	SW	SW
Higher Taxon	**Family**	**Species**						
Protozoans	Arcellidae	*Arcella discoides*				1	1	
		Arcella sp. b (SAP)					1	
Flatworms	-	Turbellaria		1	1			
Nermertini	-	Nemertini			1			
Nematodes	-	Nematoda		1	1			1
Tardigrades	-	Tardigrada			1			
	-	Bdelloidea sp.		1	1			
	-	Bdelloidea sp. 2:2	1					1
	-	Bdelloidea sp. 5:5						1
	Testudinellidae	*Testudinella patina*			1			
		Testudinella insinuata		1	1			
		Testudinella tasmaniensis		1	1			
	Asplanchnidae	*Asplanchnopus multiceps*		1	1		1	
	Brachionidae	*Keratella procurva*		1		1	1	1
	Lepadellidae	*Colurella uncinata bicuspidata*			1			
		Lepadella ovalis			1			
		Lepadella biloba		1				
		Lepadella patella			1			
		Lepadella triptera						1
		Lepadella cf. *acuminata*			1			
	Dicranophoridae	*Dicranophorus epicharis*		1	1			
	Euchlanidae	*Euchlanis dilatata*		1	1			1
		Euchlanis cf. lyra			1			
	Lecanidae	*Lecane hamata*		1				
		Lecane hornemanni		1				1
		Lecane arcula			1			
		Lecane ludwigii			1			
		Lecane luna			1	1	1	
		Lecane lunaris			1			1
		Lecane ohioensis						1
		Lecane quadridentata	1	1	1	1	1	1
		Lecane rhytida		1				
		Lecane signifera		1	1			
		Lecane latissima		1	1			
		Lecane (*Monostyla*) sp.				1		
		Lecane n. sp. ?		1				
	Notommatidae	*Cephalodella gibba*		1	1			

			Cale et al. (2005)			Jones et al. (2009)		State Salinity Strategy
		Sample code	ADS002	ADS002	ADS002	APB030	APB032	SPM030
		Date	26/08/2004	15/10/2004	15/10/2004	11/09/2007	11/09/2007	23/08/2010
		wetland	SW ***	SW	NE	NE	SW	SW
Higher Taxon	**Family**	**Species**						
		Cephalodella sp.		1				
		Monommata maculata		1	1			
		Monommata n. sp. (nr *maculata*), possibly = above					1	
		Notommata sp.		1				
	Trichocercidae	*Trichocerca elongata*						1
		Trichocerca obtusidens		1	1			
Snails (Gastropoda)	Planorbidae	*Glyptophysa* sp	1	1	1	1	1	1
		Gyraulus sp.		1			1	1
Leeches (Hirudinea)	Glossiphoniidae	Glossiphoniidae			1			
Aquatic Earthworms (Oligochaeta)	Naididae	Naididae (ex Tubificidae), immature *A. nharna?*		1				
		Dero nivea						1
		Dero furcata		1				
		Pristina leidyi		1				
		Ainudrilus nharna		1	1		1	1
Water Mites (Acarina)	Limnesiidae	*Limnesia dentifera*						1
		Limnesia sp.					1	
	Pionidae	*Acercella falcipes*	1					1
	Arrenuridae	*Arrenurus* (*Micruracarus*) sp. 1 (SAP)		1	1			1
	-	Oribatida sp.		1	1			
	-	Mesostigmata		1	1			
	-	Trombidioidea			1	1	1	1
Clam Shrimps (Conchostraca)	Lyncaeidae	*Lynceus* sp.	1	1	1	1	1	
Water Fleas (Cladocera)	Sididae	*Diaphanosoma unguiculatum*/cf. *unguiculatum*	1			1		
		Latonopsis brehmi		1	1		1	
	Chydoridae	*Alona rectangula novaezealandiae*		1	1			
		Alona setigera				1	1	
		Alona sp.			1			
		Alona kendallensis?						1
		Alonella clathratula				1		
		Alonella sp.			1			
		Celsinotum sp. ?					1	
		Dunhevedia crassa		1	1			
		Ephemeroporus barroisi s.l.				1		
		Leberis sp.	1	1	1			1
		Planicirclus alticarinatus	1	1	1		1	1
		Rak sp.		1	1	1	1	
		Armatalona macrocopa/cf. *macrocopa*					1	

			Cale et al. (2005)			Jones et al. (2009)		State Salinity Strategy
		Sample code	ADS002	ADS002	ADS002	APB030	APB032	SPM030
		Date	26/08/2004	15/10/2004	15/10/2004	11/09/2007	11/09/2007	23/08/2010
		wetland	SW ***	SW	NE	NE	SW	SW
Higher Taxon	**Family**	**Species**						
	Daphniidae	*Ceriodaphnia* sp.		1		1	1	1
		Daphnia carinata				1		
		Simocephalus elizabethae		1	1		1	1
		Simocephalus gibbosus			1			
		Simocephalus heilongjiangensis				1		
	Macrotrichidae	*Macrothrix breviseta*					1	
		Macrothrix flabelligera				1		
		Macrothrix n. sp. (Drummond)			1			
	Neotrichidae	*Neothrix armata*					1	
		Neothrix sp.		1				1
Seed Shrimps (Ostracoda)	Limnocytheridae	*Limnocythere dorsosicula*		1				
		Limnocythere sp. (probably *dorsosicula*)	1					
	Candonidae	*Candonopsis tenuis*			1	1		1
	Cyprididae	*Alboa worooa*		1	1	1	1	
		Bennelongia australis	1	1	1	1	1	
		Bennelongia sp.						1
		Candonocypris novaezelandiae		1	1			1
		Cypretta baylyi			1			
		Cypretta sp.	1					
		Cypretta aff. *globosa*		1	1	1		
		Cypretta sp. 272					1	
		Ilyodromus amplicolis			1	1		
		Ilyodromus sp. BOS089					1	
		Plesiocypridopsis sp.		1	1			
		Lacrimicypris n.sp.		1	1			
	Notodromadidae	*Newnhamia fenestra* (possibly = DR4?)				1	1	
		Newnhamia sp. DR4 (SAP)	1		1			
Copepods (Copepoda)	Centropagidae	*Boeckella geniculata*	1				1	1
		Calamoecia attenuata		1	1	1		
		Calamoecia sp.					1	
	Cyclopidae	*Microcyclops varicans*		1	1	1	1	1
		Metacyclops sp. 434 (*arnaudi* sensu Sars)	1					
		Mesocyclops brooksi	1	1	1	1	1	1
	Canthocamptidae	*Canthocamptus australicus*		1	1			
		Mesochra flava						1
		Canthocamptidae sp. B (SAP)		1				
		Harpacticoida sp.	1					

			Cale et al. (2005)			Jones et al. (2009)		State Salinity Strategy
		Sample code	ADS002	ADS002	ADS002	APB030	APB032	SPM030
		Date	26/08/2004	15/10/2004	15/10/2004	11/09/2007	11/09/2007	23/08/2010
		wetland	SW ***	SW	NE	NE	SW	SW
Higher Taxon	**Family**	**Species**						
Beetles (Coleoptera)	Haliplidae	*Haliplus* sp.			1			
	Dytiscidae	*Allodessus bistrigatus*		1	1			
		Paroster couragei						1
		Paroster sp. larvae		1	1	1	1	
		Sternopriscus sp. larvae		1	1			
		Megaporus sp. larvae		1	1			
		Platynectes aenescens			1			
		Platynectes sp. larvae	1	1		1	1	1
		Rhantus suturalis						1
		Copelatus sp. larvae				1		
		Hyderodes sp. larvae	1			1		1
		Hydaticus sp. larvae		1				
	Hydrophilidae	*Berosus australiae*			1			
		Berosus approximans		1	1	1		1
		Paranacaena littoralis		1	1			
		Enochrus eyrensis		1	1			
		Limnoxenus zelandicus adults and/or larvae	1		1		1	
		Paracymus pygmaeus			1			
		Paracymus spenceri		1				
		Hydrophilus sp. larvae		1				
	Scirtidae	Scirtidae sp.		1	1	1		
Fly Larvae (Diptera)	Tipulidae	Tipulidae type E (SAP)		1				
	Chaoboridae	*Promochlonyx australiensis*	1	1		1	1	1
	Culicidae	*Anopheles annulipes* s.l.		1	1			
		Aedes (*Ochleratus*) sp. 5 (Dobaderry)			1	1	1	1
	Ceratopogonidae	*Bezzia* sp. 2 (SAP)				1		
		Clinohelea sp.			1			
		Culicoides sp.		1				1
		Monohelea sp. 4 (SAP)				1		
		Nilobezzia sp. 1 (SAP)					1	
		Dasyhelea sp.			1		1	
	Tabanidae	Tabanidae		1	1	1		
	Stratiomyidae	Stratiomyidae			1			
	Dolichopodidae	Dolichopodidae			1			
	Muscidae	Muscidae sp. H (SAP)		1				
	-	Diptera sp.			1			
	Chironomidae	*Procladius villosimanus*			1			

			Cale et al. (2005)			Jones et al. (2009)		State Salinity Strategy
		Sample code	ADS002	ADS002	ADS002	APB030	APB032	SPM030
		Date	26/08/2004	15/10/2004	15/10/2004	11/09/2007	11/09/2007	23/08/2010
		wetland	SW ***	SW	NE	NE	SW	SW
Higher Taxon	**Family**	**Species**						
		Paramerina levidensis			1		1	
		Pentaneurini sp. A (SAP)	1	1		1	1	1
		Pentaneurini sp. F (SAP)	1					
		Pentaneurini genus C						1
		Corynoneura sp. (V49) (SAP)		1	1			
		Compterosmittia ? sp. A (SAP)			1			
		Gymnometriocnemus sp.					1	
		Limnophyes sp.			1			
		Orthocladiinae sp. G (SAP)						1
		Orthocladiinae SO3 sp. A (SAP)	1			1	1	1
		Polypedilum nubifer			1			
		Cladopelma curtivalva			1			
Water Bugs (Hemiptera)	Mesoveliidae	Mesoveliidae	1					
	Saldidae	*Saldula brevicornis*		1				
	Corixidae	*Micronecta robusta*			1			
	Notonectidae	*Anisops thienemanni*			1			
		Anisops sp. (females or juveniles)		1				
Moth larvae (Lepidoptera	-	Lepidoptera (non-pyralid) sp. 9 (nr Pilbara sp. 3)	1					
Dragonflies and Damselflies	Lestidae	*Austrolestes analis*		1	1			
(Odonata)	Aeshnidae	*Hemianax papuensis*		1	1			
	Hemicorduliidae	*Hemicordulia tau*			1			
Caddisflies (Trichoptera)	Leptoceridae	*Lectrides* sp. AV1		1	1			

*** = 110 µm plankton net only