Cameco Australia Pty Ltd

Aquatic Invertebrate Assemblages in Wetlands at Kintyre

Final Report

Prepared for Cameco Australia Pty Ltd
by Bennelongia Pty Ltd

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Aquatic invertebrate assemblages in wetlands at Kintyre

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EXECUTIVE SUMMARY

For an arid region, the Pilbara is characterised by a relatively high number of wetlands and a high number of aquatic invertebrate species. This report describes the aquatic invertebrate fauna at three previously unsurveyed river pools in the eastern Pilbara on the edge of the Great Sandy Desert. By comparing the fauna assemblages at these sites with assemblages at 38 other river pools across the Pilbara region, an assessment was made of the conservation significance of the three pools.

Each of the pools was surveyed three times during 2011 during the periods 28-30 June, 23-24 November and 16-17 December. Benthic invertebrates were collected by vigorous kick and sweep sampling using a D-framed pond net with 250 µm mesh. Planktonic invertebrates were collected by sweep sampling with with a 50 µm mesh net. All aquatic habitat types were sampled at each site. Water samples were also collected and analysed.

A combined total of at least 270 invertebrate species were identified from 20,365 specimens from the three river pools. Species richness was highest at Duck Pool, at which 193 species were collected, and lowest at Rock Pool where 140 species were collected. Twenty-five major taxonomic groups were collected: two groups of protozoans (Arcellinida and Euglyphida), Porifera or sponges, Turbellaria, Nematoda, Nematomorpha, three groups of rotifers (Bdelloidea, Flosculariacea and Ploimida), Acariformes or mites, Gastropoda or snails, Hirudinea or leaches, Oligochaeta or segmented worms, five crustacean orders (Anostraca, Cladocera, Conchostraca, Copepoda and Ostracoda), and seven orders of insect (Coleoptera or beetles, Diptera or flies, Ephemeroptera or mayflies, Hemiptera or bugs, Lepidoptera or butterflies and moths, Odonata or dragonflies, and Trichoptera or caddisflies). All groups were represented at Pinbi Pool. There were 23 groups at Duck Pool and 19 at Rock Pool.

The pattern of species richness among taxonomic groups was similar at all three river pools. The most speciose groups were the insect orders of Diptera, Coleoptera and Hemiptera. The invertebrate assemblages were also characterised by significant proportions of mites and rotifers.

Comparisons with other river pools in the Pilbara region showed that species richness, and distribution of species among taxonomic groups, at Duck Pool, Pinbi Pool and Rock Pool are typical of the Pilbara region and do not represent special or unique assemblages.

Six potentially conservation significant species were identified. The anostracan *Branchinella* nr *wellardi* is either a new species or at the periphery of its known range at Pinbi Pool. The status of *Branchinella wellardi* as vulnerable on the IUCN Red List and its designation as a Priority 1 species by the Department of Environment and Conservation makes the record of *Branchinella* nr *wellardi* an important one that contributes to the conservation significance of Pinbi Pool. The other five potentially conservation significant species were the copepod *Thermocyclops* sp. B3 and four water mite (*Encentridophorus* sp. B1, *Unionicola* sp. B1, *Limnesia* sp. B2 and *Hydrachna* sp. B1). It is considered quite likely that *Limnesia* sp. B2 and *Hydrachna* sp. B1 have been previously collected at other sites in the Pilbara. It is considered likely that further sampling will show all six species occur in other wetlands around the Kintyre area or in the north-eastern Pilbara.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The Pilbara region of Western Australia contains an unexpectedly high number of wetlands for an arid zone region (Pinder *et al*. 2010). While the eastern end of the Fortescue Valley, and some other areas, contain ephemeral claypans, most Pilbara wetlands are riverine. The three most common wetland types in riverine environments are:

1. River pools scoured out by streamflow (most frequent in the Ashburton and De Grey river systems);
2. Smaller rockpools created by scouring flow around large rocks or cliffs intruding into the stream (often found in small creek lines); and
3. Springs where groundwater discharges.

Most of the riverine wetlands are linked to the large, infrequent pulses of river flow associated with tropical storms. Although most rivers and their tributaries are dry most of the time, flash flooding and scouring around cliffs generate deep shady pools in very small parts of the otherwise dry river beds. Many of these pools are permanent or persist for months providing resources and refuge for wildlife during the prolonged periods of hot and dry conditions that are characteristic of the Pilbara. Other pools are fed by springs maintained by vast aquifers.

A survey of 98 wetlands across the Pilbara found that the diversity of aquatic invertebrates is high compared with most arid zone regions, with more than 1000 species across the region, and one wetland (Pelican Pool on the De Grey River) supporting 226 species (Pinder *et al*. 2010). The richness of the Pilbara aquatic invertebrate community is not, however, matched by high levels of endemism, with approximately half of the species widespread in Australia, and a further quarter known from across northern Australian and/or inland regions. Only around 19% of the aquatic species recorded are known only from the Pilbara (Pinder and Leung 2009).

Cameco Australia Pty Ltd (Cameco) proposes to develop a uranium mine at Kintyre, which is located 60 km south of Telfer and 260 km north-east of Newman at the western edge of the Great Sandy Desert in the East Pilbara region of Western Australia (Figure 1-1). There is no expectation that mining operations threaten wetlands in the vicinity of Kintyre, but as part of a program of due diligence, Cameco commissioned surveys of three pools: namely, Duck Pool, Pinbi Pool and Rock Pool, that occur 21.5, 8.5 and 4 km from the Kintyre mine site, respectively (Figure 1-2).

The overall objective of the survey reported here was to document the biological values of the three river pools (Duck Pool, Pinbi Pool and Rock Pool) that comprise the Study Area for this report. These three wetlands fit into Pinder *et al.'s* (2010) clear river pool category of Pilbara wetlands.

The specific aims of the survey were to:

1. Document the species of aquatic invertebrate present in each pool;
2. Compare the aquatic invertebrate communities present with other clear river pool wetlands in the Pilbara; and
3. Assess the conservation status of Duck Pool, Pinbi Pool and Rock Pool.

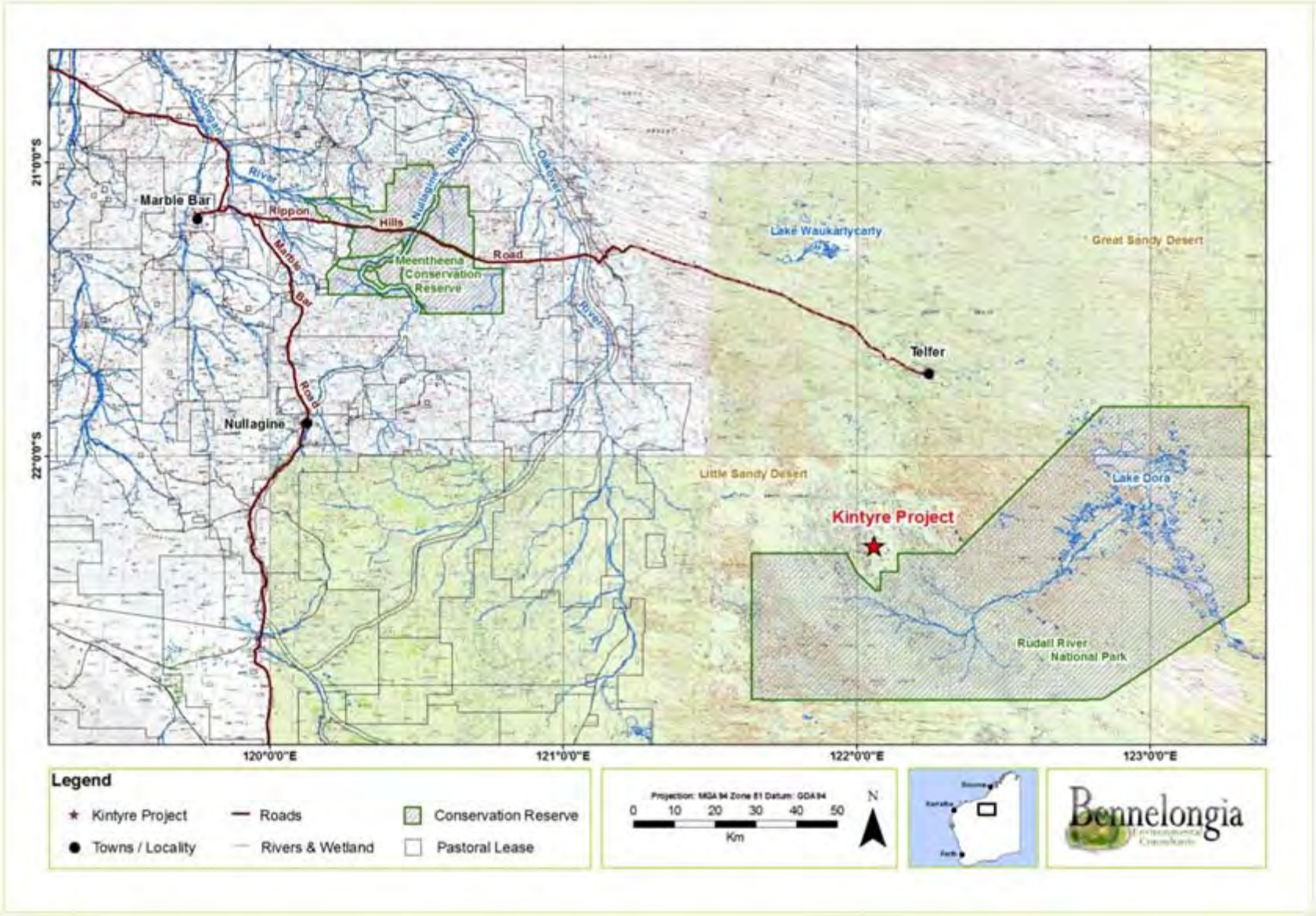


Figure 1-1. Location of the Kintyre Project.

Figure 1-2. Location of the three pools sampled at Kintrye.

2. METHODS

2.1. Study Area

Regionally, the Kintyre mine site lies within the Sandy Desert Basin of the Western Plateau Drainage Division, which is a large internally draining area in the western half of the Australian continent (Environ 2010).

The Kintyre mine site lies between two branches of Yandagooge Creek, referred to as the South Branch and the West Branch (Figure 1-2). The tributaries converge north of Kintrye and continue to flow on a northerly course to Coolbro Creek, which flows east towards the Great Sandy Desert where the surface drainage dissipates into dune systems. The Yandagooge Creek System catchment is separated from the Rudall River catchment by low hills.

2.1.1. Duck Pool

Duck Pool is semipermanent and occurs on Coolbro Creek (Figure 1-2). Duck Pool is about 400 m long, up to 40 m wide and at least 2 m deep (Figure 2-1). Steep sandy banks and 10 m high pindan cliffs predominate along the southern shoreline (Figure 2-1A,B). The soil types along the northern bank are generally coarser and a prominent sand and gravel ridge is located behind the riparian zone. At the western (upstream) end there is a flood-out with small pools amongst banks of sand and mud, interspersed with rocks and shale (Figure 2-1D). The rocky creek bed continues downstream to the east of the pool, where the water is shallower (Figure 2-1E).

The river bed is predominantly sandy with pockets of leaf mulch and mud amongst rocks at the eastern end of the pool. Most of the sediments are covered with algae - 60% cover of filamentous algae, 5% cover of *Chara* sp., and 30% cover of other mixed macrophytes (Figure 2-1C). High levels of suspended algae occur in the water column. Pool substrates are estimated to be 20% bedrock and boulders, 10% cobble and pebbles, and 70% course sand and sediment.

Riparian vegetation varies. Along the southern bank, sparse eucalypts occur in a thin line along the water's edge and behind them is a low acacia scrub over herbs, which extends up to 20m from the river bank. Acacia over spinifex grows on the gravel ridge, and a stand of casuarinas with 10% cover, grows over acacia scrub. On the northern shore, the riparian zone is dominated by buffel grass which is very dense to the cliff edge. Eucalypts line most of the shoreline.

2.1.2. Pinbi Pool

Pinbi Pool is semipermanent and occurs on the South Branch of the Yandagooge Creek (Figure 1-2). The pool is about 150 m long and 20-30 m wide (Figure 2-2A,E). However, the size of the pool length varies with season as the eastern and western ends shelve along the creek bed and are ephemeral (Figure 2-2B). A steep 4 m rocky outcrop occurs along the central northern bank and water depths probably obtain a maximum of about 2.5 m at the base of the rock wall (Figure 2-2E). A separate 2 m deep semipermanent pool is located beyond the western end of the main pool and, farther on, smaller ephemeral pools occur (Figure 2-2C,D). The northern, eastern and southern banks are also rocky in places and feature coarse sandy beaches and finer sandy loam substrates in places. The percentages of shoreline substrates are estimated to be 15% bedrock and boulders, 5% cobble and pebbles, and 80% coarse sand and sediment.

The substrate of the Pinbi Pool river bed is predominantly sediment, and sand banks are exposed at lower water levels. A 1.5 m deep narrow channel also becomes evident along part of the northern side

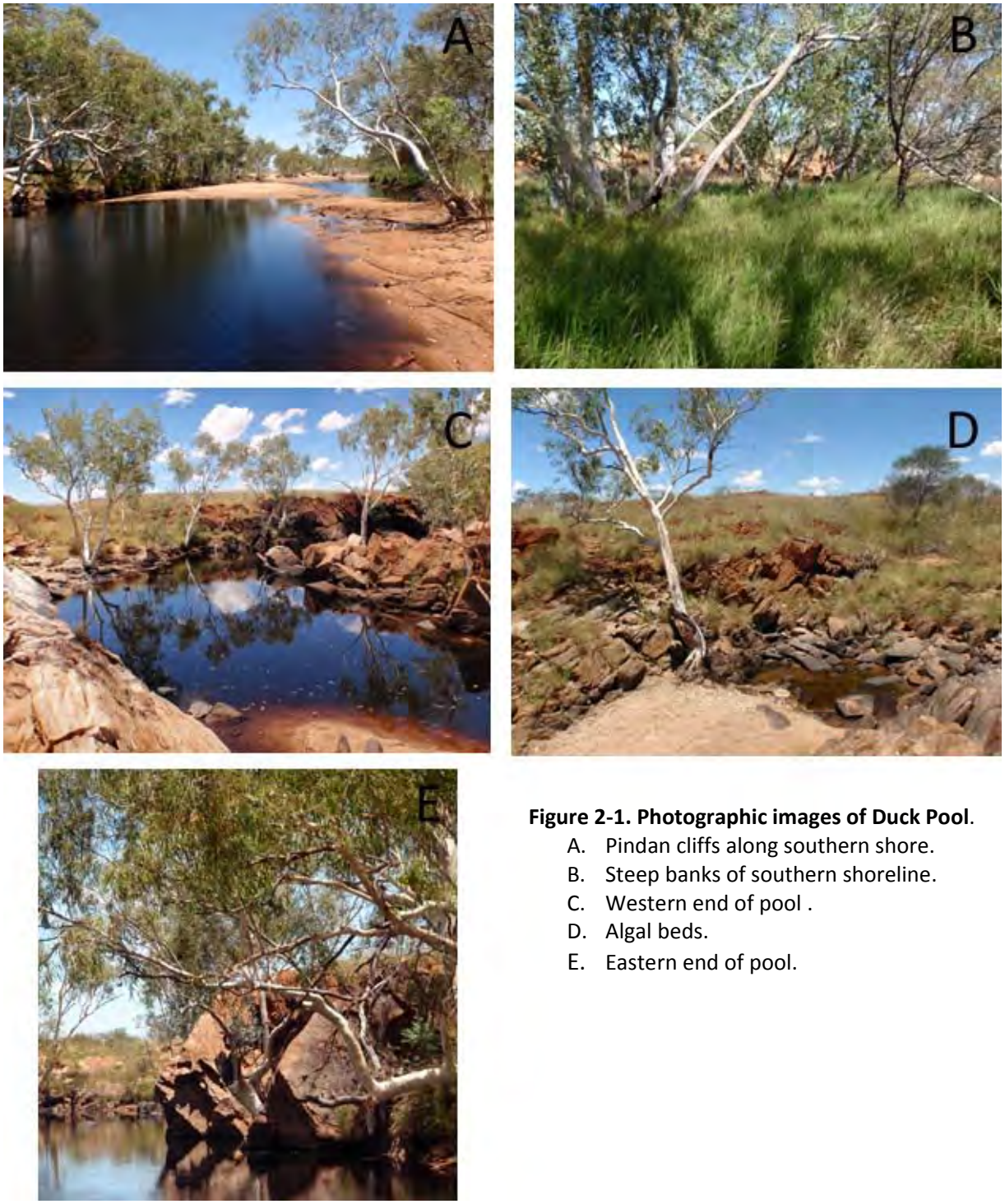


Figure 2-1. Photographic images of Duck Pool.

A. Pindan cliffs along southern shore.
B. Steep banks of southern shoreline.
C. Western end of pool .
D. Algal beds.
E. Eastern end of pool.

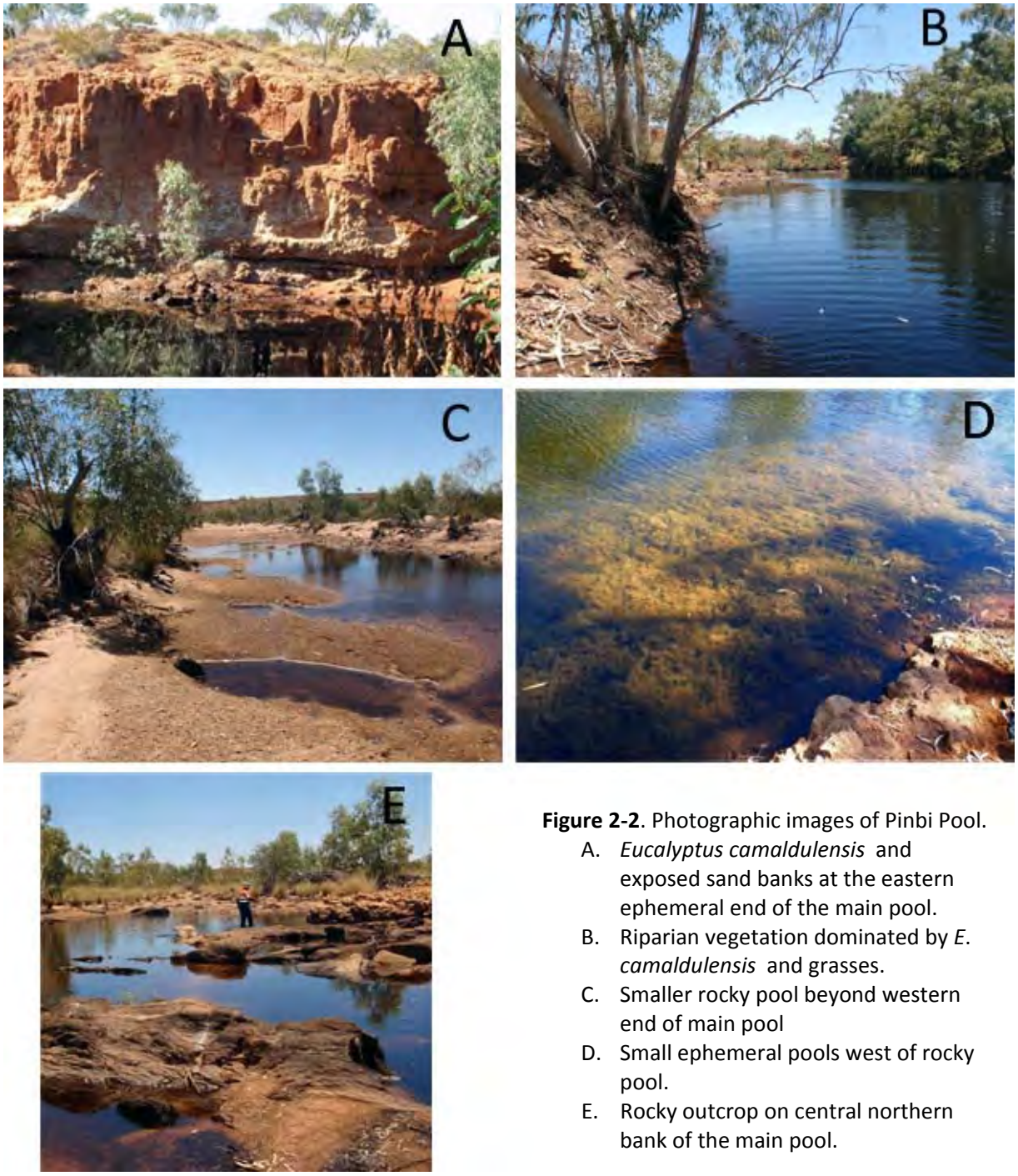


Figure 2-2. Photographic images of Pinbi Pool.

A. *Eucalyptus camaldulensis* and exposed sand banks at the eastern ephemeral end of the main pool.
B. Riparian vegetation dominated by *E. camaldulensis* and grasses.
C. Smaller rocky pool beyond western end of main pool
D. Small ephemeral pools west of rocky pool.
E. Rocky outcrop on central northern bank of the main pool.

of the pool during periods of low water levels.

No emergent aquatic vegetation was observed during the three survey dates. However, filamentous algae were estimated to cover 20% of the river bed while *Chara* sp. covered 2%. Riparian vegetation was characterised by *Eucalyptus camaldulensis* over acacia, with a ground cover of grass and herbs (Figure 2.2B). Along the southern shore, *E. camaldulensis* trees reached a height of 10 to 12 m with 95% canopy cover. Other areas are characterised by an open canopy of 10 to 20% cover, over 5% cover of acacias. Dense buffel grass grew along the southern bank.

2.1.3. Rock Pool

Rock Pool is considered to be semipermanent and occurs in a tributary of the West Branch of Yandagooge Creek (Figure 1-2). The pool has a diameter of about 20 m and was estimated to be about 2.5 m deep when full. The pool is flanked by a steep rock wall on the western side which dominates the shoreline (Figure 2-3A) and a steep rocky slope rises from the southern shore (Figure 2-3B). When in flood, water flows into Rock Pool by falling over a small waterfall in the middle of the rock wall (Figure 2-3A). Water flows downstream through an outfall at the eastern side of the pool into a 500 m rocky ravine. The ravine contains small shallow pools (Figure 2-3C).

The percentages of shoreline substrates are estimated to be 55% bedrock and boulders, 30% cobble and pebbles, and 15% fine sand. Sparse growth of *Chara* sp. was observed near the pool edge. Although the water was clear, phytoplankton was visible in the water column. Grey algae were observed in the small pools in the outflow.

Riparian vegetation along the eastern shoreline was dominated by grasses (90% cover) over sparse herbs and sedges, with an overstorey of *Acacia* shrubland to 5 m (50% cover) with a single small eucalypt to 1.5 m (Figure 2-3E). Farther downstream there is sparse low acacia over grass and a low cover of herbs and creepers (Figure 2-3B).

2.2. Field survey

Average annual rainfall at Telfer is 369 mm. There was 634 mm of rain in 2011, with major events being 87 mm on 1 March, 48 mm on 9 March, 113 mm on 7-8 April, 52 mm on 31 October – 1 November, and 34 mm on 21 November. Wetland surveys were conducted from 28-30 June, 23-24 November, and 16-17 December 2011, following periods of flow in the streams in which the pools were located.

Water was not flowing at any pool during the survey dates. Water levels in the pools were about 75 cm below high water mark during the June survey, approximately high water mark during the November survey, and 50 cm below high water mark a month later in December.

Water and aquatic invertebrates were sampled during the survey.

2.2.1. Aquatic Invertebrate Sampling

Survey techniques followed the sampling protocols used by Pinder *et al*. (2010) for the Pilbara Biodiversity Survey. Several aquatic invertebrate subsamples were collected at each pool to ensure that all habitat types in the pools were sampled, including sandy, rocky and detrital substrates, vegetation, and the water column. Separate smaller pools adjacent to the three were also sampled

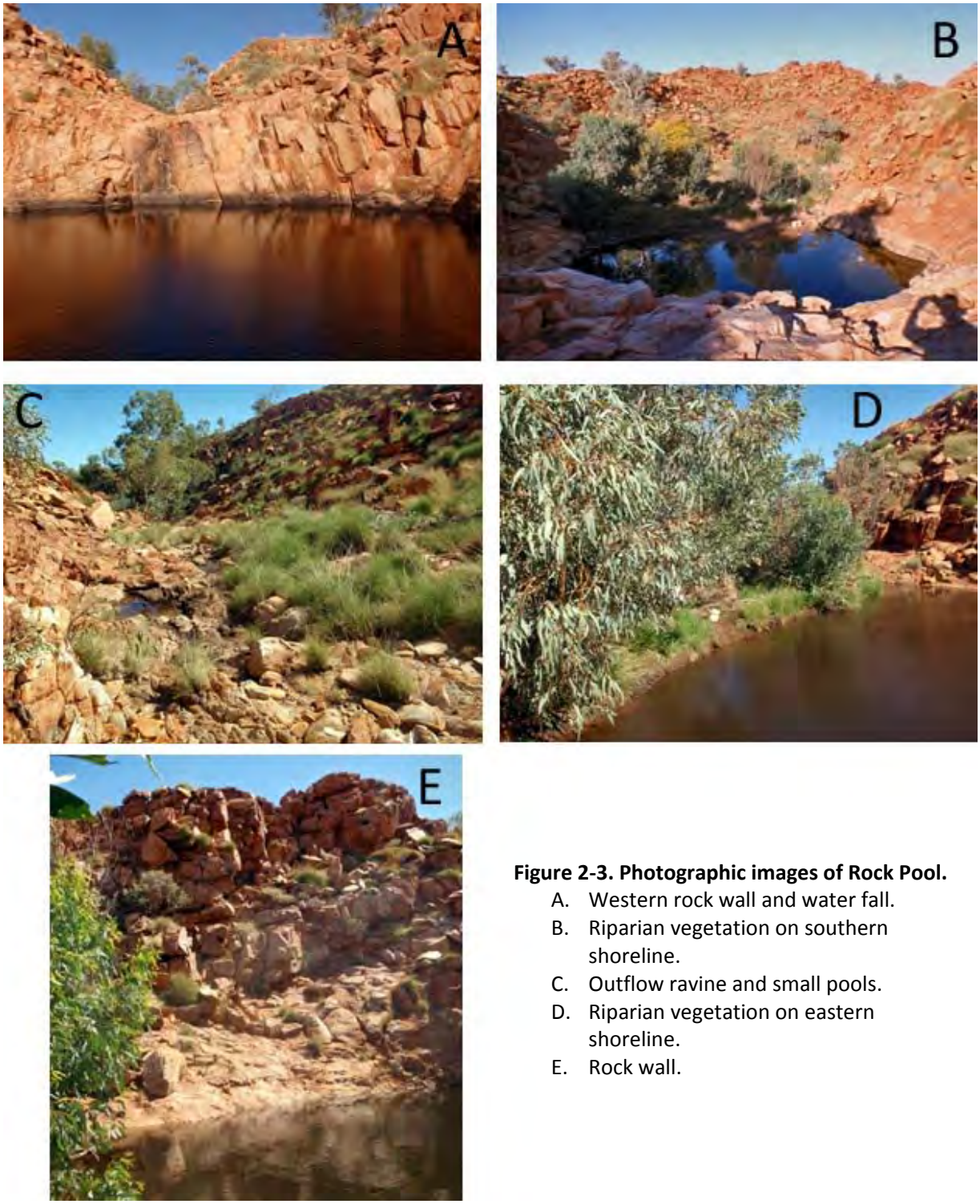


Figure 2-3. Photographic images of Rock Pool.

A. Western rock wall and water fall.
B. Riparian vegetation on southern shoreline.
C. Outflow ravine and small pools.
D. Riparian vegetation on eastern shoreline.
E. Rock wall.

Benthic invertebrates were collected by vigorous kick sampling and sweep sampling over a discontinuous length of 50 m using a D-framed pond net with 250 µm mesh. The net was regularly emptied into a bucket to prevent much sample accumulating in the net and the sample in the bucket was elutriated to remove rocks and sediment. As much vegetation and organic matter as possible was also removed from the sample, with the material being washed vigorously as it was removed.

Planktonic invertebrates were collected by sweep sampling using a D-framed pond-net with 50 µm mesh. The sample was collected in the same areas and habitats as the benthic sample, except that the stream bed was not sampled and vegetation was sampled carefully to avoid collecting too much filamentous algae.

Samples were preserved in the field using 100% ethanol.

2.2.2. Water chemistry

Water samples were collected from 15 cm below the surface during the June and November surveys for laboratory analysis by the ChemCentre, which is NATA accredited. In addition, electrical conductivity, pH and temperature were measured *in situ* during all three sampling periods using a WP 81 field meter.

2.3. Species identification

All aquatic invertebrate samples were washed in the laboratory, and passed through a set of sieves (2000, 500, 250, 90, 53 µm) to facilitate sorting under a dissecting microscope. Animals were identified to species using published keys, or to morphospecies using unpublished keys or the taxonomic framework developed by the Pilbara Biodiversity Survey (Pinder *et al*. 2010). Animals were dissected and examined under a compound microscope with differential interference contrast lighting as necessary for identification.

Representative specimens will be lodged with the Western Australian Museum.

2.3.1. Compiling species lists

Animal specimens that could not be identified to species or morphospecies level were included in estimates of species richness only if they could not belong to species already recorded. For example, when immature or damaged specimens of the genus *Berosus* sp. were collected in the same sample as mature specimens of *B. australiae,* all specimens were treated as a single species because it was likely that the animals identified to genus as *Berosus* sp. were in fact *B. australiae*. The purpose of this criterion was to prevent higher level identifications falsely inflating species richness. Incomplete identifications are listed separately from species level identifications.

2.3.2. River pool invertebrate assemblage comparisons

Species richness of aquatic invertebrates collected during the June and November surveys at Duck Pool, Pinbi Pool and Rock Pool were compared with the number of species at 38 other non-saline river pools surveyed during a Pilbara wide survey conducted between 2003 and 2006 (Pinder *et al*. 2010) (Figure 3.1). The pools in the Pilbara Biodiversity Survey were each surveyed twice, once during April to May and again between August and September. These survey periods were close to, but not directly comparable with, the June and November survey dates of the 2011 survey.

The list of aquatic invertebrate species collected at Duck Pool, Pinbi Pool and Rock Pool was compared with that collected during the Pilbara Biodiversity Survey to determine whether any of the species in the three pools might be restricted to the Kintyre pools, represent significant range extensions, or represent

new species. Most species names were directly comparable between the two surveys, but without access to the specimens collected during the Pilbara Survey, some assumptions had to be made about the equivalence of some slightly different names (particularly when aff. or cf. was applied to an established name).

2.4. Personnel

Grant Pearson conducted all field surveys. Specimens were sorted by Jane McRae and identified by Jane McRae, Stuart Halse (ostracods) and Mike Scanlon (oligochaetes). Advice on identifications was provided by Chris Watts of the South Australian Museum (beetles), and Brian Timms of the University of New South Wales (large branchipods).

3. RESULTS

3.1. Water chemistry

Laboratory analysis confirmed that water at all three sites was fresh, with values of electrical conductivity being lower at most variable at Rock Pool (134 µS/cm in June, and 33 µS/cm in November) (Appendix C). Electrical conductivities in the December survey were similar to those in June and November at Duck and Rock pools (Table 3.2).

Table 3-1. On-site measurements of electrical conductivity, pH and water temperature.

	Conductivity µS/cm	pH	Temp°C		
	December	December	June	November	December
Duck Pool	40	5.5-6.3	23.9	25.9-27.3	30.1-43.4
Pinbi Pool	90	5.9	20.7	24.0	3.02-34.0
Rock Pool	40	5.3	22.8	31.0	28.0

More than one reading was taken from different locations during some surveys.

Laboratory analysed samples were neutral with all pH values between 6.3 and 7.5 during the June and November surveys. *In situ* recordings of pH fell below 6 at both Pinbi and Rock pools during December (Table 3-2) but, on the basis *in situ* values in November were about 1-1.3 units lower than laboratory measurements, it is considered unlikely that there was a real decline in pH in December.

On-site measurements of water temperature varied by up to 20°C. Temperatures in June were all in the low 20s. Temperatures between 30 and 43°C were recorded at Duck Pool in December survey, depending on the part of the pool sampled.

When compared with trigger levels for slightly disturbed tropical ecosystems (ANZECC & ARMCANZ 2000), laboratory analysed nutrient levels were relatively high. Total nitrogen levels exceeded trigger levels at all sites during both surveys with consistently higher levels in November (between 0.55 and 0.6 mg/L). Total phosphorus levels were equivalent to, or exceeded trigger levels at all sites in June, and were below the limit of detection in November. The more elevated phosphorus levels in June were probably associated with significant inflow into the pools in March but it should be recognized that ANZECC & ARMCANZ (2000) guidelines are not appropriate for arid zone, non-flowing wetlands. The average concentration of Total phosphorus recorded by Pinder et al. (2010) in a range of Pilbara wetlands was about 0.05 mg/L. Average Total nitrogen concentrations were about 1.1 mg/L.

Moderately high levels of turbidity were recorded at all sites in November with readings of 6.7 NTU at Duck Pool, 5.2 NTU at Pinbi Pool, and 7.5 NTU Rock Pool. These high levels are likely to have been caused by fine sediment suspended during the flood event prior to November surveys, together with phytoplankton, and the suspended breakdown products of filamentous algae.

Anions in the water of all three pools were dominated by bicarbonate (60-65% of anionic activity), while similar amounts of all cations occurred. Ionic composition of the water is probably a result of local geology.

3.2. Aquatic invertebrates

After adjusting species lists for higher level identifications that may represent double counting of the same species (refer to section 2.4), a combined total of at least 270 species were identified from Duck Pool, Pinbi Pool and Rock Pool (Appendices A and B). Species richness was highest at Duck Pool with 193 species, and lowest at Rock Pool with 140 species (Table3-1).

Table 3-2. Species richness at each Kintyre pool by sample and site.

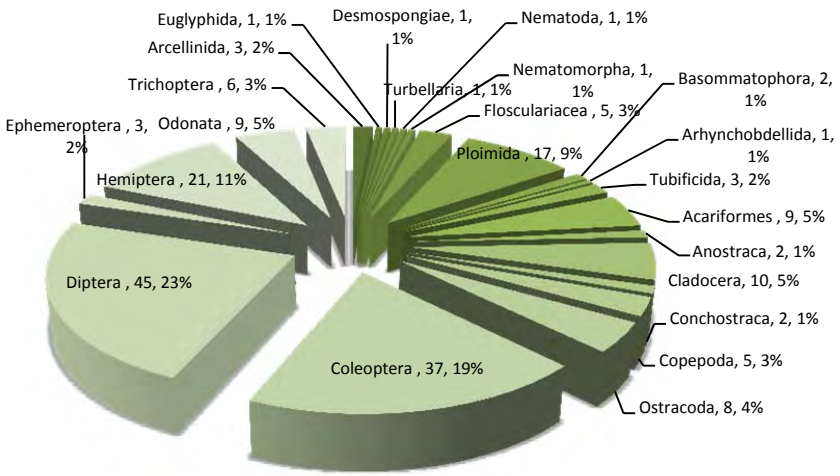
	Duck Pool				Pinbi Pool				Rock Pool				
	Jun	Nov	Dec	Total	Jun	Nov	Dec	Total	Jun	Nov	Dec	Total	GRAND TOTAL
No. species	126	92	111	193	91	93	141	188	87	53	104	140	270

The number of major taxonomic groups represented across all three sites was 25: two groups of protozoans (Arcellinida and Euglyphida), Porifera or sponges, Turbellaria, Nematoda, Nematomorpha, three groups of rotifers (Bdelloidea, Flosculariacea and Ploimida), Acariformes or mites, Gastropoda or snails, Hirudinea or leaches, Oligochaeta or segmented worms, five crustacean orders (Anostraca, Cladocera, Conchostraca, Copepoda and Ostracoda), and seven orders of insect (Coleoptera or beetles, Diptera or flies, Ephemeroptera or mayflies, Hemiptera or bugs, Lepidoptera or butterflies and moths, Odonata or dragonflies, and Trichoptera or caddisflies). All groups were represented at Pinbi Pool. There were 23 groups at Duck Pool and 19 at Rock Pool (Figure 3-2).

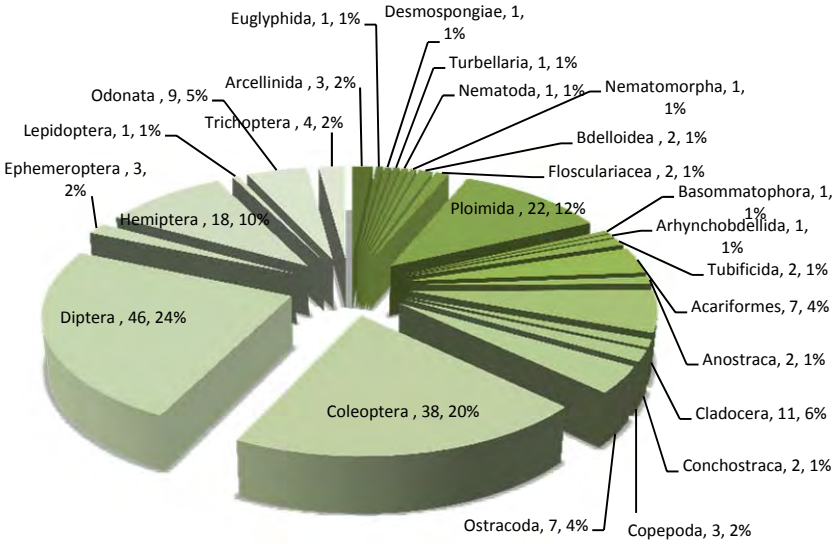
The pattern of species richness among taxonomic groups was similar at all three surveyed river pools. The most speciose groups were the insect orders of Diptera (22 – 24% of the species), and Coleoptera (19 – 27% of the species) (Figure 3-2). Other well represented insect orders were Hemiptera (10 – 12 % of species), and Odonata (a consistent 5% of species at each site). Two crustacean orders consistently made up small but significant components of the assemblages, Cladocera (5 or 6% of species), and Acariformes (3 to 5% of species). Between 6-12% of species were rotifers (mostly of the Order Ploimida). No other taxonomic group contributed more than 3% of the species at any of the surveyed river pools (Figure 3-2).

3.3. Comparisons with other Pilbara wetlands

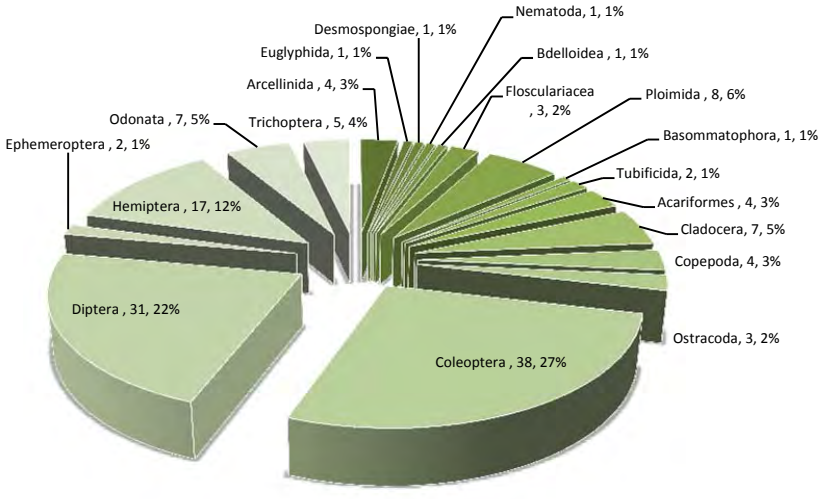
Comparisons between the number of species recorded in each sample from the three surveyed pools, and 38 other non-saline river pools sampled by Pinder *et al*. (2010) (Figure 3-3) demonstrate that the high species richness at Duck, Pinbi and Rock pools are not exceptional for the Pilbara region (Figure 3-4).



Duck Pool



Pinbi Pool



Rock Pool

Figure 3-2.Species numbers and percentages in each taxonomic group at each surveyed river pool.

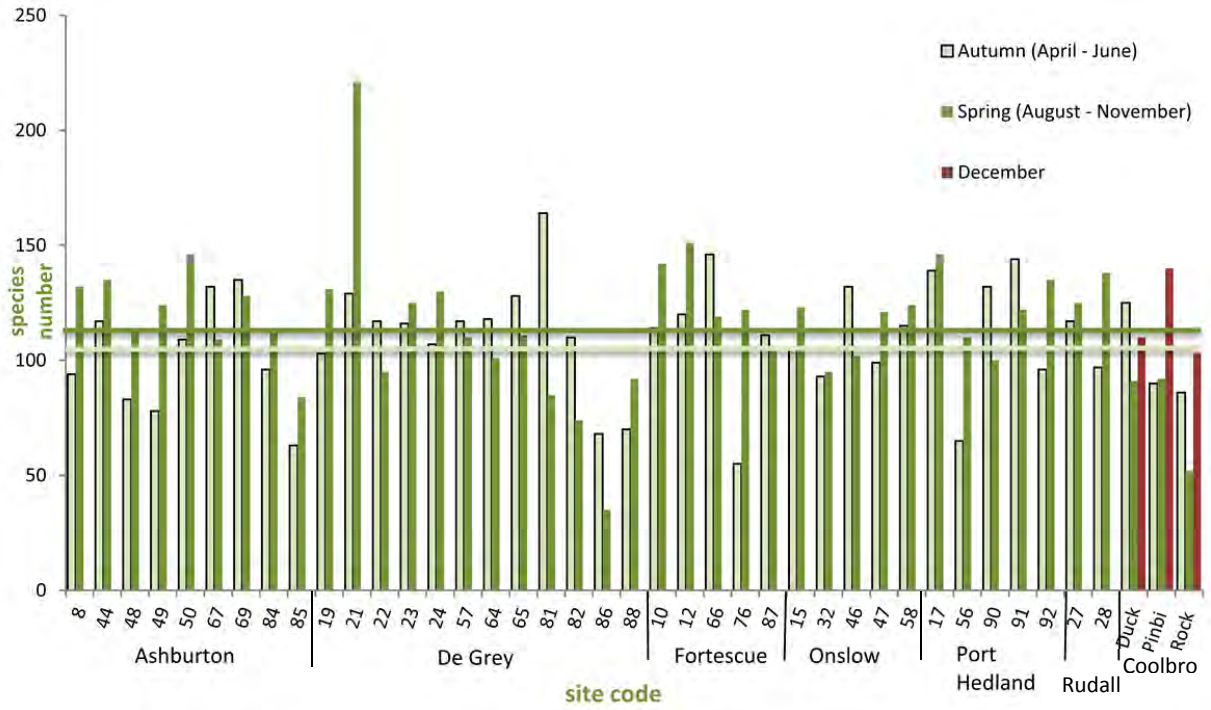


Figure 3-3. Species numbers in samples from the three Kintyre pools and 38 Pilbara river pools.
The spring and autumn data from numbered sites are from Pinder *et al.* (2010). The sites are grouped according to catchment areas, named at the bottom of the chart. The coloured horizontal lines represent average species numbers per sample across the 38 Pilbara sites in autumn (light green, 109) and spring (dark green, 118).

Although the total number of species recorded across the 38 Pilbara river pool sites was over 900, the average number of species at these pools per spring and autumn sample was just over 100. The autumn survey at Duck Pool provided the only sample from the Kintyre pools with more species than the Pilbara average for river pools during that time of year (Figure 3-2). There are no data with which to compare December species richness for the Kintyre pools but the consistently greater richness of these samples suggests conditions were more favourable to invertebrates in December than in June or November for unidentified reasons. Large and inconsistent inter-seasonal variations in species richness was observed at most sites during the Pilbara Biodiversity Survey (Pinder *et al*. 2010).

The pattern of species richness among taxonomic groups across the 38 Pilbara river pools was very similar to those from the three Kintyre pools. The most species-rich insect groups were Coleoptera, Diptera and Hemiptera, and both the ploimid rotifers and Acariformes contribute significant species components to the assemblage, just as they did at the three surveyed pools (Figure 3-5).

3.4. Conservation significance of aquatic invertebrate species

Attributes that contribute to the conservation value of wetlands include the presence of conservation significant species. Therefore, an understanding of the conservation significance of species collected at the three Kintyre pools and their known ranges informs assessment of the conservation values of Duck, Pinbi, and Rock pools.

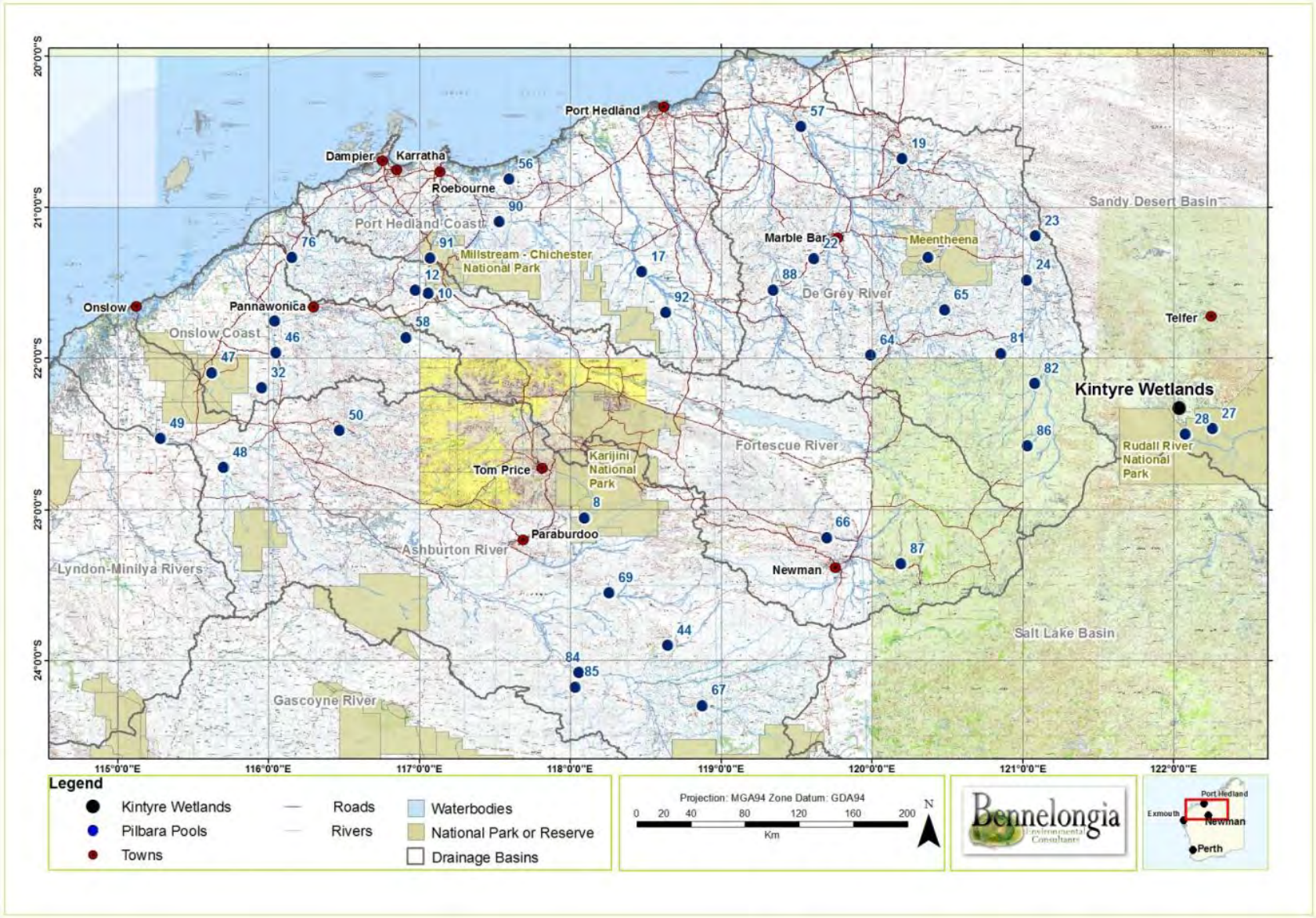


Figure 3-4. Location of clear river pools surveyed during the Pilbara Survey. Data sourced from Pinder *et al*. 2010.

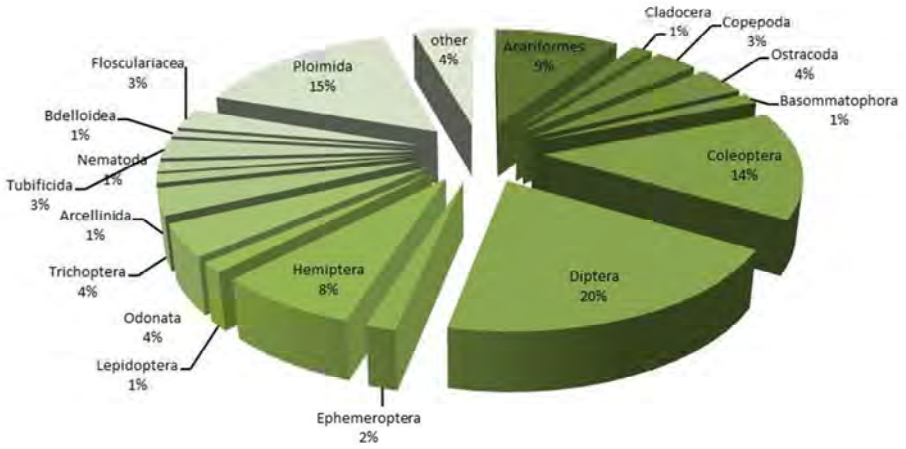


Figure 3-5. Pattern of species richness among taxonomic groups from river pools across the Pilbara.
The segment labelled "other" is an amalgamation of groups with less than five species, or 1% of the overall species count. They include: Arcellinida Euglyphida Sessilida, Loboseta, Hydrozoa, Desmospongiae, Collothecacea, Monogononta, Nemertini, Trematoda, Turbellaria, Hirudinea, Tricladida, Bosommatophora, Neotaenioglossa, Gastrotricha, Aphanoneura, Unionida, Veneroida, Acarina, Parasitiformes, Amphipoda, Conchostraca, Decapoda, and Isopoda.
Data sourced from Pinder e*t al*. 2010.

An assessment of all species distributions is summarised in Appendix A. Most species are known to have a Pilbara-wide or broader distribution. Species considered to be of potential conservation significance are listed in Table 3-3.

There are many undescribed water mites (Acariformes) from the Pilbara region and four undescribed species were collected in the Kintyre pools (Table 3-3) In the case of nr *Encentridophorus* sp. B1, the only member of the genus collected during the Pilbara Biodiversity Survey was *Encentridophorus sarasini*, so that nr *Encentridophorus* sp. B1 probably represents a new species. *Unionicola* sp. B1 may also be a new species; four named species of the genus and a fifth species closely resembling a named species were collected during the Pilbara Biodiversity Survey (Pinder *et al*. 2010). It is less likely that *Hydrachna* sp. B1 and *Limnesia* sp. B2 represent new species; they perhaps match two of the seven undescribed species of these genera collected during the Pilbara Biodiversity Survey but voucher material was not available for comparison. Few surface water mites have localised distributions because they are widely dispersed during their nymphal stage by other insects (Williams 1980).

Also of potential conservation significance, the branchiopod *Branchinella* nr *wellardi* was collected only at Pinbi Pool. The specimens either represent a new species or a morphological variant on the periphery of the range of *Branchinella* nr *wellardi* (B. Timms pers. comm.). *Branchinella wellardi* is listed as vulnerable in the IUCN Red List and has been identified as a Priority 1 species (taxon with few, poorly known population on threatened lands) by the Department of Environment and Conservation. Whether a new species or *Branchinella wellardi*, the record of *Branchinella* nr *wellardi* has high conservation significance. It seems likely, however, that further sampling in the Kintyre area would locate other populations of *Branchinella* nr *wellardi*.

Table 3-3. Species of potential conservation significance.

Higher taxonomic groups	Lowest level of identification	Species occurrence at surveyed sites			Known Distribution beyond surveyed sites
		Duck Pool	Pinbi Pool	Rock Pool	
Arachnida					
Acariformes					
	Hydrachna sp. B1	✓	✓	✓	Possibly a new species
	Limnesia sp. B2	✓			Possibly a new species
	nr. *Encentridophorus* sp. B1			✓	Probably a new species
	Unionicola sp. B1	✓			Probably a new species
Crustacea					
Anostraca					
	Branchinella nr *wellardi*		✓		Species variant on the periphery of its distribution or new species
Copepoda					
	Thermocyclops sp. B3	✓			Probably a new species

A sixth species of potential conservation significance is the *Thermocyclops* sp. B3 (Table 3-3). This appears to be an undescribed species with an unknown distribution. Most other species of surface water *Thermoscyclops* have moderately wide distributions (Holynska *et al*. 2003) and it unlikely the species is restricted to Duck Pool.

4. DISCUSSION

Comparisons with other river pools in the Pilbara region indicate that, although Duck Pool, Pinbi Pool, and Rock Pool have relatively high species richness for an arid region, this richness is not unusual in the local region. Only the autumn sample from Duck Pool contained species numbers that exceeded the sample average for autumn surveys across the region. Even the closest sites to the three surveyed pools (sites 27 and 28 – Desert Queen Baths and Watrara Creek pool in the Rudall River catchment), appeared to be characterised by higher species richness than the Kintyre sites, although the Duck Pool sample in June contained a relatively high number of species.

The pattern of samples containing high proportions of dipteran, coleopteran and hemipteran insects, together with the significant representation of ploimid rotifers and mites, was consistent both among the three Kintyre pools and conformed with the overall river pool pattern in the Pilbara region. None of the Kintyre pools appeared to support a unique aquatic invertebrate assemblage that could be considered to have special conservation significance.

Although the aquatic invertebrate communities at Duck, Pinbi and Rock pools lack conservation significance, they do contain some potentially conservation significant species. The most notable of these is *Branchinella* nr *wellardi*, which is either a range extension of a Priority 1 species (also on the IUCN Red List) or a new species. This raises the conservation value of Pinbi Pool.

Conservation value of the Kintyre pools is further increased by the occurrence of the copepod *Thermocyclops* sp. B3 at Duck Pool, and the mites *Encentridophorus* sp. B1 at Rock Pool and *Unionicola*

sp. B1 at Duck Pool. It is quite likely that the other two potentially new species (*Limnesia* sp. B2 at Duck Pool and *Hydrachna* sp. B1 at all three pools) were recorded in the Pilbara Biodiversity Survey without being identified to species level.

The occurrence of a small number of species known only from the Kintyre pools is to be expected. Twenty-one per cent of the species recorded in Pilbara wetlands by Pinder et al. (2010) were collected at only one wetland and the proportion of such singletons was 33% in a similar survey in the Carnarvon Basin (Halse *et al*. 2000). It is likely that further sampling will show the potentially new species in the Kintyre pools have a more widespread occurrence.

4.1. Ecological condition

Examination of the three Kintyre pools and the surrounds while sampling suggested that Pinbi Pool and Rock Pool were pristine. Some camping occurs around Duck Pool but it is otherwise undisturbed. Comparison of the aquatic invertebrate communities of the Kintyre pools with the 38 Pilbara pools supported this conclusion. The Pilbara Survey sites were selected as wetlands in good condition with low levels of impact. Community composition of the Kintyre pools and the Pilbara pools was similar (Figures 3-2 and 3-5). Nutrient levels in Duck Pool, Pinbi Pool, and Rock Pool also indicated there was little disturbance. This matches the catchment level conclusions of Halse et al. (2007) as a result of the surveys undertaken for the First National Assessment of River Health.

5. SUMMARY

A combined total of at least 270 species were identified from the three clear river pool wetlands. Species richness was highest at Duck Pool with 193 species, and lowest at Rock Pool with 140 species.

The pattern of species richness among taxonomic groups was similar at all three river pools. The most speciose groups were the insect orders of Diptera and Coleoptera and Hemiptera. The invertebrate assemblages were also characterised by significant proportions of mites and ploimid rotifers.

Comparisons with other river pools in the Pilbara region indicate that the species richness and distribution of species among taxonomic groups at Duck Pool, Pinbi Pool, and Rock Pool are typical of the Pilbara region and do not represent special or unique assemblages.

Six potentially conservation significant species were identified. The anostracan *Branchinella* nr *wellardi* is either a new species or at the periphery of its known range at Pinbi Pool. The status of *Branchinella wellardi* as vulnerable on the IUCN Red List and its designation as a Priority 1 species by the Department of Environment and Conservation makes the record of *Branchinella* nr *wellardi* an important one that contributes to the conservation significance of Pinbi Pool. The other five potentially conservation significant species were the copepod *Thermocyclops* sp. B3 and four water mite (*Encentridophorus* sp. B1, *Unionicola* sp. B1, *Limnesia* sp. B2 and *Hydrachna* sp. B1). It is considered quite likely that *Limnesia* sp. B2 and *Hydrachna* sp. B1 have been previously collected at other sites in the Pilbara. It is considered likely that further sampling will show all six species occur in other wetlands around the Kintyre area or in the north-eastern Pilbara.

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APPENDICES

Appendix A. Species identifications, distributions and known distributions.

Cells show numbers of animals identified

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
Protozoa											
Arcellinida											
	Centropyxis sp.	10					1	1			Recorded during Pilbara survey[1]
	Difflugia sp.	10		1	10		100	100			Recorded during Pilbara survey[1]
	Lecquereusia sp.							5			Recorded during Pilbara survey[1]
	Arcella sp.	10		1	4		10	20			Recorded during Pilbara survey[1]
Euglyphida											
	Euglypha sp.	10			1			10			Recorded during Pilbara survey[1]
Porifera											
	Spongillidae sp.	10		5	1	1	20	3		10	Recorded during Pilbara survey[1]
Turbellaria											
	Microturbellaria sp.						1				Recorded during Pilbara survey[1]
	Turbellaria sp.	1									Recorded during Pilbara survey[1]
Nematoda											
	Nematoda sp.			2	2	1	1	2	2	1	Recorded during Pilbara survey[1]
Nematomorpha											
	Gordiidae sp.			3	1		2				Recorded during Pilbara survey[1]
Rotifera											
Bdelloidea											
	Bdelloidea sp. 2:2				10		100		1		Recorded during Pilbara survey[1]
	Bdelloidea sp. 3:0						10				Poor taxonomy status unclear
Flosculariacea											
	Conochilus cf. *coenobasis*									1	Probable Pilbara survey record[1]
	Conochilus cf. *dossuarius*		1	100							Probable Pilbara survey record[1]

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
	Conochilus cf. *natans*								5		Recorded during Pilbara survey[1]
	Conochilus cf. *unicornis*	100									Probable Pilbara survey record[1]
	Filinia longiseta		1					100		1000	Recorded during Pilbara survey[1]
	Hexarthra mira						50				Recorded during Pilbara survey[1]
	Testudinella amphora	1									Recorded during Pilbara survey[1]
	Testudinella patina				10		10				Recorded during Pilbara survey[1]
Ploimida											
	Asplanchna sieboldi		1	100				2			Recorded during Pilbara survey[1]
	Anuraeopsis navicula		2							2	Recorded during Pilbara survey[1]
	Brachionus dichotomus			1000	1						Recorded during Pilbara survey[1]
	Brachionus falcatus		2	10			1000		2	20	Recorded during Pilbara survey[1]
	Brachionus lyratus		5	10		1	10	1000	2	1000	Recorded during Pilbara survey[1]
	Brachionus urceolaris s.l.						1				Recorded during Pilbara survey[1]
	Keratella procurva	1			100		10				Recorded during Pilbara survey[1]
	Keratella tropica	200		1000	1000	5	1	5		20	Recorded during Pilbara survey[1]
	Plationus patulus						10				Recorded during Pilbara survey[1]
	Euchlanis dilatata	2					10				Recorded during Pilbara survey[1]
	Lecane bulla			1			10	2			Recorded during Pilbara survey[1]
	Lecane cf. *rhytida*	1									Not recorded in Pilbara survey, but expected at site– widespread species[2]
	Lecane crepida						2				Recorded during Pilbara survey[1]
	Lecane elsa						2				Recorded during Pilbara survey[1]
	Lecane ludwigii				1						Recorded during Pilbara survey[1]
	Lecane lunaris	2									Recorded during Pilbara survey[1]
	Lecane signifera	10					10				Recorded during Pilbara survey[1]
	Lecane unguitata					1					Recorded during Pilbara survey[1]
	Colurella sp.				2						Recorded during Pilbara survey[1]
	Cephalodella gibba	2									Recorded during Pilbara survey[1]
	Notommata copeus				1						Recorded during Pilbara survey[1]

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
	Polyarthra dolichoptera	100	5				50				Recorded during Pilbara survey[1]
	Trichocerca pusilla		1	10	10						Recorded during Pilbara survey[1]
	Trichocerca similis	100	1	100	1000				10		Recorded during Pilbara survey[1]
	Trichocerca similis grandis						50	1000		1000	Recorded during Pilbara survey[1]
Gastropoda											
Basommatophora											
	Ferrissia sp.	8		5				1		4	Recorded during Pilbara survey[1]
	Isidorella egraria	12	4	30	1	14	26				Recorded during Pilbara survey[1]
Hirudinea											
Arhynchobdellida											
	Richardsonianidae sp. B1 (9 stripe)		5	12		7	18				Poor taxonomy status unclear
Oligochaeta											
Tubificida											
	Dero furcata		1		1				1	1	Recorded during Pilbara survey[1]
	Pristina aequiseta	1									Recorded during Pilbara survey[1]
	Tubificidae stygo type 5	3		4			1			1	Probable Pilbara survey record[1]
Arachnida											
Acariformes											
	Trombidioidea sp.				1						Recorded during Pilbara survey[1]
	Arrenurus (Brevicadaturus) sp. 18 (PSW)	1									Recorded during Pilbara survey[1]
	Arrenurus separatus	3								3	Recorded during Pilbara survey[1]
	Arrenurus sp. B4 (nr sp 15)	1				1	1				Probable Pilbara survey record[1]
	Eylais sp.					4					Recorded during Pilbara survey[1]
	Hydrachna sp. 4/5 (PSW)					2					Recorded during Pilbara survey[1]
	Hydrachna sp. B1	30	5	25	3	1		50	1	60	Possibly a new species
	Limnesia sp. B2			2							Possibly a new species
	Piona sp. P2 (nr. *australica*) (PSW)		1				1				Recorded during Pilbara survey[1]

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
	Neumania nr *ambigua*			3							Probable Pilbara survey record[1]
	nr. *Encentridophorus* sp. B1									3	Probably a new species
	Unionicola sp. B1	2		2							Possibly a new species
	Unionicola vidrinei						4				Recorded during Pilbara survey[1]
Crustacea											
Anostraca											
	Streptocephalus queenslandicus		2	11		5	4				Not recorded in Pilbara survey, but expected in survey area[3]
	Branchinella affinis		17	11							Recorded during Pilbara survey[1]
	Branchinella nr *wellardi*					5					Species variant on the periphery of its distribution[3]
Cladocera											
	Alona cf. *longinqua* (CB)							2	1	50	Not recorded in Pilbara survey, but known elsewhere[4, 5]
	Alona cf. macrocopa				1						Not recorded in Pilbara survey, but known elsewhere[4]
	Alona cf. *rectangula* (CB, but may be > 1 spp.)	2						3		1	Recorded during Pilbara survey[1]
	Chydorus nr *kalypygos*									1	Probable Pilbara survey record[1]
	Chydorus nr. *eurynotus*				2		1				Probable Pilbara survey record[1]
	Ceriodaphnia aff *cornuta*			2		1	1			1	Probable Pilbara survey record[1]
	Ceriodaphnia aff *laticaudata* (CB)	20									Probable Pilbara survey record[1]
	Ceriodaphnia quadrangula s.l.						1	10	2	50	Not recorded in Pilbara survey, but known elsewhere[5, 6]
	Daphnia cf. *angulata*	1	1								Not recorded in Pilbara survey, but known elsewhere[5, 6]
	Daphnia projecta		4	100			1				Recorded during Pilbara survey[1]
	Simocephalus heilongjiangensis					7	6				Recorded during Pilbara survey[1]
	Ilyocryptus sp. B1			1			1				Probable Pilbara survey record[1]
	Macrothrix sp.		2			2	1			3	Recorded during Pilbara survey[1]
	Moina micrura s.l.		2	50		1					Recorded during Pilbara survey[1]

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
	Neothrix cf. *armata*							2			Probable Pilbara survey record[1]
	Diaphanosoma excisum			50	1		16				Recorded during Pilbara survey[1]
	Latonopsis australis			1		1	15				Recorded during Pilbara survey[1]
Conchostraca											
	Caenestheriella packardi	1	3	1		5	19				Recorded during Pilbara survey[1]
	Limnadopsis nr. *Occidentalis*		4			2					Not recorded in Pilbara survey, but expected in survey area [7]
Copepoda											
	Mesocyclops brooksi	20	20	50	10	10	10	20	20	10	Recorded during Pilbara survey[1]
	Microcyclops varicans	20						20			Recorded during Pilbara survey[1]
	Thermocyclops decipiens	20				10	5			10	Recorded during Pilbara survey[1]
	Thermocyclops sp. B3		10	10							Probably a new species
	Eudiaptomus lumholtzi	300	50	500	10	10	100	50	100	100	Recorded during Pilbara survey[1]
Ostracoda											
	Candonocypris fitzroyi			8			3				Recorded during Pilbara survey[1]
	Cypretta seurati		2		15	1	40				Not recorded in Pilbara survey, but widespread in Pilbara groundwater[5]
	Cypretta sp. PSW032	3	8	2		7	10	40	10	20	Recorded during Pilbara survey[1]
	Cypricercus sp. 444 (CB)	100	6	2	5	1	5	500	40	50	Recorded during Pilbara survey[1]
	Ilyodromus viridulus	15	15	17	60	25	20	150	10	100	Recorded during Pilbara survey[1]
	Stenocypris major	2									Recorded during Pilbara survey[1]
	Strandesia sp. 466				20	4					Recorded during Pilbara survey[1]
	Newnhamia sp. BOS030	10			40	4	60				Recorded during Pilbara survey[1]
	Newnhamia fenestra		3								Recorded during Pilbara survey[1]
Insecta											
Coleoptera											
	Brentidae sp.					1					Recorded during Pilbara survey[1]
	Carabidae sp.	1			1			3		14	Recorded during Pilbara survey[1]
	Curculionidae sp.	1					1				Recorded during Pilbara survey[1]

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
	Allodessus bistrigatus	31	2	20	10	6	32	17	1	17	Recorded during Pilbara survey[1]
	Bidessini sp.		2								Recorded during Pilbara survey[1]
	Copelatus ater					1					Recorded during Pilbara survey[1]
	Copelatus nigrolineatus		1								Recorded during Pilbara survey[1]
	Cybister tripunctatus			1			1	4	4	2	Recorded during Pilbara survey[1]
	Eretes australis	5	12	7	4	9	13	50	1	2	Recorded during Pilbara survey[1]
	Hydaticus consanguineus	4				2				2	Recorded during Pilbara survey[1]
	Hydroglyphus grammopterus (=trilineatus)	65	7	5	1	14	15	9	1	26	Recorded during Pilbara survey[1]
	Hydroglyphus leai	1									Recorded during Pilbara survey[1]
	Hydroglyphus orthogrammus	3		20			4		1	5	Recorded during Pilbara survey[1]
	Hyphydrus elegans	1	1	10	1		5	7		5	Recorded during Pilbara survey[1]
	Hyphydrus lyratus	3	1	8	7	6	18	8	3	14	Recorded during Pilbara survey[1]
	Laccophilus clarki	3				1	2	2			Recorded during Pilbara survey[1]
	Laccophilus sharpi	41	5	18	14	2	9	50	13	25	Recorded during Pilbara survey[1]
	Limbodessus compactus	7	1					3			Recorded during Pilbara survey[1]
	Limbodessus shuckhardii	1									Inland WA but not recorded quite this far north[8]
	Megaporus howitti									2	Recorded during Pilbara survey[1]
	Necterosoma regulare						1				Recorded during Pilbara survey[1]
	Necterosoma wollastoni	5		6			1	23	3	5	Recorded during Pilbara survey[1]
	Rhantaticus congestus	2	7	14		5	16	8	3	2	Recorded during Pilbara survey[1]
	Rhantus suturalis							1	2		Not recorded in Pilbara survey, but occurs elsewhere – widespread[5]
	Sternopriscus sp.					1					Recorded during Pilbara survey[1]
	Tiporus lachlani		2	10				9		1	Probable Pilbara survey record[1]
	Dineutus australis	22	9	5	20	9	16	1	10	12	Recorded during Pilbara survey[1]
	Heteroceridae sp.						2			9	Recorded during Pilbara survey[1]
	Hydraena barbipes	14					23	21	2	18	Recorded during Pilbara survey[1]

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
	Hydraena luridipennis	3						10			Not recorded in Pilbara survey, but occurs elsewhere[5, 9]
	Hydraena nr. *rudallensis*	5			2			3			Recorded during Pilbara survey[1]
	Limnebius sp.				8		6	2			Recorded during Pilbara survey[1]
	Ochthebius sp.						1				Recorded during Pilbara survey[1]
	Hydrochus burdekinensis	1		1	5		3				Recorded during Pilbara survey[1]
	Hydrochus group 3									1	Recorded during Pilbara survey[1]
	Agraphydrus coomani					1	25			1	Patchily common in Pilbara and also across much of northern Australia[8]
	Berosus australiae									1	Recorded during Pilbara survey[1]
	Berosus nutans									1	Recorded during Pilbara survey[1]
	Berosus pulchellus	3		7			2	1		1	Recorded during Pilbara survey[1]
	Enochrus deserticola	28			1	1	8	1		7	Recorded during Pilbara survey[1]
	Enochrus elongatus	15	4		3		5			6	Recorded during Pilbara survey[1]
	Enochrus maculiceps							3			Recorded during Pilbara survey[1]
	Helochares tatei	1									Recorded during Pilbara survey[1]
	Hydrochus eurypleuron	1									Recorded during Pilbara survey[1]
	Hydrophilus brevispina		1						1		Recorded during Pilbara survey[1]
	Laccobius clarus			2							Not recorded in Pilbara survey, but occurs elsewhere[10]
	Laccobius matthewsi						1				Recorded during Pilbara survey[1]
	Paracymus pygmaeus	1					2				Recorded during Pilbara survey[1]
	Paracymus spenceri	1		3	2		3			2	Recorded during Pilbara survey[1]
	Paranacaena horni	1								1	Recorded during Pilbara survey[1]
	Regimbartia attenuata		1								Recorded during Pilbara survey[1]
	Sternolophus immarginatus					2	1				Recorded during Pilbara survey[1]
	Sternolophus marginicollis	1	4	1		2	2	6			Recorded during Pilbara survey[1]
	Sternolophus australis							11		1	Recorded during Pilbara survey[1]
	Unknown hydrophillid B1					2					Most likely the larva of *Agraphydrus coomani* (which is patchily common in

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
											Pilbara[8]
	Staphylinidae sp.	2		1	1					4	Recorded during Pilbara survey[1]
Diptera											
	Bezzia sp. P1 (PSW)	1	2	2	1	1	3			3	Recorded during Pilbara survey[1]
	Bezzia sp. P2 (PSW)	5		5	2		1			1	Recorded during Pilbara survey[1]
	Clinohelea sp.	1									Recorded during Pilbara survey[1]
	Culicoides sp.	50	5	1	4	8	42	6	1	2	Recorded during Pilbara survey[1]
	Dasyheleinae sp. P1 (PSW)				6						Recorded during Pilbara survey[1]
	Dasyheleinae sp. P2 (PSW)				1		1				Recorded during Pilbara survey[1]
	Lanatomyia sp.	2	1	14						8	Recorded during Pilbara survey[1]
	Monohelea sp.		6			1	2				Recorded during Pilbara survey[1]
	Nilobezzia sp.	25	7	18	50	2	18	19		15	Recorded during Pilbara survey[1]
	Chaoborus punctilliger			1							Recorded during Pilbara survey[1]
	Ablabesmyia hilli			5	1	5	1			6	Recorded during Pilbara survey[1]
	Ablabesmyia notabilis		11	5		5	7		5	2	Recorded during Pilbara survey[1]
	Chironomus aff. *alternans* (V24)		9			20	15				Recorded during Pilbara survey[1]
	Chironomus tepperi		1								Recorded during Pilbara survey[1]
	Cladotanytarsus sp.	10	1	2			5	20	10	40	Recorded during Pilbara survey[1]
	Coelopynia pruinosa						4				Recorded during Pilbara survey[1]
	Cryptochironomus griseidorsum	2								2	Recorded during Pilbara survey[1]
	Dicrotendipes 'CA1' Pilbara type 1 (was lindae) (PSW)			2	20						Recorded during Pilbara survey[1]
	Dicrotendipes 'CA1' Pilbara type 2 (PSW)		2			1					Recorded during Pilbara survey[1]
	Dicrotendipes 'CA1' Pilbara type 3 (= 'K4', P3) (PSW)	4		3	5					2	Recorded during Pilbara survey[1]
	Dicrotendipes jobetus		2	1			2			2	Recorded during Pilbara survey[1]
	Djalmabatista sp.							1			Recorded during Pilbara survey[1]
	Kiefferulus intertinctus	6	1	20	30			5			Recorded during Pilbara survey[1]

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
	Larsia albiceps	10	16	30	40	6	15	30	3	13	Recorded during Pilbara survey[1]
	Microchironomus sp. P1			5							Recorded during Pilbara survey[1]
	Parachironomus 'K1' (PSW)	1							2	2	Recorded during Pilbara survey[1]
	Parachironomus 'K2' (PSW)		1	5							Recorded during Pilbara survey[1]
	Paramerina sp. A (*parva*?)	10	3	5		1	1	2		13	Recorded during Pilbara survey[1]
	Pentaneurini sp. P1					1					Recorded during Pilbara survey[1]
	Polypedilum leei	4			30			5		8	Recorded during Pilbara survey[1]
	Polypedilum nr. convexum (PSW)			2	5					1	Recorded during Pilbara survey[1]
	Polypedilum nubifer		1		1						Recorded during Pilbara survey[1]
	Polypedilum sp. K1 (PSW)	4				4					Recorded during Pilbara survey[1]
	Polypedilum sp. S1 (PSW)						20	1			Recorded during Pilbara survey[1]
	Procladius paludicola	10	11	6	6	10	20	20	3	5	Recorded during Pilbara survey[1]
	Procladius Pilbara sp. 1 (PSW)	1		2	1		1				Recorded during Pilbara survey[1]
	Skusella/"V12 ex-WA" (Cranston)	3	7	50		2	51	2	2	16	Not recorded in Pilbara survey but known elsewhere[12]
	Stenochironomus sp. B1				12		3				Poor taxonomy status unclear
	Stenochironomus sp. B2	1		1				1		1	Poor taxonomy status unclear
	Tanytarsus 'K12' (PSW)	15		5	10		10	30	5	10	Recorded during Pilbara survey[1]
	Tanytarsus sp. P01 (PSW)				5		5				Recorded during Pilbara survey[1]
	Tanytarsus sp. P05 (PSW)		10	5					1	5	Recorded during Pilbara survey[1]
	Tanytarsus sp. P07 (PSW)					20	5			5	Recorded during Pilbara survey[1]
	Tanytarsus sp. P09 (PSW)	5	9	5	10	20	5			18	Recorded during Pilbara survey[1]
	Unknown *Chironomini* genus K2			1			10			4	Recorded during Pilbara survey[1]
	Xenochironomus sp. B1						10				Probable Pilbara survey record[1]
	Aedes pseudonormanensis					6			2		Recorded during Pilbara survey[1]
	Culex (Culex) annulirostris		12								Recorded during Pilbara survey[1]
	Culex palpalis						1				Recorded during Pilbara survey[1]
	Culex starkae	2									Recorded during Pilbara survey[1]
	Dolichopodidae sp.	1				1					Recorded during Pilbara survey[1]

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
	Ephydridae sp. 13 (PSW) (=SAP sp. 4 - check)		1								Recorded during Pilbara survey[1]
	Muscidae nr. sp. D				4						Poor taxonomy status unclear
	Muscidae sp. B1					1					Poor taxonomy status unclear
	Muscidae sp. P1	1									Recorded during Pilbara survey[1]
	Stratiomyidae sp.						1				Recorded during Pilbara survey[1]
	Syrphidae sp.		1			2					Recorded during Pilbara survey[1]
	Tabanidae sp.		1	2		2	5			1	Recorded during Pilbara survey[1]
	Tipulidae type E	1						1			Recorded during Pilbara survey[1]
	Tipulidae type I					1					Probable Pilbara survey record[1]
	Tipulidae type P1 (PSW)					12	6				Recorded during Pilbara survey[1]
	Tipulidae type P3 (nr. SAP type D)	7				8	3	1		17	Recorded during Pilbara survey[1]
Ephemeroptera											
	Cloeon sp.	8	19	20	1	10	5	3	10	9	Recorded during Pilbara survey[1]
	Tasmanocoenis arcuata			1	8		10			5	Recorded during Pilbara survey[1]
	Tasmanocoenis sp. M (PSW)					5	40				Recorded during Pilbara survey[1]
	Tasmanocoenis sp. P (PSW)			17							Recorded during Pilbara survey[1]
Hemiptera											
	Lethocerus distinctifemur					2	1				Recorded during Pilbara survey[1]
	Agraptocorixa eurynome	1						1	3		Recorded during Pilbara survey[1]
	Agraptocorixa parvipunctata	4				1	40	13		6	Recorded during Pilbara survey[1]
	Micronecta annae annae									2	Recorded during Pilbara survey[1]
	Micronecta annae illiesi						6	1		10	Recorded during Pilbara survey[1]
	Micronecta gracilis	4		2		2	35	5	1		Recorded during Pilbara survey[1]
	Micronecta lansburyi	55	8	35	1		1	30		3	Recorded during Pilbara survey[1]
	Micronecta n. sp. P2 (PSW)			6			1				Recorded during Pilbara survey[1]
	Nerthra sp.		1			1	6				Recorded during Pilbara survey[1]
	Limnogonus fossarum gilguy		3	6		1	1				Recorded during Pilbara survey[1]
	Hebrus axillaris							1			Recorded during Pilbara survey[1]

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
	Laccotrephes tristis	2	1	1					7	3	Recorded during Pilbara survey[1]
	Ranatra dispar			1							Not recorded in Pilbara survey, but occurs elsewhere[5, 12]
	Anisops canaliculatus			1							Recorded during Pilbara survey[1]
	Anisops deanei	1									Not recorded in Pilbara survey, but occurs elsewhere[11]
	Anisops elstoni							3		2	Recorded during Pilbara survey[1]
	Anisops gratus	2		1			1				Recorded during Pilbara survey[1]
	Anisops hackeri	4		1	1		46			2	Recorded during Pilbara survey[1]
	Anisops nabillus	3		5	3						Recorded during Pilbara survey[1]
	Anisops nasuta	30	6		6		4	3		2	Recorded during Pilbara survey[1]
	Anisops occipitalis					1		1			Recorded during Pilbara survey[1]
	Anisops paraexigerus				4		3			1	Recorded during Pilbara survey[1]
	Anisops semitus	1									Not recorded in Pilbara survey, but occurs elsewhere[5, 11]
	Anisops stali	27	8	15	9		26	17	1	4	Recorded during Pilbara survey[1]
	Anisops thienemanni		2	2							Recorded during Pilbara survey[1]
	Enithares woodwardi	2	2				1	1		2	Recorded during Pilbara survey[1]
	Paraplea n. sp. (ANIC 6)	1		1				1			Recorded during Pilbara survey[1]
	Microvelia (Austromicrovelia) peramoena	1			1			2			Recorded during Pilbara survey[1]
Lepidoptera											
	Lepidoptera sp.					1					Recorded during Pilbara survey[1]
Odonata											
	Hemianax papuensis	12	1		5			3	1	2	Recorded during Pilbara survey[1]
	Ischnura aurora aurora	6			1		1	3			Recorded during Pilbara survey[1]
	Ischnura heterosticta heterosticta									8	Recorded during Pilbara survey[1]
	Xanthagrion erythroneurum	1			6		8				Recorded during Pilbara survey[1]
	Hemicordulia tau			4	1	2	6				Recorded during Pilbara survey[1]
	Eurysticta coolawanyah						6				Recorded during Pilbara survey[1]

Higher taxonomic groups	Lowest level of identification	DUCK POOL			PINBI POO			Rock Poo			Distribution
		June	Nov.	Dec.	June	Nov.	Dec.	June	Nov.	Dec.	
	Austrolestes analis				1	2	2		2		Recorded during Pilbara survey[1]
	Diplacodes haematodes	2	5	9	41	10	31	7		1	Recorded during Pilbara survey[1]
	Orthetrum caledonicum	24	6	23	10	1	11	18	2	15	Recorded during Pilbara survey[1]
	Traema stenoloba	1	2		6		3		3	11	Probable Pilbara survey record
	Ictinogomphus dobsoni	1									Recorded during Pilbara survey[1]
Trichoptera											
	Ecnomus pilbarensis	61	12	11	24		8	23	5	27	Recorded during Pilbara survey[1]
	Orthotrichia sp.							1			Recorded during Pilbara survey[1]
	Oecetis sp. Pilbara 1 (PSW)	4	2	12	1						Recorded during Pilbara survey[1]
	Oecetis sp. Pilbara 5 (PSW)	2		3	2	8	1			6	Recorded during Pilbara survey[1]
	Triaenodes sp. P1 (PSW)	2									Recorded during Pilbara survey[1]
	Triplectides australis		1	8	1	21	21		8	16	Recorded during Pilbara survey[1]
	Triplectides ciuskus seductus	34						6			Recorded during Pilbara survey[1]
	Totals	**2034**	**482**	**3819**	**2816**	**435**	**2737**	**3643**	**341**	**4058**	

1 Pinder *et al.* 2010, 2 Koste and Shiel 1990, 3 Brian Timms pers. comm., 4 Griggs *et al*. 1999, 5 Bennelongia unpublished data, 6 Smirnov and Timms 1983, 7 Timms 2009, 8 Chris Watts pers. comm, 9 Macleay 1871, 10 Gentili 1981, 11 Brooks 1951, 12. Montandon 1903, 13 Cranston 2000.

Appendix B. Higher order specimen identifications.

Higher taxonomic groups	Lowest level of identification	DUCK POOL			DUCK POOL Total	PINBI POO			PINBI POOL Total	Rock Poo			Rock Pool Total	Grand Total
		June	Nov.	Dec.		June	Nov.	Dec.		June	Nov.	Dec.		
Rotifera														
	Flosculariacea													
	Hexarthra sp.	100			100									100
	Ploimida													
	Trichocerca sp.							1	1					1
Arachnida														
	Acariformes													

Higher taxonomic groups	Lowest level of identification	DUCK POOL June	DUCK POOL Nov.	DUCK POOL Dec.	DUCK POOL Total	PINBI POO June	PINBI POO Nov.	PINBI POO Dec.	PINBI POOL Total	Rock Poo June	Rock Poo Nov.	Rock Poo Dec.	Rock Pool Total	Grand Total
	Arrenurus sp.			1	1			1	1					2
	Hydrachna sp.		2	2	4			3	3	4	1	2	7	14
Insecta														
Coleoptera														
	Berosus sp.		1		1		1	1	2					3
	Cybister sp.						3		3					3
	Enochrus sp.		3		3			1	1					4
	Hydraena sp.					1	5		6					6
	Hydrophilus sp.						1		1					1
	Hyphydrus sp.	6	13	5	24		5	12	17		3	4	7	48
	Laccophilus sp.		2	1	3		1	5	6		1	1	2	11
	Necterosoma sp.	2	1		3	3			3	1			1	7
	Paracymus sp.		1		1		1	1	2					3
	Sternolophus sp.			1	1		2		2					3
	Tiporus sp.		1	7	8		1	4	5		1		1	14
Hemiptera														
	Agraptocorixa sp.		3	2	5	1			1					6
	Anisops sp.	30	11	30	71	26	2	49	77		3	3	6	154
	Enithares sp.			1	1	3			3		3		3	7
	Hebrus sp.						1		1					1
	Micronecta sp.					1			1					1
	Microvelia sp.							2	2					2

Numbers in grey represent specimens that were not included in the species count for that sample (column)

Appendix C. Laboratory chemical analysis of water samples.

	Duck Pool		Pinbi Pool		Rock Pool		
Analyte	June 2011 [1]	Nov 2011	June 2011	Nov 2011	June 2011	Nov 2011	**Units**
Total Dissolved Solids	14	22	46	55	60	16	mg/L
Electrical conductivity	3.5	3.9	8.9	9.9	13.4	3.3	mS/m
pH	6.3	6.4	7.5	6.9	6.8	6.5	
Turbidity	0.8	6.7	1.1	5.2	3.8	7.5	NTU
Colour	22	48	10	43	10	27	TCU
Anions							
Na	1	1	6.6	6.7	4	0.8	mg/L
K	1.7	4.6	3.3	5	2.1	3.5	mg/L
Ca	2.4	1.7	5	3.5	4.4	1.9	mg/L
Mg	0.9	1	2.3	2.3	0.8	0.7	mg/L
Cations							
Cl	1	3	6	9	8	2	mg/L
HCO_3	31	13	31	32	12	11	mg/L
CO_3	<1	<1	<1	<1	<1	<1	mg/L
SO_4	0.7	0.9	3.4	3.3	4.5	0.9	mg/L
Nutrients							
Total P	0.02	<0.01	0.01	<0.01	0.02	<0.01	mg/L
Total N	0.25	0.59	0.28	0.55	0.39	0.6	mg/L
N_NOx	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/L
N_NH_3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	mg/L

1 Ions do not balance and HCO_3 concentration appears too high. Analyses repeated with same result.