Aquatic invertebrate communities in Gwambygine Pool following dredging in 2010

Report to
Wheatbelt Natural Resources Management Inc.

by

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Department of Environment and Conservation
Our environment, our future

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EXECUTIVE SUMMARY

In 2010 restoration work commenced on Gwambygine Pool, including sediment removal. As a contribution to determining whether this restoration work has affected the ecological condition of the pool, aquatic invertebrates were surveyed in November 2011 and February 201 and compared to existing data.

In 2011 and 2012, five 12 metre sweep net were taken from different habitats present at the time of sampling (e.g. open water, macrophyte, overhanging vegetation). When combined these are equivalent to the 60 metre samples collected in 2007 and 2008.

- Invertebrate Richness
  - Gwambygine has high species richness compared to other Avon pools.
  - There was no significant change in species richness between 2007/2008 and 2011/2012 sampling occasions, with 90% of the species recorded in 2007/2008 being collected in 2011/2012. Between 2007 and 2012 a total of 78 species have been collected. Species richness varied between sampling occasions, from 18 in February 2007 to 46 in November 2011. The total number of species collected increased with each round of sampling. The November 2011 and February 2012 samples increased the cumulative richness by 16 species.
  - Species richness was lower in open water habitats compared to habitats with overhanging vegetation (branches or samphire) or macrophytes.

- Community Composition
  - The invertebrate communities varied between November 2011 and February 2012. Thirty two species occurred only in the November samples, 14 species occurred only in the February samples and 24 species occurred in both sampling occasions.
  - Community composition was slightly different between open water and the other habitats. This was a case of lower richness in open water habitats rather a change in community structure. i.e. the open water communities were a subset of the richer samples taken in vegetation.

- Water Quality
  - Salinity concentrations seem to be stable in Gwambygine Pool and have not increased since the 1990's.
  - Concentrations of nutrients were lower in 2011 and 2012 than in 2007.

Overall, Gwambygine Pool is currently in reasonable ecological condition. Invertebrate richness is as high as could be expected given the salinity, generally poor riparian condition and simple habitats (mostly bare sediment) and has not declined following the 2010 dredging. Neither has community composition altered greatly. Ongoing monitoring of Gwambygine Pool will provide information on how the pool invertebrate communities track over the long term with current and future restoration work.

INTRODUCTION

The Avon River

The Avon River arises near the town of Wickepin, about 25 km upstream of where it receives overflow from Lake Yealering. Further downstream, near Brookton, it is joined by the vast inland Yilgarn palaeodrainage system via the Salt River and the Yenyening (or Beverley) Lakes. These lakes are naturally saline but have increased in salinity and hydroperiod since clearing (Water and Rivers Commission 2002). Water is retained in the lakes by a man-made structure at the Qualandary Crossing, which reduces flows and salt load into the Avon (Water and Rivers Commission, 2002). Several other major tributaries flow in to the Avon including the Dale River. At Northam, the Avon receives the saline Mortlock Rivers (north, east and south branches) and below Toodyay it is joins Toodyay Brook. The Avon River is severely affected by siltation, salinisation and nutrient enrichment, but these have been dealt with in other publications, so are not discussed in detail here (Department of Water, 2007, Kendrick, 1976); and Water and Rivers Commission River Recovery Plans).

The Avon River flows intermittently, with stream flow commencing in the autumn and drying into a series of pools during the hot and dry summer months, typical of a Mediterranean climate. Originally there were 26 major pools on the Avon Rivers plus numerous smaller ones separated from each other by long shallow braided channels (Department of Water, 2007). Many of the Avon pools have now filled with sediment, largely as a result of engineering works in the late 1950s to early 1970s (the 'River Training Scheme'). This scheme was designed to prevent flooding by straightening the river and removing braided sections to allow more rapid movement of water. About half of the pools have partly or completely filled with sediments (Advanced Choice Economics and Viv Read and Associates, 2007, Davies and Ecoscape, 1997) but some of these have been dredged in recent years in an attempt to restore their depth. The Avon River pools form valuable habitats along the Avon River having ecological significance as drought refuges for aquatic invertebrates, fish, amphibians and waterbirds, plus as a water source for terrestrial vertebrates, including humans. Presently, the pools continue to fulfil this role, although an increase in salinity, eutrophication and sedimentation will reduce the value of the pools for many taxa. The remaining pools and braided sections of the Avon and tributaries are listed as a Priority Ecological Community by Department of Environment and Conservation (DEC).

The deeper pools are a feature of the middle section of the Avon River and have high aesthetic, nature conservation, recreational and Aboriginal values. Based on ecological, social and economical values, 16 pools (one of which is Gwambygine) have been nominated as high priority for rehabilitation (Department of Water, 2007).

Objective

Restoration work has been completed at Gwambygine Pool on the Avon River, since 2010. The restoration included removal of sediment from the upstream (southern) end of the pool and revegetation and fencing of the riparian zone upstream of the pool. The purpose of this report is to summarise new and previous macroinvertebrate community data collected from Gwambygine Pool and to assess whether restoration has improved the ecological health of the pool.

Gwambygine Pool on the Avon River

Gwambygine Pool is located 13 km south of York. It is about 1 km long and up to four metres deep, making it the deepest pool upstream of York. Sediments are mostly silt/clay except at the upstream extent where a sand slug dominated by medium course sand is often present. Sediment has been excavated from the pool on three occasions. In May1996, 8300m³ of sediment was removed, in May 1999 4060 m³ was removed and in October 2010 8000m³ was removed (Figure 1). The pool is set within cleared farmland and since 2010 the Department of Water has been working with Wheatbelt NRM on the restoration of Gwambygine Pool. This has included removal of sediment from the upstream end of the pool and revegetation and fencing of the riparian zone upstream of the pool.

Figure 1. Removal of sediment from Gwambygine Pool in October 2010 (photos courtesy Wheatbelt NRM Inc).

The Avon fauna

There have been several studies of aquatic invertebrates of the lower Avon Catchment – here defined as the Avon and tributaries upstream of Jimperding Brook, but excluding the large inland zone of ancient drainage above Yenyening Lakes.

Kendrick (1976) documented changes that had (or were likely to have had) occurred in the mollusc fauna since European settlement. He noted presence of thiarid and hyriid molluscs in mid-19th century accounts and 20th century records of five other molluscs. He suggested that the hyriids (*Westralunio carteri*) had become very rare in the Avon by 1976. This still seems to be the case, although they were collected at two sites on the Avon River by Halse *et al.* (2001) and in Gwambygine Pool by River Conservation Society (1999). The thiarid appears to have disappeared from the main channel of the Avon River before 1950, but remains in smaller tributaries flowing off the Darling Range and was collected from Duck Pool on the Mortlock River by Halse *et al.* (2001). Smith (1996) found most of the species discussed by Kendrick, except for *Westralunio* and *Ferrissia*. Kendrick suggested that *Ferrissia peterdi* (ancylid gastropods) would have occurred in the Avon River prior to salinisation, based on their widespread distribution elsewhere in the south-west. This limpet-like snail is rare in water with salinity above 1 g/L (DEC unpublished data), but was recorded in Christopher Brook (a freshwater tributary of Dale River, 0.72 g/L) by Pinder *et al.* (2004).

Tresslyn Smith's 1996 honours project involved sampling aquatic invertebrates and water chemistry at 19 sites along the Avon River and a few tributaries, each sampled once in spring. Seven pools (Bland, Scarp, Cobbler, Glen Avon, Northam, Public Utility and Tipperary pools) were included in that study, but only the first five of these were sampled for invertebrates using methods comparable with those used in the current study (Tipperary Pool was sampled by grab sampling only). One hundred aquatic invertebrate taxa (mostly identified to species level) were collected, with site richness ranging from 6 to 18 species. Conductivity was the strongest predictor of richness. Smith (1996) particularly noted the absence or rarity of stoneflies, annelids and water mites: three groups that are particularly salt-sensitive, although stoneflies, which inhabit flowing water, would not be expected in the river pools.

River Conservation Society (1999)sampled Gwambygine Pool for aquatic invertebrates over an 18 month period between January 1996 and June 1997. A total of 56 macroinvertebrate species were collected, with the highest richness in spring 1996. Some of the species collected were not collected from any of the sites sampled by Smith (1996), including *Gyraulus* snails, *Eylais* water mites, the beetle *Megaporous howitti,* hemipteran *Anisops thienemanni* and dragonflies *Pantala flavescens* and *Orthetrum caledonicum*. Diversity of annelids and water mites were low, although unidentified leeches, which are very rare in the Avon River and particularly salt-sensitive, were recorded.

Nineteen sites in the lower Avon River catchment were included in the Monitoring of River Health Initiative (MRHI) and/or the associated First National Assessment of River Health (FNARH) (Kay *et al.*, 2001, Halse *et al.*, 2001). Identifications were to family level only except that Sutcliffe (2003) later identified the stoneflies, caddisflies and odonates to species level. This project aimed to develop models to predict the richness of invertebrate families that would be expected at a site assuming that it was undisturbed. The Avon catchment was allocated to condition band “B” meaning that it was significantly impaired, rather than severely or extremely impaired (bands C and D). However, it was difficult to find undisturbed reference sites with which to build the predictive models. This meant that the models probably under predicted ‘reference’ (unimpaired) richness, so the catchment scored higher than it perhaps deserved (Halse *et al*. 2001). Halse *et al.* (2001) also pointed out that there is no pre-salinisation data on aquatic invertebrates for the Wheatbelt region and that it may be that the fauna has always predominantly consisted of salt tolerant species, although documented changes in the mollusc fauna argue against that. Fifty seven families of macroinvertebrates were collected from the Avon catchment during the MRHI/FNARH projects. None of the sites sampled were deep pools, although sites AVO11 and AVO13 were in the channel just upstream of Gwambygine Pool and just downstream Wilberforce Pool respectively.

Sutcliffe (2003) also accumulated all known records of Odonata, Trichoptera and Plecoptera from south-western Australia, including the Avon catchment. Twenty eight species from these groups have been recorded from the Avon Catchment.

DEC has surveyed several wetlands within the Avon region as part of the Avon Baselining Project and the Biological Survey of the South-west Agriculture zone (Pinder *et al.*, 2004). In 2007 and 2008 several river pools along the Avon and Dale Rivers were sampled by DEC to assess whether Avon River pool invertebrate communities represent a threatened ecological community (Pinder, 2009). The remaining pools and braided sections of the Avon and tributaries are listed as a Priority Ecological Community by Department of Environment and Conservation (DEC). Data from Pinder (2009) have been used for analyses in this report to help determine if there have been any significant changes to the invertebrate community at Gwambygine Pool since 2008.

METHODS

All field work, sorting and identification of invertebrates was undertaken by Melita Pennifold, Audrey Cartraud and Kirsty Quinlan from DEC. Sampling in 2011 and 2012 was undertaken in late spring (November) and summer (February) because this was when previous samples collected by DEC had been taken from the Gwambygine Pool. In each season, five samples were taken from different habitats present at the time of sampling (e.g. open water, macrophyte, overhanging vegetation). . Invertebrates were collected by sweeping a 250 µm mesh net through the littoral water column, disturbed sediments and when present, aquatic and draped riparian vegetation. Each sample consisted of a 12m sweep, giving a total sweep of 60m. This method differs from previous sampling occasions where only a single 60 metre sample was taken per site, but the five samples collected in 2011/12 can be combined to give the equivalent of a 60 metre sweep net sample. The separate habitat sampling has the advantage of providing a greater understanding of invertebrate-habitat relationships and better ability to interpret any future changes to the fauna, if this is associated with altered habitat. The samples were preserved in 100% ethanol. All identifications are to species level where possible, using names compatible with previous DEC projects, including Pinder (2009). For analysis, data collected from the 2011 and 2012 sampling period was combined with previous data collected by DEC on the Avon Pools (Pinder, 2009).

Conductivity, pH, oxygen concentration and water temperature were measured in the field. Nutrient and chlorophyll concentrations were measured in the laboratory by the ChemCentre.

Multivariate analyses were performed using Primer 6.1.1.1 and Permanova + 1.01 (Primer-E Ltd., 2008). Primer's Sorensen index was used as a measure of similarity between invertebrate samples. Nematodes were excluded from the multivariate analysis as there was probably more than one species involved. The ordination was a non-metric multidimensional scaling using 50 restarts and a minimum marginal stress value of 0.01. The hierarchical agglomerative cluster analysis used 'group averaging' to position new samples in the dendrogram. A distance-based linear model (in Primer, using adjusted r^2 as an indicator of model performance) was used to estimate the degree to which salinity and pH was correlated with community composition. The Chao 2 estimator in Primer was used to estimate the likely total species richness in the pools using the data in Appendix 1.

RESULTS

Water Chemistry

Water chemistry data are provided in Table1. Gwambygine Pool is subsaline (i.e. between 3-20g/L TDS) with salinity varying over the hydrological cycle. The pool is circum-neutral to moderately alkaline. Water in the pool was generally well oxygenated and turbidity was low. The concentrations of nitrogen, phosphorus and chlorophyll indicated mild nutrient enrichment in 2007, but concentrations in 2011 and 2012 were low, even below detection limits in some cases.

Table 1. Water chemistry data for Gwambygine Pool.

	Electrical conductivity (mS/cm)	pH	Temp (C°)	Dissolved O^2 (mg/L)	Dissolved O^2 (%)	Oxygen reduction potential (mV)	Calculated total dissolved solids (g/L)	Measured total dissolved solids (g/L)	Alkalinity (mg/L)	Turbidity (NTU)
13/02/2007	18.8	7.5	25.2				12.5			
26/07/2007	10.4	7.6					6.9			
13/11/2007	13.72	8.29	30.96	7.07			9.1			
1/03/2008	17	8.62	27.04	9.9	134.5	56	11.3	10.9		9
23/12/2008	14.5	8.57	28.91	10.28	146.9	126	9.6	9.3		0
15/11/2011	15.33	7.88	21.6	7.3	84.4		10.2		104	2.5
22/02/2012	13.78	8.95	28.2	12.77	165.6		9.2		158	4.3

	Ammonia (µg/L)	Orthophosphate (µg/L)	Nitrite/Nitrate (µg/L)	Total nitrogen (µg/L)	Total phosphorus (µg/L)	Chlorophyll a (µg/L))	Phaeophytin (µg/L))
26/07/2007	74	15	1100	2500	62	20	3.4
15/11/2011	<10 *	<10 *	<10 *	1000	<10 *	2	
22/02/2012	<10 *	<10*	<10 *	1500	10	9	

*** < below detection limit**

Invertebrate diversity

A total of 78 species of aquatic invertebrates have been collected from Gwambygine Pool between 2007 and 2012 (Appendix 1). The samples varied in species richness from 18 in February 2007 to 46 in November 2011 (Figure 2.). The total number of species collected has increased with each round of sampling. The November 2011 and February 2012 samples increased the cumulative richness by 16 species (about 18% of the total). Ninety percent of the species which were recorded in 2007/2008 were present in 2011/2012. The Chao2 richness estimator suggested a total species pool for this site of 106 species, suggesting that samples to date have collected about three quarters of the species potentially present. The Chao2 estimator reached a peak and dipped slightly so the estimated total richness would not be expected to rise further with additional sampling.

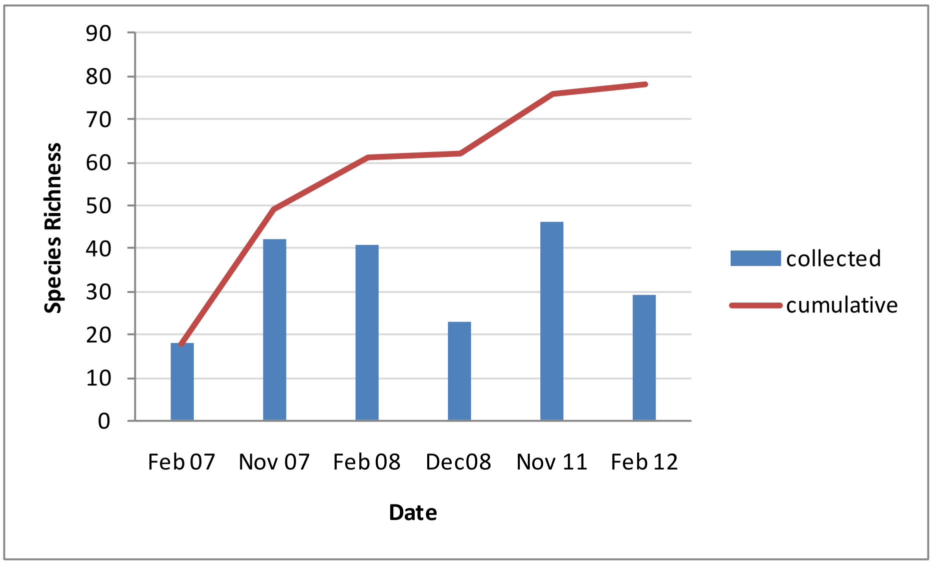

Figure 2. Species richness for each sampling occasion and cumulative richness.

During sampling in 2011 and 2012, samples were collected from different habitats to examine species-habitat relationships. Species data for the different habitats is listed in Appendix 2. Sweeps were taken from open water and underneath vegetation (tree branches) overhanging the water's edge. In November there were no macrophytes present, but there was samphire hanging into the water on the shore edge. In February, the samphire had died off and macrophytes were growing in the shallows (Figure 3). Figure 4 shows that for both sampling occasions open water habitats had lower species richness than habitats with overhanging vegetation, samphire or macrophytes. The samphire habitat had almost double the species richness of the open water samples. All habitats had higher species richness in November than in February.

Figure 3. Habitats sampled. A) open water; B) vegetation; C) samphire ; D) macrophyte

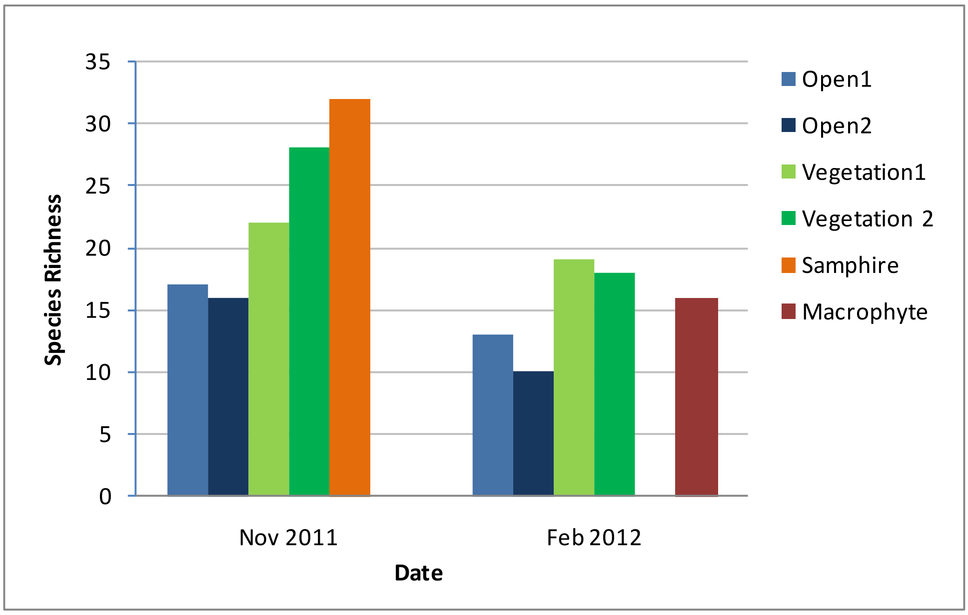

Figure 4. Species richness for each habitat sampled at Gwambygine Poo during 2011 and 2012.

Species richness varied across pools on the Avon and Dale Rivers (Figure 5.) Gwambygine Pool had the highest species richness for the four pools sampled in November 2007 and February 2008. In November 2011 and February 2012 a comparatively high number of species was also collected, so there has been no decline in richness following the dredging operation.

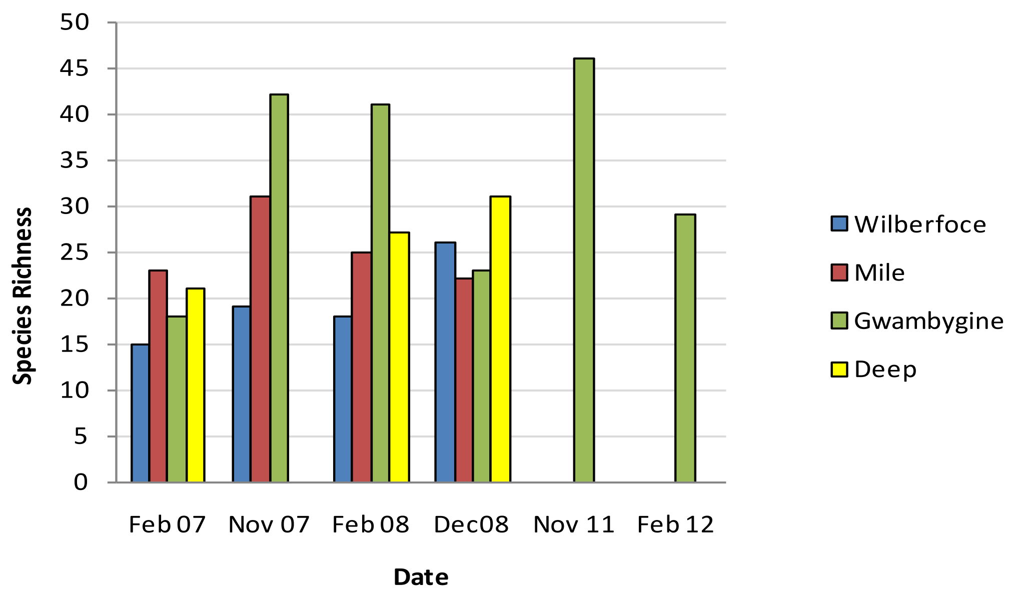

Figure 5. Species richness for Wilberforce, Mile, Gwambygine and Deep Pools.

Community Composition

An n-MDS ordination (Figure 6) showed that there was a tendency for samples to group together by season. There was also some separation by habitat, especially in 2011, with samples from open water separating from those collected amongst vegetation. A cluster analysis also suggested that there was greater similarity of invertebrate communities within sampling occasions than between habitats (Figure 7).

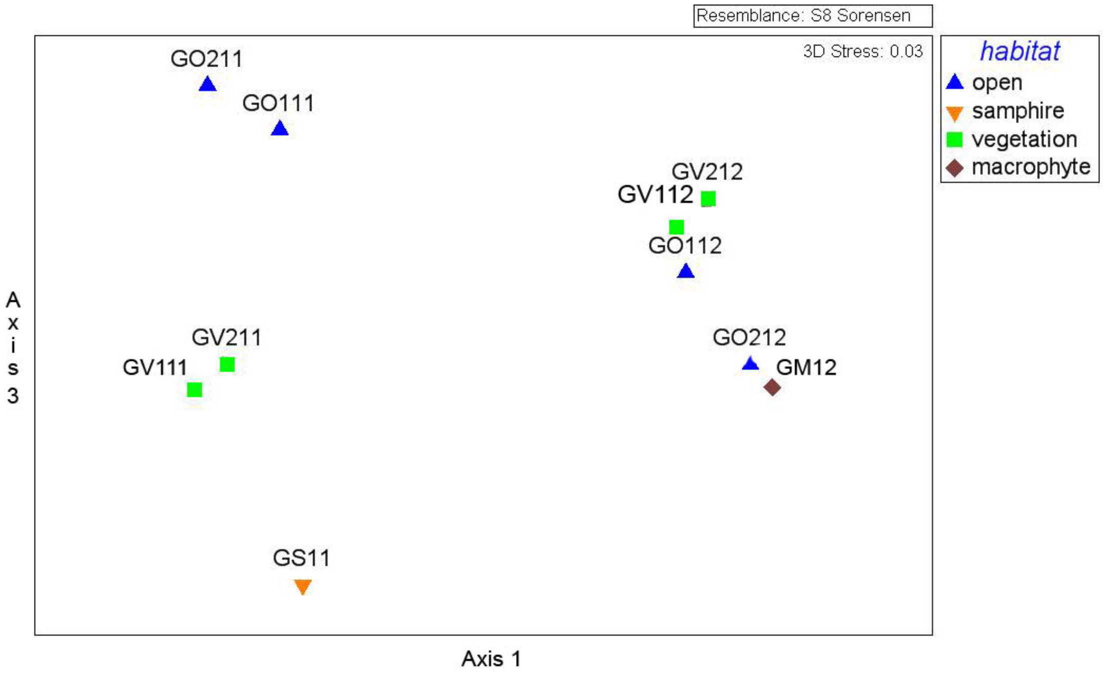

Figure 6. Axes 1 versus 3 of a 3 dimensional n-MDS ordination of samples from Gwambygine Pool. Sample labels are combined habitat and year. (e.g. Gwambygine Open water1 2012 is GO112).

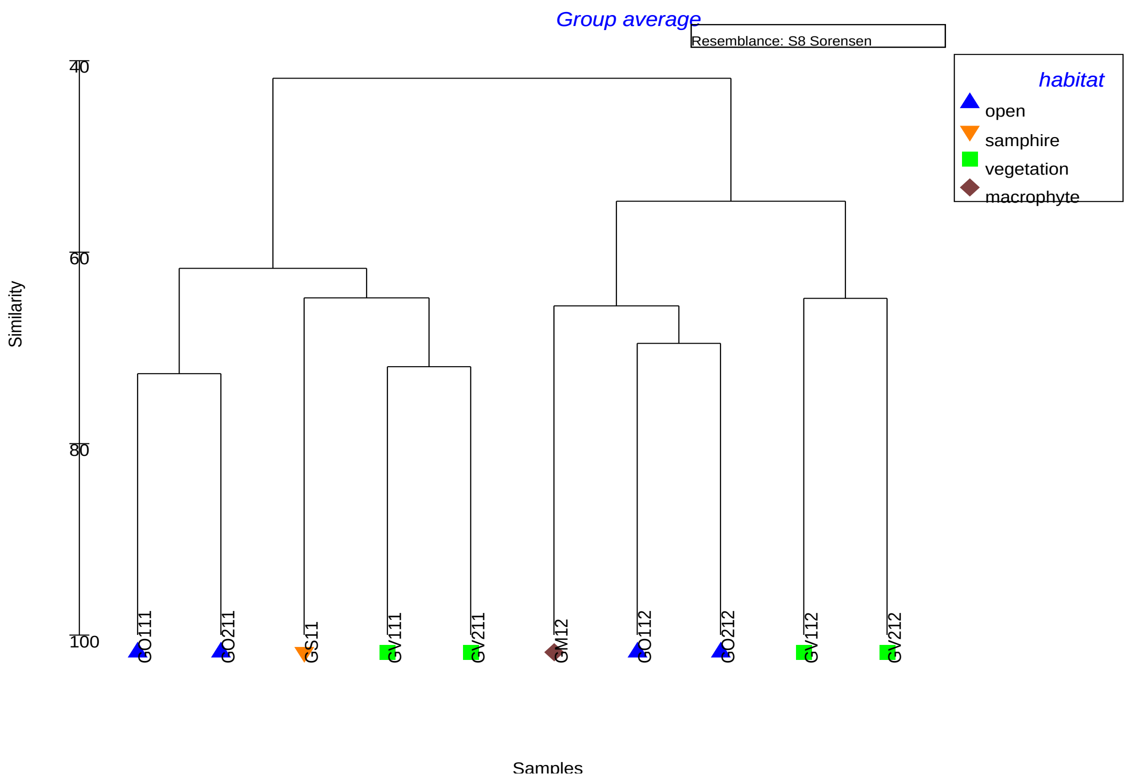

Figure 7. Cluster analysis of invertebrate communities at Gwambygine Pool. Sample labels are combined habitat and year. (e.g. Gwambygine Open water1 2012 is GO112).

The two main cluster groups in Figure 7 were each composed of samples from just one sampling occasion. This shows that there was a shift in the species composition between the November and February samples. Thirty two species occurred only in the November samples, 14 species occurred only in the February samples and 24 species occurred in both sampling occasions. In the cluster analysis open water samples separated from vegetation samples. The samphire invertebrate community showed similarities to those in the vegetation samples and the macrophyte community had similarities to the open water community.

The five samples collected in either spring or summer 2011/12 were combined to give data for a single 60 metre sweep for comparisons with previous data. Pinder (2009) showed there was a significant difference in community composition between pools of the Dale and Avon Rivers based on the 2007 and 2008 samples, but that pools within a river did not have clearly different invertebrate communities. These patterns are still evident once the 2011/12 data are included. Thus, in an ordination (Figure 8) Wilberforce and Gwambygine Pools on the Avon River are still reasonably well separated from Mile and Deep pools on the Dale River. There is also still significant overlap in composition between the two pools on each river. In the ordination plot, the 2011/12 Gwambygine samples (arrowed in Figure 8) were position closer to the November 2011 and February 2008 samples from the same pool than to samples collected in February 2007 and December 2008 (best seen on axes 1 v 3 and 2 v 3). The 2011/12 Gwambygine samples are also slightly closer to some of the samples from Deep and Mile pools on the Dale River than are previous Gwambygine samples (best seen on axes 1 v 2).

In summary, the sediment removal work has not significantly altered community composition compared to previous samples taken from this and other pools.

A cluster analysis (Figure 9) initially split most of the samples collected in November and December (the left most main group) from most of those collected in February. Within these two major groups, samples from the Avon pools tended to cluster separately to samples from Dale River Pools. An exception to this is the February 2012 sample from Gwambygine Pool which grouped with the February 2007 samples from Deep and Mile Pool (far left group in dendrogram).

A distance-based linear model indicated that salinity (as calculated TDS) explained about 16% of the variation in community composition ($p<0.01$) across all of the 2007 to 2012 samples. Only five percent of the variation in community composition was attributed to pH and this was not statistically significant ($p=0.53$) (Figure 10).

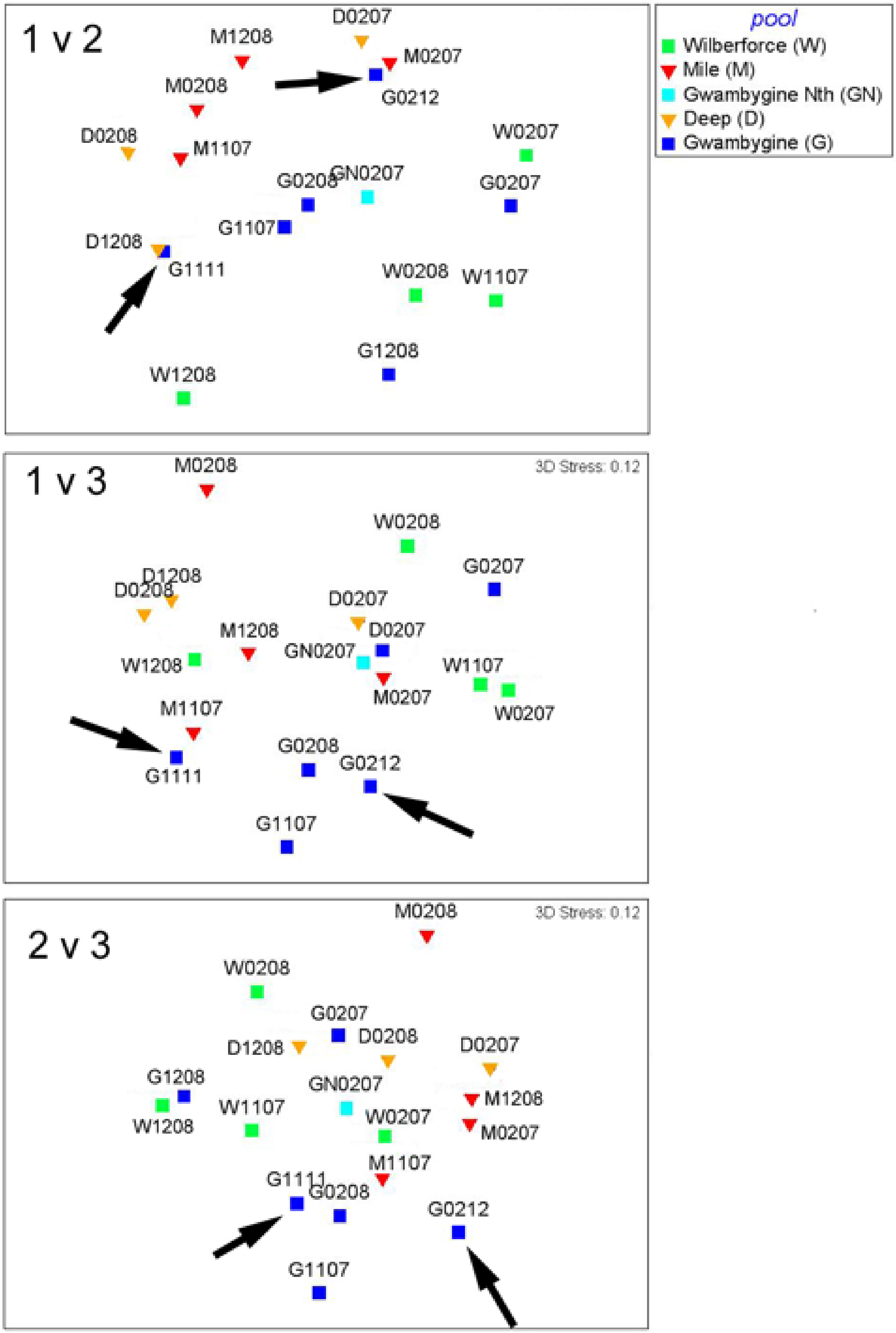

Figure 8. Results of a 3 dimensional n-MDS ordination of samples from Gwambygine (G) and Wilberforce (W) pools on the Avon River and Mile (M) and Deep (D) pools on the Dale River. Sample labels are combined pool, month and year (e.g. Gwambygine February 2012 is G0212). Arrows indicate 2011 and 2012 samples.

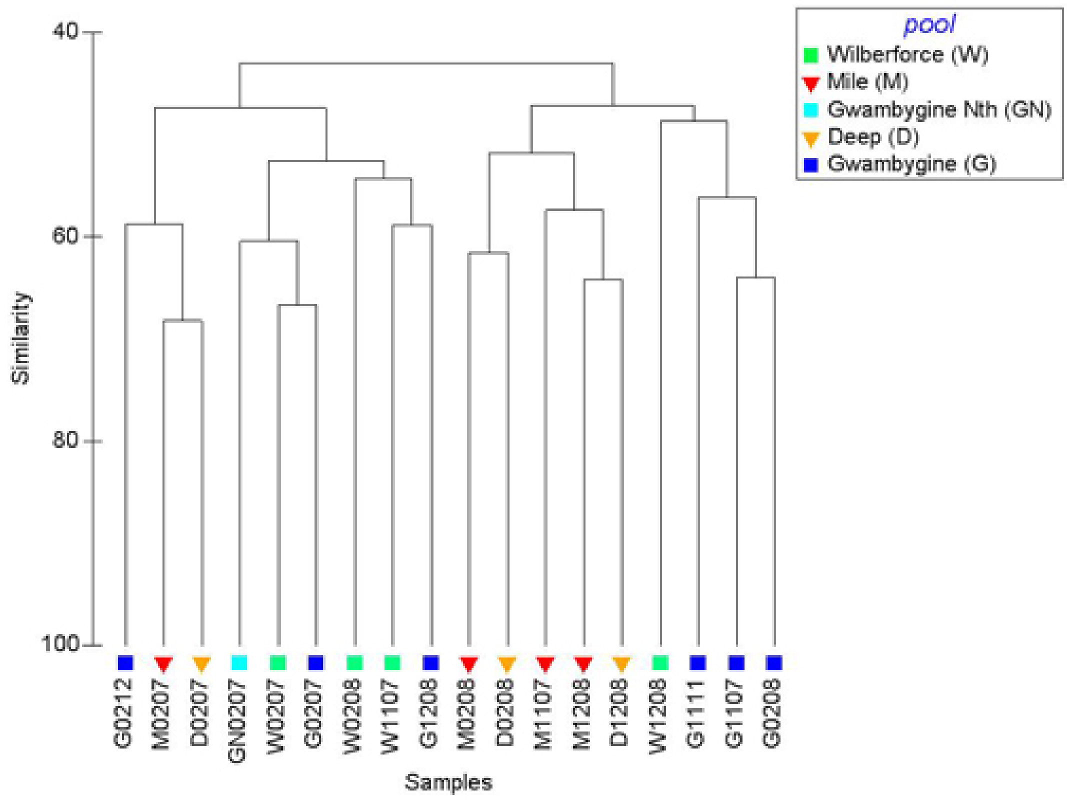

Figure 9. Cluster analysis of invertebrate communities. Sample labels are combined pool, month and year. (e.g. Gwambygine February 2012 is G0212).

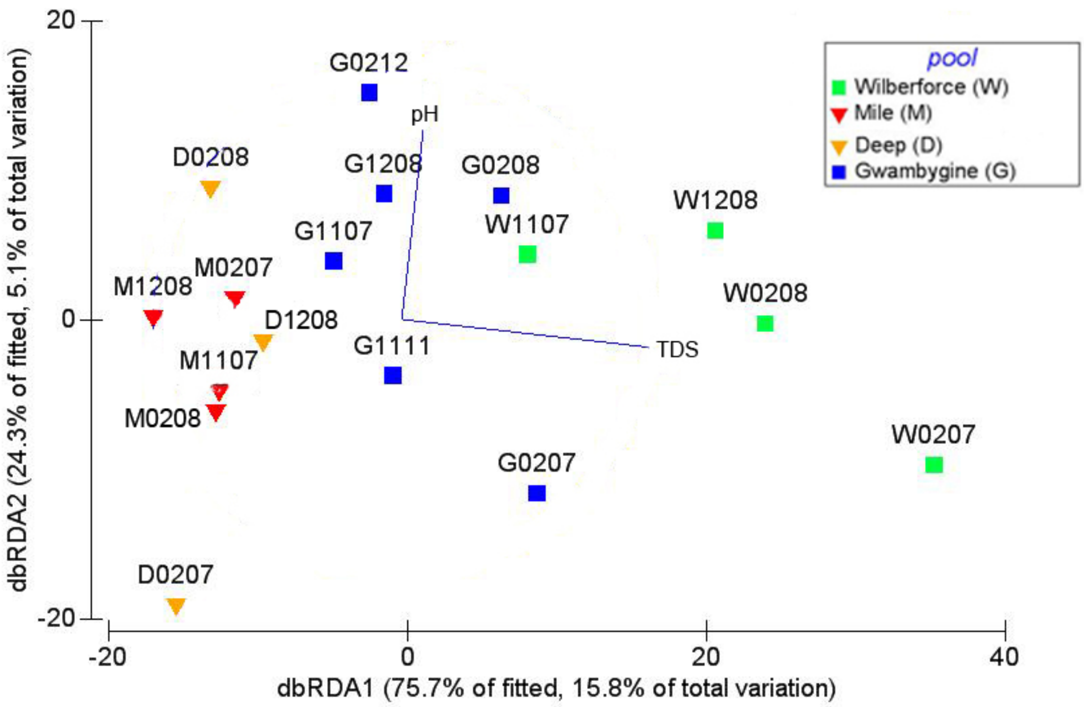

Figure 10. Plot of the Distance-based linear modelling analysis showing variation in the invertebrate community composition in relation to salinity (TDS) and pH. Sample labels are combined pool, month and year. (e.g. Gwambygine February 2012 is G0212).

DISCUSSION

Diversity

Gwambygine Pool has high aquatic invertebrate species richness compared to other sampled pools of the Avon and Dale rivers (Figure 5). Almost all of the 78 species collected from Gwambygine Pool between 2007 and 2012 (Appendix 1) are widespread in south-western or southern Australia. Two of these species are less common in the south west but are common, or at least widely distributed elsewhere; water mites of the genus *Hydrodroma* and the beetles *Berosus dallasi*. *Hydrodroma* were recorded only from three reservoirs during the Biological Survey of the South-west Agricultural Zone by Pinder et al. (2004), but were very common in the Pilbara (Pinder *et al.*, 2010) and also occurred in the Carnarvon Basin (Halse et al. 2000). The genus has been recorded further south-west (e.g. in the Lake Muir wetlands by A. Storey, UWA, unpublished data). *Berosus dallasi* is more common in northern than in southern Australia, but there are other records from the south-west, including records from the south-coast (one of which was verified by Chris Watts from the South Australian Museum).

The majority of species recorded at Gwambygine are salt tolerant freshwater species. That is, they are most frequently recorded in freshwater but will tolerate some salinity. For these species, any further rise in salinity would reduce richness or at least alter composition. Some additional species that may be tolerant of the measured salinity (Table 2) may have been prevented from surviving in the pool by higher salinities at other times of the year. Several species of ostracod (*Diacypris sp., Mytilocypris sp and Alboa wooroa*) and many bivalves (*Fluviolanatus subtorta*) were dead on collection in February 2012, but were collected alive in November 2011. Gwambygine Pool is subsaline with salinity varying over the hydrological cycle. For example, River Conservation Society (1999) recorded conductivities in Gwambygine Pool between 5.8 and 38 mS/cm during a 21 month period in 1996/97 and Smith (1996) recorded salinities in summer that were 20 to 100% higher than those recorded in the previous spring. It is possible that high salinities over the summer period may be the cause of the loss of some of these species, even though salinity when the invertebrates were sampled in February was lower than in November.

Several species recorded are those that normally inhabit estuarine or near coastal saline waters, but will extend up rivers when salinity allows. These are the oligochaete *Paranais litoralis*, the copepods *Sulcanus conflictus* and *Onychocamptus bengalensis*, the shrimp *Palaemonetes australis* and the bivalve *Fluviolanatus subtorta*.

Several extra species, not collected in 2007/8 or 2011/12, were collected from Gwambygine Pool by the River Conservation Society (1999). These were the bivalve *Westralunio carteri*, chydorid water fleas, the gilgie (*Cherax quinquecarinatus*), leeches, the snails *Gyraulus sp*. and *Coxiella striatula*, hydrachnid and eylaid water mites, *Paroster* and *Antiporus* beetles, at least one additional gyrinid beetle (two species were recorded), *Agraptocorixa parvipunctata* backswimmers and the dragonfly *Pantala flavescens*. The RCS (1999) identification of the beetle *Berosus amoenus* is probably wrong since it is a far northern Australian species and another beetle, the gyrinid "*Macrogyrus reichei?",* needs verification since it is otherwise a south-eastern Australian species.

Species richness and community composition

Species richness at Gwambygine Pool varied between sampling occasions, with November samples having the highest richness.(Figure 4). Ninety percent of the species recorded in 2007/2008 were collected in 2011/2012. The November 2011 and February 2012 samples increased the cumulative species richness by 16 species (about 18% of the total). Four of these taxa (*Paranais litoralis*, *Mesocyclops brooksi*, *Notalina spira* and Mesostigmata) have been previously collected from other river pools in the Avon region and the rest have been recorded by DEC in the Avon Baselining Project and/or Biological Survey of the South-west Agriculture zone (Pinder *et al.*, 2004). Seven other species (*Helochares percyi, Limbodessus inornatus, Paracymus pygmaeus, Agraptocorixa eurynome, Anisops thienemanni, Anisops gratus* and *Eycypris virens*) were recorded at Gwambygine Pool prior to 2011 but were not collected in 2011 or 2012. These species are widespread in wetlands in south-western Australia and it is possible that they may be more common in the river pool when flow has ceased and the pool has become more lentic. Discharge rates measured at the Beverley Bridge (upstream of Gwambygine Pool) were 929.3ML in November 2011, which was the highest November discharge rate recorded since 1995 (DOW Water Resources Data).

Open water habitats had low species richness when compared to vegetation, samphire and macrophyte habitats (Figure 4, Appendix 2). Except for single records of *Macrothrix sp*. and Opisthopora (earthworms) all species found in open water were also collected from at least one other habitat. Most odonates (except *Hemicordulia tau*), lepidopterans, dipterans (except chironomids and *Nilobezzia sp*), *Berosus* beetles, *Hydrodroma sp.* and the caddisfly *Triplectides australis* were not found in open water. This is not surprising as in open water habitats there are fewer food resources (such as macrophytes, attached algae and detritus) and little shelter from (or for) predators. Pyralid lepidopterans and *Triplectides* caddisflies use macrophytes and detritus respectively to create cases and damselflies usually crawl around macrophytes seeking prey. Species richness was lower in February compared to November for all habitat types.

There were differences in community composition between season and habitat (Figures 6 and 7). Cluster analysis showed that there was a greater similarity of invertebrate communities within sampling occasions than between habitats (Figure 7). Thirty two species occurred only in the November samples, 14 species occurred only in the February samples and 24 species occurred in both sampling occasions. Even though time of year (or season) may seem to be a source of variation in community composition, all species collected in November 2011 and February 2012 have been recorded previously at various times of the year, except for *Kennethia cristata* which has only been collected from samples taken in November. Presence or absence of species in one season may be related to altered water chemistry or changes in habitat between sampling events, but probably not to time of year per se. In the 2011 and 2012 samples, there was a shift in microcrustacean composition with ostracods only present in November, the copepods *Mesocyclops brooksi* and *Cletocamptus dietersi* dominating in November, and *Halicyclops sp.1, Sulcanus conflictus,* and *Onychocamptus bengalensis* dominating in February. The latter two species are estuarine and may have extended up the Avon River over the summer period as saline water has encroached upriver. *Halicyclops* prefers saline conditions whereas *Mesocyclops brooksi* is a primarily freshwater species. It is possible that salinity has driven the changes in the community composition, even though the salinity recorded at the time of sampling in February was lower than that for November, there may have been an intervening period of high salinity.

The differences in community composition between open water and the other habitats was a case of lower richness in the open water, rather than a change in community structure. Except for species with single records, all species which occurred in the open water habitats were also recorded in at least one other habitat type.

Current state of Gwambygine Pool

In 2007, the concentrations of nitrogen, phosphorus and chlorophyll indicated mild nutrient enrichment, but concentrations recorded in 2011 and 2012 were low. Nutrient concentrations recorded in the middle to late 1990s by River Conservation Society (1999) and Smith (1996) recorded high concentrations of ammonium, ortho-phosphate, total phosphorus and chlorophyll. Low nutrients concentrations recorded in 2011 and 2012 may be a result of restoration work carried out since 2010, such as fencing, revegetation and sediment removal (which may have increased flushing of the pool), or other catchment variables reducing nutrient runoff into the Avon River. However, further nutrient monitoring is recommended to see if the low 2011/12 nutrient concentrations persist.

Sedimentation and increased salinisation of Gwambygine Pool is a threat to some invertebrate species, especially if this leads to summer drying or declining water quality. The extent to which the present community is threatened depends on whether salinity is likely to increase further and whether sedimentation can be managed. Salinities recorded at Gwambygine Pool by River Conservation Society (1999) in summer 1996 and 1997 were about the same as those listed in Table 2. Presently, salinity does not appear to be increasing in Gwambygine and does not pose a threat to the existing community. Sedimentation within the pool is an ongoing threat that will need to be managed. The sediment plug in the southern end of the pool has been removed in 1996, 1999 and 2010. While there must be disturbance to the aquatic invertebrates during and immediately after sediment removal, species richness has not declined in the pool between 2007/8 and 2011/12. While there was a slight change in community composition, with sixteen additional species present in 2011/2012 and seven species previously recorded not collected, such changes often occur between sampling events and this does not necessarily indicate a significant or permanent change in ecological condition. Further monitoring of Gwambygine Pool will determine if there are any long term changes to the invertebrate community.

In 1996/97 the River Conservation Society (1999) collected several extra species from Gwambygine which have also not been recorded in the present study (or in 2007/8). These were the bivalve *Westralunio carteri*, chydorid water fleas, the gilgie (*Cherax quinquecarinatus*), leeches, the snails *Gyraulus sp*. and *Coxiella striatula*, hydrachnid and eylaid water mites, *Paroster* and *Antiporus* beetles, at least one additional gyrinid beetle (two species were recorded), *Agraptocorixa parvipunctata* backswimmers and the dragonfly *Pantala flavescens*. It is possible that some of these specimens were collected prior to any sediment removal from pool and have not re-established after dredging, but the data provided in River Conservation Society (1999) doesn’t allow examination of this hypothesis.

Sampling various habitats present in Gwambygine Pool in 2011 and 2012 showed that there is a higher species richness in areas with overhanging vegetation (whether branches or samphire on the shore edge) compared to open water samples. Restoration work has included revegetating the area just upstream of Gwambygine, however there is little natural remnant riparian vegetation around the southern end of the pool. Knowles (2010) describes the remnant vegetation as lacking diversity and can be summed up by three tree species (*Casuarina obesa, Melaleuca rhaphiophylla and Eucalyptus rudis)* and their respective understorey and exotic species. Near the sampling location there are no reed species present and mainly grasses (salt water and marine couch) or beaded samphire (*Atriplex exilifolia* and *Atriplex semibaccata*) grow to the water’s edge. Further rehabilitation of the riparian vegetation around the pool may improve invertebrate species abundance and richness occurring within the pool.

Overall, Gwambygine Pool is currently in reasonable ecological condition. Salinity concentrations seem to be stable and nutrient concentrations were lower in 2011/12 than in 2007. Invertebrate community composition is as high as could be expected given the salinity, generally poor riparian condition and simple habitats (mostly bare sediment) and has not declined following the 2010 dredging. Ongoing monitoring of Gwambygine Pool will provide information on how the pool invertebrate communities track over the long term with current and future restoration work.

ACKNOWLEDGMENTS

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Appendix 1. Aquatic Invertebrate data.

This table presents data collected from the present round of sampling at Gwambygine Pool and additional Avon Pool invertebrate data previously collected by DEC.

National Code	Pyhlum/Class	Order	Family	LowestID	Wilberforce Pool (APR001)				Mile Pool (ARP002)				Gwambygine Nth (APR003)
					3/02/2007	14/11/2007	27/02/2008	22/12/2008	13/02/2007	13/11/2007	26/02/2008	22/12/2008	12/02/2007
IA019999	Desmospongiae	-	Spongillidae	Spongillidae									
KG1301A1	Gastropoda	Neotaeniglossa	Pomatiopsidae	*Coxiella glabra*									
KP050101	Bivalvia	Veneroida	Trapeziidae	*Fluviolanatus subtorta*	1	1	1	1	1	1	1	1	1
II999999	Nematoda	-	-	Nematoda									
LO052101	Oligochaeta	Tubificida	Naididae	*Ainudrilus nharna*									
LO050801				*Paranais litoralis*		1							
LO051401				*Potamothrix bavaricus*					1	1		1	
LO049999				Immature Naididae		1							
LO089999			Enchytraeidae	Enchytraeidae									
LO989999		Opisthopora	-	Opisthopora (earthworms)		1							
MM050299	Arachnida	Acariformes	Hydryphantidae	*Diplodontus sp.*						1	1	1	
MM070199			Hydrodromidae	*Hydrodroma sp.*					1		1	1	1
MM1602A8			Unionicolidae	*Koenikea nr australica (=verrucosa)*									
MM259999			Pezidae	Pezidae		1							
MM999999			-	Juvenille water mites									
MM9999A1			-	Oribatida									1
MM9999A6			-	Trombidioidea								1	1
MM9999A2		Parasitiformes	-	Mesostigmata					1				
OG060299	Crustacea	Cladocera	Macrotrichidae	*Macrothrix sp.*									
OH060101		Ostracoda	Ilyocyprididae	*Ilyocypris australiensis*		1							
OH080101			Cyprididae	*Alboa worooa*				1					
OH080403				*Candonocypris novaezelandiae*				1		1		1	
OH080703				*Diacypris spinosa*									
OH080801				*Eucypris virens*		1		1					
OH081204				*Mytilocypris mytiloides*	1	1	1	1					
OH083099				*Plesiocypridopsis sp.*				1					
OH090101			Cypridopsidae	*Sarscypridopsis aculeata*			1			1			
OH100101			Leptocytheridae	*Leptocythere lacustris*						1			
OH110201			Notodromadidae	*Kennethia cristata*									
OJ130101		Copepoda	Sulcaniidae	*Sulcanus conflictus*	1				1			1	
OJ3104A0			Cyclopidae	*Halicyclops sp. 1 (nr ambiguus) (SAP)*					1				
OJ310703				*Mesocyclops brooksi*		1				1	1	1	
OJ610402			Canthocamptidae	*Cletocamptus dietersi*	1				1	1		1	1
OJ620101			Laophontidae	*Onychocamptus bengalensis*	1	1	1		1		1	1	1
OP020102		Amphipoda	Ceinidae	*Austrochiltonia subtenuis*	1	1	1	1	1	1		1	1
OT020201		Decapoda	Palaemonidae	*Palaemonetes australis*			1	1	1	1		1	
QC091101	Insecta	Coleoptera	Dytiscidae	*Allodessus bistrigatus*									
QC091006				*Limbodessus inornatus*		1							
QC091805				*Sternopriscus multimaculatus*		1	1			1	1		
QC091899				Sternopriscus larvae									1
QC092001				*Necterosoma penicillatus*		1	1		1	1			
QC092099				Necterosoma larvae	1			1					
QC092401				*Lancetes lanceolatus*			1						
QC092103				*Megaporus howitti*							1		
QC092199				Megaporus larvae or female									
QC109999			Gyrinidae	Gyrinidae larvae							1		
QC110401			Hydrophilidae	*Berosus australiae*	1								
QC110406				*Berosus dallasi*	1	1	1						1
QC110409				*Berosus discolor*									
QC110499				*Berosus larvae*					1				
QC111202				*Helochares percyi*									
QC111299				Helochares larvae			1	1			1		
QC111204				*Helochares tatei*				1					1
QC111499				Limnoxenus larvae									
QC111601				*Paracymus pygmaeus*									
QC130199			Hydraenidae	*Hydraena sp.*									
QC130399				*Ochthebius sp.*			1	1		1	1		1

National Code	Pyhlum/Class	Order	Family	LowestID	Wilberforce Pool (APR001)				Mile Pool (ARP002)				Gwambygine Nth (APR003)
					3/02/2007	14/11/2007	27/02/2008	22/12/2008	13/02/2007	13/11/2007	26/02/2008	22/12/2008	12/02/2007
QC209999			Scirtidae	Scirtidae									
QD070101		Diptera	Culicidae	*Anopheles annulipes*				1		1			
QD090499			Ceratopogonidae	*Bezzia sp.*									
QD090899				*Culicoides sp.*	1	1			1	1			1
QD0919A0				*Monohelea sp. 1 (SAP)*	1		1	1	1		1	1	1
QD092099				*Nilobezzia sp.*		1				1	1	1	1
QD092999				*Dasyhelea sp.*			1				1		
QD239999			Tabanidae	Tabanidae					1	1			
QD249999			Stratiomyidae	Stratiomyidae				1		1			
QD789999			Ephydridae	Ephydridae (early instar)								1	
QD7899A7				*Ephydridae sp. 3 (SAP)*							1		
QD7899B1				*Ephydridae sp. 7(SAP)*									
QD899999			Muscidae	Muscidae (not sp. A)									
QD8999A0				*Muscidae sp. A (SAP)*									
QDAE0803			Chironomidae	*Procladius paludicola*	1	1	1		1	1		1	1
QDAE1701				*Larsia albiceps*									
QDAF0699				*Corynoneura sp.*									
QDAH03A0				*Cladotanytarsus sp. A (SAP)*	1			1		1		1	1
QDAH04D8				*Tanytarsus fuscithorax/semibarbitarsus*	1	1		1	1	1	1	1	1
QDAI0408				*Chironomus occidentalis*									
QDAI0414				*Chironomus tepperi*									
QDAI04A0				*Chironomus aff. alternans (V24) (CB)*					1	1	1	1	
QDAI0603				*Dicrotendipes conjunctus*						1			
QDAI06A0				*Dicrotendipes sp. A (V47) (SAP)*								1	
QDAI0701				*Kiefferulus intertinctus*						1	1		
QDAI0801				*Polypedilum leei*									
QDAI0804				*Polypedilum nubifer*					1		1	1	
QDAI2201				*Cladopelma curtivalva*						1			
QE080101		Ephemeroptera	Caenidae	*Tasmanocoenis tillyardi*					1				
QH650301		Hemiptera	Corixidae	*Agraptocorixa eurynome*						1	1		
QH650399				Agraptocorixa sp. (juvenilles/females)	1	1	1						
QH650502				*Micronecta robusta*		1	1	1	1	1	1	1	1
QH650599				Micronecta sp. (juvenille/females)								1	
QH670401			Notonectidae	*Anisops thienemanni*									
QH670403				*Anisops gratus*									
QH670499				Anisops sp. (juvenille/females)						1			
QH560199			Veliidae	*Microvelia sp.*									
QL0199A0		Lepidoptera	Pyralidae	*Pyralidae nr. sp. 39/40 of JHH (SAP)*				1	1		1		
QL019999				Pyralidae (early instars)									
QL9999A1			-	*Lepidoptera (non-pyralid) sp. 3 (SAP)*									
QO021001		Odonata	Coenagrionidae	*Ischnura aurora aurora*									
QO021002				*Ischnura heterosticta heterosticta*	1			1	1				
QO021099				Ischnura sp. (early instars)			1				1	1	
QO021301				*Xanthagrion erythroneurum*			1	1			1		
QO050102			Lestidae	*Austrolestes annulosus*				1					
QO050107				*Austrolestes psyche*									
QO050199				Austrolestes sp. (early instars)									
QO121201			Aeshnidae	*Hemianax papuensis*				1					
QO129999				Aeshnidae (early instars)									
QO029999			Coenagrionidae	Coenagrionidae (early instars)									
QO169999			Corduliidae	Corduliidae (early instars)									
QO171601			Libellulidae	*Orthetrum caledonicum*						1			1
QO300101			Hemicorduliidae	*Hemicordulia australiae*						1			
QO300102				*Hemicordulia tau*				1					
QT0804A0		Trichoptera	Ecnomidae	*Ecnomus pansus/turgidus*							1		
QT250504			Leptoceridae	*Notalina spira*				1					
QT250799				*Oecetis sp.*	1	1	1	1	1	1	1		1
QT251103				*Triplectides australis*				1		1	1	1	1
QT259999				Leptoceridae (early instars)			1						

National Code	Gwambygine South (ARP004)						Deep Pool (ARP005)	
	12/02/2007	13/11/2007	27/02/2008	22/12/2008	15/11/201	22/02/201	12/02/2007	26/02/2008
IA019999				1				
KG1301A1		1						
KP050101	1	1	1	1	1	1	1	1
II999999					1			
LO052101						1		
LO050801					1	1		
LO051401								
LO049999		1			1	1		
LO089999					1			
LO989999		1			1			
MM050299								1
MM070199		1			1		1	1
MM1602A8		1			1	1		1
MM259999								
MM999999			1					
MM9999A1		1	1		1			1
MM9999A6	1	1					1	
MM9999A2					1		1	
OG060299					1			
OH060101		1	1	1	1			
OH080101				1	1			
OH080403					1			1
OH080703		1	1		1			
OH080801		1	1					1
OH081204	1	1	1	1	1			
OH083099					1			
OH090101		1	1					
OH100101								
OH110201		1			1			
OJ130101	1		1		1	1		
OJ3104A0		1				1		
OJ310703					1			1
OJ610402	1	1	1		1			
OJ620101	1	1	1			1	1	
OP020102	1	1	1	1	1	1	1	1
OT020201		1	1		1	1	1	1
QC091101							1	
QC091006		1						
QC091805	1		1					1
QC091899						1		
QC092001	1	1	1	1	1	1	1	
QC092099					1			
QC092401		1				1		
QC092103			1					
QC092199						1		
QC109999								
QC110401								
QC110406	1					1		
QC110409					1			
QC110499		1	1		1	1		
QC111202			1					
QC111299	1							
QC111204		1						
QC111499						1		
QC111601		1	1					
QC130199					1			
QC130399		1	1	1	1			1

National Code	Gwambygine South (ARP004)						Deep Pool (ARP005)	
	12/02/2007	13/11/2007	27/02/2008	22/12/2008	15/11/201	22/02/201	12/02/2007	26/02/2008
QC209999					1			
QD070101					1			
QD090499						1		
QD090899	1	1	1		1	1		
QD0919A0	1		1	1	1	1	1	1
QD092099		1	1	1	1	1	1	
QD092999								
QD239999			1			1		
QD249999		1	1	1	1			
QD789999		1				1		
QD7899A7								
QD7899B1	1							
QD899999					1			
QD8999A0	1							
QDAE0803	1	1	1	1	1	1	1	1
QDAE1701								
QDAF0699							1	
QDAH03A0		1	1		1	1		
QDAH04D8			1	1	1	1	1	
QDAI0408								1
QDAI0414							1	
QDAI04A0		1	1		1	1	1	1
QDAI0603								
QDAI06A0					1			
QDAI0701		1	1		1	1		1
QDAI0801								1
QDAI0804			1		1	1		1
QDAI2201								
QE080101							1	
QH650301		1						1
QH650399	1		1					
QH650502	1	1		1	1		1	1
QH650599			1	1	1	1		
QH670401		1						
QH670403			1					
QH670499								
QH560199					1			
QL0199A0			1			1		
QL019999				1				
QL9999A1				1				
QO021001								
QO021002						1	1	1
QO021099	1			1	1	1		
QO021301			1		1			1
QO050102		1						
QO050107			1					
QO050199					1			
QO121201					1			
QO129999			1		1	1		
QO029999					1			
QO169999					1			
QO171601								
QO300101								
QO300102		1			1	1		
QT0804A0								1
QT250504					1			1
QT250799	1	1	1	1	1	1	1	1
QT251103		1	1		1	1	1	1
QT259999						1		

Appendix 2. Aquatic Invertebrate data from the various habitats at Gwambygine Pool collected in 2011 and 2012

National Code	Pyhlum/Class	Order	Family	LowestID	15/11/2011					22/02 2011				
					Open Water 1	Open Water 2	Vegetation 1	Vegetation 2	Samphire	Open Water 1	Open Water 2	Vegetation 1	Vegetation 2	Macrophyte
IA019999	Desmospongiae	-	Spongillidae	Spongillidae										
KG1301A1	Gastropoda	Neotaeniglossa	Pomatiopsidae	*Coxiella glabra*										
KP050101	Bivalvia	Veneroida	Trapeziidae	*Fluviolanatus subtorta*			1	1	1		1	1	1	1
II999999	Nematoda	-	-	Nematoda				1						
LO052101	Oligochaeta	Tubificida	Naididae	*Ainudrilus nharna*								1		
LO050801				*Paranais litoralis*	1		1	1	1	1	1		1	1
LO051401				*Potamothrix bavaricus*										
LO049999				Immature Naididae	1	1				1	1		1	
LO089999			Enchytraeidae	Enchytraeidae			1							
LO989999		Opisthopora	-	Opisthopora (earthworms)		1								
MM050299	Arachnida	Acariformes	Hydryphantidae	*Diplodontus sp.*										
MM070199			Hydrodromidae	*Hydrodroma sp.*			1	1	1					
MM1602A8			Unionicolidae	*Koenikea nr australica (=verrucosa)*	1	1		1	1			1	1	
MM259999			Pezidae	Pezidae										
MM999999			-	Juvenille water mites										
MM9999A1			-	Oribatida					1					
MM9999A6			-	Trombidioidea										
MM9999A2		Parasitiformes	-	Mesostigmata			1							
OG060299	Crustacea	Cladocera	Macrotrichidae	*Macrothrix sp.*		1								
OH060101		Ostracoda	Ilyocyprididae	*Ilyocypris australiensis*				1						
OH080101			Cyprididae	*Alboa worooa*	1	1	1	1	1					
OH080403				*Candonocypris novaezelandiae*		1	1	1						
OH080703				*Diacypris spinosa*	1									
OH080801				*Eucypris virens*										
OH081204				*Mytilocypris mytiloides*	1	1	1	1	1					
OH083099				*Plesiocypridopsis sp.*			1							
OH090101			Cypridopsidae	*Sarscypridopsis aculeata*										
OH100101			Leptocytheridae	*Leptocythere lacustris*										
OH110201			Notodromadidae	*Kennethia cristata*			1	1	1					
OJ130101		Copepoda	Sulcaniidae	*Sulcanus conflictus*				1		1	1		1	
OJ3104A0			Cyclopidae	*Halicyclops sp. 1 (nr ambiguus) (SAP)*						1		1	1	1
OJ310703				*Mesocyclops brooksi*	1	1	1	1	1					
OJ610402			Canthocamptidae	*Cletocamptus dietersi*		1	1	1	1					
OJ620101			Laophontidae	*Onychocamptus bengalensis*						1	1	1	1	1
OP020102		Amphipoda	Ceinidae	*Austrochiltonia subtenuis*	1	1	1	1	1	1		1	1	
OT020201		Decapoda	Palaemonidae	*Palaemonetes australis*	1	1	1	1	1	1	1		1	1
QC091101	Insecta	Coleoptera	Dytiscidae	*Allodessus bistrigatus*										
QC091006				*Limbodessus inornatus*										
QC091805				*Sternopriscus multimaculatus*										
QC091899				Sternopriscus larvae										1
QC092001				*Necterosoma penicillatus*					1	1	1			1
QC092099				Necterosoma larvae	1	1	1							
QC092401				*Lancetes lanceolatus*									1	
QC092103				*Megaporus howitti*										
QC092199				Megaporus larvae or female										1
QC109999			Gyrinidae	Gyrinidae larvae										
QC110401			Hydrophilidae	*Berosus australiae*										
QC110406				*Berosus dallasi*										1
QC110409				*Berosus discolor*				1						
QC110499				*Berosus larvae*					1			1		
QC111202				*Helochares percyi*										
QC111299				Helochares larvae										
QC111204				*Helochares tatei*										
QC111499				Limnoxenus larvae								1		
QC111601				*Paracymus pygmaeus*										
QC130199			Hydraenidae	*Hydraena sp.*					1					
QC130399				*Ochthebius sp.*					1					
QC209999			Scirtidae	Scirtidae					1					

National Code	Pyhlum/Class	Order	Family	LowestID	15/11/2011					22/02 2011				
					Open Water 1	Open Water 2	Vegetation 1	Vegetation 2	Samphire	Open Water 1	Open Water 2	Vegetation 1	Vegetation 2	Macrophyte
QD070101		Diptera	Culicidae	*Anopheles annulipes*					1					
QD090499			Ceratopogonidae	*Bezzia sp.*								1		
QD090899				*Culicoides sp.*	1	1	1	1	1	1	1	1	1	1
QD0919A0				*Monohelea sp. 1 (SAP)*				1					1	
QD092099				*Nilobezzia sp.*	1				1	1	1		1	1
QD092999				*Dasyhelea sp.*										
QD239999			Tabanidae	Tabanidae								1	1	
QD249999			Stratiomyidae	Stratiomyidae			1	1	1					
QD789999			Ephydridae	Ephydridae (early instar)								1		
QD7899A7				*Ephydridae sp. 3 (SAP)*										
QD7899B1				*Ephydridae sp. 7(SAP)*										
QD899999			Muscidae	Muscidae (not sp. A)				1						
QD8999A0				*Muscidae sp. A (SAP)*										
QDAE0803			Chironomidae	*Procladius paludicola*	1	1	1	1	1		1	1	1	1
QDAE1701				*Larsia albiceps*										
QDAF0699				*Corynoneura sp.*										
QDAH03A0				*Cladotanytarsus sp. A (SAP)*				1				1		1
QDAH04D8				*Tanytarsus fuscithorax/semibarbitarsus*	1	1	1	1	1	1	1	1	1	1
QDAI0408				*Chironomus occidentalis*										
QDAI0414				*Chironomus tepperi*										
QDAI04A0				*Chironomus aff. alternans (V24) (CB)*	1		1	1	1			1	1	
QDAI0603				*Dicrotendipes conjunctus*										
QDAI06A0				*Dicrotendipes sp. A (V47) (SAP)*			1							
QDAI0701				*Kiefferulus intertinctus*	1	1	1	1	1	1				
QDAI0801				*Polypedilum leei*										
QDAI0804				*Polypedilum nubifer*	1	1		1		1				
QDAI2201				*Cladopelma curtivalva*										
QE080101		Ephemeroptera	Caenidae	*Tasmanocoenis tillyardi*										
QH650301		Hemiptera	Corixidae	*Agraptocorixa eurynome*										
QH650399				Agraptocorixa sp. (juvenilles/females)										
QH650502				*Micronecta robusta*	1			1	1					
QH650599				Micronecta sp. (juvenille/females)		1								1
QH670401			Notonectidae	*Anisops thienemanni*										
QH670403				*Anisops gratus*										
QH670499				Anisops sp. (juvenille/females)										
QH560199			Veliidae	*Microvelia sp.*					1					
QL0199A0		Lepidoptera	Pyralidae	*Pyralidae nr. sp. 39/40 of JHH (SAP)*								1		1
QL019999				Pyralidae (early instars)										
QL9999A1			-	*Lepidoptera (non-pyralid) sp. 3 (SAP)*										
QO021001		Odonata	Coenagrionidae	*Ischnura aurora aurora*										
QO021002				*Ischnura heterosticta heterosticta*								1	1	1
QO021099				Ischnura sp. (early instars)					1				1	1
QO021301				*Xanthagrion erythroneurum*					1					
QO050102			Lestidae	*Austrolestes annulosus*										
QO050107				*Austrolestes psyche*										
QO050199				Austrolestes sp. (early instars)					1					
QO121201			Aeshnidae	*Hemianax papuensis*					1					
QO129999				Aeshnidae (early instars)					1			1	1	
QO029999			Coenagrionidae	Coenagrionidae (early instars)	1									
QO169999			Corduliidae	Corduliidae (early instars)	1		1	1	1					
QO171601			Libellulidae	*Orthetrum caledonicum*										
QO300101			Hemicorduliidae	*Hemicordulia australiae*										
QO300102				*Hemicordulia tau*		1			1			1		
QT0804A0		Trichoptera	Ecnomidae	*Ecnomus pansus/turgidus*										
QT250504			Leptoceridae	*Notalina spira*					1					
QT250799				*Oecetis sp.*	1	1	1	1	1	1		1	1	1
QT251103				*Triplectides australis*				1	1			1		1
QT259999				Leptoceridae (early instars)							1			