Wetland biodiversity patterning along the middle to upper Fortescue valley (Pilbara: Western Australia) to inform conservation planning

Pilbara Corridors Project

Adrian Pinder[1], Michael Lyons[1], Margaret Collins[1], Loretta Lewis[1], Kirsty Quinlan[1], Russell Shiel[2], Rebecca Coppen[1], Faye Thompson[1]

1, Department of Biodiversity, Conservation and Attractions
2, Ecology and Environmental Science, University of Adelaide

Wetlands Conservation Program
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Department of Biodiversity, Conservation and Attractions
GOVERNMENT OF WESTERN AUSTRALIA
Australian Government
National Landcare Programme
pilbara corridors

Department of Biodiversity, Conservation and Attractions
Locked Bag 104
Bentley Delivery Centre WA 6983
Phone: (08) 9219 9000
Fax: (08) 9334 0498

www.dbca.wa.gov.au

Questions regarding the use of this material should be directed to:

Program Leader
Wetlands Conservation Program
Department of Biodiversity, Conservation and Attractions
Locked Bag 104
Bentley Delivery Centre WA 6983
Phone: 9219 9868
Email: adrian.pinder@dbca.wa.gov.au

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Cover photos (clockwise from top left): Cracking clay at a claypan south of Perkililly Dam on Roy Hill Station which would contain drought resistant eggs of aquatic invertebrates; an un-named claypan on Ethel Creek Station (site FV25); *Peplidium* sp. C (Evol. Fl. Fauna Arid Aust., N.T. Burbidge & A. Kanis 8158); *Tecticornia verrucosa*; a clam shrimp *Eocyzicus argilaquus*; a freshwater sponge (Spongillida) from Jinerabar Pool (Jimblebar Creek).

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Bart Huntley (DBCA GIS Branch) undertook the analyses of wetland inundation using Landsat data (Appendix 1). Ricky van Dongen (also from the GIS Branch) provided Landsat imagery showing wetland inundation for field work planning.

Contents

Appendices

1 Summary

- Within the Pilbara, the middle to upper Fortescue Valley (upstream and downstream of Fortescue Marsh) has an especially high number and diversity of floodplain wetlands. These types of wetlands support distinct flora and fauna communities, but are poorly represented in the region's formal conservation estate, so off-reserve management of the biodiversity values of these wetlands is important. Wetlands of this area have been identified as priority assets in several planning processes and listings, but there is relatively little information on their biological values and how these are distributed along the valley.
- To address this, a survey of wetland biodiversity (aquatic invertebrates and riparian flora) was undertaken in this part of the Fortescue catchment to inform wetland management on pastoral lands. Forty seven wetland sites were sampled on Mount Florence, Mulga Downs, Roy Hill, Ethel Creek and Balfour Downs stations between 2015 and 2017. The survey was part of the Pilbara Corridors Project, which is a collaboration between Rangelands Natural Resource Management WA, Greening Australia and Department of Biodiversity, Conservation and Attractions and aimed to *"describe geographic patterning of wetland biodiversity along the middle reaches of the Fortescue valley to inform spatially efficient planning of wetland management".*
- Data from this project were combined with data from the same area collected for the Pilbara Biological Survey (PBS) and analyses undertaken to describe the distribution of the flora and fauna across the study area in relation to the occurrence of wetland habitats. For this project, 47 samples of aquatic invertebrates were collected from 39 sites and 51 flora quadrats were scored at 45 sites.
- Across all wetlands sampled (and across this project and the PBS) we collected 590 aquatic invertebrate taxa, representing up to about half of the broader Pilbara aquatic invertebrate fauna. These include a wide range of species that are strongly adapted to living in intermittently inundated wetlands and/or turbid waters, especially some crustacean groups such as clam shrimps, fairy shrimps and some ostracods. About 80 species may be more common in the study area than elsewhere in the Pilbara, including ten species collected for the first time in this project. These species are more common in the larger claypans on Mulga Downs Station plus claypans on the Jigalong/Fortescue floodplain upstream of Fortescue Marsh. Invertebrate community composition varied across the study area and was associated with sediment composition, position on the floodplain, water quality (turbidity, ionic composition and salinity) and season. Analysis indicated that wetlands on Mount Florence, Mulga Downs, Fortescue Marsh, Roy Hill south of Fortescue Marsh (small ephemeral pans) and the Jigalong/Fortescue floodplain tended to support different combinations of species.
- For the wetlands in the current study and sites within the study area sampled in the PBS, 284 riparian plant species were recorded. This represents about 60% of the flora recorded in quadrat based studies for wetlands across the Pilbara region as a whole. The flora includes species structurally dominant in a wide variety of Pilbara wetlands (e.g *Eucalyptus victrix)* along with a diverse array of grasses and herbaceous taxa that occur in damp riparian margins. Several of these have restricted occurrences or disjunct distributions elsewhere in Australia. This unique element of the Fortescue valley flora is overwhelmingly concentrated in the non-riverine wetlands. Riparian flora composition was related to wetland categories (riverine/non-riverine), geographic location, and landscape geomorphological and inferred hydrological attributes. Spatial patterning was limited in the rivers with the claypans and floodplain wetlands showing the greatest turnover in plant biodiversity. Broad geographic areas capturing differing

non-riverine riparian communities included the Fortescue Marsh, the Jigalong Fortescue floodplain, Roy Hill south of Fortescue Marsh (small ephemeral pans), the *Eriachne* grasslands and floodplain wetlands of Mulga Downs, and the large morphologically complex claypans of Mulga Downs, plus Coondiner Pool.

- Key aspects of the distribution of wetland flora and fauna revealed during this project, and knowledge of wetland ecology and conservation more generally, were used to derive a number of principals to guide the geographic spread of wetland management programs. These included:

  - For maximum effectiveness, conservation programs should be distributed across the four main regions sampled (Mount Florence, Mulga Downs, Roy Hill south of Fortescue Marsh and the upper Jigalong/Fortescue Creek floodplain). Of these, the priority should be a focus on claypans on Mulga Downs and on the Jigalong/Fortescue floodplain, plus Coondiner Pool.
  - Floodplain wetlands form interconnected metacommunities. Managing suites of interconnected wetlands would be more effective and efficient than focussing on multiple individual wetlands.
  - The larger claypans on Mulga Downs, claypans on Ethel Creek and Balfour Downs, Coondiner Pool and Fortescue Marsh tended to have the highest number of rarer and potentially restricted species of invertebrate and flora.
  - The larger and more morphologically diverse claypans, especially those on Mulga Downs, such as Mungthannannie and Mulga Downs Outcamp claypan, have complexes of different wetland habitats on their periphery, which, taken together, support more species than smaller simpler wetlands. These wetlands also tend to support greater numbers and diversity of waterbirds. Representation of these in wetland management programs will be important.
  - Plant and invertebrate communities in and along river channels differ from those of the associated floodplain wetlands so management plans should include both and consider the critical ecological linkages between rivers and their floodplain.
  - Management of stock numbers around wetlands is particularly important when the landscape is drying as cattle will concentrate (and impacts intensify) on the declining number of wetlands retaining water. Larger river pools are particularly vulnerable in this respect.

2 Introduction

2.1 Background to project

In the Pilbara region, the middle to upper Fortescue Valley is distinguished by extensive floodplains, a large salt marsh, anabranching river channels and a large number and diversity of non-riverine wetlands. A survey of biodiversity across the Pilbara (McKenzie *et al.*, 2009) indicated that this area has wetland and terrestrial biodiversity values that are distinct from most of the rest of the Pilbara but poorly represented in the formal conservation estate (Gibson *et al.*, 2015). Four of the five large reserves in the Pilbara (Karijini National Park, Mungaroona Range Nature Reserve, Millstream National Park and Meentheena Conservation Park) primarily represent upland landscapes (albeit with some significant rivers) and the fifth (Cane River Conservation Park) has very few non-riverine wetlands. Most of Fortescue Marsh and its fringe are now managed primarily for conservation after being excised from pastoral leases, but this does not extend to the floodplains upstream and downstream of the marsh that are the focus of this study. Even counting the Fortescue Marsh Planning Area as an informal part of the conservation estate, Gibson *et al.* (2015) showed that aquatic habitats in the rest of the Fortescue Valley remain poorly represented in the reserve system. In the absence of formal protection for these areas, off reserve management can make an important contribution to maintaining their biodiversity values.

The broader Fortescue Marsh environs was identified as a priority Pilbara asset for investment by Rangelands NRM WA following a workshop in 2012. Subsequently, 'Claypans', 'Fortescue Marsh' and 'Rivers, Creeks and Associated Floodplains on Open Plains' were listed as regional assets in the Conservation Action Plan for the Pilbara (Heydenrych *et al.*, 2015). Similarly, the 'alluvial plains, saltmarsh and seasonal wetlands and river systems of the Fortescue valley' were highlighted as important biodiversity assets in the Pilbara Conservation Strategy (Government of Western Australia, 2017), with management of stock and feral animals identified as a priority management action. The importance of the Fortescue Marsh environs was further highlighted by the Western Australian Environmental Protection Authority's (2013) report titled 'Environmental and Water Assessments Relating to Mining and Mining-related Activities in the Fortescue Marsh Management Area'. This report noted the need to undertake further surveys of aquatic communities inhabiting claypans of some of the land classes in the marsh environs.

The Pilbara Biological Survey included enough Fortescue valley wetlands to highlight the importance of this area in a regional context, but sampling intensity was not sufficient to provide information for more detailed catchment scale planning. This report describes a smaller but more intensive survey designed to:

> *Describe geographic patterning of wetland biodiversity along the middle reaches of the Fortescue valley to inform spatially efficient planning of wetland management.*

This project was funded under the Pilbara Corridors Project, a collaboration between Rangelands NRM, Greening Australia and Department of Biodiversity, Conservation and Attractions, with support from the Australian Government's National Landcare Programme. This overarching project aims to "control invasive pests and weeds and protect endemic fauna and flora by applying shared knowledge and best practice through disciplined landscape scale activities" in the Fortescue Valley.

This wetland survey project commenced in early 2015 and was initially scoped to survey flora and fauna of wetlands on Mulga Downs Station west of Fortescue Marsh. In early 2016 the project was expanded to cover a much larger area, from river pools on Mount Florence Station in the west to claypans within Balfour Downs Station in the east. The study area is thus the Fortescue Valley floors between Mount Florence and Balfour Downs stations, excluding the slopes of the Hamersley and Chichester ranges.

In this report, sites sampled for the current project have an 'FV' prefix whereas those sampled for the Pilbara Biological Survey (sometimes referred to herein as the PBS) by Pinder *et al.* (2010) and Lyons *et al.* (2015) have a 'P' prefix. Herein, the term Fortescue Valley refers to the study area between Mount Florence and Balfour Downs Stations straddling the Lower and Upper Fortescue Catchments.

2.2 Fortescue valley

2.2.1 Setting

The Fortescue valley contains two consecutive Fortescue Rivers; the Upper Fortescue terminating at Fortescue Marsh and the Lower Fortescue starting from below the marsh and discharging to the ocean near Karratha (see Section 2.2.4 Hydrology). The distinctive substrates and vegetation of the valley has led to the dual catchment being recognised as a biogeographic subregion (within the Pilbara Region) in the Interim Biogeographic Regionalisation of Australia

(Australian Government, 2004). This project straddles both rivers, focussing on the extensive areas of floodplain wetlands, extending from the Fortescue/Jigalong floodplain on Ethel Creek and Balfour Downs Stations through to where the Lower Fortescue starts to form well-defined channels on Mount Florence Station. This area has the largest concentration and diversity of non-riverine wetlands in the Pilbara, so is likely to be the most effective place to conserve biota associated with such wetlands. The coast and hinterland south of Onslow also has many non-riverine wetlands but this area has not been well surveyed and the wetlands appear to be of a different hydrological and geomorphic character, more uniform and more likely support a biota with affinities to the Carnarvon Basin (Gibson *et al.*, 2000; Halse *et al.*, 2000). Elsewhere in the Pilbara, there are other smaller concentrations of non-riverine wetlands, including areas of the lower De Grey River, parts of the Roebourne Plains (e.g. Karratha and Croyden Stations) and the headwaters of Duck Creek on Hamersley Station.

2.2.2 Land systems and soils

The Fortescue Valley floors consist of variable fine alluvial/lacustrine sediments, interspersed with patches of calcrete plateaus and rockier hills and fringed by coarser colluvial elements on the fringes derived from the surrounding uplands. Several land systems comprise the valley floors (sensu van Vreeswyk *et al.* (2004) (Figure 1 and

Table 1). Eighty percent of the sites sampled for this project occurred on the Coolibah Land System which runs from Ethel Creek and balfour Downs stations through to Mount Florence, broken only by the Fortescue Marsh (Marsh Land System) and an occurrence of the Brockman Land System around the Roebourne-Wittenoom Road (with site FV39). The Coolibah Land System is described as primarily 'floodplains with weakly gilgaied clay soils and alluvial plains'. Two Mulga Downs sites lie on peripheral and variably coarser, but still largely alluvial, soils of the Hooley (site FV38) and Christmas (FV9) land systems and Jinerabar Pool (FV27) is on the alluvial Fortescue Land System on Ethel Creek Station. Coondiner Pool (FV34=P1) lies on gravelly/stony plains of the Marillana/Adrian Land Systems while the nearby Roy Hill claypans south-east of the marsh lie on either a sandplain (Divide Land System, sites FV36=P39 and FV33) or alluvial washplains (Narbung Land System, site FV35). The beds of the wetlands and, to some extent, the riparian zones have their own lacustrine or riverine sediments; mostly clay to sand dominated or (in some Mount Florence Pools) with coarser components, but derived from the local and catchment setting (see Appendices 5 and 6).

Soils in the east (Ethel Creek, Balfour Downs, eastern extent of Roy Hill) are primarily calcarosols and vertosols (McFarlane *et al.*, 2015b). In the Australian Soils Classification (Bureau of Rural Sciences, 2009) these areas are types Lb12 (valley flats along major drainage lines, associated with limestone and calcareous gravels) and MM16 (primarily alluvial plains dominated by deep cracking clays) respectively. Soils on Mulga Downs and Mount Florence valley floors are kandosols or sodosols (eastern Mulga Downs) with smaller areas of calcarosols (McFarlane *et al.*, 2015a). Bureau of Rural Sciences (2009) describe these soils as Ja1 (extensive valley plains largely associated with the Fortescue River and chiefly earthy clays), Oc71 (outwash plains with much coarse surface gravel and primarily hard alkaline red soils) and Lb12 (see above) respectively. The Roy Hill claypans around the Roy-Hill-Munjina Road also lie on Oc71 soils, while the area around Coondiner Pool are type Mz25 (plains associated with the Fortescue valley with acid red earths and a cover of stony gravels close to the ranges and hills).

2.2.3 Climate

Rainfall patterns in the region derive from the dominant influence of summer (December-February) rainfall associated with cyclonic and thunderstorm events, with a lesser influence of winter cold fronts from southern latitudes that deliver precipitation concentrated in a broad coastal area that attenuates inland. Within the study area, summer rainfall contributes ca. 55% of total average annual rainfall, with late 'wet season' (autumn; March-May) falls contributing a further 30% (Leighton, 2004). Winter rainfall events (June-August) add a little over 10 % of annual rainfall across the study area, with only an additional ca. 5% occurring during spring (September – November) (Leighton, 2004). Summer rainfall in particular is highly variable, both spatially and inter-annually. Cyclones can contribute up to 50% of annual rainfall but it is largely restricted to each system's path. Summer convective thunderstorm activity can be similarly intense and very highly localised. Later in the wet season, rain bearing depressions can generate significant rainfall that is more widespread (Leighton, 2004). Notwithstanding the variability in the region's year to year rainfall, long term average annual rainfall in the study area ranges from 340mm at Mt Florence in the west to 327 mm at Newman aerodrome (SE of the study area).

Long term monthly average temperature data (using Wittenoom and Newman BOM data respectively) shows maximum temperatures occur in December and January (38-39.5°C) and the coolest period occurs in July (22-24 °C). Minimum temperatures range from an average of 26-25°C in December to 8-11.4°C in July.

2.2.4 Hydrology

Above the permanent pools of Millstream National Park the Fortescue River flows episodically following heavy rains, so that most of the time surface water is only present in isolated pools, some of which are semi-permanent (rarely dry completely) to permanent. Non-riverine wetlands in the valley are filled intermittently, from local runoff or from overbank flows from the Fortescue River and tributaries. The Upper Fortescue River arises on the far south-eastern slopes of the Hamersley Ranges, curving north-east around the ranges past the town of Newman and feeding into Ophthalmia Dam. Below Ophthalmia the Fortescue is well defined but becomes increasingly braided as it joins Jimblebar Creek and then Jigalong Creek to form an extensive north-westerly tending floodplain with anabranching channels, semi-isolated ox-bow wetlands and numerous interconnected claypans on Ethel Creek Station, west of Balfour Downs Station and east of Roy Hill Station. The system continues to be braided, joining other creeks (e.g. Kondy Creek, Kulkinbah Creek) as it flows west towards Fortescue Marsh. Before entering the marsh, it forms a series of large deep pools (Yunera, 8 Mile, 14 Mile and Moorimoordinina Pools). Fortescue Marsh is the terminus of the Upper Fortescue River, with the Goodiadarri Hills preventing surface flows downstream, although there is believed to be some groundwater flows from the western end of the marsh (Skrzypek *et al.*, 2016). To the south-east of the marsh, on Roy Hill Station, there are numerous wetlands, primarily claypans, fed by local runoff and flows off the northern slopes of the Hamersley Ranges. Significant amongst these is Coondiner Pool on Coondiner Creek which holds water for longer than most wetlands in this area and overflows towards the marsh. Downstream of the Goodiadarri Hills the Fortescue River starts as a new catchment, receiving intermittent flows from streams running off the Chichester and Hamersley Ranges and from elevated areas within the valley. These feed broad floodplains on Mulga Downs Station containing numerous claypans (some quite large) and semi-connected shallow drainage lines rather than well-defined continuous channels with pools. The Fortescue River does not form distinct continuous channels until about 90km downstream of the marsh on Mount Florence Station. Even then the river consists of braided channels until Millstream National Park.

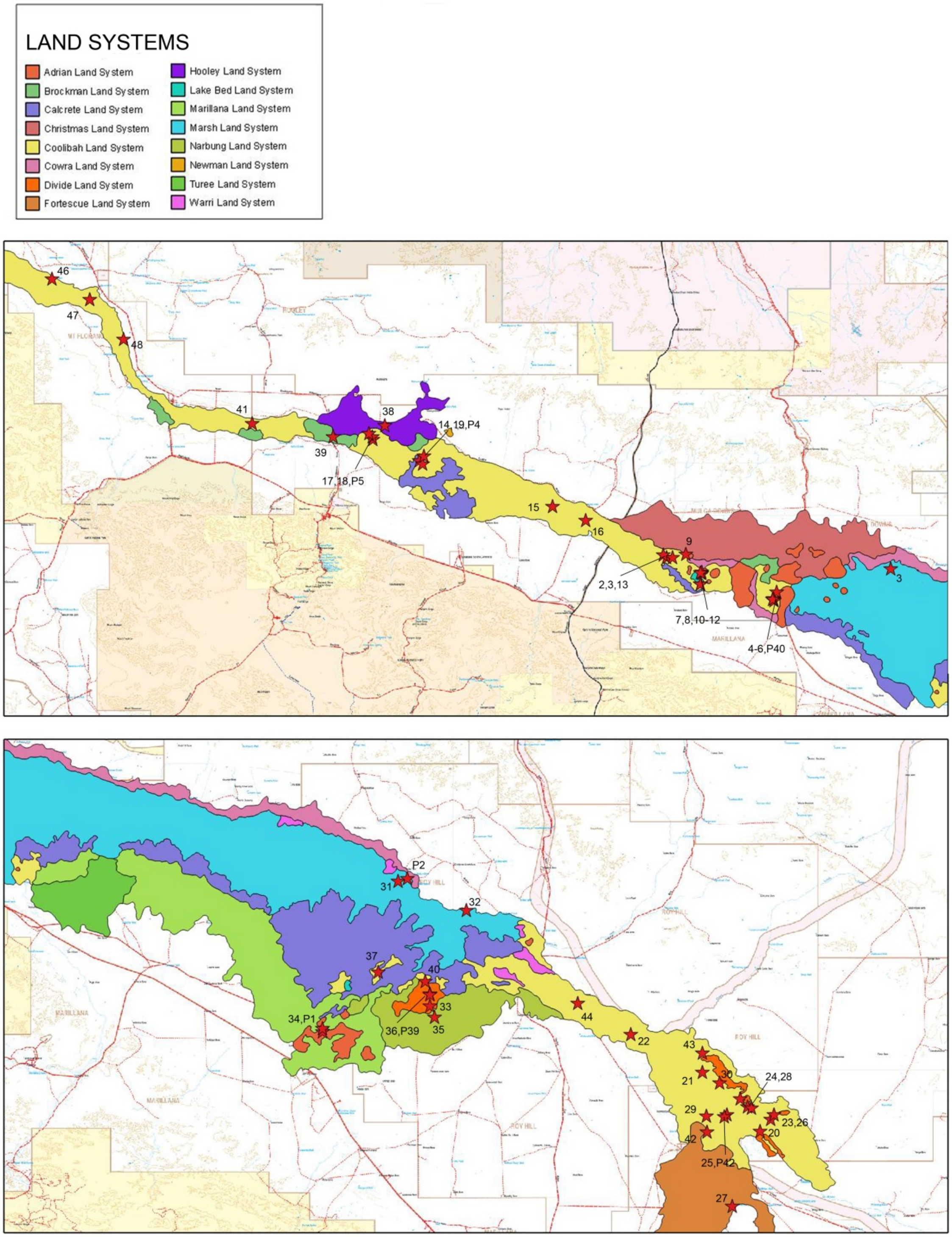

Figure 1. Map showing occurrence of sampled sites (red stars) in relation to land systems (van Vreeswyk *et al.* 2004) along the lower elevation parts of the Fortescue valley study area.

Table 1. Land system context for the wetlands sampled for this project. Text from van Vreeswyk *et al.* (2004).

Land System	General description	Geomorphology	Relevant sites
Adrian/Marillana	**Adrian**: Stony plains and low silcrete hills supporting hard spinifex grasslands **Marillana**: Gravelly plains with large drainage foci and unchannelled drainage tracts supporting snakewood shrublands and grassy mulga shrublands	**Adrian**: Erosional surfaces; low rounded hills and rises, gently undulating to almost level stony plains, and short drainage lines with radial patterns away from hills. Relief up to 40 m but usually much less. **Marillana**: Depositional surfaces; level plains with dense surface mantles of ironstone gravel, subject to sheet flow; broad, usually unchannelled drainage tracts receiving more concentrated through flow, drainage foci and groves with clay soils; no channelled drainage patterns	FV34, P1 (Coondiner Pool which straddles these land systems)
Brockman	Alluvial plains with cracking clay soils supporting tussock grasslands	Depositional surfaces; level, non-saline alluvial plains with clay soils and gilgai microrelief and flanked by slightly more elevated hardpan wash plains, sluggish internal drainage zones on plains and occasional through going trunk channels	FV39
Christmas	Stony alluvial plains supporting snakewood and mulga shrublands with sparse tussock grasses	Depositional surfaces; level to gently inclined stony plains subject to sheet flow with numerous small, diffuse drainage foci and groves, stony clay plains with gilgai microrelief; sparse or rare drainage tracts with tributary, distributary and reticulated channels	FV9 near boundary with Coolibah Land System
Coolibah	Flood plains with weakly gilgaied clay soils supporting coolibah woodlands with tussock grass understorey	Depositional surfaces; active flood plains and alluvial plains with shallow, meandering and anastomosing central channels of the Fortescue River	All other sites
Divide	Sandplains and occasional dunes supporting shrubby hard spinifex grasslands	Depositional surfaces; level to gently undulating sandplain with occasional linear dunes and plains with thin sand cover, very little organised drainage but some tracts receiving run-on from adjacent more elevated systems, these tracts mostly unchannelled but locally with sandy channels. Relief up to 20 m	FV33, FV36=P39, FV40
Fortescue	Alluvial plains and flood plains supporting patchy grassy woodlands and shrublands and tussock grasslands	Depositional surfaces; alluvial plains, active flood plains and depressions with minor levees and major river channels	FV27
Hooley	Alluvial clay plains supporting a mosaic of snakewood shrublands and tussock grasslands	Depositional surfaces; level plains of clayey and stony alluvium as a mosaic of surfaces with gilgai microrelief, sometimes stony, and non-gilgaied surfaces with abundant stony mantles; tracts with major through going channelsmostly sluggish internal drainage but occasional drainage	FV38
Marsh	Lakebeds and flood plains subject to regular inundation, supporting samphire shrublands, salt water couch grasslands and halophytic shrublands	Depositional surfaces; lake beds and saline peripheral flood plains forming a termination basin for the upper reaches of the Fortescue River	FV31, FV32, P2 and P3
Narbung	Alluvial washplains with prominent internal drainage foci supporting snakewood and mulga shrublands with halophytic low shrubs	Depositional surfaces; almost level alluvial plains receiving overland sheet flow, minor sand patches and sandy banks; no defined channelled drainage features but internal drainage zones with prominent drainage foci, groves and small claypans	FV35

Connectivity between floodplain wetlands is fundamental to their ecology and a key determinant of spatial and temporal patterning of biodiversity (Casanova *et al.*, 2000; Amoros *et al.*, 2002; Sheldon *et al.*, 2002; Hermoso *et al.*, 2012; Bishop-Taylor *et al.*, 2017). Figure 2, Figure 3 and Figure 7 show examples of the degrees of connectivity between wetlands on Mulga Downs Station. Figure 2 shows flows entering the Gnalka Gnoona and Koodjeepindarranna wetland systems from the slopes of the Chichester Ranges and a connection between these wetlands in March 2003. These systems normally connect during large fill events. The extension of inundation upstream of Gnalka Gnoona (B in Figure 2) is probably overflow from Gnalka Gnoona rather than flows from the valley upstream, though such flows would occur. Figure 3 shows inundation of Mungthannannie Claypan and the *Eriachne* floodplain to its west (with Chaddellinna Pool, site FV2) during the same filling event (March 2003). Both wetland areas had presumably also filled from flows off the Chichester Ranges (plus direct rainfall) and there are drainages into Mungthannannie from hills to the east (although not shown in this image), but these two wetlands are not connected as frequently as Gnalka Gnoona and Koodjeepindarranna. Figure 7 shows sites FV24 and FV28 on Ethel Creek Station when both were dry (Jan 2017), connected to each other and the surrounding floodplain 2 weeks later and then still inundated but isolated from one another in March. Maintaining connections between wetlands and to source waters is critical to maintaining their biodiversity values. Inundation extents can also help delineate management areas. Fortunately, unlike some Australian floodplain systems, connectivity is little altered in the study area, although some concern has been raised about the influence of Ophthalmia Dam (Payne *et al.*, 1999) on the Fortescue floodplain above Fortescue Marsh, especially with respect to frequency of lower intensity flood events. Mining operations on the Hamersley and Chichester Ranges are also affecting surface water flows in various ways, although these primarily affect flows towards Fortescue Marsh rather than the floodplains upstream and downstream of there.

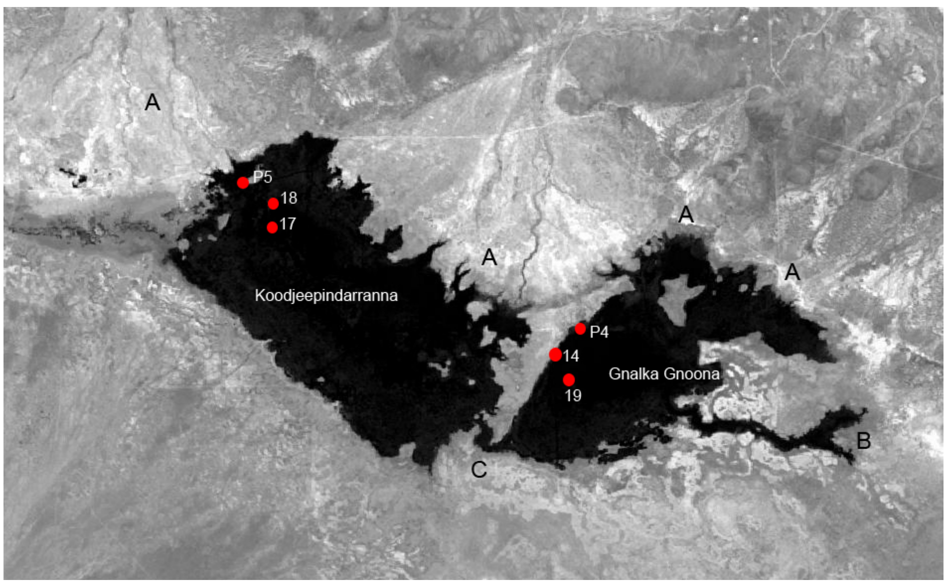

Figure 2. Short-wave infrared Landsat imagery showing extent of inundation of Gnalka Gnoona Claypan and the Koodjeepindarranna system on Mulga Downs Station during a major inundation event in March 2003. Red circles are sampling locations. A = flows coming off the Chichester Ranges into both wetlands; B = water extending up the valley from Gnalka Gnoona; C = connection between the two wetlands. Landsat data from US Geological Survey.

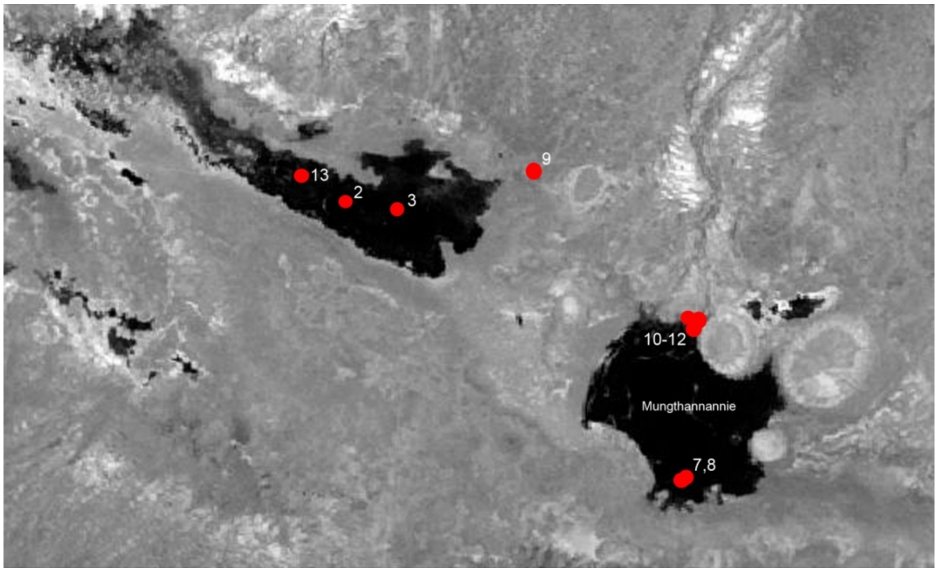

Figure 3. Short-wave infrared Landsat imagery showing extent of inundation of Mungthannannie Claypan and the floodplain to its west on Mulga Downs Station during a major inundation event in March 2003. Red circles are sampling locations. Landsat data from US Geological Survey.

Five main concentrations of wetlands were sampled for this project. These were:

1. Fortescue River pools on Mount Florence Station.
2. Floodplains and associated intermittent creeks and claypans on Mulga Downs Station west of Fortescue Marsh.
3. Claypans on Roy Hill Station north and south of the Roy-Hill Munjina Road, plus Coondiner Pool.
4. Large semi-permanent to permanent pools on the Fortescue River east of Fortescue Marsh (e.g. Moorimoordinina Pool, Yunera Pool) on Roy Hill Station.
5. Claypans and intermittent creek and river pools on the Jigalong/Fortescue floodplain in the far east of Roy Hill Station, far west of Balfour Downs Station and on Ethel Creek Station.

2.2.5 Wetland types.

Wetlands in the Fortescue valley are of four main types:

Pools are deeper longer lasting sections of the otherwise intermittent rivers and creeks, often formed by sub-surface geology that hinders downstream movement of water and causes upwelling of hyporheic water and/or by riverine geomorphology (such cliffs and sharp bends) that cause scouring of the bed. Pool banks are typified by *Eucalyptus victrix* woodlands over rich grass and herbaceous understories. Notably, *Eucalyptus camaldulensis* is largely absent from the riparian communities of the Fortescue Valley within the study area.

Floodplains are low lying areas either receiving overbank flows from rivers (e.g. where the Fortescue River and Jigalong Creek flood on Ethel Creek Station) or where runoff accumulates in the absence of defined channels (the Fortescue valley on Mulga Downs Station). In these areas, water often recedes quite quickly after a flood, leaving longer-lasting claypans and pools in semi-isolated anabranches and creeks. The plains (e.g. sites FV3 and FV39 in Appendix 2) are dominated by grasslands of *Eriachne flaccida* and *E. benthamii* with rich herbaceous layers, interspersed with *Eucalyptus victrix* woodlands.

Claypans are seasonally to intermittently filled off-river wetlands with clayey substrates that hinder infiltration of water. They fill as a result of floodwaters from rivers or rainfall accumulating in local catchments. They are often unvegetated, especially when dry, though larger examples frequently have *Eucalyptus victrix, Melaleuca glomerata* and *Acacia* spp. on low rises within the wetlands (sometimes forming semi-isolated sub-basins), while shallower examples can have *Eragrostis flaccida* and or *Tecticornia verrucosa* on their otherwise bare beds. In the Fortescue Valley, claypans often occur as extensive semi-connected complexes, some of which have deeper elongate areas that are probably maintained during high flow events. These appear like creeks but are not connected to formal creek systems. Herein they are referred to as 'claypan channels'. Examples are sites FV18 and FV25 in Appendix 2. Claypans in the east of the study area tend to have softer clay substrates with gilgaid microrelief and substantial coverage of *Eleocharis* in the understorey. Those on Roy Hill south-east of the marsh, and on Mulga Downs have hardpan substrates with more stones and most have little vegetation on the wetland floor.

Fortescue Marsh is the terminus of the upper Fortescue catchment formed by the Goodiadarrie Hills preventing downstream flows of surface water. It is an episodically inundated samphire dominated marsh, approximately 100 km long and up to 30 km wide when in flood (Environmental Protection Authority, 2013). When it fills it is fresh, but becomes saline as it dries. The vegetation of the Marsh is described in detail by Markey (2017).

2.2.6 Conservation status of Fortescue Valley wetlands

Several wetland based priority ecological communities (PECs) are recognised within the study area (Table 2). These were primarily based on results of the Pilbara Biological Survey (Pinder *et al.*, 2010; Lyons, 2015).

Table 2. List of Priority Ecological Communities based on wetland biota along the Fortescue valley. 'P' sites are from the Pilbara Biological Survey and 'FV' sites are from the current project.

PEC name	Priority status	Relevant survey sites
Mulga Downs Outcamp South	Priority 2	P40, FV1 and FV4-6
Fortescue Marsh	Priority 4	P2 and P3
Mungthannannie Well	Priority 1	FV7-8 and FV10-12
Gnoona Pool South	Priority 1	P4, FV14, FV19
Koodjeepindarranna Pool	Priority 1	P5, FV17-18

Fortescue Marsh is listed on the Directory of Important Wetlands of Australia (DIWA)[1] but the DIWA boundary extends well west of the Goodiadarrie Hills to cover the whole Mulga Downs floodplain and wetland complexes listed in Table 2 up to the Roebourne-Wittenoom Road, so includes many different wetlands and wetland types. Fortescue Marsh is also considered to be a potential Ramsar site so has values of international importance.

[1]http://www.environment.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands

2.3 Previous survey work

Pilbara Biological Survey. Nine of the 100 wetlands sampled for the Pilbara Biological Survey (Pinder *et al.*, 2010; Lyons, 2015) were located within the bounds of the present project area (sites with a 'P' prefix in Appendix 3) and five were resampled (albeit in different locations) for the current project. Resampled wetlands were Gnalka Gnoona Claypan, the Koodjeepindarranna system, Mulga Downs Outcamp Claypan, Coondiner Pool and a small claypan pan on Roy Hill Station (FV36). Two sites on Fortescue Marsh and two claypans on Ethel Creek Station were not resampled, although site FV25 (on Ethel Creek) was similar to, and very close to, P42. These nine sites are listed in Appendix 3 and shown on Figure 8, together with some other PBS sites in the Fortescue Catchment that were outside the study boundary.

Inland Aquatic Integrity Resource Condition Monitoring Project. A project to document baseline condition at significant Western Australian wetlands included three wetland sites within the study area (Department of Environment and Conservation, 2009). These were the western and eastern Fortescue Marsh sites sampled during the PBS (sites P2 and P3) and Moorimoordinina Pool on the Fortescue River (site FV30 of the current project). Wetland flora and aquatic invertebrates were sampled at each site. However, two of the three sites were dry and microinvertebrates were not identified, so the invertebrate data for Moorimoordinina Pool was not used in our analyses.

Fortescue Marsh vegetation mapping project. The riparian and halophyte dominated communities of Fortescue Marsh were mapped by Markey (2017). That project provided valuable information on the distribution of the marsh's flora as context for the current project.

Other. BHP Billiton have also had surveys of aquatic invertebrates undertaken within Fortescue Marsh but this work has not been published and Fortescue Marsh is already recognised as being unique within the State and was not the focus of this project.

2.4 Threats to Fortescue valley wetlands

2.4.1 Non-native grazers

Large feral herbivores including cattle, horses and donkeys can affect wetlands through trampling and grazing of riparian plants, soil compaction, reduced riparian and aquatic litter accumulation (through reduced tree recruitment), disturbance of littoral algal production, erosion of river banks and more general landscape erosion leading to increased sediments in wetlands and rivers, spread of weeds and changes to water quality such as nutrient enrichment and turbidity (Kauffman *et al.*, 1984; Burrows, 2000; Natural Resources Northern and Yorke, 2014). However, these effects have rarely been quantified for Australian arid zone wetlands. Petit (2002) documented patchy effects of stock grazing on riparian vegetation centred around access points (primarily on perennial shrubs) at a waterhole on Queensland's Cooper Creek, noting that an increase in bare areas and loss of litter. Naturally turbid arid zone wetlands and pools, like many of those surveyed for this project, derive much of their energy from benthic algal growth in the shallow water on the edge of the wetland where light can penetrate (Bunn *et al.*, 2003) (see photo of site FV05 in Appendix 2). This can be significantly diminished by physical disturbance by stock (Bunn *et al.*, 2006). Many of the wetlands surveyed for this project showed signs of cattle usage, including riparian grazing and physical disturbance (pugging and bank erosion, Figure 4). However, few of the sampled sites would be considered highly degraded (when visited for this project) as a result of cattle, unlike some of the coastal Pilbara river pools sampled by Pinder and Leung (2009). River pools, such as Jinerabar pool on Ethel Creek Station, showed heaviest disturbance by cattle (Figure 4), probably reflecting their use by stock for water, fodder and shade after other wetlands dry. When claypans have water there tends to be water widely available across the landscape and cattle are therefore likely to be more dispersed and their impacts diluted. Exceptions would be the larger longer lasting claypans such as Mulga Downs Outcamp

Claypan (where grazing on riparian vegetation was quite heavy in August 2015 but not apparent in March 2017) and Gnalka Gnoona Claypan (riparian vegetation also heavily grazed when visited in August 2015). An un-named claypan on Balfour Downs also had obvious heavy grazing pressure (sparsely vegetated understorey and little tree recruitment) but it was located next to a stock watering bore (Bullina Bore).

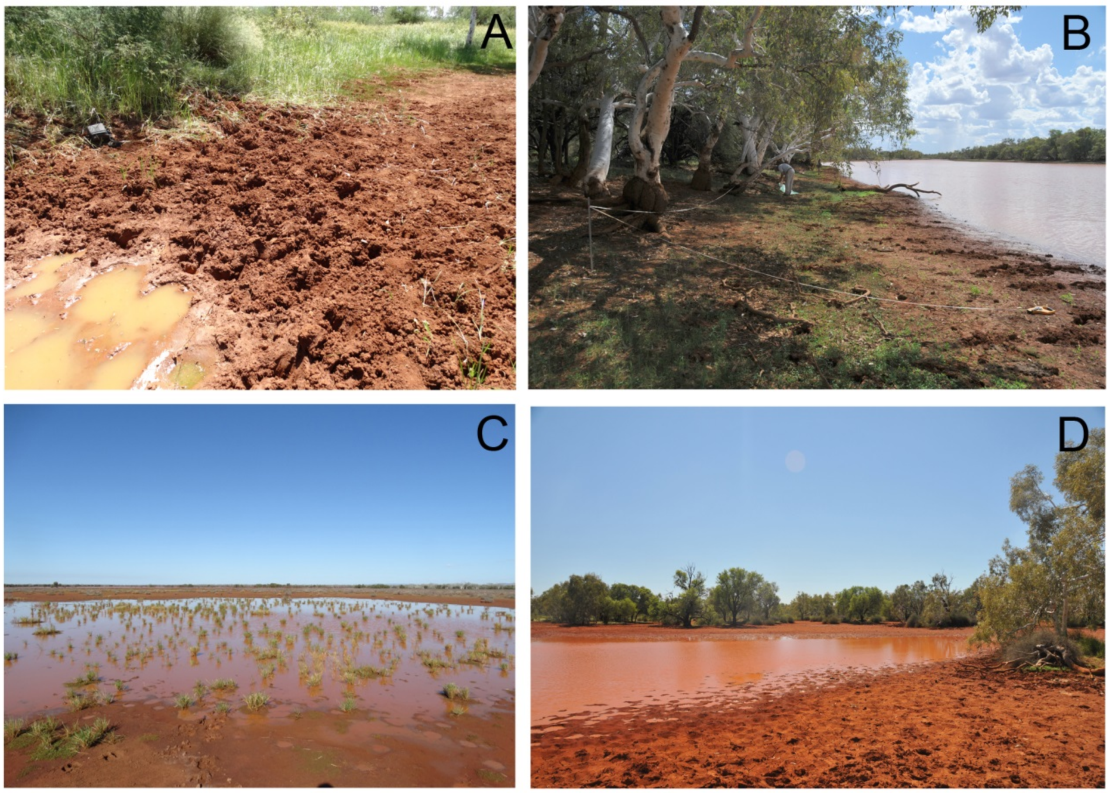

Figure 4. Visible signs of disturbance by cattle. A, pugging, but not significant grazing, at a small Fortescue River anabranch pool on Ethel Creek Station (site FV29); B, denuded riparian zone with little overstorey recruitment at Jinerabar Pool; C, Grazing of *Eriachne flaccida* on the edge of Gnalka Gnoona claypan on Mulga Downs Station (tussocks all with grazed tops); D, bare fringe and heavy physical disturbance at Powellina Pool on Mulga Downs Station.

2.4.2 Weeds

The results of the wetlands flora component of the PBS (Lyons, 2015) showed that the most frequent weed species included *Cenchrus ciliaris* (46% of sites), *Cynodon dactylon* (22%) and *Cenchrus setigera* (17%). In the PBS, these weedy grasses were concentrated in riverine sites with silty and sandy soils, with *Cynodon dactylon* largely restricted to the sandy margins of larger lowland rivers.

In the context of Pilbara wetlands, these species, in particular, can have major impacts on riverine riparian zones, forming dense stands that reduce diversity and abundance of native plants through competition, coupled with their potential to alter fire regimes. The wetlands sampled during the current survey however, did not demonstrate the levels of impact from these taxa evident across the larger rivers sampled during the PBS.

In a review of the naturalised vascular plants of the Pilbara, Keighery (2010) highlighted an additional suite of taxa that have the potential to invade and impact both river banks (e.g.

Parkinsonia aculeata, Tamarix aphylla and *Clitoria ternata)* and the floodplains and claypans that are the focus of the current study. For floodplain wetlands, Keighery (2010) stresses the potential for taxa such as *Xanthium strumarium* (Noogoora Burr), *Leptochloa fusca* subsp*. uninervia,* and *Paspalum fasciculatum* to be major weeds of the types of habitats that are common within the study area. *Polypogon monspeliensis* (a salt tolerant grass) poses a particular threat to the Fortescue Marsh should it become established (Keighery, 2010).

Recent pastoral initiatives including the production of irrigated fodder crops (mostly weedy grasses), coupled with long distance transport of stock and hay, require careful biosecurity assessments to minimize the risk of introducing known and potential weedy taxa within the Fortescue valley.

2.4.3 Altered hydrology

The only significant impoundment affecting rivers in the study area is Ophthalmia Dam, which holds water back from the Fortescue River near Newman. Payne and Mitchell (1999), using the work of Ng (1991), concluded that Ophthalmia Dam was reducing the frequency of low to moderate flow flood events downstream of the dam and that this was affecting survival of riparian trees. It is not clear whether this equates to reduced frequency or duration of flooding of the claypans surveyed in this project but these aspects of hydrology are key drivers of floodplain wetland ecology (Boulton *et al.*, 1992a, 1998; Amoros *et al.*, 2002; Alexander *et al.*, 2008). Numerous mining operations in the Chichester and Hamersley Ranges are also diverting flows, dewatering aquifers and/or discharging groundwater towards the valley floor, especially around Fortescue Marsh. Exploration lines on the uplands running perpendicular to the valley may increase rates of sheet flow runoff towards the valley floor. Manipulation of surface water for stock, which could reduce flow to wetlands, accelerate drying of natural wetlands or divert flood waters seems to be a minor issue in the catchment.

2.4.4 Redclaw crayfish

Redclaw crayfish (*Cherax quadricarinatus*) is endemic to the tropical parts of the Northern Territory and Queensland. It was introduced to the east Kimberley Region as an aquaculture species and separately as wild populations (Doupé *et al.*, 2004). In the Pilbara, it was introduced to the Harding Dam near Karratha some years ago, but in 2016 it was discovered in Hamersley Gorge in Karijini National Park[2]. A subsequent survey by Department of Biodiversity, Conservation and Attractions also found it in a tributary of the Ashburton River near Tom Price and in the George River (next river east of the Harding in the north of Millstream) and there are even more recent records from a tributary of the lower Fortescue River (Weelumurra Creek downstream of Mount Florence). This latter record is most concerning in respect of the study area as it could easily move upstream to the Mount Florence Pools, although it is unlikely to survive in intermittent claypans. It seems that this species is spread by Pilbara residents as a recreational fishing species, but it is highly invasive and likely to have severe deleterious effects in Pilbara rivers, especially as there are no native crayfish in northern western Australia. The most important effects will be predation on other invertebrates and degradation of aquatic plant communities, with cascading effects on other water quality and fauna, including fish through removal of nursery habitat.

[2] Records from survey work by Wetland Research and Management consultants.

3 Methods

3.1 Site selection

Sites were selected to be representative of the major types of wetlands present within each of the areas described in section 2.2.4. The main waterbody of Fortescue Marsh was excluded from this study, although marsh data from the Pilbara Biological Survey (Pinder *et al.*, 2010; Lyons, 2015) were included in analyses.

A total of 47 sites were sampled. These are shown on Figure 8, listed in Appendix 3 and illustrated in Appendix 2. Of these, aquatic invertebrates were collected at 39, either in one season or two (47 samples in total) and flora was sampled at 45 sites, with a total of 51 quadrats (1 or 2 per site, most scored at least twice, see Appendix 4). Several formally named wetlands were sampled including Powellinna Pool, Gnalka Gnoona claypan, Koodjeepindarranna Pool, Maddina Pool, Chaddelinna Pool and Gidyea Pool on Mulga Downs Station, Coondiner Pool on Roy Hill Station and several pools on the Fortescue River (Moorimoordinina, Meecardagunna, 8 Mile, 14 Mile, Yunera and Jinerabar). Place name spelling is as per the Geoscience Australia Gazeteer (www.ga.gov.au/placename). Note that the large claypan area south of Koodjeepindarranna Pool on Mulga Downs (site P5 of the PBS) is herein referred to as the Koodjeepindarranna claypan but this is not a formal name.

Site selection was deigned to be representative of the major wetland types present in each area. To a large extent this was achieved but there are some gaps, especially floodplain areas outside of well-defined claypans. In particular, the lowest elevation valley floors on Mulga Downs Station between Mungthannannie Pool and Gnalka Gnoona is geomorphically and floristically complex and requires further survey work to document its wetland biodiversity values.

Four main field trips were undertaken. In late July to early August 2015, 19 wetlands were sampled on Mulga Downs Station (following an earlier aborted trip in April). In March 2016, 14 wetlands were sampled on Ethel Creek, Balfour Downs and Roy Hill Stations. In July and August 2016 a few additional wetlands were sampled on Roy Hill and Mulga Downs Stations and most previously sampled sites were rescored for flora. A final trip in March 2017 involved collections at five new sites and some additional collections at previously sampled sites across the study area. Landsat imagery was used to track which wetlands had water and how quickly they were drying prior to the field trips (Figure 5).

3.2 Water quality and soils

At each site where water was present, a hand-held water meter (TPS WP-81) was used to measure electrical conductivity (with in-meter calculated salinity), water temperature and pH. The probes were suspended in the water column approximately mid-way between the water surface and the sediment, or, for very shallow wetlands, the probes were laid on the bed. At the same sites, a one litre water sample was collected for analysis of major ions, gravimetric total dissolved solids (some samples only), turbidity (nephelometric turbidity) and total (persulphate digestion and FIA) nitrogen and phosphorus. A separate water sample was filtered in the field (Figure 6C) for chlorophyll (though a glass fibre filter paper), except for a couple of sites where high turbidity prevented filtration. For most sites high turbidity prevented the filtering water through a finer 0.45 µm filter paper to provide a sample for analysis of dissolved nutrients. For analyses, ionic concentrations were converted to milliequivalents and these used to calculate percent contribution to anions and cations.

Wetland depth in the area sampled for invertebrates was measured using a graduated pole. While we did not have time to search for the actual maximum depth of the wetland it was not likely to be much more than that measured – even the deepest river pools were walked across and measurements taken along the way.

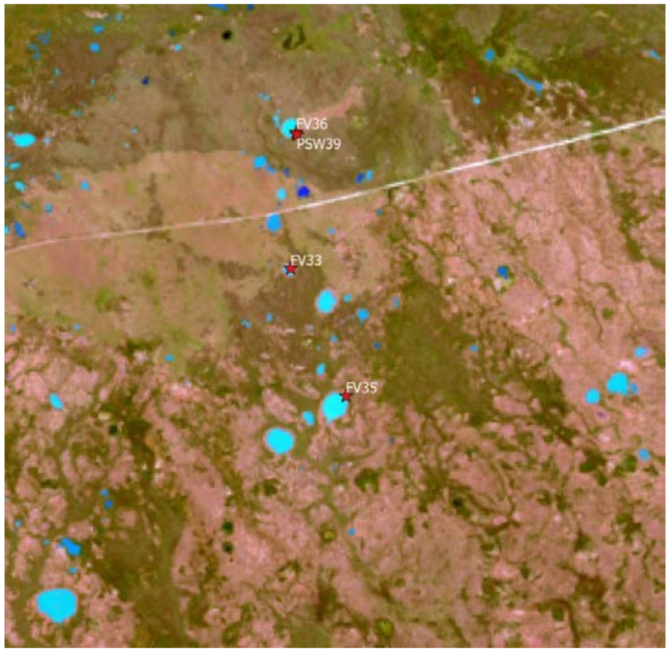

Figure 5. Landsat 8 imagery captured 17 Feb 2016 with bands 6, 5 and 4 displayed in red, green and blue. Surface water shows up as blue in these claypans on Roy Hill Station either side of the Roy Hill - Munjina Road near Perkililly Dam on 19 Feb 2017. These include sites FV33, FV35 and FV36 (=P39) which were sampled about one month later.

A sediment sample was collected at each site where invertebrates were collected, by combining small samples of the top 2-3 cm of sediment from the area sampled for invertebrates to make up a 1 litre sample. This was analysed for proportions of clay, silt, sand and stone fractions (<0.002mm, 0.02-0.002mm, 0.02-2mm and >2mm). Sediment was not collected at site 9 so average values for all other non-riverine wetlands were calculated (Appendix 5). A few sites had some areas of the bed dominated by coarser materials (cobbles, boulders and bedrock) that could not be collected for quantitative analysis. In these cases, the proportion of the bed dominated by fine sediments was estimated and the laboratory results were scaled by this 'fine sediment proportion'.

Soil samples within riparian plant quadrats were taken from the top 10 cm (excluding surface litter) at 20 evenly spaced points (Figure 6D). The subsamples were bulked in the field to yield composite samples of ca. 2 kg. Particle size distribution (% sand, silt and clay) and soil chemical analyses were performed on the samples by the Chemistry Centre of Western Australia (Appendix 6). Parameters included: pH, electrical conductivity, organic carbon, total nitrogen, total phosphorus, exchangeable phosphorus, exchangeable magnesium. exchangeable sodium, exchangeable calcium and percent sand, silt and clay.

Figure 6. Field work between April 2015 and March 2017. A. Adam Turnbull taking an aquatic invertebrate sample; B, Adrian Pinder elutriating an invertebrate sample; C, Faye Thompson filtering water for nutrients; D, Adam Turnbull collecting a soil sample; E, Simon Lyons marking out a flora quadrat; F, Michael Lyons and Loretta Lewis collecting plants at site FV21.

3.3 Inundation extent and hydroperiod from Landsat imagery

An approximation of the number of days between inundation of a temporary wetland and sampling was determined using short-wave infrared Landsat data and imagery (see methods in Appendix 1 and example in Figure 7). Since the frequency of Landsat imagery is fortnightly at best, the timing of fill was then narrowed down using rainfall data from the nearest weather stations obtained from the Bureau of Meteorology. For most sites, we are confident that we have determined the duration of fill prior to sampling to within a few days. Exceptions are some small shallow wetlands (sites FV33 and 35) where Landsat data was inconclusive and which may have repeatedly dried and filled during the time that the Landsat imagery suggested continuous presence of water. The fauna of these wetlands (e.g. some crustaceans present only as nauplii) indicated that the wetland had not held water for very long (perhaps a week) whereas the intermittent Landsat imagery indicated a fill period of several weeks.

Area of inundation was obtained by manually tracing the area of inundation, as indicated from Landsat imagery, onto Google Earth aerial imagery. To validate this procedure, we were occasionally able to find a Google Earth image (where inundation extent was clear) taken on about the same date as a Landsat image. For most wetlands, this was straightforward and the calculated areas are considered reasonably accurate for our purposes. This was more difficult for some floodplain wetlands where wetland boundaries are ill-defined and dark areas on Landsat imagery was probably also indicating soil moisture or vegetation. However, such wetlands were particularly large and their exact size is probably not as important in analyses as their relatively large size.

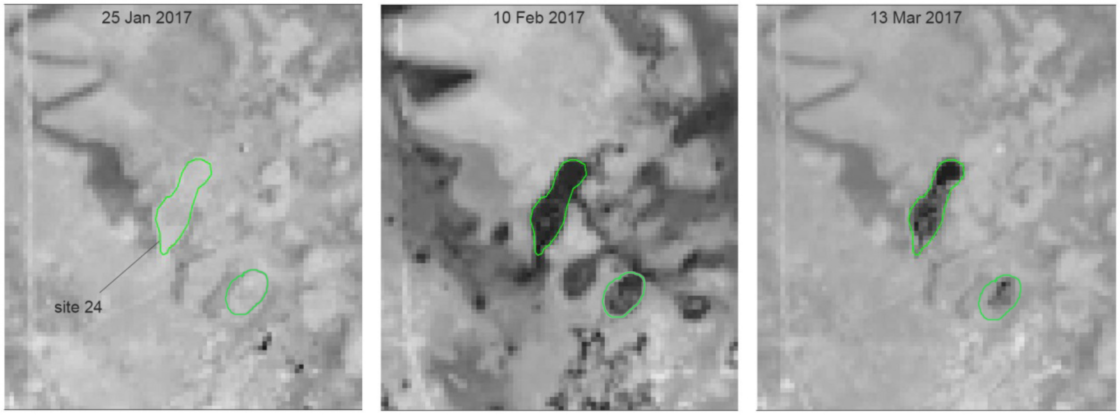

Figure 7. Landsat short-wave infrared images showing sites FV24 and FV28 (green polygons) dry on 25 Jan 2017 (left), inundated and connected to each other and to other wetlands and low lying areas on 10 Feb 2017 following rains in late January (centre) and then with water restricted to the wetlands on 13 Mar 2017, two days after sampling.

3.4 Aquatic invertebrate sampling

Two aquatic invertebrate sweeps were taken at each site that held water on each visit (both sweeps covering the same area of the wetland). These were: a plankton sample, using a 50 µm mesh net to sample invertebrates in the water column, and a benthic sample, using a 250 µm mesh net to sample larger animals in the water column plus benthic habitats within wadeable depth (e.g. open water, submerged vegetation, sticks/logs/leaf litter etc.). Pinder *et al.* (2010) concluded that this sampling effort collected at least 70% of invertebrates present within the area sampled. Coarse inorganic sediment and coarse organic matter were removed prior to sample preservation by washing and discarding coarse debris and elutriating the sample in buckets, before passing the water back through the net. Samples were then preserved in 100% ethanol in the field and taken back to the laboratory for processing.

3.5 Invertebrate sample processing

Plankton samples were washed with tap water and sieved through 250 µm, 90 µm and 50 µm sieve sizes. The 250 µm, and 90 µm fractions were examined under the dissecting microscope, with representatives of each discernible species (other than rotifers and cladocerans), picked out and re-preserved in 100% ethanol. The residue of the plankton sample (including the 50 µm fraction) was then sent to one of the authors (R.J. Shiel) in Adelaide for identification of rotifers, cladocerans and some copepods. The first 200 rotifers, cladocerans and copepods were removed from the sample and the rest of the sample was scanned for additional taxa.

The benthic samples were washed with tap water and sieved through 2000 µm, 500 µm and 250 µm sieve sizes. Representatives of each discernible species were picked from the 2mm, 500um and a quarter of the 250um fractions under a dissecting microscope and re-preserved in 100% ethanol.

All taxa were identified to the lowest taxonomic level possible using keys and voucher specimens and undescribed taxa were assigned morphospecies names based (where species matched) on previous survey work by Biodiversity, Conservation and Attractions. Ostracods plus rare harpacticoid copepods, polychaetes and amphipods were sent to a specialist[3] for identification.

A survey specific reference collection was prepared and will be lodged with the Western Australian Museum.

3.6 Riparian floristic sampling and specimen identification

At each site vegetation and floristics were sampled at a representative section of each wetland's riparian zone. At most sites a single linear quadrat (40m x 5m or 50m x 4m) was established with the dimensions dependent on riparian zone width. At six wetlands in the current survey (FV020, FV024, FV027, FV028, FV033, and FV039) an additional quadrat was established to capture the full range of vegetation zonation. The paired quadrats herein are designated A and B. Quadrats were marked with steel pegs and their locations recorded using handheld GPS.

Within each quadrat, comprehensive plant collections were made at each visit to generate quadrat species lists that were as complete as possible. Additional collections adjacent to formal quadrats and opportunistic collections within the broader study provided records of particular taxa of interest or high quality material for identification. Sampling methodology followed the methods developed by Lyons (2015) for the broader PBS, ensuring consistency when amalgamating existing survey datasets.

Plant material was determined to the lowest possible taxonomic rank. Nomenclature follows that used by the Western Australian Herbarium. Determination of weed status and conservation codes follows the Western Australian Herbarium (1998) and Jones (2016). Examination of the known distributions of taxa used both the specimen data from *Florabase* (Western Australian Herbarium, 1998) and the Australasian Virtual Herbarium (CHAH, 2014). Representative voucher collections will be lodged with the Western Australia Herbarium.

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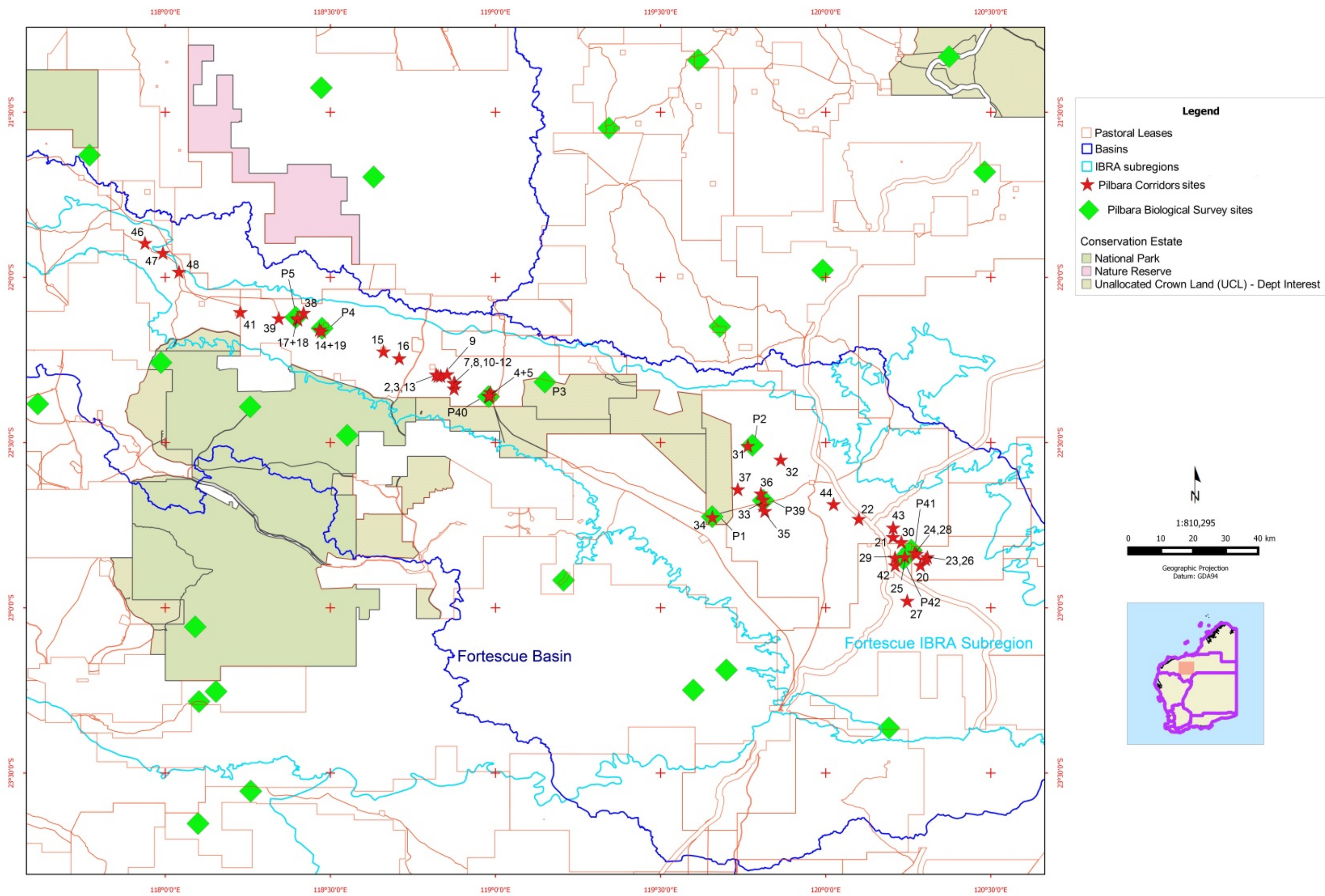
[3] Stuart Halse, Bennelongia Environmental Consultants



The Department of Parks and Wildlife does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted.

Figure 8. Map of the study area showing drainage basins, IBRA regions and survey locations from both the Pilbara Biological Survey (Lyons et al. 2015, Pinder et al. 2010) (green diamonds with 'P' prefix) and the current project (red stars).

3.7 Data Management

All data from this project will be available on NatureMap (https://naturemap.dpaw.wa.gov.au) and Atlas of Living Australia (www.ala.org.au) in due course. Collection information for botanical voucher specimens will be available in Florabase (www.florabase.dpaw.wa.gov.au). All data for the project are also provided in the appendices.

3.8 Data analysis

Multivariate analyses. Two types of multivariate analyses were performed: cluster analysis and ordination, all within the Primer statistical package (Primer-E Ltd, 2016). Cluster analysis places samples or sites into discrete groups based on the similarity of their environmental or biological characteristics. We used agglomerative hierarchical clustering (which starts with a randomly chosen sample and then forms groups by adding further randomly selected samples based on their similarity to samples already in the grouping structure) with group average linkage (new samples are placed based on their average similarity to members of existing groups). The hierarchical grouping structure can be seen on a dendrogram (a tree-like diagram with each sample on a terminal branch). The reliability of these groups can be assessed by a statistical test (SIMPROF) and the degree of differences between samples and groups can be determined from the similarity level (y axis) at which they merge on the dendrogram. Species that best distinguish cluster groups were identified using the SIMPER routine in Primer. Cluster analyses force samples into groups even where differences between samples are not substantial. To visualise whether discrete groups formed by cluster analyses are distinct, the groups can be overlain on an ordination which shows more continuous differences (in environment or biological composition) between samples. The type of ordination used here (non-metric multidimensional ordination) attempts to portray the biological or environmental similarity of sites in a 2 or 3 axis graph. So, in these ordination graphs the relative position of symbols reflects their rank order of biological or environmental similarity of the samples or sites they represent (i.e. the samples or sites with greatest real life similarity should be closest together in the graph). To have all these distances on the graphs match actual similarities is impossible in 2 or 3 dimensions, but it can be approximated and the extent to which this is achieved is given by the ‘stress’ value of the ordination (which should be <0.15).

Similarity matrices. The multivariate analyses are based on site or sample similarity matrices. These are a listing (as a triangular matrix) of how similar each sample is to each other site based on their biological or environmental characteristics. This similarity is calculated using one of a number of indices that combines either all of the biological (all invertebrate or flora species) or all of the environmental data. These are necessary as 1) there are generally too many species to analyse each one independently and 2) we are interested in overall community composition as much as we are in occurrence patterns of species. Environmental similarity was calculated using the Euclidean distance index. Similarity of biological composition between samples was calculated using Sørenson similarity index.

Environmental data. For multivariate analyses based just on environmental data, variables were range standardised so that variables with large ranges (such as conductivity: 4.8 to 1925 mS/m) were not more influential than variables with narrow ranges (such as pH: 7.3 to 10.2). For multivariate analyses of environment-biota relationships, environmental variables were also transformed to better approach normality (if required) before being range standardised. Where pairs of highly correlated variables ($r > 0.95$) were present only one was retained in analyses and where several variables comprised a whole (sediment and ionic percentage compositions) one variable from each set was discarded as these sets are correlated by definition.

Invertebrates. Site FV1 was excluded from analyses as it had only been flooded for a few days and had not had time for a full community to develop. Site FV15 was excluded from analyses because it was a small sample (~10 metres) from an almost dry wetland, so was not comparable to other samples. Invertebrate data from remaining 45 samples collected for this project and 21 samples collected for the PBS were combined into a single matrix, with taxonomy adjusted to make the identifications compatible. Several ostracod genera (including *Bennelongia* and *Cypretta*) were omitted from analyses because new ideas about species boundaries for the new data were not compatible with identifications made during the PBS. Otherwise, adjustments were mostly lumping a few taxa and removing partial identifications. Species occurring in only one of the 66 samples (singletons) were excluded from multivariate analyses as they do not contribute to determining which other sample a sample is most similar to.

Relating environment to biota. Matrix correlations (Relate in Primer) were used to quantify relationships between pair-wise sample/site similarities based on environmental data and similarities based on community composition. Step-wise matrix correlations (Bio-env in Primer) was used to refine such analyses by finding best subsets of environmental variables that together created a new similarity matrix with highest correlations with the biotic matrix. Distance-based linear modelling (DistLM in Primer) was used to find a subset of individual environmental variables (rather than environmental variables combined to form a similarity matrix) with highest correlation with community patterns. The modelling was run with all environmental variables allowed into the model with a backwards step-wise model building procedure and adjusted R^2 used to assess model performance. Where this produced a model with some variables having non-significant contributions, this procedure was re-run using only those variables that contributed significantly to the original model. Step-wise linear modelling of richness was undertaken using R Statistical software (R Development Core Team, 2017). Ternary diagrams of sediment and ionic composition were produced using the ggtern package (Hamilton, 2016) for R.

4 Aquatic environment

Aquatic environmental data, including hydrology, is provided in Appendix 5

4.1 Hydrology

Some of the sampled pools on the Fortescue River would very rarely dry completely. These include sites FV31 (Moorimoordinina Pool), FV32 (14 Mile Pool) and FV44 (Yunera Pool) on Roy Hill Station and some pools on Mount Florence Station (e.g. sites FV46 and FV48). These are listed as semi-permanent or permanent in Table 2, but given a nominal inundation period of 1000 days for analyses. Coondiner Pool had held water for only 46 days when sampled for this project but had water for 233-515 days prior to sampling for the PBS. The larger claypans such as Gnalka Gnoona (sites FV14/19) and Mungthannannie (sites FV7, 10, 11 and 12) and the Mulga Downs Outcamp Claypan (FV5) have had water for periods greater than six months prior to sampling (up to 3.5 years for Gnalka Gnoona sampled in August 2006.) Other wetlands sampled for this project and the PBS had water for periods of weeks to a several months at a time (mostly 40-60 days). A few wetlands had probably been inundated for under a month. On average, the temporary wetlands sampled for the current project had been inundated for 71 days (median 44) whereas temporary wetlands sampled for the PBS had been inundated for 168 days on average (median 110).

Area of inundation ranged from under 10 ha (70% of sites from both projects) through to >1000 ha (Gnalka Gnoona Claypan when sampled in 2006 for the PBS and the western PBS site on Fortescue Marsh). Inundated areas for sites sampled during the current project ranged from under 1 ha to 346 ha (site FV5, Mulga Downs Outcamp Claypan in March 2017). Sites sampled on multiple occasions have varied considerably in area of inundation. Gnalka Gnoona (sites FV14 and FV19 in this project and site P4 of the PBS) was sampled on four dates across the two projects and had inundated extent ranging from 149 ha to 1240 ha. The extent of inundation at Gnalka Gnoona was lower when sampled for this project (149 ha) than the three occasions on which it was sampled for the PBS project (>500 ha). The similarly large Mulga Downs Outcamp Claypan (FV5) did not vary in inundation extent as much (152 and 206 ha during the PBS versus 206 and 346 ha for the present project).

Most wetlands were estimated to be under a metre deep, with several of the smaller claypans (especially those on Roy Hill Station southeast of Fortescue Marsh) having as little as 3 cm of water. Deepest wetlands were pools in river and creeks, including Koodjeepindarranna Pool on Mulga Downs (site P5) at about 1.5 metres.

4.2 Wetland sediments

Only three sites had substrates with components (cobbles to bedrock) too coarse to sample quantitatively (Appendix 5). Coondiner Pool (FV34) had substantial amounts of cobbles on the mid-western shore where it was sampled for this project (they were estimated to cover a third of the area sampled for invertebrates), but this component was absent where we sampled the north-eastern side of the pool for the Pilbara Biological Survey. One of the Fortescue River pools (FV47) on Mount Florence Station had substantial areas of bedrock, boulders and cobbles (estimated to cover about three-quarters of the area sampled for invertebrates) and another nearby pool (FV46) had some cobble substrate. Another five sites had more than 10% of sediment coarser than sand (gravels and pebbles) but this component was never dominant. About two–thirds of sites had sediments dominated by clay (median 52%, with sand or silt subdominant at an equal number of those sites) and most of the rest had sand dominant (median 44%, mostly with clay subdominant). By contrast, sites sampled for the PBS within the study area tended to have sandier sediments (median 59% sand, with clay, silt or stones subdominant) but none had cobbles, bedrock or boulders. Sediments within the upper Fortescue/Jigalong floodplain claypans had much lower silt content and were more gilgaid (creating complex wetland morphologies with uneven surfaces that are soft when inundated) compared to those on Mulga Downs and Roy Hill south of Fortescue Marsh, which tended to be more hardpans with little microrelief. This seems to be an important contrast between claypans sampled on these two parts of the valley. Small areas of more complex gilgaid claypans may occur on the Mulga Downs floodplain between Chaddelinna Pool and the Great Northern Highway but we did not get to these.

4.3 Water quality

A single measurement of water temperature is rarely a useful variable when analysing invertebrates because it varies so much throughout the day in response to air temperature. However, average water temperature in early autumn (28.3 ± 0.9˚C) was higher than in mid to late autumn (24.8 ± 1.5˚C) and winter (21.8 ± 1.0˚C). There was no relationship between wetland depth and water temperature, although temperature was generally measured within 20cm of the surface and some temperature stratification was present in Coondiner Pool in March 2016.

All wetlands were alkaline (pH 7.49 to 9.72, interquartile range 7.87 to 8.69), as were all of the wetlands sampled for the PBS (7.29 to 10.18) (Table 2). Only one site in the current project had clear water: FV43, a small claypan in the far east of Roy Hill Station with turbidity 8.6 NTU. This had probably been turbid but the wetland complex within which it lies was drying out and dense beds of Characeae had grown, which had probably allowed suspended clays to settle by reducing wind mixing. Alternating states of turbid and clear phases related to growth of submerged plants has been observed in other shallow wetlands, including Coondiner Pool where turbidity has ranged from clear (turbidity 0.3 NTU in Aug 2003) to moderately turbid (430 NTU in Mar 2016) and Gidyea Pool (FV16). Gnalka Gnoona claypan has also varied from clear (Aug 2003, 0.7 NTU with 80% cover of *Characeae*) to turbid (>1000 NTU in Mar 2015 when there was very little submerged macrophyte). The very shallow (≤ 10 cm) open claypans on Roy Hill Station south of Fortescue Marsh had highest turbidity: most in excess of 10000 NTU and one >100000 NTU in this study and up to 200000 NTU recorded during the PBS, giving them a 'choc milk' appearance. These had particularly fine sediments. Several sites on Mulga Downs also had moderately high turbidity (mostly 1000-7000 NTU) while those on Ethel Creek and the eastern parts of Roy Hill mostly had turbidity under 1000 NTU. Lower turbidity in the latter was probably related to a combination of coarser sediments, depth (most > 30cm), presence of macrophytes in some wetlands and configuration of the waterbodies (e.g. FV20 was a moat with very uneven bed around a central island and some were creek pools which tend to have lower turbidity than claypans).

Turbidity was much more variable for wetlands sampled for the PBS, including several clear water sites. Across both datasets turbidity was not linearly related to sediment composition, but 90% of samples with turbidity > 5000 NTU were from sites with above average fine fractions (clay+silt) in the sediment.

Almost all sites sampled for this project were fresh, with only four having conductivity (as measured in the field) above 100 mS/m. These were the Fortescue River pools on Mount Florence Station (FV46 to FV48) and a small drying claypan on Roy Hill Station (115.9 mS/m when sampled for this project compared to 63.5 and 65 when it was sampled with more water during the PBS). Only FV48, which was clearly groundwater fed, would be considered marginally subsaline with a conductivity of 640 mS/m. That all three of the Mount Florence Pools had elevated conductivity suggests an influence of saline groundwater on these pools. Site FV48 had three stygofaunal species within its sampled community which also indicates groundwater influence.

Figure 9 shows the proportional contribution to ionic composition of anions and cations. Calcium was the dominant cation (30-40%) in nine samples. These were all from the Fortescue and Jigalong floodplains on Ethel Creek, Balfour Downs and the far east of Roy Hill, including claypans and pools in creeks. In four samples Mg^{2+} was the dominant cation (Mg^{2+}>Ca^{2+}>Na^{+}>K^{+}): another Ethel Creek claypan (FV20), the two samples from Coondiner Pool sampled for the PBS (P1) and one sample from the western PBS site on Fortescue Marsh (P3A). Remaining samples had Na^{+} dominance, with Ca^{2+}, Mg^{2+} or K^{+} next dominant. Those with Na^{+}+>Ca^{2+}>(Mg^{2+} and K^{+}) were mostly on Mulga Downs or from the sites closer to Fortescue Marsh on Roy Hill Station and were mostly from river and creek pools. Those with Na^{+}+>Mg^{2+}>(Ca^{2+} or K^{+}) were from a mix of wetland types but almost all on Mulga Downs, Mount Florence (the three western-most Fortescue River pools) or Roy Hill south of Fortescue Marsh. Samples with Na^{+}>K^{+}>(Mg^{2+} or Ca^{2+}) were almost all from Mulga Downs Station and all but one were from claypans. The only such samples not collected on Mulga Downs were one from the small claypans on Roy Hill Station near Pilkililly Dam.

About a third of samples had chloride as the dominant anion, mostly Cl^{-}>HCO_3^{-}>(SO_4^{2-} or CO_3^{2-}). These were mostly from claypans on Mulga Downs and Roy Hill south of Fortescue Marsh, the three river pools on Mount Florence and Fortescue Marsh itself (Figure 9). All but three of the remaining samples had bicarbonate dominant, almost all HCO_3^{-}>Cl^{-}>SO_4^{2-}>CO_3^{2-}. Being from such a large group of sites they were spread across the study area and wetland types, but included almost all of the eastern-most claypans and pools. The only samples with SO_4^{2-} dominant were collected from Fortescue Marsh (2 samples) and the channel (P5) within the Koodjeepindarranna system on Mulga Downs in August 2015 (whereas a sample from an adjacent site (FV18) in March 2017 had much more HCO_3^{-} than SO_4^{2-}). Of the 11 sites sampled more than once, half did not change in cation dominance between dates, especially with respect to the dominant two ions. At five sites there were changes in cation dominance, probably associated with either carbon dynamics affecting bicarbonate concentrations or different sources of floodwaters and types of fill events and residence time.

There was thus some differentiation amongst the various parts of the study area and wetland types with respect to ionic composition, reflecting catchment and local geology and soils plus algal growth and carbon equilibria. In particular, the eastern-most claypans and pools, lying on more calcareous soils (Bureau of Rural Sciences, 2009; McFarlane *et al.*, 2015b), tended to have higher proportions of calcium, magnesium and bicarbonate (green samples on Figure 9) while samples from Fortescue Marsh and the Mount Florence Pools had proportionately little bicarbonate but higher sulphate (red and blue samples on Figure 9). Pinder et al. (2010) noted that potassium tended to dominate anion composition in turbid waters (claypans and creek pools) whereas magnesium tended to predominate in clear river pools and springs, with this thought to be associated with binding of K^{+} by clay particles. The relative concentrations of potassium versus magnesium in this study was not correlated with turbidity across our dataset, probably because almost all sites were turbid.

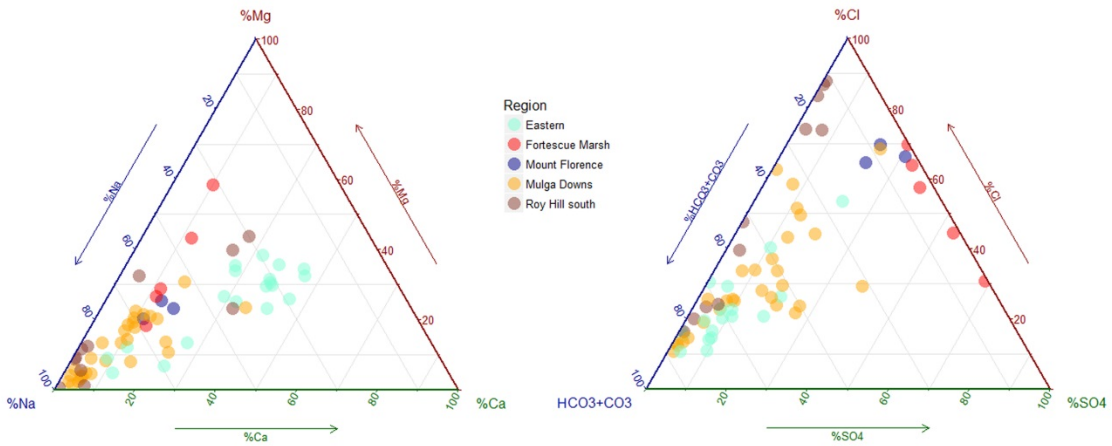


Figure 9. Ternary diagrams showing relative proportions of major anions (left) and cations (right) with symbols representing sites coloured by region. This includes data from both the current survey and the PBS. Eastern = eastern-most sites on the Jigalong Creek/Fortescue Floodplain.

For macronutrients, the National Water Quality Guidelines (Australian and New Zealand Environment and Conservation Council (ANZECC) *et al.*, 2000) propose a range of 0.35 to 1.2 mg/L for total nitrogen and 0.01 to 0.05 mg/L for total phosphorus in northern Australian waters for triggering management concern. However, these values are based on limited research and are currently being revised and do not account for turbidity. Almost all water samples taken for this project had total nitrogen concentrations above 0.35 mg/L and about half exceeded 1.2 mg/L. Almost all wetlands had total phosphorus concentrations exceeding 0.05 mg/L. However, in highly turbid waters dissolved nitrogen and phosphorus bind to suspended clay particles. In our samples, concentrations of nitrogen and phosphorus were clearly correlated with turbidity (Figure 10) and therefore do not reflect nutrient availability for primary production (algal and plant growth). Nonetheless, some of the wetlands with lowest turbidity (<100 NTU) still had nutrient concentrations within or higher than the above ranges so enrichment from the catchment or fringes is still a possibility.

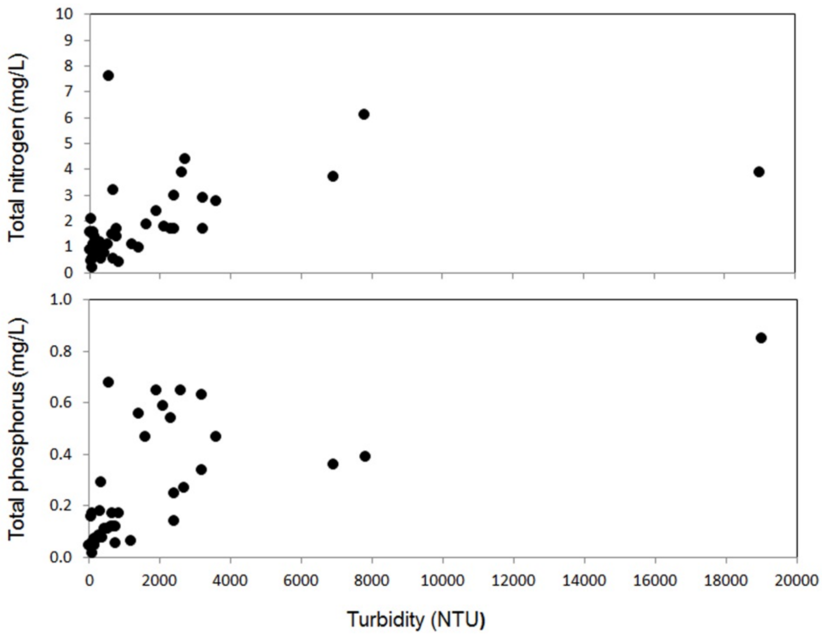


Figure 10. Turbidity (within the range 0 to 20000 NTU) versus total nitrogen and phosphorus

Chlorophyll is an indicator of the amount of phytoplankton in the water column and phaeophytin is measured because it a breakdown product of chlorophyll. These are indicative of primary production in the water column and can provide some indication on nutrient enrichment. Chlorophyll-a concentrations in wetlands sampled for this project ranged from 0.0001 mg/L to 0.07 mg/L and were not correlated with turbidity. The above guidelines suggest a trigger level for concern of 0.01 mg/L. Only eight wetlands exceeded this value. However, in turbid arid zone rivers and wetlands primary production tends to occur mostly around the edges of highly turbid arid-zone waters, where light penetration is sufficient to allow growth of algae on the mud, so water column chlorophyll is probably not a good measure of primary production in these wetlands. Similar 'bathtub rings' of algae were noted for some of the wetlands studied for this project (see photo for site FV5 in Appendix 2). This is not necessarily indicative of nutrient enrichment from stock and can be an important source of organic carbon driving food webs in such wetlands.

5 Invertebrates

5.1 Diversity

5.1.1 Regional and sample richness

From the 47 samples collected during the present study, a total of 410 invertebrate taxa were collected (Appendix 7). During the PBS about the same number of taxa (412) were recorded from the 21 samples collected within the same study area, including 44 recorded only from Fortescue Marsh which was not surveyed for this project. Deriving a regional richness from both datasets is problematic due to some differences in taxonomic scope and resolution (e.g. ostracods better resolved to species in this project, see below) but, accounting for these issues, at least 590 taxa have been recorded in the study area between the two projects. The current survey has thus increased the number of aquatic invertebrate taxa known from Fortescue valley wetlands by just over 40%.

Of the 410 taxa collected for this project, 32% were collected only in one sample and a further

14% were collected only twice. This is much higher than Pinder *et al.* (2010) recorded for their survey of the whole Pilbara (21% singletons and 9% doubletons) but that survey included 4 times as many samples.

A calculation that estimates likely total richness in the region (the 'Chao' estimator, as implemented in the 'vegan' R package of Oksanen *et al.* (2017) indicates that the total number of aquatic invertebrate species inhabiting the same types of wetlands in the study area may be ≥ 750 species. This estimator is calculated from the numbers of species that occurred in only one or two samples (about half the species recorded across both datasets). Across the whole Pilbara region, Pinder *et al.* (2010) collected just over 1000 species and estimate the regional richness to be as high as 1200. The Fortescue valley wetlands may, therefore, support over half of the species present in the Pilbara.

For the sites samples for this project, the number of species per sample ranged from 14 to 99. Lowest richness (<25 taxa) was found in the claypans on Roy Hill Station south-east of Fortescue Marsh, including the small shallow claypans (sites FV33, 35 and 36) and the larger but barely inundated site FV37. Two other sites, FV1 and FV15, also had particularly low richness, but FV1 (19 species) had only flooded a few days before sampling and FV15 (21 species) was almost dry and too small and shallow for a full sample to be taken. These two sites were excluded from multivariate analyses. The most speciose sample was taken from the Mulga Downs Outcamp claypan (site FV2 in Mar 2017) with 99 species. On average, claypan samples sampled for this project had 56 ± 5 species whereas samples collected from river and creek pools (including claypan channels like FV25) had 64 ± 4 species. The two floodplain sites (FV39 and FV41) had 39 and 80 species respectively. For the PBS, claypans had 69 ± 10 species whereas pools and claypan channels had 90 ± 11 species. The Fortescue marsh sites (P2 and P3) had 27 to 72 species. The samples collected for the PBS were thus considerably richer than those collected for this project.

Within claypans sampled for this project (n=19), species richness was positively correlated (all R^2>0.1 and p<0.05) with depth, %sand, temperature, chlorophyll, HCO_3^-, %cations other than Na^+ and negatively correlated with %clay, turbidity and days since start of year. Temperature and days since start of year are probably acting as surrogates for season, although they are not strongly correlated with one another and the average temperature for claypans in late autumn/winter is only 3.5°C less than that in early autumn. A stepwise multiple regression produced a model of claypan species richness that explained 92% of richness (p<0.001) using depth, %sand, turbidity, chlorophyll, $\%SO_4^{2-}$ and alkalinity. A model constructed for the PBS claypan samples (n=9) explained 91% of richness with exactly the same variables (except that the depth component was not significant). So, species richness is higher in claypans that are deeper, sandier, less turbid, have more chlorophyll and higher alkalinity and %sulphate.

Within river and creek pools for this project (n=13) richness was positively and significantly correlated (all R^2 > 0.1, p<0.05) only with area, temperature and longitude. A multiple regression was not produced and there were too few pool samples collected for the PBS to analyse.

5.1.2 Significant invertebrate records

A selection of the more significant invertebrates are shown in Figure 11.

New undescribed species

Many new ostracod species were recognised from the material collected for this project. Some of these would have been collected by Pinder *et al.* (2010) but not identified as distinct species. The increased number of species is a result of new ideas about ostracod morphology and diversity[4]. New detailed morphological and molecular taxonomic research on some genera (*Bennelongia* and *Ilyodromus*) have resulted in recognition of many new species that would have been lumped into fewer taxa in the past (Martens *et al.*, 2012, 2013, 2015). This level of species resolution has been provisionally applied to these and other genera (*Cypretta*, *Ilyocypris*, *Cypricercus*) for this project (Appendix 7). Unfortunately, most of

[4] Identifications by Stuart Halse, Bennelongia Environmental Consultants

this fine scale resolution was excluded from the analyses (and the following discussion about individual species) because the same taxonomic framework could not be retrofitted to the Pinder *et al.* (2010) data within the timeframe available. Some of these may have restricted distributions but most are probably widespread in at least the Pilbara.

At least ten species from other invertebrate groups are also potentially ‘new to science’ in that they are undescribed and not known to have been collected previously in the Pilbara or elsewhere (Table 3).

In addition to these new species, there are 68 others that are particularly well represented in samples from the study area. Many of these seem to preferentially occur in non-riverine wetlands and turbid pools, so the apparent high representation of these species in the Fortescue Valley may reflect the greater number of such wetlands sampled in this area (65 samples from 45 wetlands) compared to the rest of the Pilbara (34 samples from 20 wetlands). Nonetheless, with the high concentration of such wetlands in the study area, the Fortescue valley may be an important area for these species in the Pilbara irrespective of sampling bias. Just over half of these have only been collected once or twice in the Pilbara, so we are cautious about suggesting that they are more common in the study area than elsewhere in the Pilbara, although some of the more significant records of these are highlighted in Table 4. The remaining 31 species, listed in

Table 5, have been collected more frequently so there is greater likelihood that the Fortescue Valley provides particularly important habitat within the Pilbara region.

Individual samples contained between 0 and 10 of these species that are either new or potentially characteristic of the study area, with 16 samples having five or more such species, representing 42% of such records. These include samples from the larger claypans (FV5, 12, 14, 18, P4, P5) plus Gidyea Pool (FV16) and Powellinna Pool (FV41) on Mulga Downs, plus samples from some Ethel Creek/Balfour Downs claypans (FV23, 26, 28, P41 and P42), riverine pools from Ethel Creek and Roy Hill (FV22, 27 and 29) and Fortescue Marsh (P3). Richness of these species was only slightly correlated with total richness (R^2=0.06). From the perspective of conserving what is most unique about the Fortescue Valley aquatic invertebrate fauna, these wetlands, or types of wetlands, may be particularly important.

5.1.3 Stygofauna

Stygofauna are occasionally collected in surface waters where there is upwelling groundwater. The focus of this project was surface water biodiversity so these species are excluded from the above discussion about significant species. Their conservation will be more about groundwater management, although nutrient enrichment from stock is a potential groundwater quality issue. Site FV48, one of the Fortescue River pools on Mount Florence Station, had three species that primarily occur in groundwater. This site had gradually flowing water but was not connected to other pools at the surface, indicating a groundwater influence. All of the Mount Florence pools had elevated salinity which probably indicates widespread groundwater influence in this section of the river. The stygofauna species are:

Namanereis pilbarensis (polychaete). Polychaetes are primarily marine worms but there are some freshwater and salt lake species. This species was described from Pilbara groundwater by Glasby *et al.* (2014) from Yaraloola Station in the Robe River catchment and nereid polychaetes have been found in other aquifers in the Pilbara. This is the first record from surface waters in the Pilbara.

Pilbarus sp. B06 (paramelitid amphipod): This undescribed species has previously been recorded from groundwater in the same region[5].

Metacyclops mortoni (cyclopoid copepod): This species was described from groundwater habitats in Cape Range and the lower Ashburton catchment (Pesce *et al.*, 1996), but was subsequently collected from a well in the lower Fortescue River catchment[5] (near the coast) and from one groundwater fed wetland in the mid-west (Aquatic Research Laboratory, 2004).

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[5] Jane McRae Bennelongia Environmental Consultants pers. comm.

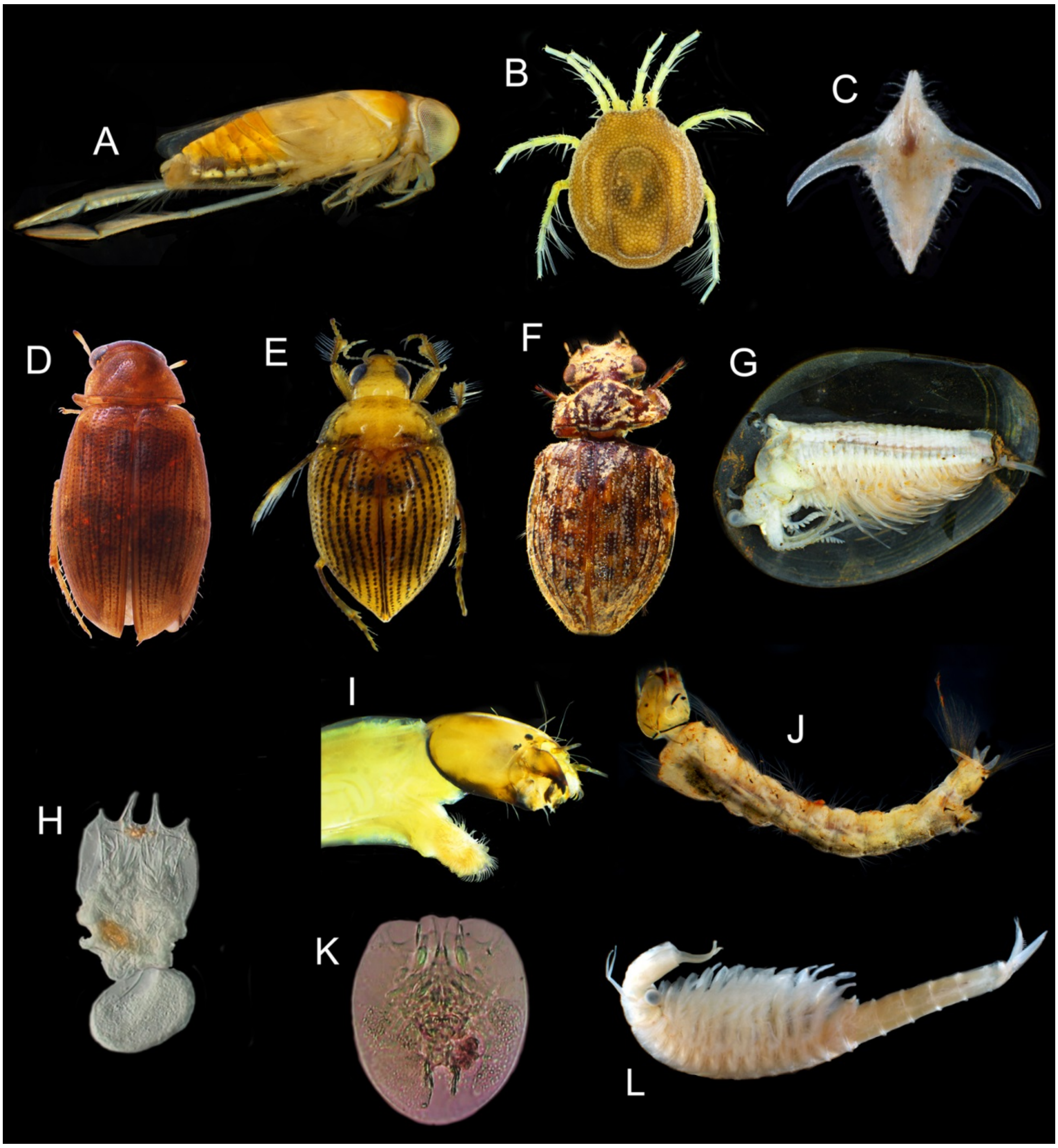


Figure 11. A selection of significant invertebrates found during this project (see Tables 3 to 5). A, *Anisops* n. sp. (new species of backswimmer); B, *Arrenurus* n. sp. (undescribed water mite); C, Limnocytherid sp. 419 (undescribed species of ostracod); D, *Berosus* sp. P4 (hydrophilid beetle); E, *Haliplus fortescuensis* (haliplid beetle); F, *Spercheus* (sperchid beetle); G, *Paralimnadia* sp. (clam shrimp); H, *Brachionus* nr *budapestensis* (new brachionid rotifer); I, *Dicrotendipes* sp. P6 (non-biting midge); J, *Anopheles amictus* (mosquito larva); K, *Testudinella* n. sp. P4 (new testudinellid rotifer); L, *Branchinella halsei* (fairy shrimp).

Table 3. Undescribed species collected for the first time in this project.

Group	Species	Number of records from study area	Number of records from elsewhere in Pilbara	Comments
Rotifers	*Testudinella* n. sp. P4 (Figure 10K)	2	0	Recorded from the samphire flat (site FV12) north of Mungthannannie Claypan (Mulga Downs) and a claypan on Balfour Downs (FV28). Three other undescribed *Testudinella* were collected in the Pilbara by Pinder *et al.* (2010) but these were not recorded from Fortescue wetlands.
	Asplanchna n. sp.	1	0	Recorded only from the channel in the Koodjepindarranna claypan system (FV18). This differs from another undescribed Pilbara *Asplanchna* collected from a river pool in the DeGrey catchment (Pinder *et al.*, 2010)
	Dicranophorus n. sp.	1	0	Recorded only from the samphire flat (site FV12) north of Mungthannannie Claypan on Mulga Downs Station.
	Lecane n. sp. P1	1	0	There is significant uncertainty about many *Lecane* collected from the Pilbara and at least a couple of others are undescribed. However, this new species, collected from an un-named pool on a Fortescue anabranch on Ethel Creek Station (FV29) differs from other species collected to date.
	Pleurata n. sp.	1	0	Collected only from Gidyea Pool (FV16). This is the first record of *Pleurata* from Western Australia.
	Polyarthra n. sp.	1	0	Another new species collected only from site FV12 (the samphire flat north of Mungthannannie Claypan). Otherwise, Pilbara *Polyarthra* have all been *P. dolichoptera* except for one other species of uncertain identify from a claypan in the Western Pilbara (Ashburton catchment).
Acarina (Water mites)	*Unionicola* n. sp.	1	0	This unionicolid is unlike congeners from the Pilbara or described from elsewhere. It was collected only from Powellinna Pool on the Fortescue floodplain on the Mulga Downs/Mount Florence boundary (FV41).
Cladocera (Water fleas)	*Celsinotum* n. sp.	1	0	This is only the second record of *Celsinotum* from the Pilbara and the genus is uncommon in Western Australia generally. It was collected only from a vegetated claypan in the far east of Roy Hill Station (FV43). The only other species collected in the Pilbara is *Celsinotum parooensis* which is also known from eastern Australia.
Copepoda	*Mesochra* n. sp.	1	0	This probably new species, from Gnalka Gnoona Claypan (FV14) was the only record of harpacticoid copepods for the project and the first record of *Mesochra* from the Pilbara. *Mesochra* harpacticoids generally inhabit subsaline to saline wetlands but Gnalka Gnoona was fresh when this sample was collected.
Hemiptera (Water bugs)	*Anisops* n. sp. (Figure 10A)	3	0	This backswimmer was collected at three localities on Mulga Downs Station (Mulga Downs Outcamp Claypan (FV5), a small creek pool (FV9) and Gidyea Pool (FV16).

Table 4. Occurrence of selected species with only 1 or 2 Pilbara records that are all from the study area.

Group	Species	Number of records from study area (including Pinder *et al.* 2010)	Number of records from elsewhere in Pilbara	Comments
Rotifers	*Anuraeopsis coelata*	1	0	The record from a creek pool on Ethel Creek Station (FV21) is the first from Western Australia. It is an otherwise widespread species in tropical areas of the world, occurring rarely across northern Australia and occasionally in the Murray
	Brachionus cf. *pineenaus*	1	0	This species was collected only from Chadolinna Pool (FV2). If it is *B. pineenaus*, then it has previously been recorded from Coolcalalaya Claypan in the southern Carnarvon Basin (Halse *et al.* 2000), a pool in the bed of Lake Austin (Geddes *et al.*, 1981) and other locations in the Murchison-Gascoyne. It is known only from Western Australia to date and may be an arid zone claypan specialist
	Epiphanes brachionus	1	0	This species, collected only from a small creek along the Mulga Downs homestead road during this project, is globally widespread, with other records in Australia including billabongs and stock dams in the Murray Darling Basin and Tasmania
	Lecane plesia	1	0	The record from the highest salinity river pool (FV48 on Mount Florence Station) is the first for Australia. In Europe and North America it is 'rare in brackish water and mineral water' (Koste, 1978)
	Trichocerca chattoni	2	0	Recorded only once previously in the Pilbara (P40 in Pinder *et al.* 2010) but also twice from a vegetated swamp on the south coast of Western Australia. In this project, it was collected only from the samphire flat (site FV12) connected to Mungathananie Claypan (FV10), but it is widespread in the tropics of Australia and overseas and is considered a freshwater species preferring warm waters
	Wolga spinifera	2	0	A probably cosmopolitan, but rare, species occupying fresh and brackish waters, in this project it was recorded from the same samphire flat (FV12) as *T. chattoni* and from a claypan channel (FV18) within the Koodjeepindarranna complex. Previous WA records are from the Wheatbelt (Pinder *et al.*, 2004) but there are other sporadic records in south-eastern Australia
Ostracods	*Mytilocypris n. sp.*	2	0	A new species originally collected from Fortescue Marsh (P3) and one of the shallow claypans on Roy Hill Station (P39=F36) and the large salt marsh on Weelaranna Station (Pinder *et al.* 2010) but subsequently collected in the Goldfields (Quinlan *et al.* 2016).
Water fleas (Cladocera)	*Anthalona harti*	1	0	This was collected only from one claypan (FV43) in the far east of Roy Hill Station. In Western Australia, it has only otherwise been collected from a spring at Walyarta (Mandora Marsh) east of the Pilbara (Quinlan *et al.*, 2016b)but it was described from South Africa by Van Damme *et al.* (2011) and has subsequently been recorded from the Caucusus Mountains in Georgia, Spain and south-east Asia (Sinev and Kotov 2012). The Pilbara and Walyarta records are the only records from Australia to date, although records of *Biapertura pseudoverrucosa verrucosa* by Smirnov (1971) from a Queensland University pond may be this species. It is usually found in vegetated claypans (FV43 was full of Chara) in warmer areas
	Alonine n. gen., n. sp. 2	1	0	This cladoceran most likely represents a new genus of the chydorid subfamily Aloninae and has only been collected from Mulga Downs Outcamp Claypan in 2004
	Alona cf. unguiculata	2	0	If *A. unguiculata* (identity requires confirmation) then it is otherwise known from Queensland but has not otherwise been reported from Western Australia
Beetles (Coleoptera)	*Berosus vijae*	2	0	A widespread species in northern and eastern Australia, recorded only four times in the north-west (two springs at Mandora Marsh and sites FV16 and FV23 in this project)
Water bugs (Hemiptera)	*Anisops semitus*	1	0	This is a widespread tropical species that has not previously been recorded in the Pilbara. In this project, it was collected only in Gidyea Pool (FV16) on Mulga Downs. Previous Western Australian records that the authors are aware of are from Kimberley wetlands, Lake Gregory (Tanami Desert) (Halse *et al.* 2000) and Mandora Marsh (Quinlan *et al.*, 2016b)

Table 5. Species collected three or more times and which may be better represented in the study area than elsewhere in the Pilbara.

Group	Species	Number of records from study area (including Pinder *et al.* 2010)	Number of records from elsewhere in Pilbara	Comments
Rotifers	Lacinularia cf. *racemovata*	6	0	All six records of this taxon in Dept Biodiversity, Conservation and Attractions's aquatic invertebrate database are from Fortescue valley wetlands, mostly from Roy Hill and Ethel Creek Stations
	Testudinella cf. *ahlstromi*	6	2	Six of the eight records of this taxon are from Fortescue valley claypans and the other two are from a claypan and a billabong elsewhere in the Pilbara
	Asplanchna brightwelli	17	3	This is a very widely distributed species but 80% of Pilbara records are from Fortescue wetlands and it seems to preferentially occur in turbid waters in Western Australia (e.g. Coolcalayaya Swamp in the southern Carnarvon Basin (Halse *et al.*, 2000))
	Asplanchnopus multiceps	4	0	This species inhabits non-riverine wetlands across the state, including swamps and vegetated and non-vegetated claypans. In the Pilbara, it has only been recorded from Fortescue valley claypans
	Lepadella cf. *rhomboides*	3	0	All three records of this species from the Pilbara are from Fortescue wetlands. If this is *L. rhomboides* then it is otherwise widespread in Australia
	Ascomorpha sp.	6	0	Seven of the 11 Western Australian records of this genus are from Fortescue claypans and turbid river pools, including *Ascomorpha saltans* from Mulga downs Outcamp Claypan (P40) and six records not identified to species. Two other species have been identified from the south-west of WA
Annelids	*Aeolosoma* cf *travancorense*	3	1	*Aeolosoma* are polychaetes and many species are thought to be cosmopolitan. The identity of these is uncertain but 3 of the 4 records of this form are from Fortescue wetlands
	Dero furcata	15	3	*Dero furcata* is a cosmopolitan Naididae occurring in a wide range of wetlands. In the Pilbara, however, it appears to be especially well represented in wetlands of the study area.
Water mites (Acarina)	*Arrenurus* sp. 15 (Figure 10B)	12	2	Twelve of the 14 records of this undescribed species, seemingly a Pilbara endemic, have been collected from Fortescue valley wetlands. The remaining two sites are also claypans near Onslow and on Coppin Station. It is closest to *Arrenurus fissipetiolus* which has not been recorded from Western Australia
Fairy Shrimps (Anostraca)	*Branchinella affinis*	3	1	This is a widespread species in Australia and is common in the mid-west and southern Carnarvon Basin and there a couple of Wheatbelt records. In this project it was collected only from the three small claypans on Roy Hill near Perkililly Dam (FV33, 35 and 36) and is only known from one other Pilbara site (a claypan on Croyden Station – (Pinder *et al.*, 2010))
	Branchinella lyrifera	3	0	This fairy shrimp has been recorded at only a few locations in Western Australia and in the north of the state is only known from two connected sites on Ethel Creek Station
	Branchinella halsei (Figure 10L)	13	2	While there are a few records of this species from south-western Australia it is primarily an inland and north-western species, occurring through the western arid zone (Quinlan *et al.*, 2016a; Parks and Wildlife unpublished data) and Carnarvon Basin (Halse *et al.*, 2000). In the Pilbara 13 of the 15 records are from claypans on Mulga Downs Station
Clam shrimps (Conchostraca)	*Ozestheria* sp. nr *sarsi*	3	0	This clam shrimp is known only from three locations on Mulga Downs Station. It may be new or it could be *Ozestheria sarsi* (which is otherwise known from near Onslow and central South Australia) or *Ozestheria elliptica* (an otherwise central Australian species) but the descriptions of these are too vague to make a definitive identification
Water fleas (Cladocera)	*Coronatella* sp.	3	0	*Coronatella* had not been recorded from Western Australia prior to (Quinlan *et al.*, 2016a) who recorded it from several Goldfields wetlands. The three Fortescue records from this project are the first for the Pilbara region. Since species identification was not possible it is not certain that these records are of the same species
	Daphnia cephalata	5	0	This a very widespread species, but in the Pilbara it has only been recorded in five Fortescue claypans, except for one possible occurrence in another turbid pool near Port Hedland
	Scapholeberis kingi	4	0	Another widespread species collected only from Fortescue wetlands within the Pilbara region (Pinder *et al.*, 2010)

Copepods (Copepoda)	*Calamoecia halsei*	9	3	This is a claypan specialist endemic to Western Australia's arid zones. While widespread, three quarters of the Pilbara records are from Fortescue valley wetlands, almost all from the shallow Roy Hill Station claypans
	Thermocyclops nr *emini*	10	1	While the exact identity of this species is uncertain, it is distinct from other species and known only from the Pilbara. Ten of the 11 records are from samples collected in this project in March 2016 or 2017. It is likely that this is a warm water specialist and has not been collected as frequently elsewhere in the Pilbara because there has been little other sampling during the wet season
	Pescecyclops sp. 442	14	2	While this species is widespread in Western Australia, in the Pilbara it is largely restricted to the Fortescue valley where it is widely distributed. The only other Pilbara location is a claypan near Onslow (Pinder *et al.*, 2010) where it was collected twice
Beetles (Coleoptera)	*Haliplus fortescuensis (Figure 10E)*	13	2	Almost all of the 16 Pilbara records of this beetle, which was described from Fortescue Marsh specimens by Watts and McRae (2010), are from the study area. The only exceptions are specimens from a Millstream Pool (still in the Fortescue catchment), a turbid creek pool near Port Hedland and a dubious record from the Kimberley
	Exocelina sp.	3	1	Three of the four records of *Exocelina* from the Pilbara are from Fortescue wetlands (two from Ethel Creek claypans and one from the Fortescue floodplain on the Roebourne-Wittenoom Road (FV41) – the latter being of uncertain identity and possibly new) and there are few other records from WA
	Berosus approximans	16	2	This is a very common and widespread species but tends to occur primarily in temporary non-riverine waters. In the Pilbara 16 of the 18 records are from wetlands in the study area. Exceptions are records from two wetlands on the Roebourne Plains
	Berosus sp. P4	6	1	Of the seven records of this undescribed species, six are from Fortescue valley wetlands (mostly claypans) with records across the study area. The seventh is from an ephemeral granite rock pool near Karratha. This species thus appears to be a Pilbara endemic preferring temporary waters
	Spercheus sp. (Figure 10F)	3	1	*Spercheus* beetles are rarely collected, but 3 of the 4 Pilbara records are from wetlands sampled in the study area. These are probably all *Spercheus wattsi* which also occurs in the Kimberley Region
Diptera	*Anopheles amictus(Figure 10J)*	4	0	While *Anopheles amictus* is widespread in northern Australia it is not commonly collected and in Dept Biodiversity, Conservation and Attractions projects has only been collected from Lake Gregory (Tanami Desert) (Halse *et al.*, 1998) and from four Fortescue valley sites
	Paraborniella tonnoiri	13	4	This midge, which is highly desiccation resistant, is a temporary water specialist. Whereas other dipterans fly in to colonise newly flooded wetlands, this species can survive in sediments as a partially dry larva. It is very widespread but in the Pilbara has mostly been recorded in the Fortescue wetlands

5.2 Comparison of invertebrate communities sampled for this project and the Pilbara Biological Survey

Multivariate analyses of Fortescue Valley invertebrate data indicated significant (Anosim R=0.184, p<0.01) differences in composition between the Pilbara Biological Survey (21 samples) and the current project (45 samples). This was even the case where only those six sites included in both projects were included (Anosim R=0.272, p<0.01). A dendrogram showing the results of a cluster analysis for just those sites sampled in both projects is shown in Figure 12. This shows samples from the Pilbara Biological Survey mostly grouping separately to those from the current project, with the exception of a small claypan on Roy Hill Station (FV36=P39).

Differences between projects may have been due to 1) sampling at different times of the year: most samples from this project were collected in early autumn (March) following summer rains whereas most Pilbara Survey samples were collected between late autumn and late winter (May to August), 2) sampling across different years over a decade apart: temporary wetlands can be expected to have substantial turnover in composition between fill events, including through variable colonisation, 3) sampling at different stages in the hydroperiod or 4) differences in identification of specimens between projects, especially for groups where there is substantial taxonomic uncertainty and/or improvements in taxonomy. Collection and laboratory methods were the same for both projects.

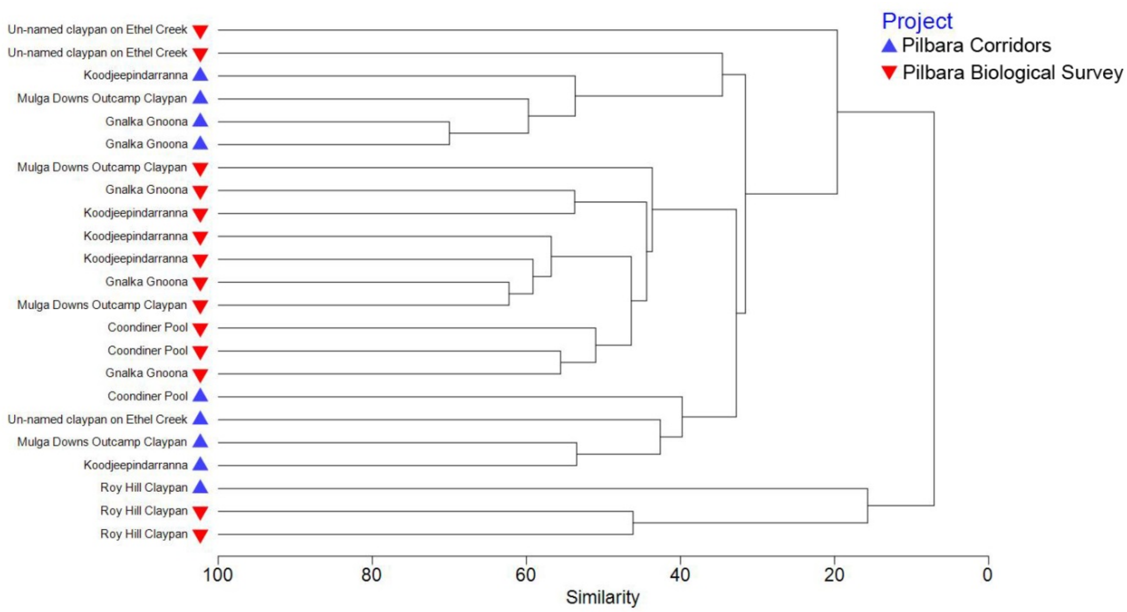


Figure 12. Dendrogram of cluster analysis of invertebrate data from those sites sampled for both the current project and for the Pilbara Biological Survey (Pinder *et al.* 2010).

To investigate the influence of identification and taxonomy on differences between the datasets, a SIMPER analysis was undertaken to identify those invertebrate taxa that best distinguished samples from the two projects. Species that best distinguished the projects (whether or not the analysis was restricted to just those sites sampled for both projects) were species that are well known, widespread in the Pilbara and unlikely to have been wrongly identified in either project. There were very few species in this list that belonged to the same genus, making identification inconsistencies an even more unlikely explanation for the differences between projects. Furthermore, very few of the distinguishing taxa were absent in one project but present in the other, the differences being more in frequency of occurrence. The SIMPER analysis thus makes the timing of sampling (between seasons, years and stage of hydroperiod) a more likely explanation. The length of time that a temporary wetland had been filled was twice as long in the PBS (average 157 ± 24 days) than in the current project (71 ± 11 days) and this may explain some of the different composition (and richness, see 5.1.1). However, even within a project, samples from the same site appeared in different groups in Figure 12. In particular, samples taken from Mulga Downs wetlands in winter 2015 grouped separately (blue triangles at top of dendrogram) to those taken in early Autumn 2017 (blue triangles near the bottom of the dendrogram, so season has an effect on composition. Similarly, the three samples from Gnalka Gnoona claypan (P4=F14 and 19) collected for the Pilbara Biological Survey in three separate years did not group together.

Since the difference in invertebrate community composition between the projects seems to be real rather than an artefact of inconsistent taxonomy and identification, samples from both projects are included in the following analyses.

5.3 Spatial and temporal variation in invertebrate community composition

A dendrogram tree arising from a cluster analysis (see Methods) of invertebrate community composition using data from both projects is shown in Figure 13. In this figure, samples within groups tended to have more similar invertebrate communities to one another than to samples in other groups. The amount of difference between samples (or groups of samples) is indicated by the position on the y-axis where their respective branches meet. Branches that represent statistically significant ($p<0.05$) groupings of samples are shown in black. Dendrograms such as this rarely represent all of the inter-sample differences accurately. However, this dendrogram had a high cophenetic index (0.88), indicating that it strongly represents the inter-sample differences in invertebrate composition. For the purpose of discussing which samples are similar to one another, seven groups of samples (plus two outlier samples) are recognised from this dendrogram, with some significant subgroupings within these. All of these groups (and subgroups) were statistically significant ($p<0.01$), meaning that randomisations of the data resulted in the same samples grouping together less than 1% of the time. It should be noted that much of the grouping structure within these seven groups was also statistically significant, but recognizing too many small groups hinders rather than helps discussion of community patterns. SIMPER analyses identified those species that best distinguished each branch in the dendrogram, including the seven terminal groups and these are shown on

Figure 14. These groups are as follows:

Group 1: **Shallow claypans on Roy Hill Station**. Seven of the eight samples from the four shallow (and mostly small) claypans on Roy Hill Station south-west of Fortescue Marsh (sites FV33, FV35, FV36=P39 and FV37). The only sample from these sites not in this group is the sample from FV33 collected in winter 2016 which came out as an outlier to all remaining samples. The separation of group 1 as a sister group to all other samples partly reflects the fact that they share low richness (17 to 24 species). Their invertebrate communities were very heterogeneous (as indicated by samples being well separated from each other in Figure 15) and they are united more by absence of species than shared species. The low richness is probably associated with very simple habitat; highly turbid water over hard clay substrate with little to no vegetation or organic matter (leaves etc.) and generally short hydroperiods. Turbidity was mostly higher in this group (all but one with turbidity >19000 NTU) than in any other samples. These samples had disproportionate representation of the copepod *Calamoecia halsei*, shield shrimps *(Triops australiensis)* and the ostracod *Ampullacypris* n. sp. 469, plus the only occurrences of the fairy shrimp *Branchinella affinis*: species commonly associated with highly turbid waters.

Group 2: Two samples from Mulga Downs (FV38 and FV39) and two from Ethel Creek (P41 and P42) collected in winter 2016 and 2005 respectively. These two site pairs were statistically significant subgroups (i.e. had differing composition) within this group. Sites FV38 and 39 are the small creek pool on the Mulga Downs homestead road and the Fortescue floodplain on the

Roebourne-Wittenoom Road. Site P41 is an extensive claypan while P42 is the deepest part of an ill-defined channel within a nearby claypan system. These two Ethel Creek samples had more species (62 and 41 respectively) than the two Mulga Downs samples (23 and 38) and the only records of the cladoceran *Alona 'davidi vermiculata'* and two of the three records of *Exocelina* beetles. The latter is very widespread but rarely collected. The four sites shared the presence of the chironomid *Paraborniella tonnoiri* (an ephemeral wetland specialist) and more frequent presence of *Daphnia carinata*. The two Mulga Downs samples had two species not found in other samples: the chironomid *Polypedilum* K1 and biting midge Forcipomyinae P6 (a species not previously collected in the Pilbara).

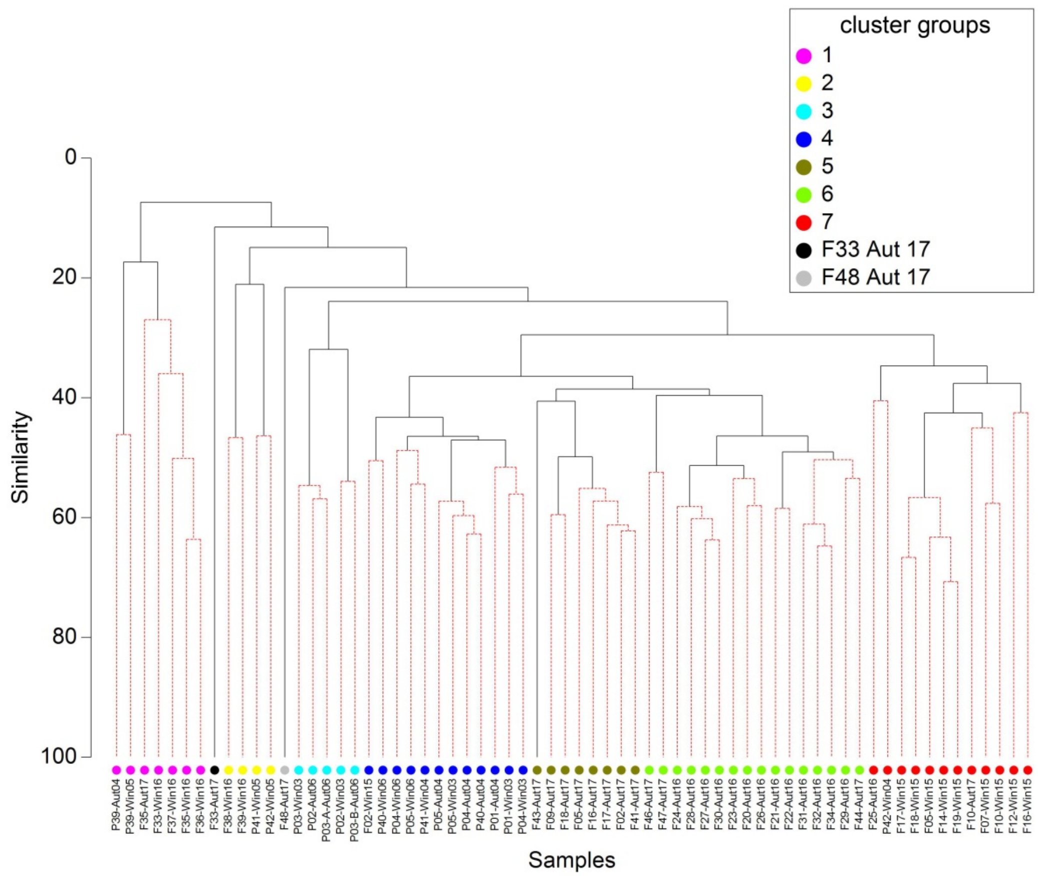


Figure 13. Cluster analysis of samples collected for both this project and the Pilbara Biological Survey (Pinder *et al.* 2010) based on composition of aquatic invertebrate communities. Black lines in the dendrogram tree represent statistically significant branches.

Group 3: **Fortescue Marsh**. All five samples collected from the main waterbody of Fortescue Marsh during the PBS (sites P2 and P3). These had some of the highest conductivities (320 to 1990 mS/m) recorded during either project and this, plus the very clear water and extensive macrophyte beds, would have contributed to distinctive communities. Many species were recorded only (or primarily) in these samples, including some species with tolerance of mild salinity such as the copepod *Apocyclops dengizicus*, ostracods *Trigonocypris globulosa* and *Cyprinotus cingalensis*, and rotifers *Brachionus plicatilis* and *Hexarthra fennica*. Pinder *et al.* (2010) noted that "several potentially endemic species were collected only from Fortescue Marsh (a variant of the rotifer *Brachionus angularis*, a new *Alona* cladoceran and a new *Ainudrilus* oligochaete) or from this wetland plus Weelarrana Salt Marsh (a new *Mytilocypris* ostracod and

Coxiella snails). The *Mytilocypris* was also recorded in P39 and has since been recorded in the Goldfields (Quinlan *et al.*, 2016a). None of these were collected during the current project.

Group 4: **Primarily Mulga Downs claypans plus Coondiner Pool, collected for the PBS.** Twelve samples, mostly from the large claypans on Mulga Downs collected during the PBS, primarily in winter. These included all eight PBS samples from Gnalka Gnoona (P4), Koodjeepindarranna (P5) and Mulga Downs Outcamp claypans (P40), both PBS samples from Coondiner Pool (P1), plus site FV2 (a small claypan set in a large grassy floodplain sampled in winter 2015) and site P41 (a claypan on Ethel Creek collected in winter 2004 – the winter 2005 sample is in group 2). These were mostly larger and deeper wetlands that had been inundated for long periods (other than F2 and P41) and tended to have high %K^+ and HCO_3^- but low Cl^-. Numerous species were particularly common in (or restricted to) this group of samples, including the waterboatman *Micronecta annae illiesi*, backswimmer *Anisops canaliculatus*, *Ferrisia* snails, the beetle *Hydroglyphus leai*, the waterfleas *Scapholeberis kingi* and *Ilyocryptus* cf. *raridentatus*, chironomids *Dicrotendipes* CA1(type 1) and *Polypedilum watsoni* and rotifers *Trichocerca similis grandis* and *Lepadella triptera.* More frequent occurrence of other species particularly distinguished these samples from those in groups 5 and 6, including the rotifer *Polyarthra dolichoptera*, ostracod *Stenocypris major* and copepod *Microcyclops varicans.*

Group 5: **Mulga Downs claypans sampled in Autumn for the current project**. Eight samples, primarily collected from Mulga Downs claypans and all collected in early autumn 2017. These were from a variety of sites including larger claypans (FV17 and 18, within the Koodjeepindarranna claypan system), smaller claypans (FV2 and FV16), a turbid pool in a small creekline (FV9) and the non-channelised Fortescue River on the Mulga Downs/Mount Florence boundary. The exception is a claypan in the far east of Roy Hill (FV43) but this is a statistically significant outlier to the remaining samples in this group. Compared to groups 4 and 7 (which contained most of the other Mulga Downs samples) these samples had greater presence of *Limnogonus* water striders, whirligig beetles *Dineutus australis*, *Ilyocypris australiensis* s.l., *Eylais* watermites, but had fewer occurrences of the copepod *Boeckella triarticulata*, ostracod *Stenocypris major* and damselfly *Ischnura aurora*. The mosquito *Anopheles amictus* and an undescribed backswimmer *Anisops* n. sp. were collected only in this group. This group of samples, despite not being the largest, had five of the ten new species (in Table 3), whereas other groups had one to three (mostly zero or one). Compared to group 6 (to which these samples are most similar) group 5 samples also had more frequent occurrence of the damselfly *Austrolestes aridus* and the beetles *Laccophilus sharpi* and *Enochrus elongatus*.

Group 6: **Primarily Jigalong Creek/Fortescue floodplain wetlands upstream of Fortescue Marsh**. A large group of samples collected in early autumn, primarily in 2016 and primarily from the Jigalong/Fortescue floodplain centred on Ethel Creek Station and riverine pools upstream of Fortescue Marsh. This group had significant subgrouping. One subgroup consists of just the two lower salinity river pools (FV46 and FV47) on Mount Florence Station collected in March 2017. Otherwise, most of the Jigalong Creek/upper Fortescue pools (including Moorimoordinina, Yunera and 14 Mile), plus Coondiner Pool, grouped separately to the claypans on the associated floodplain.

The two Mount Florence river pools shared the unique presence of the water scorpion Ranatra dispar, and these two pools, plus site FV48 (which clustered outside the group) were characterised by presence of the *Orthotrichia* caddisflies and the beetle *Haliplus pilbarensis.* Group 6 is otherwise characterised by greater presence of several species including the rotifers *Brachionus angularis and Keratella procurva*, ostracod *Ilyocypris spiculata* (s.l.), copepod *Mesocyclops notius*, chironomids *Cladotanytarsus* aff. K4 and *Dicrotendipes* P6.

Group 7: **Mulga Downs claypans sampled in winter 2015**. Twelve samples, almost all collected from Mulga Downs claypans in Winter 2015. Two claypans on Ethel Creek (P42, sampled in winter 2004 and FV25 sampled in autumn 2016) also grouped here but as outliers to the others. The only other non-winter 2015 site was FV10 (Mungthannannie Pool on Mulga Downs, sampled on its northern edge in early autumn 2017) but this sample grouped with the other two samples (FV7 and FV10 in winter 2015) from the main body of this wetland. Compared to groups 4 to 6, this group tended to have more frequent occurrence of the fairy shrimp *Branchinella halsei*, copepods *Pescecyclops* sp. 442 and *Calamoecia baylyi,* cladoceran *Daphnia projecta* and backswimmer *Anisops gratus*, but fewer occurrences of the dragonfly *Orthetrum caledonicum*, beetles *Hyphydrus lyratus* and *Hydroglyphus grammopterus*, chironomid *Larsia albiceps* and backswimmer *Anisops nasutus*.

This grouping structure indicates that invertebrate communities differed between the four main subregions: Mount Florence, Mulga Downs, Roy Hill south of Fortescue Marsh and the eastern-most sites (on Ethel Creek, eastern Roy Hill and Balfour Downs). There was also a clear separation by season and year, among the Mulga Downs samples, and by wetland type (river, marsh and claypan).

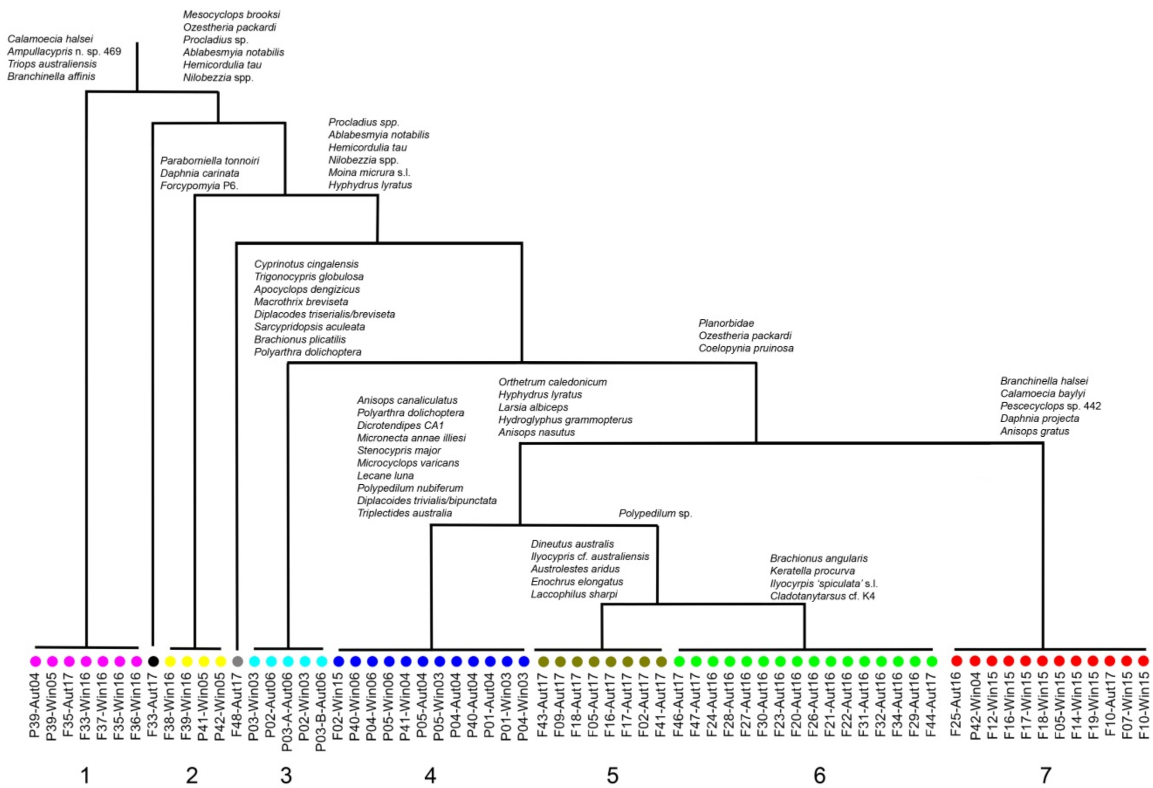


Figure 14. Aquatic invertebrate species most strongly distinguishing branch points in the dendrogram, including the seven terminal groups recognised from Figure 13. Invertebrates shown are those accounting for the top 10% of dissimilarity between the dendrogram branches. e.g. the whirligig beetle *Dineutus australis* was much more common in group 5 than in group 6 whereas the reverse was true for the rotifer *Brachionus angularis*, and the fairy shrimp *Branchinella halsei* was much more common in group 7 than in groups 4 to 6.

Species composition varies along a continuum whereas the dendrogram forces samples into discrete groups. To visualise the degree to which these groups represent distinct communities, they are overlain on a three-dimensional ordination (see Methods) in Figure 15. In this graph, samples with more similar invertebrate communities are placed closer together and samples with very different communities are placed further apart. Looking at all three axis combinations, the seven groups of samples (and the two outlier samples) were separate but adjacent to one another. This indicates that their invertebrate communities differed from one another, but not strongly. If the groups had been widely separated from one another in these graphs it would have indicated that the groups supported very different suites of species with little overlap in composition. Instead, the groups were characterised by greater or lesser proportional representation of many of the same species. Nonetheless, the preferential (if non-exclusive) occurrence of many species in certain sample groups has value for conservation planning. Incorporating the grouping structure into conservation planning will make it much more likely that optimal habitat for all species will be protected.

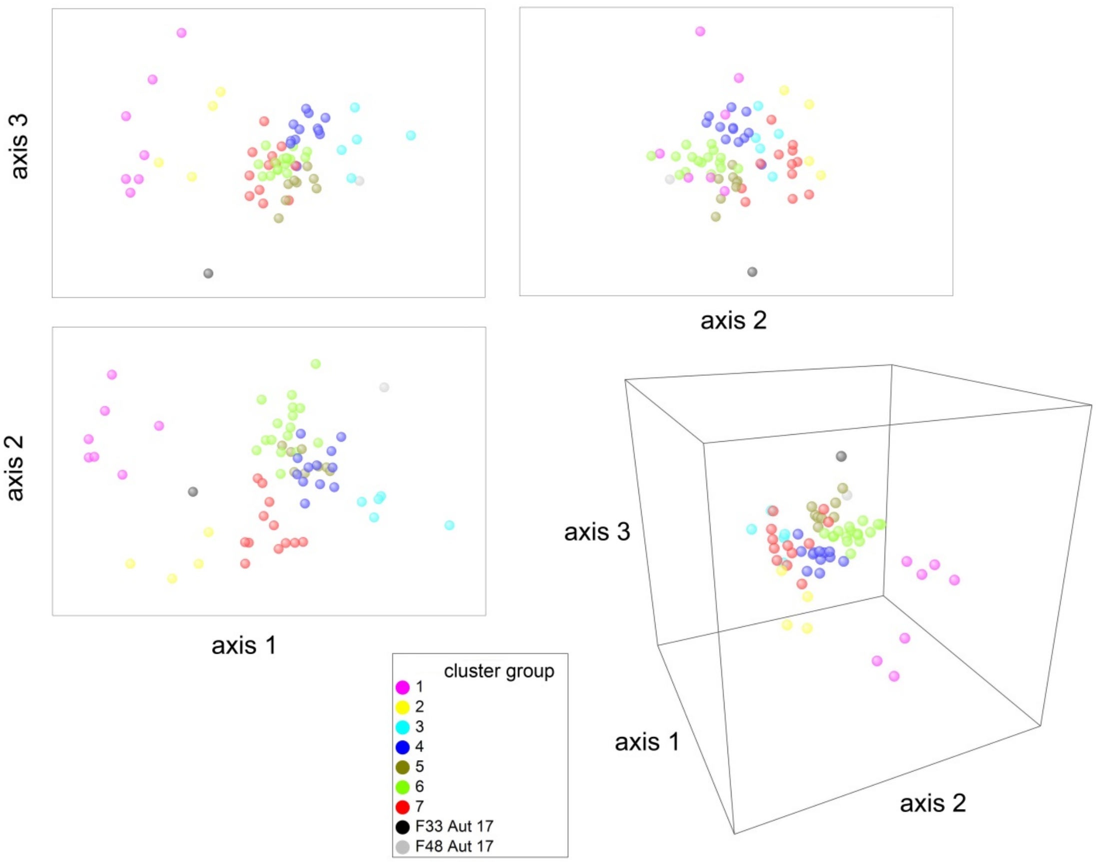


Figure 15. Three dimensional nMDS ordination of samples from the current survey and the Pilbara Biological Survey based on aquatic invertebrate composition, showing two dimensional graphs of axis combinations and a three dimensional graph of all three axes. Samples are colour coded according to their cluster group from Figure 13. Stress = 0.14.

To visualise how the invertebrate cluster groups were distributed across the study area, they are overlain on a map showing site locations in Figure 16. However, for simplicity, this does not show some of the significant subgrouping structure discussed above. The map highlights the spatial component to the distribution of aquatic invertebrate community composition. Thus, most group 6 samples (bright green symbols) were collected from Ethel Creek claypans and river pools, with the exception of two pools on Mount Florence which were a subgroup of group 6. Group 1 samples (pink symbols) were all from Roy Hill claypans and group 4 and 5 samples (dark blue and olive green) were almost all from Mulga Downs claypans. Fortescue Marsh also had distinct communities (light blue symbols).

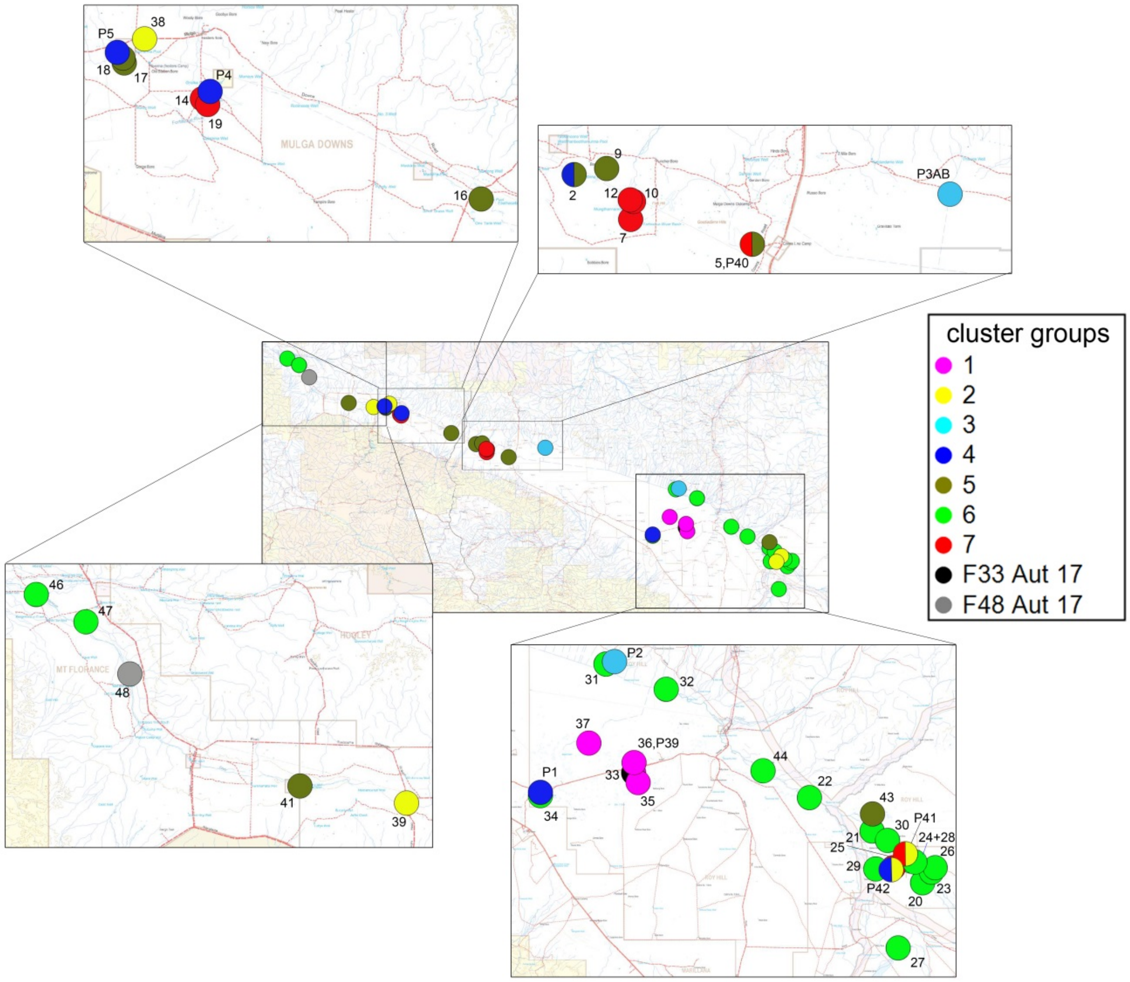


Figure 16. Sites colour coded according to their membership of groups based on their invertebrate community composition. Where different samples from the same site were in different cluster groups, the symbol for the site is segmented accordingly.

5.4 Relationships between aquatic invertebrates and wetland environments

There was a significant correlation between the similarity matrix based on invertebrate composition and the similarity matrix based on the aquatic environmental data (Spearman's $R = 0.38$, $p<0.01$). This suggests that invertebrate community composition varied between samples in the same way that environments did. This was based on all measured and calculated environmental variables, including latitude and longitude. A separate analysis showed that the similarity in invertebrate community composition between samples was also very weakly correlated ($R = 0.07$, $p<0.01$) with geographic distance between the samples (i.e. in kilometres calculated from latitude and longitude). This means that, across the whole dataset, there was only a slight tendency for sites that are closer together to have more similar invertebrate communities. Some of these samples were from the same sites on different dates (i.e. geographic distance = 0). Since the same sites sampled on different dates might be expected to have similar communities, the same analysis was repeated with only the 29 samples collected in autumn during the current survey. This increased the correlation between geographic distance and community composition to R = 0.25 ($p<0.01$).

Since environmental variables are not likely to be equally associated with invertebrate species composition, another analysis (BVStep in Primer) attempted to find a subset of environmental variables that produced a new similarity matrix with highest correlation with the similarity matrix based on invertebrate composition. This analysis found that an environmental similarity matrix calculated from just depth, time of year (days since Jan 1st), turbidity, alkalinity, %Cl^- and %K^+ was much more strongly correlated with invertebrate composition (R = 0.64, $p<0.05$) than the environmental matrix with all variables (R = 0.38 as above).

Another approach to investigating relationships between the environment and biota is to examine relationships between the similarity of invertebrate communities and individual environmental variables (rather than combining environmental variables into a second similarity matrix as in the BVStep above). For this analysis, we used a constrained ordination called distance-based linear modelling (DistLM in Primer). This analysis produced a model with adjusted R^2 of 0.35 (R = 0.59) with 12 predictor variables (Table 6). This suggested a similar degree of relationship between environment and invertebrates as did the BVStep analysis above (R = 0.63), and four of the five environmental variables from the BVStep analysis are included in the DistLM model. The additional variables are sediment composition (%sand, %silt), position along the valley (longitude), conductivity and further components of ionic composition (SO_4^{2-}, Mg^{2+} and Ca^{2+}). The R^2 of 0.35 means that about a third of the variation in invertebrate community composition is associated with these environmental variables.

Table 6. Results of distance-based linear modelling of invertebrate community composition against aquatic environmental variables.

Variable	SS(trace)	Pseudo-F	Significance (p)	Marginal proportion of variance explained
Turbidity	19746	7.63	0.001	0.11
Depth	15832	5.98	0.001	0.09
%K	14700	5.51	0.001	0.08
%Ca^{2+}	13456	5.01	0.001	0.07
Days since start of year	13026	4.84	0.001	0.07
%Cl^-	11108	4.08	0.001	0.06
Conductivity	9630	3.51	0.001	0.05
%Mg^{2+}	8126	2.93	0.001	0.04
%SO_4^{2-}	7937	2.86	0.002	0.04
%Silt	7675	2.76	0.002	0.04
%Sand	7369	2.65	0.001	0.04
Longitude	7331	2.63	0.002	0.04

Since there was a significant difference in invertebrate community composition between the samples collected for this project and those collected for the Pilbara Biological Survey (see section 5.2), and we have no quantitative explanatory variable for this source of variation, the DistLM analysis was repeated but with just the 45 samples collected for this project. This gave very similar results (Table 2) to the analysis run on all samples, suggesting that these environment-biota relationships are robust. These two DistLM models had 8 variables in common but with Cl^-, Mg^{2+}, SO_4^{2-} and %sand (from the combined project model) being replaced by temperature and alkalinity in the model using FV sites only, to give a 10 variable model with an adjusted R^2 of 0.40 (R=0.63).

Table 7. Results of distance-based linear modelling of invertebrate community composition against aquatic environmental variables for the samples from the current project.

Variable	SS(trace)	Pseudo-F	Significance (p)	Marginal proportion of variance explained
Turbidity	15578	6.48	0.001	0.13
Depth	14526	5.98	0.001	0.12
Days since start of year	14043	5.75	0.001	0.12
%Ca^{2+}	13582	5.54	0.001	0.11
%K^{+}	13301	5.41	0.001	0.11
Temperature	11786	4.73	0.001	0.10
%Silt	8653.3	3.37	0.001	0.07
Longitude	7468.6	2.88	0.003	0.06
Conductivity	4767.9	1.80	0.034	0.04
Alkalinity	4714.9	1.77	0.046	0.04

Figure 17 shows values for some of the important aquatic environmental variables sorted by cluster group. These show 1) greater depth in groups 4 and 6 (especially the Upper Fortescue river pools) and shallowest depth in group 1, 2) siltier sediments in group 3 to 5 and 7 than in the other groups, 3) more turbid water in most group 1 samples and moderately high turbidity in groups 2, 4 and 5 and 4) greater calcium in waters from groups 2 and 6 and lowest in groups 1 and 7.

The above analyses show that variation in invertebrate composition among Fortescue Valley wetlands is correlated with sediment characteristics, water quality, depth of the wetlands, time of year and position along the valley. Some of these variables are presented against invertebrate cluster group in Figure 17. Longitude accounted for only 6% of variation in invertebrate composition and is probably just a poor surrogate for unquantified differences, particularly in geomorphology and hydrology, between the various parts of the study area. The eastern claypans fill (at least in part) from overbank flows from Jigalong Creek and Fortescue River. Depending on antecedent rainfalls, these flows may have come through already inundated river pools (such as Jimblebar Pool) and rockholes in the upland reaches of tributaries, seeding the claypans with invertebrates. There are very few permanent refuges on the upper Fortescue but riverine hyporheic zones in sandier reaches of rivers provide some drought refuge compared to the hard baked clays of claypans. By contrast, on Mulga Downs Station there are no river pools to act as refuges, so faunas would be derived from propagules and aerial immigrants. That wetlands within in each of these two areas are periodically connected by different floodwaters (whether riverine or not) probably also contributes to wetland faunas tending to be more similar within each area than between them.

Another significant difference between the eastern and western claypans is their substrates and morphology. Claypans on the upper Fortescue/Jigalong floodplain have more swelling/shrinking clays with low silt content (Figure 17) that are soft when inundated and have significant gilgai microrelief. They also have extensive stands of the sedge *Eleocharis pallens* in and around the flooded areas (see site FV20, 23, 24 and 28 in Appendix 2). By contrast, claypans on Roy Hill and Mulga Downs are generally hard pans that remain firm after inundation and have less microrelief, higher silt and little non-perennial emergent vegetation on the wetland floors (see sites FV2,5,7,17,19,33 and 35-37 in Appendix 2). A proviso here is that there may be some of the more complex gilgaid wetlands on the Mulga Downs floodplain west of Chaddelinna Pool (e.g. at -22.276133°S, 118.790928°) but these were not investigated. Both sediment composition and riparian and perennial wetland floor vegetation can be important influences on aquatic invertebrates (Williams *et al.*, 1978). Submerged aquatic vegetation is also an important influence on aquatic invertebrates generally (Boulton *et al.*, 1992a; Wollheim *et al.*, 1996; Pinder *et al.*, 2010), but their occurrence was patchy across the wetlands studied here (largely due to high turbidity) and not correlated with invertebrate composition.

Salinity is one of the most important influences on aquatic invertebrates (Pinder *et al.*, 2005). In this study the primary influence would have been the higher salinity in Fortescue Marsh (group 3, Figure 17) where the communities included numerous halophilic/halotolerant species, but the Mount Florence Pools also had some species with an affinity for elevated salinity. There were notable differences in ionic composition between wetlands on Mulga Downs and those on the upper Fortescue/Jigalong Creek floodplain and these were correlated with invertebrate composition. In particular, wetlands in the east had greater %Ca^{2+} (Figure 170 and carbonates (probably associated with more carbonaceous soils) and less K^{+}. These differences may have direct influences on invertebrate communities through processes such as crustacean shell deposition and algal growth, but, like longitude, may be also correlates of other factors and processes influencing the fauna.

Contrary to expectations, the time between temporary wetlands first flooding and the sampling visit (hydroperiod in Appendix 5) was not shown to be important by any of the above analyses. A DistLM analysis with just this hydroperiod variable indicated little association with community composition in this dataset (adjusted $R^2 = 0.03$, $p<0.01$). This is despite time since inundation (and other aspects of hydrology such as average length of inundation) being known to be an important influencing on aquatic invertebrate composition generally (Boulton *et al.*, 1992b; Pinder *et al.*, 2013). After inundation, drought resistant eggs hatch, often in staggered way, and other invertebrates arrive, either via flood waters or aerial dispersal. Additional species colonise over time, habitats develop (biofilms, vegetation, water chemistry changes) and biotic interactions (especially predation) cause further changes. However, this probably happens differently in different types of wetlands and possibly in different years (depending on water source, time since last fill, frequency of filling and extent of inundation). In two vegetated claypans in south-western Australia, Pinder *et al.* (2013) followed changes in invertebrate community composition during one hydroperiod (filling to drying). Species richness increased and communities changed in a consistent way between the wetlands over five months. In four claypans studied by Hancock and Timms (2001) there were significant differences in the succession of invertebrates during a filling-drying cycle between some of the pans. Similarly, James *et al.* (2008) found substantial variation in community composition and species abundances between initially connected wetlands after a flood event, especially during the drying phase. While invertebrate communities would have changed and developed over time following flooding in the Fortescue valley wetlands it seems likely that other features of the individual wetlands are more important determinants of invertebrate composition at individual wetlands than time since filling. These other features include those quantified in this study (turbidity etc.) but might also include other hydrological descriptors such as long-term frequency of filling which determines the diversity of the egg bank in dry sediment (Boulton *et al.*, 1992a) and source of floodwaters. In addition, communities change most rapidly in the weeks immediately after filling (Lake *et al.*, 1989; Hillman *et al.*, 2002; Pinder *et al.*, 2013), so time since filling may become less important over time as communities stabilise, other than stochastic immigration, and ecological and site-specific habitat effects become dominant.

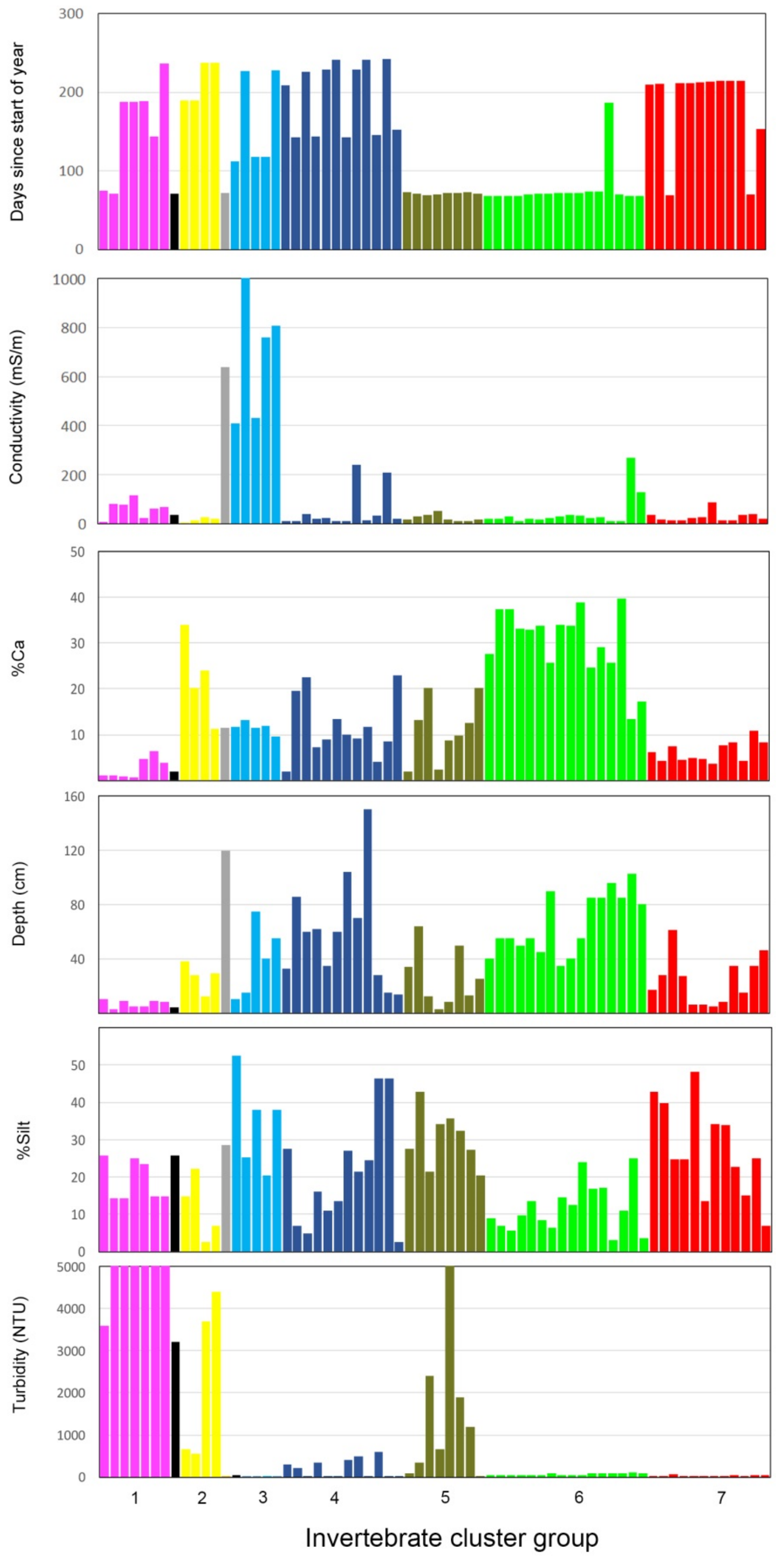


Figure 17. Column graphs of the values of selected aquatic environmental variables colour coded by invertebrate cluster group. The graph for turbidity is truncated at 5000 NTU but turbidity values for most group 1 sites were much higher than this. The graph for conductivity is similarly truncated at 1000 mS/m but conductivity for one of the group 3 samples was 1925 mS/m.

5.5 Summary of invertebrate biodiversity distribution patterns.

- The section of the Fortescue Valley studied in this project has a greater concentration of non-riverine wetlands than anywhere else in the Pilbara IBRA Region. These wetlands have very diverse aquatic invertebrate communities (with roughly 600 species), including a large proportion of the fauna known to occur in the Pilbara. Up to about 10% of these species may be more common in the study area than elsewhere in the Pilbara, associated with the greater concentration of floodplain wetlands in this region.
- Aquatic invertebrate biodiversity is not evenly distributed along study area. Claypans on Mulga Downs Station, Fortescue Marsh, claypans on Roy Hill south of Fortescue Marsh and the eastern-most wetlands (on Roy Hill, Ethel Creek and Balfour Downs) support different invertebrate communities. These patterns reflect differing physical, chemical and hydrological characteristics of wetlands in these areas.
- Invertebrate communities occupying river pools differed from those occupying claypans and claypan channels and there were some differences between river pools on Mount Florence Station and those east of Fortescue Marsh.
- The larger claypans on Mulga Downs and claypans on Ethel Creek and Balfour Downs Stations supported more of the regionally significant taxa than other wetlands sampled.

6 Flora

6.1 Flora diversity

6.1.1 Regional and site richness

A total of 284 taxa (species, subspecies and varieties) were recorded from the combined records of the current survey and data from sites sampled for the Pilbara Biological Survey (Lyons. 2015) (see Appendix 9 and Appendix 9). These taxa were distributed amongst 44 families and 146 genera. Dominant families were Poaceae (58 taxa), Asteraceae (32 taxa) Cyperaceae (29 taxa), Chenopodiaceae (27 taxa) Fabaceae (25 taxa). Dominant genera included *Eragrostis* (13 taxa), *Cyperus* (12 taxa), Acacia (7 taxa), *Dysphania* (6 taxa), *Ptilotus* (6 taxa) and *Centipeda* (5 taxa). Introduced taxa represented 6% of the combined survey species and were dominated by grasses (7 taxa).

The relative dominance of families and genera largely parallels the results from the larger dataset compiled for the Pilbara Biological Survey (see Lyons, 2015), where 98 sample sites captured 455 taxa, (see Lyons, 2015).

The current survey recorded a total of 249 taxa, with 140 not recorded for the Fortescue Valley study area by the previous PBS. Conversely, the 12 sites sampled during the previous PBS included 35 taxa that were not recorded from sites sampled during the current survey. These taxa included species that were characteristic of the saline wetlands of the main body of the Fortescue Marsh, including *Swainsona kingii, Mimulus* aff. *repens* and *Triglochin hexagona*. Additionally, a large number of the taxa not shared between the two data sets were from a single PBS site (P39 – Roy Hill Claypan) that contributed 13 annual upland taxa that occurred on the margin of a small claypan and only occurred at this site. These taxa were widespread annual grasses and herbs from the Pilbara.

A selection of recorded plant species are shown in Figure 18.

6.1.2 Conservation significant taxa.

Ten taxa listed on the Department of Biodiversity, Conservation and Attractions' priority flora list (Jones, 2016) were recorded in the combined survey data (Table 8).

- *Eleocharis papillosa* (P3): Known from scattered locations in Western Australia, with numerous populations in central Australia. Previously recorded for the Fortescue Marsh (Lyons, 2015; Markey, 2017). The current survey detected this species just west of Fortescue Marsh at Mulga Downs Outcamp Claypan (FV05A).
- *Eragrostis crateriformis* (P3): Three new records from the Fortescue valley occurred to the east of the main Fortescue Marsh on Ethel Creek Station. Recorded by Markey (2017) on Fortescue Marsh, the Fortescue valley is the southern edge of this taxon's Pilbara distribution. *E. crateriformis* also occurs in central Australia.
- *Eremophila spongiocarpa* (P1): Previously regarded as endemic to the Fortescue Marsh (Markey,2016) the current survey recorded new populations west of the Goodiadarrie Hills. These populations occurred in samphire and non-samphire communities including *Melaleuca glomerata* dominated rises and fringing shrublands at Mungthannannie Pool, and within *Erianchne benthamii* grasslands east of Chaddelinna Pool (FV03A).
- *Helichrysum oligochaetum* (P1): Known from scattered locations in the Pilbara and adjacent Ashburton region. Previously recorded during the PBS on Mulga Downs Station at Koodjeepindarranna, an additional Fortescue valley population was recorded at a small ephemeral creek west of the Mulga Downs homestead (FV38A) during the current survey.
- *Iotasperma sessilifolium* (P3): In Western Australia this species is a near endemic of the Fortescue Valley. It also occurs at scattered locations in central Australia, with a major occurrence in eastern NT and western QLD. In the current survey it was recorded from *Eriachne benthamii and E flaccida* dominated valley floor grasslands and claypans on Mulga Downs Station.
- *Myriocephalus scalpellus* (P1): Endemic to the Fortescue valley this species is known from only 2 locations, Mungthannannie Pool and the type location at Coondiner Pool.
- *Nicotiana heteranthera* (P1): Recorded by Markey (2016) across much of the Fortescue Marsh, this species has additional populations in the coastal Pilbara, Mandora Marsh and southern Kimberley. Recorded in the current survey at 14 Mile and Moorimoordinina Pools.
- *Swainsona thompsoniana* (P3): Known from numerous populations in the central Pilbara and Fortescue Valley. Recorded during the current survey at Yunera Pool.
- *Samolus* sp. Fortescue Marsh (A. Markey & R. Coppen 9702) (P1): Known from the Fortescue Marsh in areas of freshwater ponding and riparian zones of permanent pools. Outliers occur in the Little Sandy Desert. Recorded during the current survey at 14 Mile and Moorimoordinina Pool.
- *Tecticornia* sp. Christmas Creek (K.A. Shepherd & T. Colmer *et al.* KS 1063) (P1): A common component of the samphire communities of the Fortescue Marsh with disjunct occurrences in the Little Sandy Desert. Recorded at Moorimoordinina Pool during the current survey.

Table 8. Priority taxa recorded during the current survey and the PBS (Lyons, 2015). Conservation status follows Jones (2016).

Taxon	**Site records (FV= current survey, P = PBS (Lyons, 2015))**
Eleocharis papillosa (P3)	FV05A, FV31A,P02A,P03A
Eragrostis crateriformis (P3)	FV21A, FV22A, FV43A
Eremophila spongiocarpa (P1)	FV03A, FV04A, FV07A, FV10A, P03A
Helichrysum oligochaetum (P1)	FV38A, P05A
Iotasperma sessilifolium (P3)	FV38A, FV39B
Myriocephalus scalpellus (P1)	FV34A, P01A
Nicotiana heteranthera (P1)	FV31A, FV32A
Rhodanthe ascendens (P1)	FV05A
Samolus sp. Fortescue Marsh (A. Markey & R. Coppen 9702) **(**P1)	FV31A, FV32A
Swainsona thompsoniana (P3)	FV44A

6.1.3 Notable taxa, range extensions and new Pilbara records.

- *Cardamine* aff. paucijuga: A collection of *Cardamine* from Coondiner Pool is the first record of the genus for the Pilbara region and for the Western Australian arid zone. Most taxa within the genus occur in temperate regions of the both the northern and southern hemisphere. Within Australia the greatest diversity is in SE Australia including Tasmania. Further taxonomic work is required to determine the collection to specific level.
- *Isolepis cernua*: This small annual sedge occurs in temperate SW and SE Australia with a single outlier in central Australia. It was recorded at Cowra Claypan (FV005) representing a new record for the Pilbara region and arid zone WA.
- *Isolepis congrua*. This small annual sedge has a wide southern Australian distribution with scattered occurrences in central Australia and the southern Western Australian arid zone. The survey records from Coondiner Pool (FV034) and Mungthannannie (FV11A) are the first records for the Pilbara region.
- *Lachnogrostis filiformis.* Occurring across the temperate, arid and semi-arid southern half of Australia survey, records from Coondiner Pool (FV34A & P01A) represent new records for the Pilbara.
- *Lythrum wilsonii*. Known from several locations in the Carnarvon Basin and a disjunct occurrence near Kalgoorlie, *Lythrum wilsonii* was recorded from the herb rich margins of Mungthannannie (FV11A) and the crabhole *Eriachne* grasslands on Mulga Downs Station (FV39A). A genus with a largely temperate distribution, records in the arid zone probably depend on significant winter rainfall.
- *Polygonum plebeium*. Widely distributed in eastern Australia with five previous records from the southern arid zone of Western Australia, the collections from Jinerabar Pool, 14 Mile Pool and Moorimoordinina Pool (Markey, 2016) are new records for the Pilbara.

- *Spergularia diandroides*: Known previously from two localities in WA with a core distribution in inland SE Australia, *S. diandroides* was collected during the survey at Mungthannannie (FV11). This is the first record for the Pilbara.
- *Eragrostis australasica:* Occurring across the arid and semi-arid southern half of Australia, *E. australasica* was recorded at two disjunct sites, Mulga Downs Outcamp Claypan (FV06) on Mulga Downs Station and a claypan near Jackson Bore (FV25) on Ethel Creek Station. These occurrences are the northern-most records for WA and the only known Pilbara populations. Elsewhere, *E. australasica* is a dominant structural component of ephemeral and seasonal wetlands across much of its range. In the Pilbara, the populations comprise scattered plants.

Figure 18. Selected plant species recorded during the survey. A, *Aeshcyonome indica* along the margin of Coondiner Pool. A cosmopolitan species of wetlands in the tropics and subtropics; B, *Ipomoea diamantinensis*, limited occurrences in the Pilbara are outliers from elsewhere in northern Australia; C, *Marsillea exarta* in the aquatic phase with abundant submerged *Najas* sp; D, *Acacia stenophylla* is the structural dominant of many of the large claypans in the west of the study area; E, *Eragrostis australasica* at Mulga Downs Outcamp claypan, one of only two records in the Pilbara; F, *Peplidium* sp. C. Evol. Fl. Fauna Arid Aust. (N.T. Burbidge & A. Kanis 8158), a widespread lowland herb.

6.2 Weeds

For the combined survey data, the most frequent weed species recorded included *Echinochloa colona* (21 sites), *Malvastrum americanum* (10 sites), *Vachellia farnesiana* (14 sites), and *Cenchrus ciliaris* (12 sites). Whilst formally listed as introduced, *Echinochloa colona* and *Vachellia farnesiana* are regarded as pre-European introductions which may account for their widespread occurrence in the wetlands of the Fortescue Valley (Bean, 2007; Keighery, 2010). Weed impacts in the Fortescue Valley wetlands were not as significant as those observed for some wetlands types (typically larger river pools) sampled for broader Pilbara Biological Survey (Lyons, 2015).

Notable weeds records include;

- *Gnaphalium polycaulon*: Known from numerous locations across much of eastern Australia and the Kimberley (CHAH, 2017) this species was recorded for the first time in the Pilbara from a single site at Coondiner Pool (P01A).
- *Cyperus hamulosus*: With scattered occurrences across much of inland Australia, this weed has a near cosmopolitan distribution but was not previously recorded from the Pilbara. Recorded during the current study at Mungthannannie (FV11A).
- *Echinochloa microstachya*: Native to Nth America, ‘Prickly Barnyard Grass’ occurs in south-eastern Australia as a weed of irrigated crops and their surrounds. The only previous potential Western Australian record is a specimen cultivated in Canberra from seed sourced from the CSIRO Kimberley Research Station (Kununurra) in 1962. The exact origin of the seed material is unknown so it may not represent a collection from a Western Australian naturalized population. *Echinochloa microstachya* was recorded from Koodjeepindarranna Pool (FV17) and the Fortescue River at the Mulga Downs – Mt. Florence boundary (FV41).

6.3 Riparian site classification

6.3.1 Site groups

Quadrat data from the PBS and current survey were combined to produce a species by site matrix for analysis. For both surveys, seasonal samples were combined to produce a single species list for each quadrat. To simplify interpretation of the cluster analysis, a reduced data set was generated, where species occurring at a single site (singletons) were removed. Comparison of the full and reduced matrices (RELATE routine in Primer) revealed the two to be highly correlated (Rho= 0.99, P<0.001).

A dendrogram produced by clustering analysis (see Methods) is shown in Figure 19. Significant branches in the dendrogram were determined (SIMPROF routine in Primer, P<0.05) and the final site groups determined at a higher level within the dendrogram structure.

To examine the validity of combining data from different surveys (albeit by the same researcher and applied methodology) the group membership of sites from different surveys was examined. Quadrats from the different surveys sampling the same wetlands classified together with the exception of FV36A and P41A that sampled the margin of a small claypan (see group 5 below). Other sites sampled for the PBS classified with FV valley sites that shared similar environmental attributes. Together these observations confirm the veracity of combining the survey datasets.

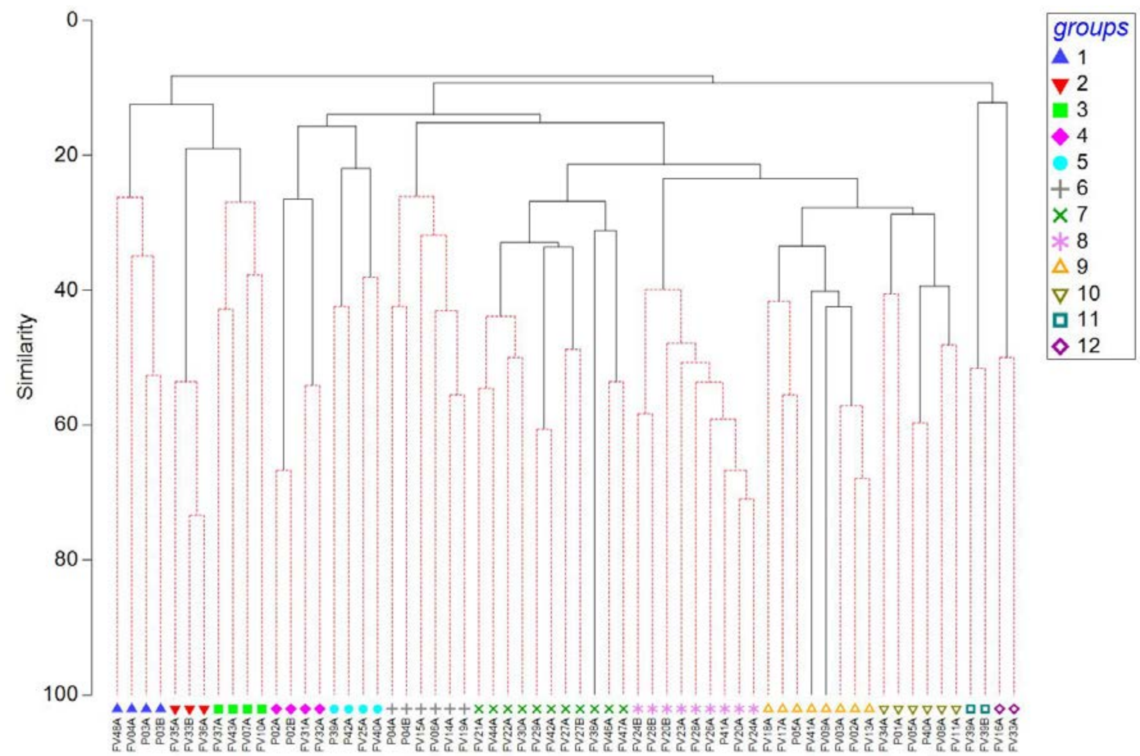


Figure 19. Cluster analysis of floristic sites sampled during the current study (FV codes) and sites within the study area, sampled during the Pilbara Biological Survey (P codes) (Lyons, 2015). Cluster groups are based on the floristic composition of sites with species only occurring at a single site (singletons) excluded. Branches significant at P<0.05 are solid lines.

Twelve site groups were identified from the dendrogram coupled with examination of a site by species matrix reordered by the site and species (not shown) clustering groups. Some groups were delineated and considered robust, despite containing very few quadrats, since they represented distinct wetland types and associated plant communities (e.g. group 11 & 12). The groups are described below in terms of wetland morphology, spatial distribution, and structural vegetation types. Figure 20 shows the results of an ordination analyses of the same flora matrix while Figure 21 shows the sampling locations classified by cluster group to show the how the grouping structure varied across the study area. Diagnostic species were derived for each group using the SIMPER routine in Primer for taxa contributing >10% to group similarity.

Group 1: A group of four sites including two sampled during the PBS on the main body of the Fortescue Marsh (Figure 21) and a samphire marsh immediately to the west of the Goodiadarrie Hills sampled during the current survey. The group included *Tecticornia spp, Eremophila spongiocarpa*, and *Muellerolimon salicorniaceum* shrublands and low shrublands. Species richness was low (9 to 13 taxa) and sites showed the highest mean soil electrical conductivity (452.5 mS/m) of all groups. Taxa such as *Tecticornia indica*, *Nicotiana rostulata*, *Cyperus bulbosus* and *Eragrostis dielsii* (upright Fortescue Marsh form) were significant from the SIMPER analysis. The inclusion of site FV48A (a ground water fed river pool) in this group is an artefact of it being species poor and sharing a few species with the remaining sites that are more typical of the halophytic plant communities of the Fortescue Marsh (e.g. *Cyperus bulbosus*). The group illustrates that some of the taxa (e.g. *Eremophila spongiocarpa*), and vegetation types (e.g. FV04A) typical of the Fortescue Marsh have occurrences that extend to the west Fortescue Marsh Land system (van Vreeswyk *et al.*, 2004) in the vicinity of the Goodiadarrie Hills.

Group 2: A group of three sites sampling the margins of small shallow claypans on Roy Hill Station (Figure 21). The wetlands were set in broad plains of *Acacia* shrubland over *Triodia* occurring on the Nambung and Divide land systems (see Figure 1) on Roy Hill Station. Soils on the margins are sandy compared to the claypan basin. The group is characterised by a shared suite of annual herbs and grasses including *Cynodon prostratus, Bulbostylis microcarya, Dactyloctenium radulans, Sclerolaena cuneata* and *Portulaca* spp*.* Species richness ranged from 15 to 19 species per quadrat. These wetlands do not have a significant riparian flora *per se,* but after rain their bare sand strewn margins provide habitat for a range of widespread largely annual taxa that occur within the surrounding *Acacia* and *Triodia* dominated vegetation.

Group 3: A group of three sites sampling the moderately elevated dunes that occur in the basin and edges of Mungthannannie Pool and a low rise within a large claypan NE of Howards Dam (FV37A). A fourth quadrat (FV43A) was species poor yet shared overstorey taxa with the Mungthannannie sites. The group consisted of *Eucalyptus victrix* open woodlands over shrublands of *Melaleuca glomerata, Acacia stenophylla* and *A. tetragonophylla.* The group appears naturally species poor (mean richness 17 species per quadrat) with the dunes at Mungthannannie Pool the most elevated sampled during the survey, and lacking many of the annual taxa recorded on lower elevation damp wetland margins.

Group 4: These four sites occur at the eastern end of the Fortescue Marsh, and sampled the riparian margins of Moorimoordinina Pool, 14 Mile Pool and areas of the adjacent marsh flats sampled during the PBS (P02A & B). The group reflects the large compositional differences between the Marsh and the other wetlands of the study area. The group includes *Eucalyptus camaldulensis* woodlands and *Acacia ampliceps* shrublands along the pool banks, and the open shrublands of *Muellerolimon salicorniaceum* and *Tecticornia* spp. of the adjoining flats. Significant species in defining the group include *Cressa australis*, *Muellerolimon salicorniaceum, Cyperus bulbosus, Eleocharis papillosa* and *Heliotropium curassavicum.* The group showed lower soil EC (97.3 mS/m) than other sites on the Fortescue Marsh (cf. group 1 , 452.5 mS/m).

Far greater resolution of the plant communities of the Fortescue Marsh is provided by Markey (2016), where the pool banks and flats are characterised and mapped as two separate community types.

Group 5: An artefactual group of four claypan edges from Roy Hill and Ethel Creek stations. They share a small number of widespread wetland related taxa including *Centipeda minima, Alternathera nodiflora,* and *Vachellia farnesiana* coupled with a variable complement of widespread non-wetland annuals including *Glinus lotoides, Portulaca oleracea,* and *Chloris pectinata.* The group includes Howards Dam (FV40A) which had received little rain when sampled in August 2016. The two claypan sites on Ethel Creek (P42A & FV25A) occur nearby to one another between low rises dominated by *Acacia synchronicia*, suggesting significant grazing impacts in this area. Site P39A sampled during the PBS was species rich and dominated by non-wetland annuals. The margin of same wetland, sampled during the current survey (FV36A), classified with site group 3 suggesting these highly ephemeral relatively bare claypan margins are sensitive to seasonal differences.

Group 6: A group of six large claypans occurring exclusively on Mulga Downs Station and dominated by sites within the Gnalka Gnoona claypan. The site also included the basin plant community of Mulga Downs Outcamp claypan (FV06A) immediately west of the Goodiadarrie Hills. The very broad margins of these large pans are subject to prolonged inundation and relatively species poor with richness in the group ranging from 5 to 26 species. The group included open *Acacia stenophylla* shrublands and very open woodlands of *Eucalyptus victrix*. Sparse understory shrublands of *Duma florulenta* and *Tecticornia verrucosa* occurred at three sites. Important species in defining the group included *Sporobolus mitchellii, Bergia perennis, Tecticornia verrucosa* and *Acacia stenophylla*. *A. stenophylla* occurs across much of inland eastern Australia with the occurrences in the Fortescue valley a major disjunction form its core distribution. It is the dominant overstorey tree/large shrub in many of the large claypan wetlands on Mulga Downs, but is absent from the wetlands sampled in eastern part of the study area.

Group 7: A group of eleven, exclusively riverine sites, occurring across the full geographic extent of the study area. The only riverine pools not included in the group occurred at the eastern end of the Fortescue Marsh (see group 4) and the atypical site FV048 (see group 1). The group included two permanent and nine intermittent creek pools. The sites sampled pool banks and were typically open *Eucalyptus victrix* woodlands over relatively species rich grass and herbaceous ground layers. Shrub layers were commonly present, and variably included *Melaleuca glomerata, Vachellia farnesiana, Acacia distans, A. tetragonophylla, A. coriacea* subsp*. pendens* and *Duma florulenta*. Species richness ranged from 20 to 38 taxa per quadrat. Diagnostic species from SIMPER results included *Eucalyptus victrix, Rostellularia adscendens* var*. clementii, Cyperus bifax, Vachellia farnesiana,* and *Eriochloa psuedoacrotricha*.

Group 8. A geographically and compositionally discrete (average group similarity 48.7) group of 9 sites, that all occurred in the eastern part of the study area on Balfour Downs (8 sites) and Ethel Creek Stations (FV041A). They were characterised by the presence of open woodlands of *Eucalyptus victrix* over understoreys consistently dominated by *Eleocharis pallens* with variable occurrence of *Eriachne benthamii* and *E. flaccida.* Many sites had closed low swords of *Marsilea* spp. within the riparian zone and across the wetland basin. A feature of several of these wetlands was significant gilgai development within the wetland basin and margins. In this eastern part of the study area crabhole (gilgai) flats immediately adjacent to wetlands were dominated by *Eleocharis pallens* rather than *Eriachne* spp. as seen in the western part of the study area. Species richness was relatively low ranging from 9 to 19 taxa per quadrat, driven by the absence of many annual herbaceous taxa recorded elsewhere. SIMPER analysis revealed *Eleocharis pallens, Schoenoplectus laevis, S. dissacanthus, Marsilea* spp*. Aeschyonome indica,* and *Eucalyptus victrix* as diagnostic of the group.

Group 9. A group of eight sites occurring on Mulga Downs Station including floodplain wetlands, small floodplain channels, large wooded claypans and a single intermittent creek (FV013). Species richness ranged from 27 to 41 taxa per quadrat. The relative species richness of the group (mean 31 taxa per quadrat) was the product of the presence of a large number of herbaceous taxa, including *Mimulus gracilis, Bergia perennis, Ammannia multiflora* and *Myriocephalus oldfieldii*. The group included all sites within the Koodjeepindarranna wetlands complex on Mulga Downs Station, sampled during the current survey (FV17A, 18A) and the PBS (P05A). Structurally the sites included open woodlands or isolated trees of *Eucalyptus victrix* over *Acacia distans, A. stenophylla* and *A. tetragonophylla* open shrublands over sparse herb and sedge layers.

Group 10: A group of six large wooded claypans and linear turbid creek pools. The group included quadrats sampling the herb rich margins of mostly non-riverine wetlands with species richness ranging from 21 to 55. Quadrats established at Coondiner Pool (creek pool) sampled during both the current (FV34A) survey and the PBS (P01A) clustered together in this group. The lower riparian edges of Mulga Downs Outcamp claypan (sampled during both surveys, FV05A, P40A) and Mungathannannie Pool also classified with Coondiner Pool quadrats. The group included Species delineating the group were dominated by annual herbs and grasses, including *Centipeda thespidioides, C. pleiocephala, Eragrostis tenellula, Cyperus iria, C. rigidellus, Mimulus gracilis* and *Alternanthera denticulata*.

The wetlands in the group were set in the broad basins between moderately elevated rocky terrain, with the Goodiadarrie Hills and First Hill occurring in the vicinity of Mungthannannie Pool and Mulga Downs Outcamp Claypan, and low rocky ridges framing the drainage line at Coondiner Pool. This was in contrast to group 9 described above, with those wetlands sitting within the broad floodplain of the western part of Mulga Downs Station. The absence of the dominant floodplain tussock grasses (*Eriachne benthamii,* and *E. flaccida*) from group 10 reflects its contrasting geomorphological setting to group 9.

Group 11: Two sites sampling *Eriachne benthamii* floodplain ‘crabhole’ grasslands in the western part of Mulga Downs. These floodplain grasslands are extensive on Mulga Downs Station in the vicinity of the Roebourne – Wittenoom Road, and in the eastern area of the station in the vicinity of Chaddelinna Pool. The two sampled sites were characterised by the presence of *Eriachne benthamii, Lotus cruentus, Cullen graveolens, Centipeda minima,* and *Lythrum wilsonii.*

The degree of crabhole (gilgai) development was variable across the extent of these grasslands. Sampling access was difficult so some additional sampling would be valuable to resolve in more detail the compositional differences between sites with deeper crabholes (this group) and *Eriachne* dominated floodplain areas with more subdued microtopography.

Group 12: This group of two sites contained two ephemeral claypans with beds dominated by species poor stands of *Eriachne benthamii* s.l. Species richness was extremely low (2 species). The only other taxa present were *Leptochloa fusca* subsp. *muelleri* and *Aeschynomene indica*. Not all morphologically similar and small ephemeral claypans (which otherwise have bare basins) supported these very species poor grasslands, which probably relates to their subtlety different hydroperiods. Some small localised depressions within the beds of otherwise very large and essentially flat claypans such as Gnalka Gnoona also contain this plant community (see Figure 4C).

Species composition varies along a continuum whereas the dendrogram forces sites into discrete groups. To visualise the degree to which these groups represent distinct floristic community types they are overlain on a three-dimensional ordination (see Methods) in Figure 20. In this graph, sites that are more floristically similar are placed closer together and sites that are more floristically dissimilar are placed further apart. In order to examine the compositional variation within and between the circumscribed groups, non-metric multidimensional scaling ordination (nMDS, 50 starts; Primer-E Ltd, 2008) was used to generate a 3-dimensional representation that best matches the original matrix of site resemblances based on their species composition.

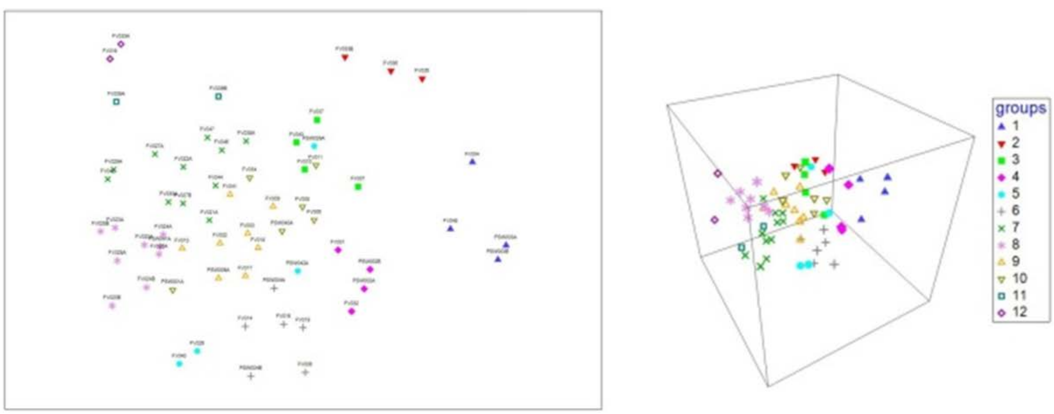


Figure 20. Two and three dimensional nMDS ordinations of FV and PBS flora sites based on their species composition. Group symbols match those from the dendrogram in Figure 19. (Stress values; 2D = 0.23, 3D = 0.17).

Whilst the grouping structure in the dendrogram is statistically significant (SIMPROF results), in 3D (and 2D) space the groups are less clearly separated, suggesting that several groups are compositionally closely related. Some groups however were compositionally very distinct and well separated in ordination space including the river pools and flats of the Fortescue Marsh (group 4, Figure 20Figure 21). Albeit with very few samples, the basins and margins of small ephemeral claypans (groups 2 & 12) are also compositionally separated from the remaining sites. The more intensive sampling of the current survey has also revealed a relatively discrete group of river pools that occur along the main drainage line in both the eastern and western parts of the study area (group 7, Figure 20Figure 21). This contrasts somewhat with the results of the PBS, which sampled the full range of Pilbara wetlands including large rivers, springs and groundwater fed river pools (Lyons, 2015). At the broader regional scale of the PBS, smaller riverine pools with fine textured soils (and often turbid water) were not always clearly separated from many claypans and floodplains channels. The current survey therefore has markedly improved the resolution of riverine vs non-riverine wetlands in the study area.

Group 8 is also relatively discrete in ordination space reflecting greater compositional homogeneity that other groups with larger numbers of sites (Figure 20). These claypans are restricted to the east of the study area on Ethel Creek and Balfour Downs (Figure 21).

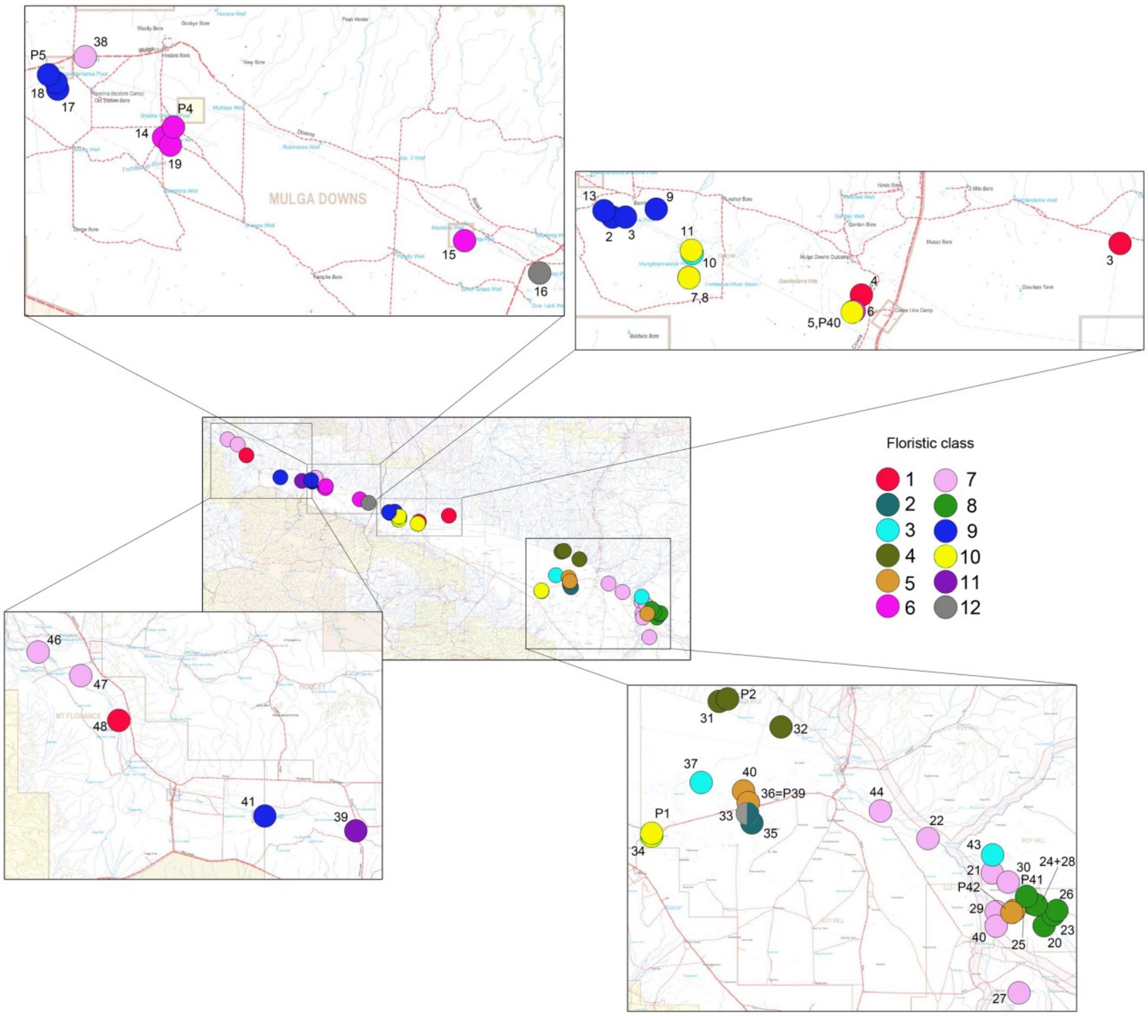


Figure 21. Map showing the distribution of site groups coloured according to their membership of groups based on their floristic composition. Where different quadrats from the same wetland were in different cluster groups, the symbol for the site is segmented accordingly. Quadrats sampled during the PBS have a P prefix.

6.4 Spatial patterning and environmental correlates

For descriptive purposes some of the spatial and environmental attributes characterising the riparian environments of the wetlands of the study area have been included in the group descriptions above. An explicit analysis of the relationships between riparian plant composition and environmental attributes was undertaken using the matrix correlation (Relate) and distance based modelling (DistLM) routines in Primer.

Preliminary analysis revealed a significant relationship between the similarity matrix based on plant species composition and a single similarity matrix based on environmental variables, including soil physical and chemical attributes, riverine vs lacustrine wetlands, and longitude ($R=0.42$, $p<0.001$).

To identify which of the variables are potentially important in influencing plant species composition (or at least useful surrogates for actual environmental drivers) each environmental variable's contribution was assessed.. As per the analysis of environmental variables influencing invertebrate composition, we used the distance based linear modelling routine DistLM in Primer. Inclusion of all 12 variables in the model produced an adjusted R^2 of 0.41 (excluding two non-significant variables) (Table 9). Thus, in decreasing order of variance explained, EC (1:5), position along the valley (Longitude), Riverine vs lacustrine, Sand %, pH (H^2O), three soil cations (K^+, Ca^{2+}, Na^+), Silt% and Soil Organic C% explained 41% of the variation in floristic composition. The values of selected variables are shown in Figure 22 for each cluster group.

Table 9. Results of distance- based linear modelling of riparian plant community composition against environmental variables.

Variable	**SS(trace)**	**Pseudo-F**	**Significance (p)**	**Marginal proportion of variance explained (R^2)**	**Cumulative proportion of variance explained (R^2)**
EC (1:5)	18994	5.67	0.001	0.09	0.09
Longitude	12521	3.91	0.001	0.06	0.14
Riverine / lacustrine code	11886	3.90	0.001	0.05	0.19
Sand %	10599	3.63	0.001	0.05	0.24
pH (H2O)	8745.2	3.10	0.001	0.04	0.28
K ex	6752.8	2.46	0.001	0.03	0.31
Ca ex	5769.1	2.14	0.004	0.03	0.34
Na ex	5897.5	2.24	0.001	0.03	0.36
Silt %	5259.5	2.03	0.007	0.02	0.39
OrgC	4277.3	1.68	0.032	0.02	0.41
Mg ex	3345.3	1.32	NS	0.01	0.42
Clay %	2546.4	1.00	NS	0.01	0.43

High EC is a feature of group 1 & 2 (marsh pools and flats) and 4 (some upper margins of small ephemeral clay pans).The inclusion of EC in the model highlights the dominant variation in riparian floristic composition along the Fortescue valley is the distinction between the main body and eastern pools of the Fortescue Marsh, from the remaining riverine and non-riverine wetlands of the study area.

Additional floristic variation is related to the difference between riverine and non-riverine (lacustrine) wetlands amongst non-marsh wetlands. This is largely driven by group 7 which includes most of the river banks of pools along the main drainage lines of Jigalong Creek and the Fortescue River east and west of the marsh (Figure 21 & Figure 22).

Longitude is significant in the model and reflects the geographic distribution of cluster groups illustrated in Figure 21 & Figure 22. For non-riverine wetlands the cluster groups partition in fairly discrete longitude classes along the valley (Figure 22; groups 4-6 & 9-10). As suggested for the aquatic invertebrate DistLM analysis (see section 5.3.1) longitude is acting as a surrogate for habitat attributes that probably varying discontinuously along the valley which we were unable to measure. Here position along the valley (codified as longitude) might be integrating a number of contrasting wetland attributes including connectivity, geomorphological and hydrological setting that is reflected in wetland morphology and hydroperiod.

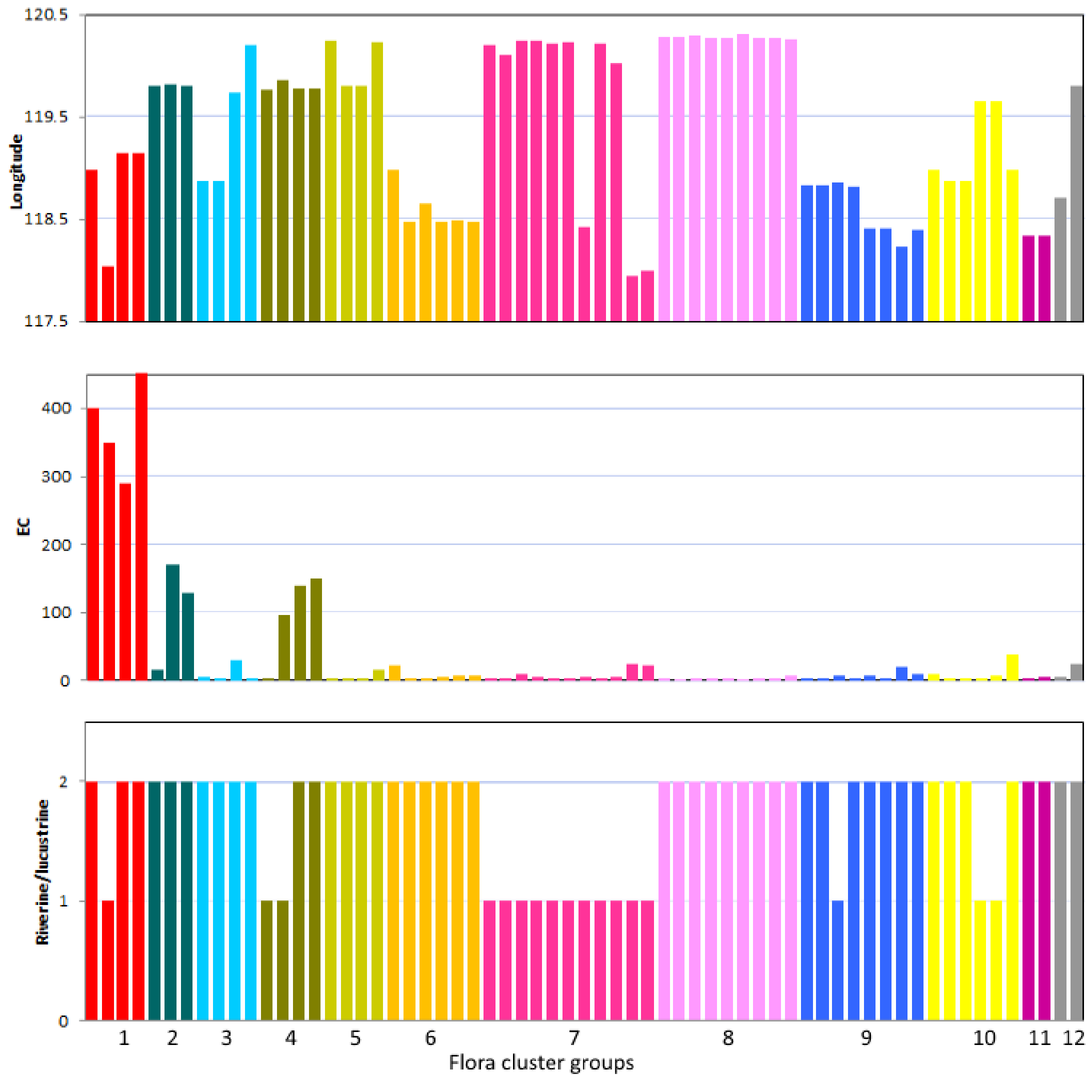


Figure 22. Selected environmental variables identified as important in DistLM analysis of the riparian flora data. Values for EC at site in group 1 are truncated (P03B=770 mS/m). For riverine/lacustrine categories; riverine sites =1, lacustrine sites =2.

6.5 Summary of flora biodiversity values and distribution patterns.

- The rivers and the diverse array of non- riverine wetlands sampled along the middle and upper Fortescue valley have a rich flora (about 280 species) including populations of ten species of conservation significance.
- Greatest spatial patterning in riparian plant biodiversity occurs in the non-riverine wetlands of the valley. The *Eriachne* dominated grasslands, large claypans on Mulga

Downs, claypans on Ethel Creek and Balfour Downs, and the Fortescue Marsh capture different elements of the Fortescue Valley's wetland plant communities.

- A small number of wetlands capture most of the restricted elements of the Pilbara riparian flora, including Coondiner Pool, Mulga Downs Outcamp Claypan, Mungthanannie Pool and Koodjeepindarranna Pool.
- The flora of the river pools of the Fortescue River and Jigalong Creek are distinct from the non-riverine wetlands and similar along the length of the valley.

7 Implications for wetland conservation planning

The above analyses of wetland biodiversity patterning across the Fortescue Valley lead to several principles to guide the spatial configuration of wetland conservation planning, outlined below. These are primarily based on to how to efficiently represent wetland biodiversity in wetland management programs. As the study area is largely on pastoral lands, other factors, including economics and stock management, will influence configurations of which wetlands are protected and how.

1. Wetland biodiversity is not uniformly distributed across the study area. The four areas sampled for this project (Mount Florence, Mulga Downs, Roy Hill south of Fortescue Marsh and the upper Fortescue/Jigalong Creek floodplain), support different assemblages of wetland flora and fauna, partly driven by differing substrates, water chemistry, hydrology and geomorphology. Incorporating this information into wetland management programs will increase the proportion of the area's wetland biodiversity protected.
2. Of these four areas, the claypans on Roy Hill Station south of Fortescue Marsh have lowest diversity of aquatic invertebrates and only modest plant biodiversity values. While these represent a distinct wetland type (highly turbid, very shallow and short-lived pans) and do have some distinct elements in their flora and fauna, they do not seem to be subject to much disturbance by stock, at least when visited during this project. Claypans on Mulga Downs and Ethel Creek/Balfour Downs have much richer wetland associated communities and are subject to greater disturbance by stock and so are a higher priority for conservation efforts.
3. Floodplain wetlands are variably connected in space and time and support metacommunities that are more diverse than present at any one wetland. On average, a single wetland had 10 % of the total invertebrate fauna and 7% of the total flora recorded across this project and the PBS. The mix of species at a wetland will fluctuate over time (especially for the invertebrates) in response to natural changes in habitats and due to dispersal. It therefore makes ecological sense to consider suites of interconnected wetlands rather than single wetlands, during conservation planning, to protect the full range of habitats and areas used by species over time. Moreover, wetlands are partly a function of their broader catchment so larger scale land management can also help to maintain wetland ecosystems.
4. Samples from the larger claypans on Mulga Downs (Mulga Downs Outcamp, Mungthannannie, Gnalka Gnoona and Koodjeepindarranna) plus Powellinna Pool on the Mulga Downs/Mount Florence boundary and the smaller claypans on Ethel Creek and Balfour Downs, had the highest number of invertebrate species that are likely to be characteristic of the study area. The same larger Mulga Downs claypans, plus Coondiner Pool captured most of the restricted elements of the Pilbara riparian flora. A focus on these wetlands could help protect these species at a Pilbara or wider scale.

5. Fortescue Marsh was not the focus of this project but is widely recognised as having significant biodiversity values and requiring management to preserve these.
6. The larger and more morphologically diverse claypans, especially those on Mulga Downs, such as Mungthannannie and Mulga Downs Outcamp claypan, have complexes of different wetland habitats on their periphery, which, taken together, support more species than smaller simpler wetlands. Representation of these in wetland management programs will be important.
7. Waterbirds were not surveyed during this project, but the larger claypans and river pools tend to support greater numbers and diversity of waterbirds than smaller shallower wetlands. This provides another reason to prioritise the larger Mulga Downs wetlands.
8. Plant and invertebrate communities in and along river channels differ from those of the associated floodplain wetlands so management plans should include both and consider the critical ecological linkages between rivers and their floodplain wetlands, especially on the Jigalong Creek/Fortescue River floodplain. River pools tend to be especially impacted by stock as they are often the last places to retain water during dry periods.
9. Pastoral management to enhance wetland biodiversity conservation needs to focus on changes to stock management during dry seasons (and years) when few wetlands hold water and remaining wetlands are reduced in extent. This is when stock tend to concentrate on the few wetlands that still retain water and when disturbance is greatest. This principal might guide the fencing of targeted wetlands, provision of alternative stock watering infrastructure and spatial management of stock numbers.

8 References

Alexander P., Nielsen D.L. & Nias D. (2008) Response of wetland plant communities to inundation within floodplain landscapes. *Ecological Management and Restoration* **9**, 187–195.

Amoros C. & Bornette G. (2002) Connectivity and biocomplexity in waterbodies of riverine floodplains. *Freshwater Biology* **47**, 761–776.

Aquatic Research Laboratory (2004) *Buntine-Marchagee Natural Diversity Recovery Catchment (BMRC). Wetland Invertebrate Fauna Monitoring: August 2004. Report to the Department of Conservation and Land Management*. Aquatic Research Laboratory, University of Western Australia, Perth.

Australian and New Zealand Environment and Conservation Council (ANZECC) & Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. ANZECC & ARMCANZ, Canberra.

Australian Government (2004) *Interim Biogeographic Regionalisation of Australia v6.1. http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html accessed 30 June 2011*.

Bean A.R. (2007) A new system for determining which plant species are indigenous in Australia. *Australian Systematic Botany* **20**, 1–43.

Bishop-Taylor R., Tulbure M.G. & Broich M. (2017) Surface-water dynamics and land use influence landscape connectivity across a major dryland region. *Ecological Applications* **27**, 1124–1137.

Boulton A.J. & Jenkins K.M. (1998) Flood regimes and invertebrate communities in floodplain wetlands. In: *Wetlands in a Dry Land: Understanding for Management*. (Ed. W.D. Williams), pp. 137–148. Environment Australia, Canberra.

Boulton A.J. & Lloyd L.N. (1992a) Flooding frequency and invertebrate emergence from dry floodplain sediments of the River Murray. *Regulated Rivers Research and Management* **7**, 137–151.

Boulton A.J., Peterson C.G., Grimm N.B. & Fisher S.G. (1992b) Stability of an aquatic macroinvertebrate community in a multiyear hydrologic disturbance regime. *Ecology* **73**, 2192–2207.

Bunn S., Balcombe S.R., Davies P.M., Fellows C.S., McKenzie-Smith F.J. & Kingsford R. (2006) *Aquatic productivity and food webs of desert river ecosystems*. Cambridge University Press, Melbourne.

Bunn S.E., Davies P.M. & Winning M. (2003) Sources of organic carbon supporting the food web of an arid zone floodplain river. *Freshwater Biology* **48**, 619–635.

Bureau of Rural Sciences (2009) Digital Atlas of Australian Soils. Bioregional Assessment Source Dataset. Viewed 05 July 2017.

Burrows D.W. (2000) *Literature Review of the Potential Impacts of Grazing on Aquatic and Riparian Ecosystems in the Australian Dry Tropical Rangelands*. Australian Centre for Tropical Freshwater Research. James Cook University, Townsville.

Casanova M.T. & Brock M.A. (2000) How do depth, duration and frequency of flooding influence the establishment of wetland plant communities? *Plant Ecology* **147**, 237–250.

CHAH (2014) *Australia's Virtual Herbarium. The Council of Heads of Australasian Herbaria. http://avh.chah.org.au. [Last accessed July 2017].*

Department of Environment and Conservation (2009) *Resource Condition Report for Significant Western Australian Wetland: Fortescue Marshes.* Department of Environment and Conservation, Perth, Western Australia.

Doupé R., Morgan D.L., Gill H. & Rowland A.J. (2004) Introduction of redclaw crayfish Cherax quadricarinatus (von Martens) to Lake Kununurra, Ord River, Western Australia: prospects for a 'yabby' in the Kimberley. *Journal of the Royal Society of Western Australia* **87**, 187–191.

Environmental Protection Authority (2013) *Environmental and water assessments relating to mining and mining-related activities in the Fortescue Marsh management area*. Environmental Protection Authority, Perth.

Geddes M.C., De Deckker P., Williams W.D., Morton D.W. & Topping M. (1981) On the chemistry and biota of some saline lakes in Western Australia. *Hydrobiologia* **82**, 201–222.

Gibson L.A., Williams K.J., Pinder A.M., Harwood T.D., McKenzie N.L., Ferrier S., Lyons M.N., Burbidge A.H. & Manion G. (2015) Compositional patterns in terrestrial fauna and wetland flora and fauna across the Pilbara biogeographic region of Western Australia and the representativeness of its conservation reserve system. *Records of the Western Australian Museum, Supplement* **78**, 515–545.

Gibson N., Keighery G.J. & Lyons M.N. (2000) The flora and vegetation of the seasonal and perennial wetlands of the southern Carnarvon Basin, Western Australia. *Records of the West Australian Museum* **Supplement 61**, 175–216.

Glasby C.J., Fiege D. & Van Damme K. (2014) Stygobiont polychaetes: notes on the morphology and the origins of groundwater *Namanereis* (Annelida: Nereididae: Namanereidinae), with a description of two new species: Two New Species Of Groundwater *Namanereis*. *Zoological Journal of the Linnean Society* **171**, 22–37.

Government of Western Australia (2017) *Pilbara Conservation Strategy*. Government of Western Australia, Perth.

Halse S., Shiel R.J. & Williams W.D. (1998) Aquatic invertebrates of Lake Gregory, northwestern Australia, in relation to salinity and ionic composition. *Hydrobiologia* **381**, 15–29.

Halse S.A., Shiel R.J., Storey A.W., Edward D.H.D., Lansbury I., Cale D.J. & Harvey M.S. (2000) Aquatic invertebrates and waterbirds of wetlands and rivers of the southern Carnarvon Basin, Western Australia. *Records of the Western Australian Museum* **Supplement 61**, 217–265.

Hamilton N. (2016) *ggtern: An Extension to 'ggplot2', for the Creation of Ternary Diagrams. R package version 2.2.0. https://CRAN.R-project.org/package=ggtern*.

Hancock M.A. & Timms B.V. (2001) Ecology of four turbid clay pans during a filling-drying cycle in the Paroo, semi-arid Australia. *Hydrobiologia* **479**, 95–107.

Hermoso V., Kennard M.J. & Linke S. (2012) Integrating multidirectional connectivity requirements in systematic conservation planning for freshwater systems. *Diversity and Distributions*, no-no.

Heydenrych B., Parsons B. & Berkinshaw T. (2015) *Conservation Action Plan for the Pilbara: Summary Report*. Greening Australia, Perth.

Hillman T.J. & Quinn G.P. (2002) Temporal changes in macroinvertebrate assemblages following experimental flooding in permanent and temporary wetlands in an Australian floodplain forest. *River Research and Applications* **18**, 137–154.

James C.S., Thoms M.C. & Quinn G.P. (2008) Zooplankton dynamics from inundation to drying in a complex ephemeral floodplain-wetland. *Aquatic Science* **70**, 259–271.

Jones A. (2016) *Threatened and Priority Flora List for Western Australia*. Department of Parks and Wildlife, Western Australia.

Kauffman J.B. & Krueger W.C. (1984) Livestock Impacts on Riparian Ecosystems and Streamside Management Implications... A Review. *Journal of Range Management* **37**, 430.

Keighery G. (2010) The naturalised vascular plants of the Pilbara region, Western Australia. *Records of the Western Australian Museum, Supplement* **78**, 299–311.

Koste W. (1978) *Die Raedertiere Mitteleuropas, I. Textband*. Borntraeger, Stuttgart.

Lake P.S., Bayly I.A.E. & Morton D.W. (1989) The phenology of a temporal pond in western Victoria, Australia with special reference to invertebrate succession. *Archiv fur Hydrobiologie* **115**, 171–202.

Leighton K.A. (2004) Climate. In: *An inventory and condition survey of the Pilbara region, Western Australia. Technical Bulletin No. 92*. (Eds A.M.. Van Vreeswyk, A.L. Payne, K.A. Leighton & P. Hennig), pp. 19–38. Western Australian Department of Agriculture, Perth , Western Australia.

Lyons M.N. (2015) The riparian flora and plant communities of the Pilbara region of Western Australia. *Records of the Western Australian Museum, Supplement* **78**, 485–513.

Markey A. (2017) *Floristic survey And mapping of the riparian and halophyte dominated communities on the Fortescue Marsh (Martuyitha), Western Australia. DRAFT VERSION*. Department of Parks and Wildlife, Perth , Western Australia.

Martens K., Halse S. & Schon I. (2012) Nine new species of Bennelongia De Deckker & McKenzie, 1981 (Crustacea, Ostracoda) from Western Australia, with the description of a new subfamily. *European Journal of Taxonomy* **8**, 1–56.

Martens K., Halse S. & Schön I. (2013) On the *Bennelongia barangaroo* lineage (Crustacea, Ostracoda) in Western Australia, with the description of seven new species. *European Journal of Taxonomy* **0**, 1–59.

Martens K., Halse S. & Schön I. (2015) On the Bennelongia nimala and B. triangulata lineages (Crustacea, Ostracoda) in Western Australia, with the description of six new species. *European Journal of Taxonomy* **0**.

McFarlane D. & Hodgson G. (2015a) Chapter 2. Overview of the Region. In: *Pilbara Water Resource Assessment: Lower Fortescue Hedland region. A report to the Government of Western Australia and industry partners from the CSIRO Pilbara Water Resource Assessment*. CSIRO, Land and Water, Perth.

McFarlane D.J., Hodgson G., Barron O., Commander P. & Silberstein R. (2015b) Chapter 2. Overview of the Region. In: *Pilbara Water Resource Assessment: Upper Fortescue Region. A report to the Government of Western Australia and industry partners from the CSIRO Pilbara Water Resource Assessment*. CSIRO Land and Water.

McKenzie N.L., van Leeuwen S. & Pinder A.M. (2009) Introduction to the Pilbara biodiversity survey, 2002 - 2007. *Records of the Western Australian Museum Supplement* **78**, 3–89.

Natural Resources Northern and Yorke (2014) Stock management on watercourses.

Ng Y.H. (1991) *Assessment of the hydrologic impact of Ophthalmia Dam*. Water Authority of Western Australia, Perth , Western Australia.

Oksanen J., Blanchett F.G., Kindt R., Legendre P., Minchin P.R., O'Hara R., Simpson G.L., Solymos P., Stevens M.H.H. & Wagner H. (2017) *Vegan: Community Ecology Package, v2.0-8*.

Payne A.L. & Mitchel A.A. (1999) *An assessment of the impact of Ophthalmia Dam on the floodplains of the Fortescue River on Ethel Creek and Roy Hill Stations*. Department of Agriculture and Food, Western Australia.

Pesce G.L., de Laurentiis P. & Humphreys W.F. (1996) Copepods from ground waters of Western Australia. I. The genera Metacyclops, Mesocyclops, Microcyclops and Apocyclops (Crustacea: Copepoda: Cyclopidae). *Records of the Western Australian Museum* **18**, 67–76.

Pettit N.E. (2002) riparian vegetation of permanent waterhole on Cooper Creek, southwest Queensland. *Proceedings of the Royal Society of Queensland* **10**, 15–25.

Pinder A., Halse S.A., McRae J.M. & Shiel R.J. (2005) Occurrence of aquatic invertebrates of the wheatbelt region of Western Australia in relation to salinity. *Hydrobiologia* **543**, 1–24.

Pinder A.M., Halse S.A., McRae J.M. & Shiel R.J. (2004) Aquatic invertebrate assemblages of wetlands and rivers in the Wheatbelt region of Western Australia. *Records of the Western Australian Museum* **Supplement 67**, 7–37.

Pinder A.M., Halse S.A., Shiel R.J. & McRae J.M. (2010) An arid zone awash with diversity: patterns in the distribution of aquatic invertebrates in the Pilbara region of Western Australia. *Records of the Western Australian Museum* **Supplement 78**, 205–246.

Pinder A.M. & Leung A. (2009) *Conservation status and habitat associations of aquatic invertebrates in pilbara coastal river pools*. Department of Environment and Conservation, Perth.

Pinder A.M., Quinlan K., Cale D.J. & Shiel R.J. (2013) *Invertebrate community development over a hydrological cycle in seasonal claypans of Drummond Nature Reserve, Western Australia (with updated cladoceran data in January 2015)*. Department of Environment and Conservation.

Primer-E Ltd (2016) *Primer v7.0.12*. Primer-E Ltd, Plymouth, UK.

Quinlan K., Pinder A.M., Coppen R. & Jackson J. (2016a) An opportunistic survey of aquatic invertebrates in the Goldfields region of Western Australia. *Conservation Science Western Australia*.

Quinlan K., Pinder A.M. & Lewis L. (2016b) *Aquatic Fauna Survey at Mandora Marsh (Walyarta) in September 2015*. Department of Parks and Wildlife, Perth.

R Development Core Team (2017) *R: A language and environment for statistical computing, v 3.3.2*. R Foundation for Statistical Computing, Vienna, Austria.

Sheldon F., Boulton A.J. & Puckridge J.T. (2002) Conservation value of variable habitat connectivity: aquatic invertebrate assemblages of channel and floodplain habitats of a central Australian arid-zone river, Cooper Creek. *Biological Conservation* **103**, 13–31.

Skrzypek G., Dogramaci S., Rouillard A. & Grierson P.F. (2016) Groundwater seepage controls salinity in a hydrologically terminal basin of semi-arid northwest Australia. *Journal of Hydrology* **542**, 627–636.

van Vreeswyk A.M.E., Payne A.L., Leighton K.A. & Hennig P. (2004) *An inventory and condition survey of the Pilbara region, Western Australia. Technical Bulletin No. 92*. Department. of Agriculture, South Perth, W.A.

Western Australian Herbarium (1998) *Florabase – The Western Australian Flora. Department of Parks and Wildlife, https://florabase.dpaw.wa.gov.au/ [last accessed July 2017]*. Department of Parks and Wildlife, Western Australia.

Williams D.D. & Mundie J.H. (1978) Substrate size selection by stream invertebrates and the influence of sand. *Limnology and Oceanography* **23**, 1030–1033.

Wollheim W.M. & Lovvorn J.R. (1996) Effects of macrophyte growth forms on invertebrate communities in saline lakes of the Wyoming High Plains. *Hydrobiologia* **323**, 83–96.

Appendix 1. Wetland inundation from remote sensing

Bart Huntley, GIS Branch, Department of Biodiversity, Conservation and Attractions

1 Introduction

These analyses involves the use of Landsat satellite data to determine the hydroperiod of wetlands sampled for the Pilbara Corridors Project along the Fortescue Valley. This analysis specifically targets the inundation record prior to multiple sampling dates.

2 Location

The wetlands in this analysis are located in the Pilbara region of Western Australia and occur along the Fortescue River. The image below shows the coverage of the three Landsat path rows (in green) used in this analysis and the wetlands (in red).

3 Method

The short wave infrared data from Landsat readily responds to the presence of water. Low reflectance (low values) indicate water whereas high reflectance (high values) indicates the absence of water. Using this response it is possible to analyse hydroperiods.

Processing and analysis included the following steps:

1. Locations of wetlands of interest were supplied along with dates on which they were sampled.
2. Landsat data was downloaded from the USGS, processed, corrected to top of atmosphere and checked for cloud and other artifacts.

3. Shortwave infrared (band 5) data was converted to small black and white jpegs centred on and displaying each individual wetland (n = 44). These were examined to determine the location of the last place to lose water when the wetland dries out.
4. A point shape file was produced of the locations identified in step 3 above. Band 5 data was then extracted from the appropriate Landsat scenes creating a time series for each wetland.
5. These time series were graphed (and a band 5 threshold was determined which represented the distinction between the presence/absence of water. This threshold was not universal.
6. From the graphs it was possible to then double check the black and white short wave infrared jpegs and determine the dates of the last dry and first wet images in the time series preceding each sampling date.

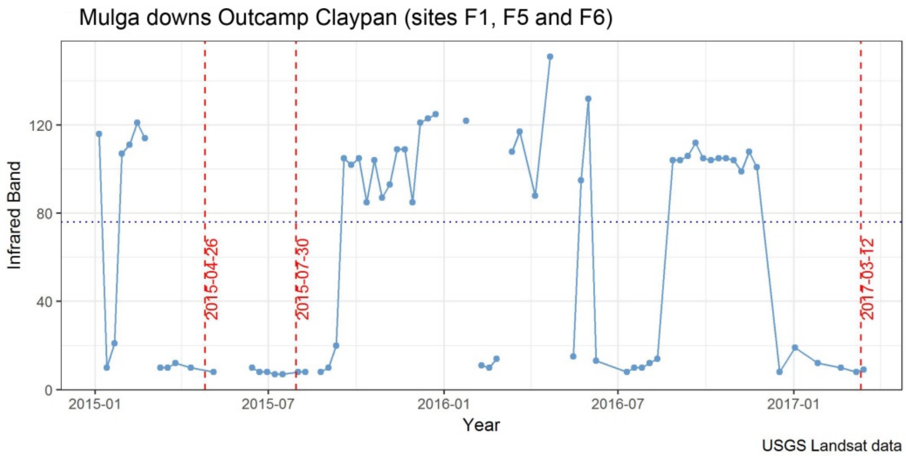


Figure 1. Short-wave infrared (band 5) Landsat scores for a point (last point to hold water) in Mulga Downs Outcamp Claypan. High infra-red scores represent absence of water and low scores indicate presence of water. Vertical red dashed lines indicate sampling dates over the study period. A similar graph was produced for the period of the Pilbara Biological Survey (Pinder et al. 2010, Lyons et al. 2010) where the wetland was sampled as site P40.

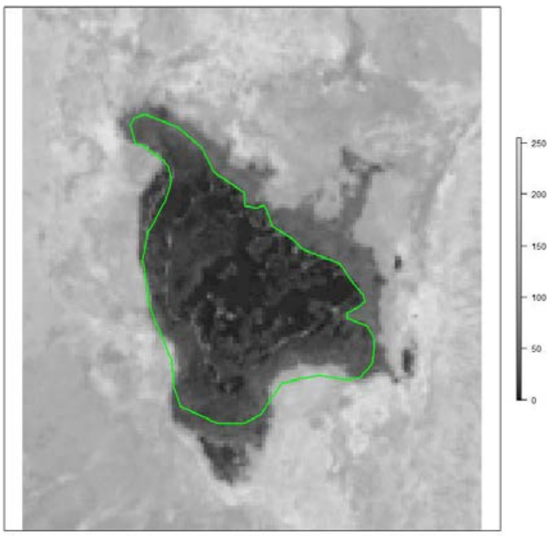


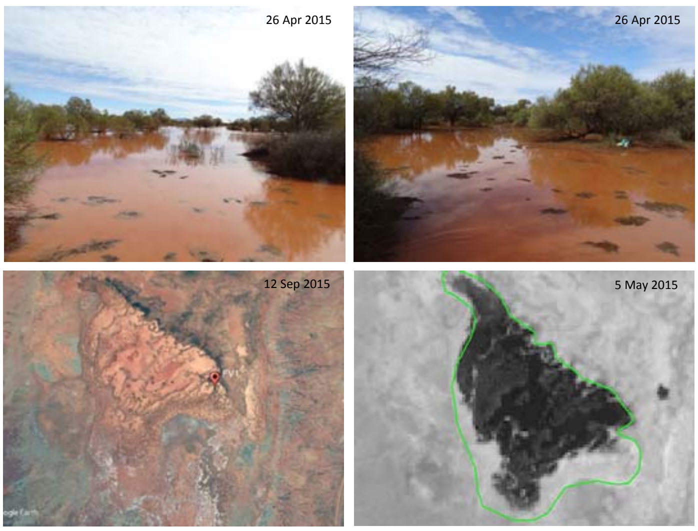
Figure 2. Short-wave infrared (band 5) image for Mulga Downs Outcamp Claypan (sites F1,5,6) captured on 7 Mar 2017, five days before being sampled.

4 Notes on Analysis

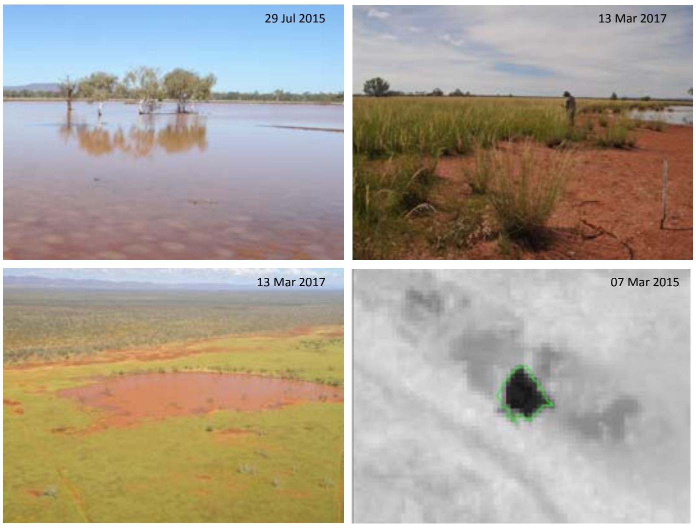
- In some instances, the wetland was too small to obtain accurate or meaningful results (e.g. site 48). Generally, when using Landsat data it is good to have the object of interest to be at least 2-3 pixels (60-90m) wide.
- Some very narrow wetlands (part of stream channels) could be wet all the time but, for reasons stated above or due to fringing vegetation, are difficult to analyse.
- The graphs are indicative of hydroperiods only. They were used as a guide to work out which image dates might be dry, which were then confirmed by looking at the jpegs. In instances where there are very clear wet and dry periods the threshold may not be the precise value indicating presence/absence of water.
- The graphs give a good indication of how many images there are between a sampling date and the indicated previous dry. There could be intervening inundation cycles if there are many missing dates (e.g. FVS035). Missing dates occur when satellite data has been excluded due to cloud cover or the wetland falls within a missing data stripe of a Landsat 7 scene.
- As explained in the Methods section above the satellite data was extracted from a point located within the bounds of a wetland. Where possible these points were placed in locations that appeared to be the last places to dry out. In the case of FVS037 there was not a point that was consistently the last place to dry and as such the previous dry date was selected from the jpegs and not driven by the information in the corresponding graph.

Appendix 2. Imagery for sampling sites

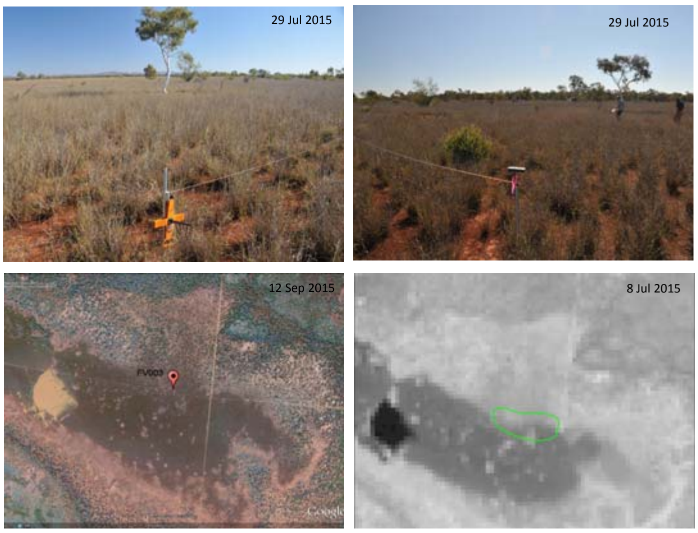
The plate for each site includes a general photo of the wetland (upper left), a photo of the fringing vegetation (generally a photo of the flora quadrat, upper right), an aerial or Google Earth image (lower left) and a short-wave infrared Landsat 7 or 8 image taken around the time of one of the sampling dates (lower right).



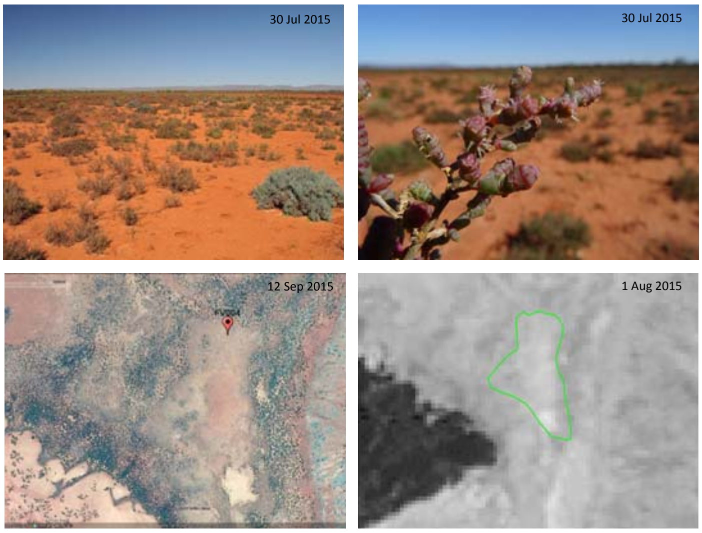
Site FV01. Mulga Downs Outcamp Claypan. A large wetland with low linear rises across the bed dominated by *Acacia stenophylla* and *Melaleuca glomerta* forming sub-basins. This site (near FV05) was sampled for invertebrates only shortly after flooding and data was not used in analyses. Google Earth image © Google and CNES/Airbus 2017.



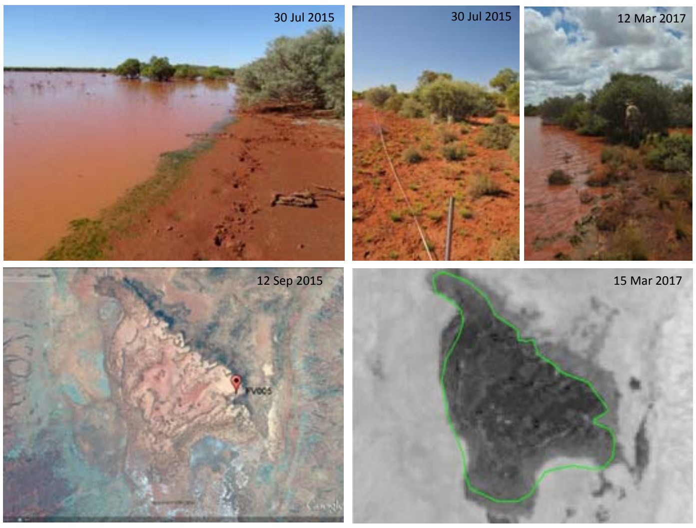
Site FV02. Chaddelinna Pool on Mulga Downs Station. A mostly open water claypan which retains water for much longer than the *Eriachne flaccida* and *E. benthamii* dominated floodplain in which it lies (see site FV3). The aerial photograph is taken looking south-west.



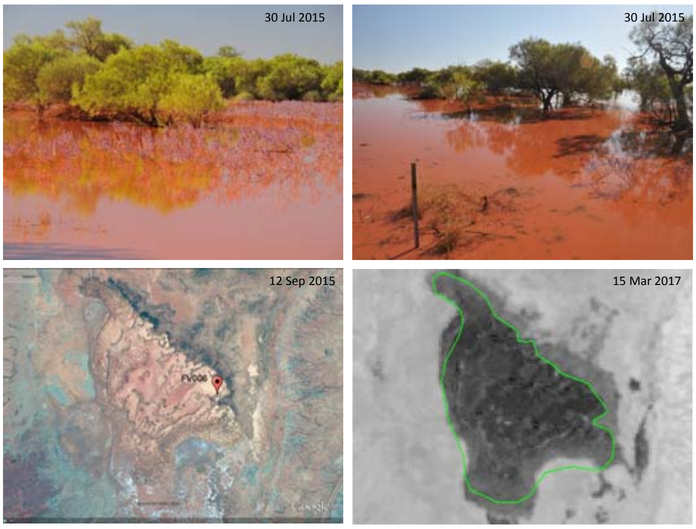
Site FV03. Edge of the *Eriachne benthamii* grassland floodplain which is fed by creeks from the Chichester and Hamersley Ranges that flow after major episodic rainfall events. Site FV02 can been in the left of the Google Earth image.



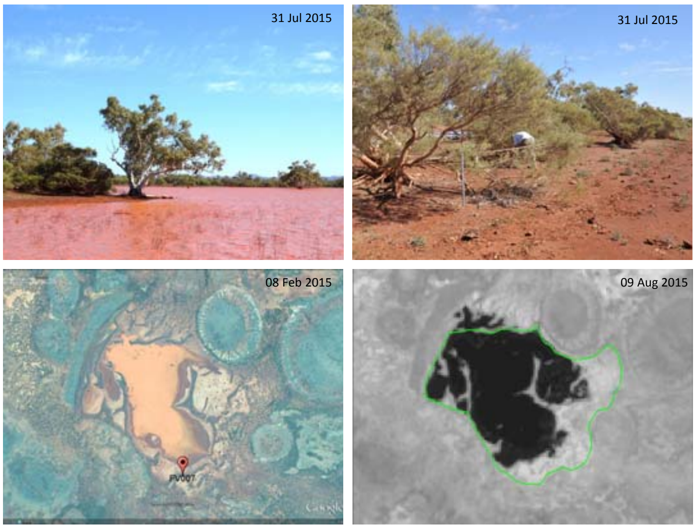
Site FV04. An intermittently inundated *Tecticornia* dominated flat north-east of Mulga Downs Outcamp Claypan (FV5 and 6). This site was dry when surveyed but occasionally has water when the associated claypan overflows. Top right image is *Tecticornia indica.* The site is floristically similar to the Fortescue Marsh. Google Earth image © Google and CNES/Airbus 2017.



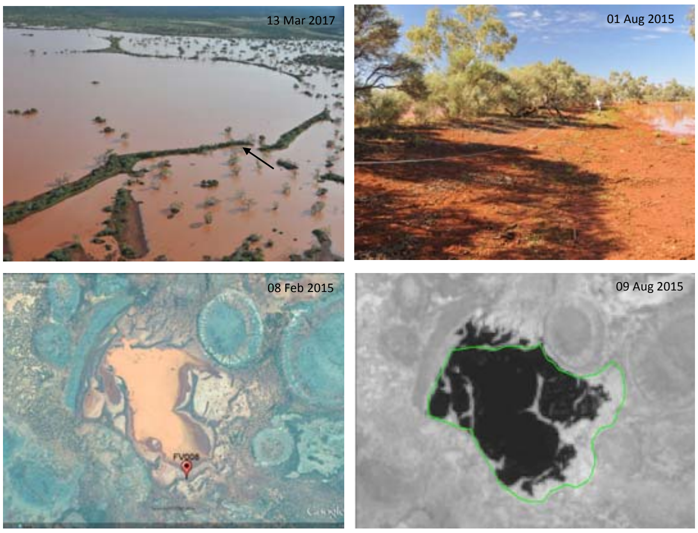
Site FV05. Mulga Downs Outcamp Claypan. A large wetland with numerous low linear rises with *Acacia stenophylla* and *Melaleuca glomerata* forming sub-basins. The green rim is filamentous algae growing in the very shallow turbid water on the wetlands edge where there is sufficient light for photosynthesis. The top right photos show the flora quadrat when the wetland was shallower (July 2015) and deeper (March 2017). Google Earth image © Google and CNES/Airbus 2017.



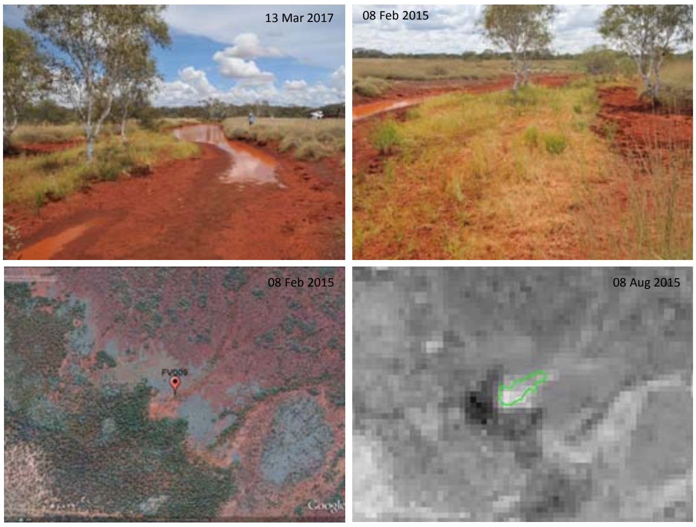
Site FV06. Mulga Downs Outcamp Claypan. A large wetland with numerous low linear rises with *Acacia stenophylla* and *Melaleuca glomerata* forming sub-basins. *Tecticornia verrucosa* (foreground top left) recruits in the basin after filling, and persists for 2-3 years.



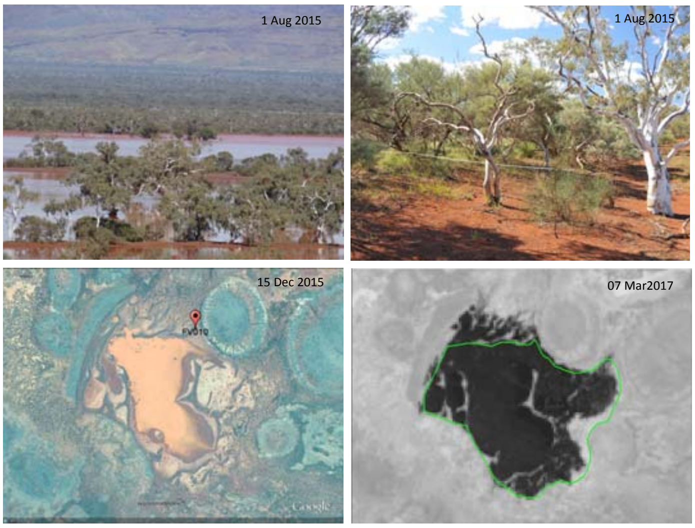
Site FV07. Southern side of Mungthannannie Claypan. The flora quadrat, dominated by *Melaleuca glomerata*, sampled the inner (main water body) side of the low dune on the southern shore of the claypan.



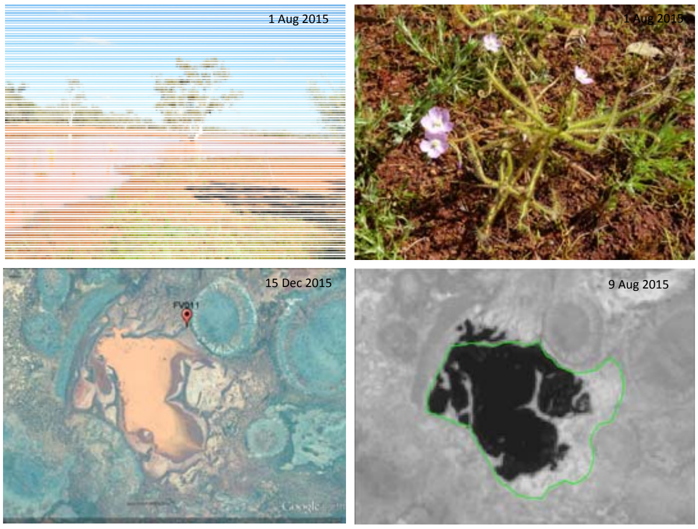
Site FV08. Mungthanannie Claypan on Mulga Downs Station. The flora quadrat is on the outer side of low dune between the main wetland (other side of dune) and a backwater area (top right of quadrat photo). The quadrat photo was taken in August 2015 when only the main area of wetland and a small backwater area had water. The aerial image taken in March 2017 shows the claypan inundated well beyond its usual shoreline. Approximate position of quadrat site is arrowed in the aerial image. Google Earth image © Google and CNES/Airbus 2017.



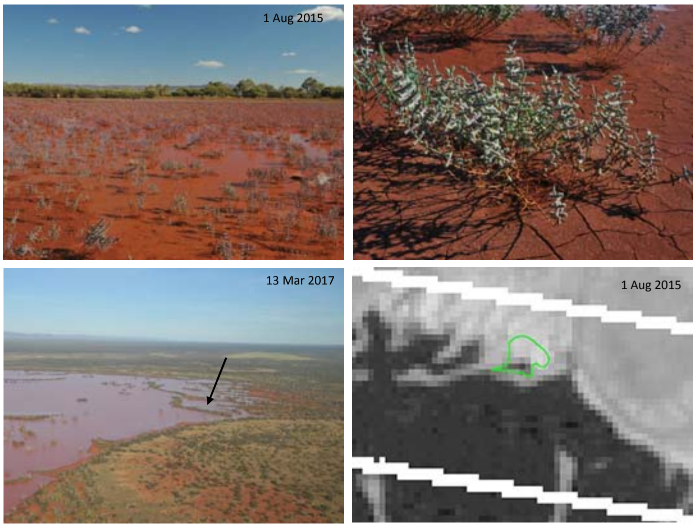
Site FV9. A small, deeper and longer lasting section of an otherwise ill-defined drainage line fed by sheet flow off the Chichester range north of the floodplain west of Mungthannannie Claypan. Google Earth image © Google and CNES/Airbus 2017.



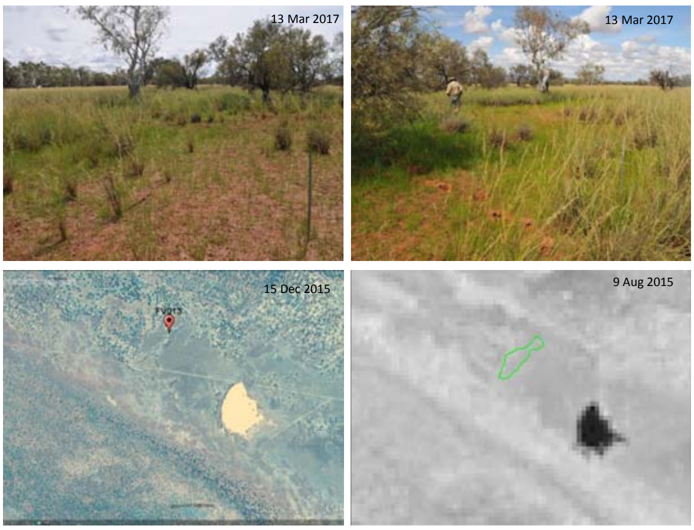
Site FV10. Northern side of Mungthannannie Claypan on Mulga Downs Station. This site number refers to both a flora quadrat on a low dune and the invertebrate sample from the adjacent open water. Note the greater inundation extent in this 2017 Landsat image compared to the 2015 image shown for FV07.



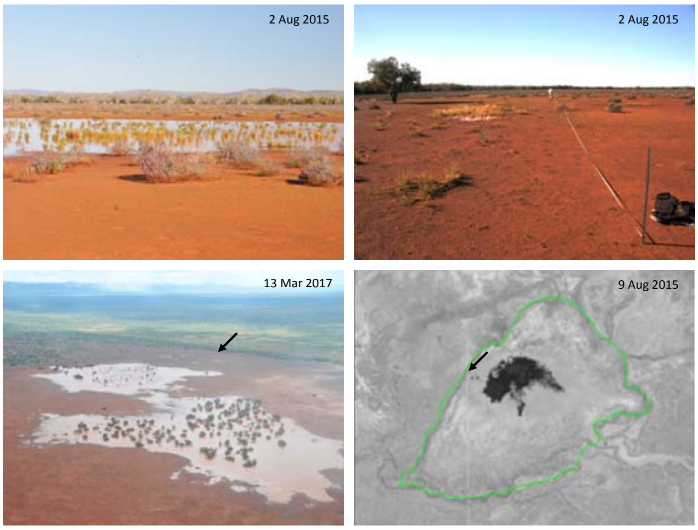
Site FV11. Northern side of Mungthannannie Claypan on Mulga Downs Station. This is a flora quadrat on a herbaceous fringe of one of the deltaic channels where a creek flowing off the Chichester Ranges enters the claypan. The site included one of the few survey records of *Drosera finlaysoniana*. The large round structures on the satellite image are adjacent rocky domed hills.



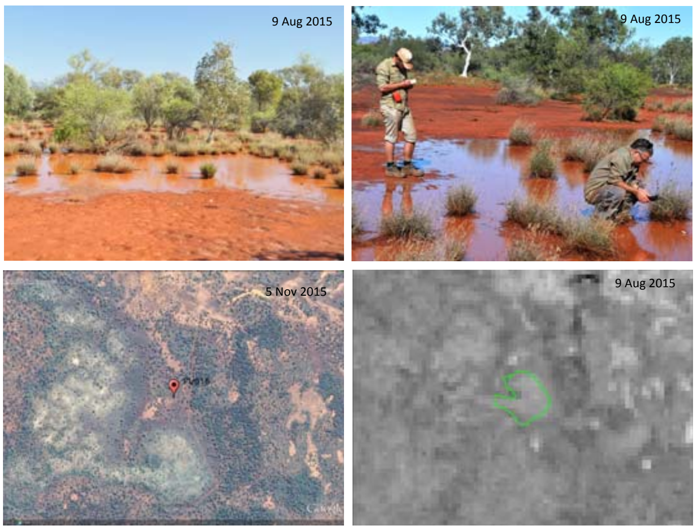
Site FV12. Overflow area connected to north of Mungthannannie Claypan on Mulga Downs Station that was shallow and dominated by *Tecticornia verrucosa* (top right) when sampled for invertebrates in Aug 2015 (top left) but deeper when flown over in March 2017 (bottom left).



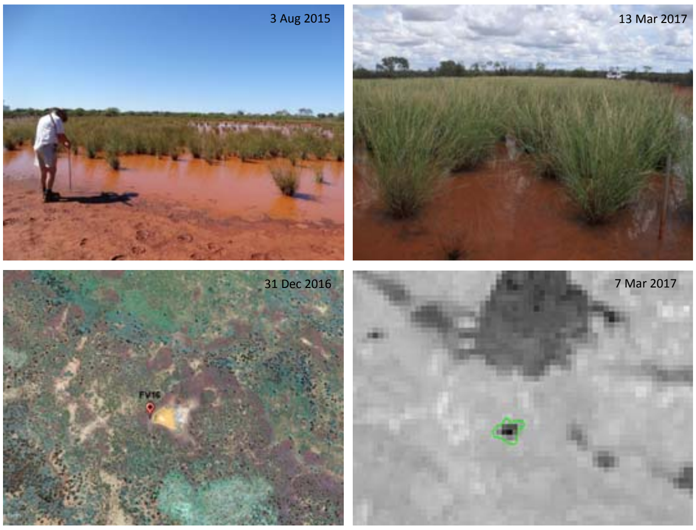
Site FV13. Flora quadrat sampling *Eucalyptus victrix* and *Acacia distans* in a linear depression within the *Eriachne benthamii, E flaccida* dominated floodplain west of Mungthannannie Claypan. This area never held water on the times it was visited. The open water on the Google Earth image is Chaddelinna Pool (FV02). Google Earth image © Google and CNES/Airbus 2017.



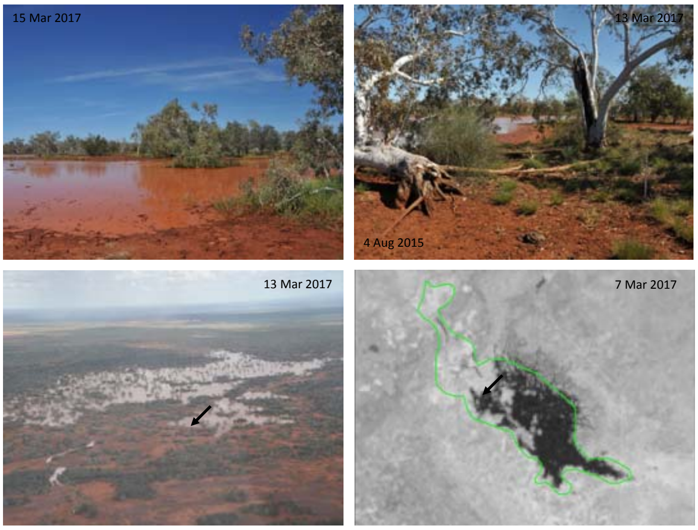
Site FV14. The *Tecticornia verrucosa* and *Eriachne flaccida* dominated western edge of Gnalka Gnoona Claypan on Mulga Downs Station. Arrow on aerial photograph indicates approximate sample site.



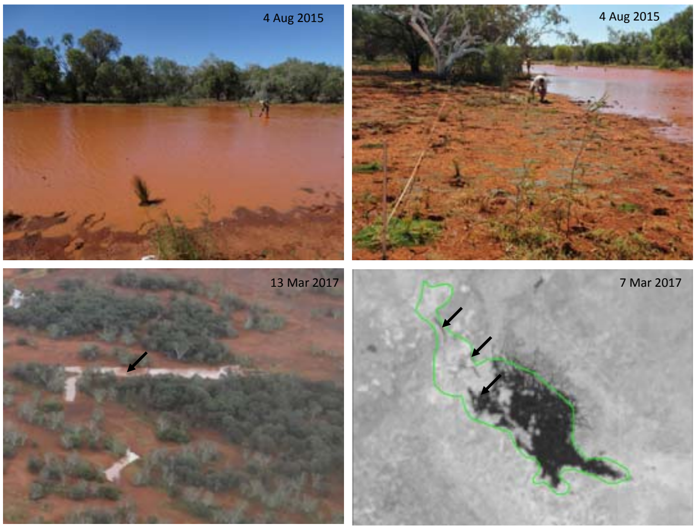
Site FV15. Maddina Pool. A small drying *Acacia synchronicia* and *Eriachne benthamii* dominated flat south of Maddina Well. The Landsat imagery was captured 9 Aug 2015, 6 days after we visited and indicated no water present. Google Earth image © Google and CNES/Airbus 2017.



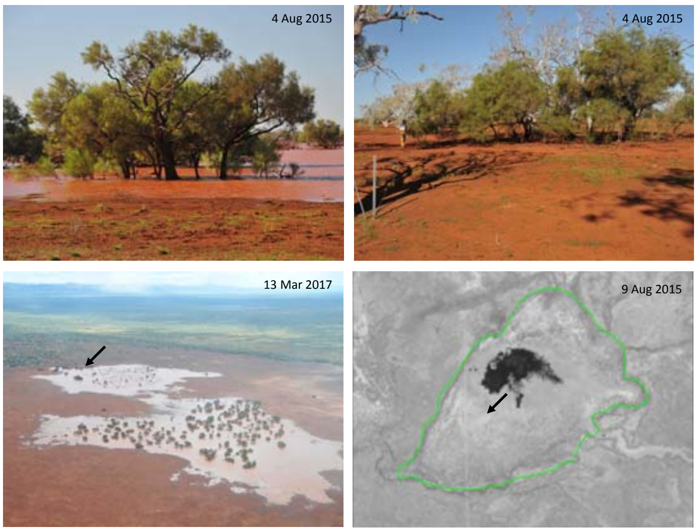
Site FV16. Gidyea Pool on Mulga Downs Station just west of the Great Northern Highway. This and FV15 were the only claypan sampled west of the Marsh with significant wetland floor vegetation. Note the turbid water in 2015 and the clear water in 2017. Google Earth image © Google and CNES/Airbus 2017.



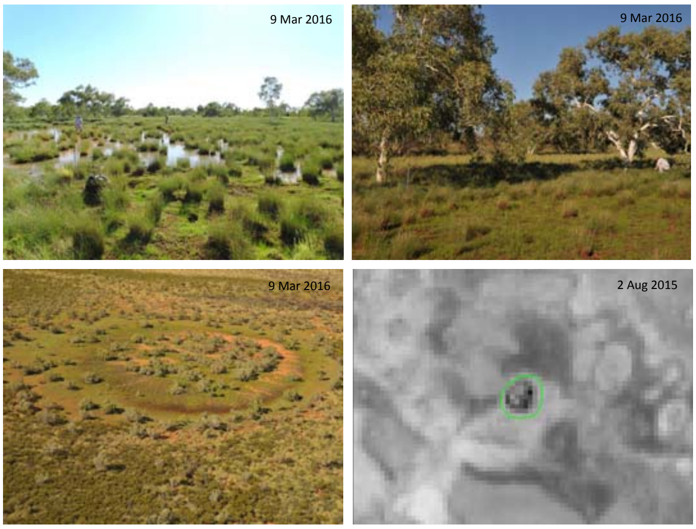
Site FV17. Koodjeepindarranna Claypan on Mulga Downs Station. A large wooded claypan fed from multiple drainage lines off the Chichester Ranges and with occasional connections to Gnalka Gnoona Claypan (FV14,19). Arrows show approximate sampling location.



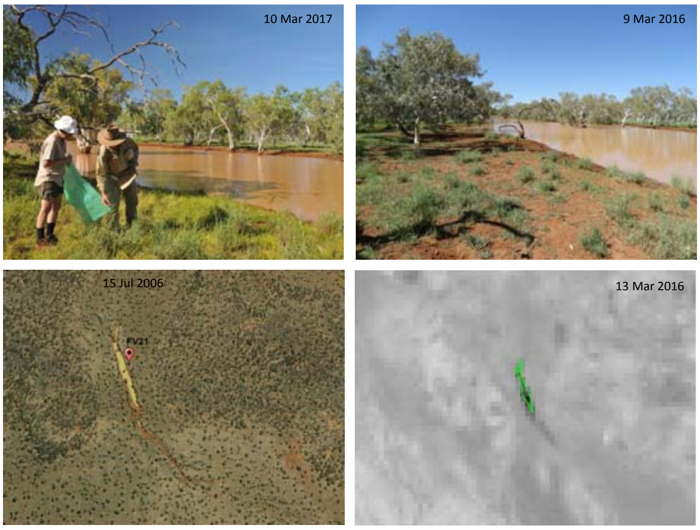
Site FV18. A channel within the Koodjeepindarranna Claypan complex on Mulga Downs Station (see also FV17). Arrows on the Landsat image show locations of this site (centre arrow) plus P5 (upper arrow) sampled for the Pilbara Biological Survey and FV17 (lower arrow).



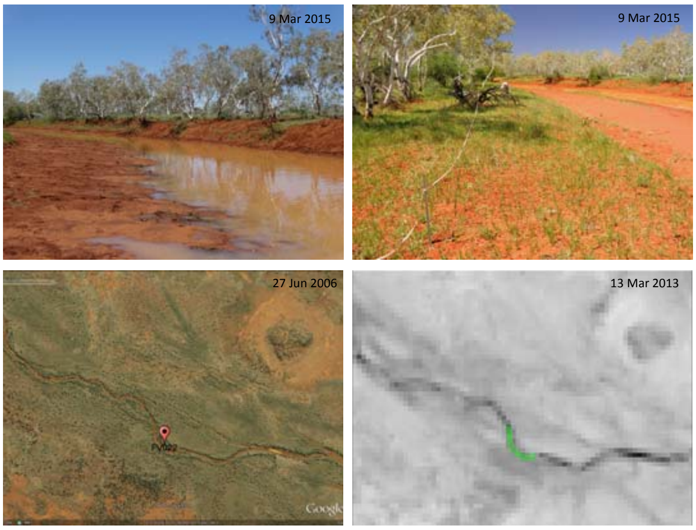
Site FV19. Gnalka Gnoona Claypan on Mulga Downs Station. Arrows indicate approximate sampling location. Stands of *Acacia stenophylla* occur across the wetland basin. *Eucalyptus victrix* occurs within the upper margin of the basin as seen in the upper left of the aerial image.



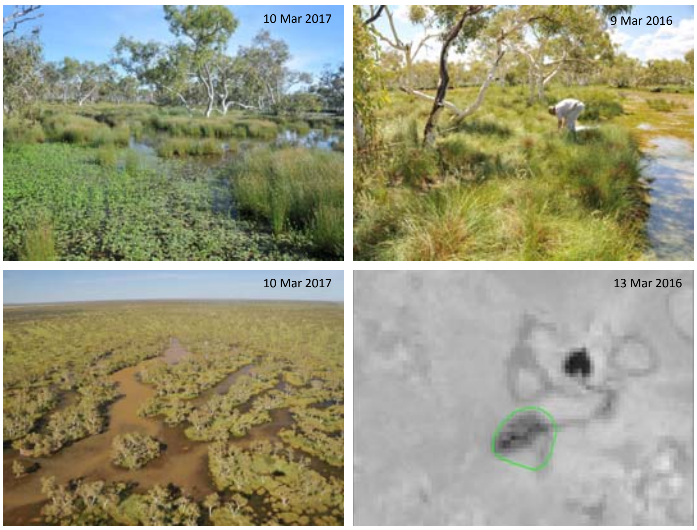
Site FV20. Un-named vegetated claypan on Ethel Creek Station consisting of *Eucalyptus victrix* on the central rise surrounded by a shallow moat. The wetland is dominated by tussocks of *Eleocharis pallens*.



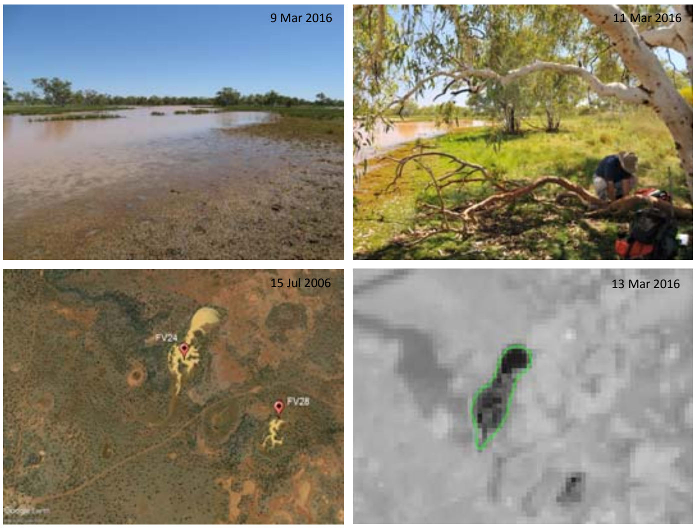
Site FV21. Un-named semi-isolated creek pool on Roy Hill Station lies on the Jigalong Creek floodplain. The top left photo was taken in March 2017 and the top right photo was taken in March 2016. Google Earth image © Google and Digital Globe 2017



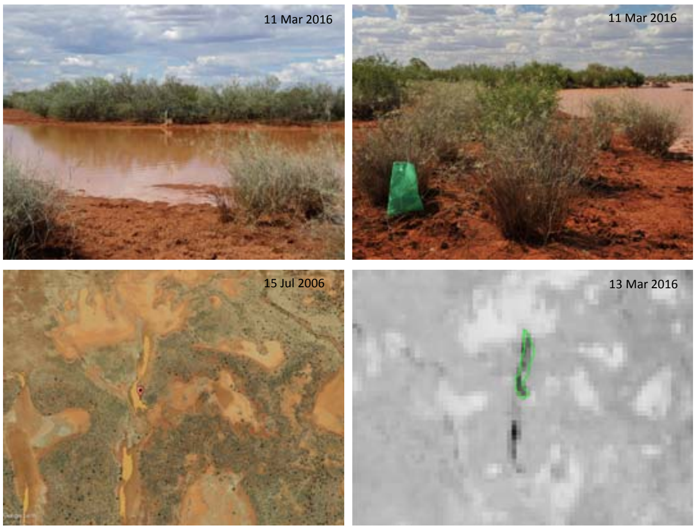
Site FV22. Un-named intermittent Fortescue River pool on Roy Hill Station downstream of the Fortescue River - Jigalong Creek confluence. *Cyperus bifax* dominates the ground layer within the plant quadrat. Google Earth image © Google and Digital Globe 2017



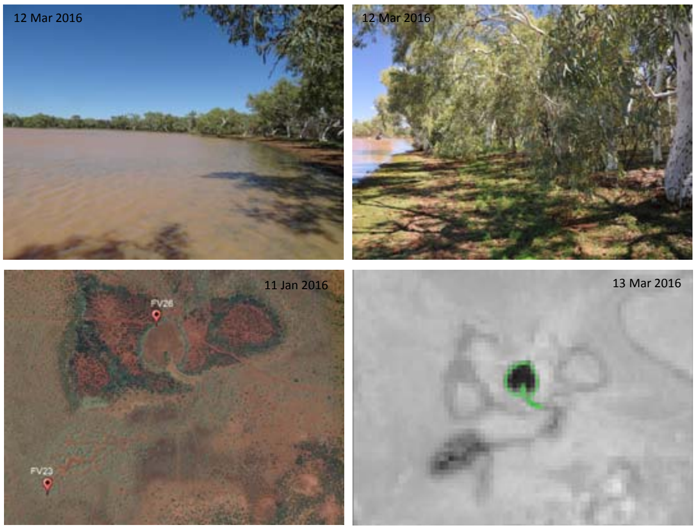
Site FV23. Un-named partly vegetated claypan (with *Eleocharis pallens*) on Ethel Creek Station, connected to a deeper more open water claypan (FV26, the dark area on the Landsat image).



Site FV24. Un-named claypan on Balfour Downs Station. This site and site FV28 are amongst the last areas to dry within a local area of interconnected claypans and flats. Google Earth image © Google and Digital Globe 2017.

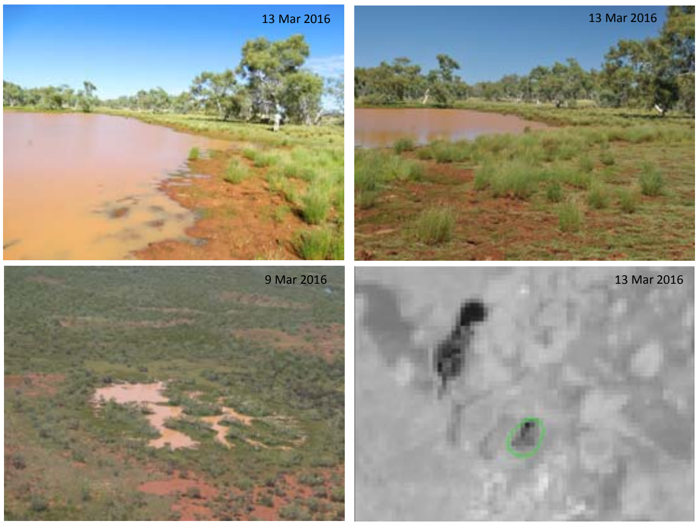


Site FV25. Channel in un-named claypan complex on Ethel Creek Station. The riparian vegetation is dominated by canegrass (*Eragrostis australasica)*, one of only two known occurrences in the Pilbara. Google Earth image © Google and Digital Globe 2017.

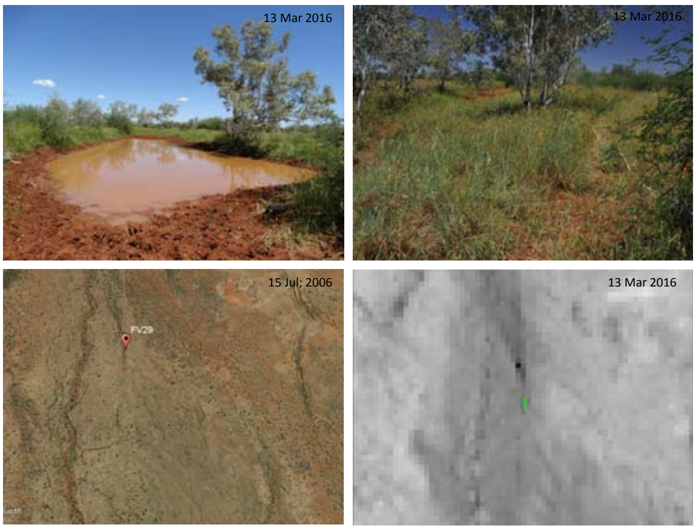


Site FV26. Un-named claypan next to Bullina Bore on Balfour Downs Station. Being next to a bore this site is well used by cattle, reflected in the simplified riparian vegetation. The Google Earth image shows this site with an excavated channel to increase water inflows and shows site FV23 to which it is connected. The channel likely drains water from FV23. Google Earth image © Google and Digital Globe 2017.

Site FV27. Jinerabar Pool on Jimblebar Creek on Ethel Creek Station. The photo at top right suggests heavy grazing of riparian vegetation. Google Earth image © Google and Digital Globe 2017.

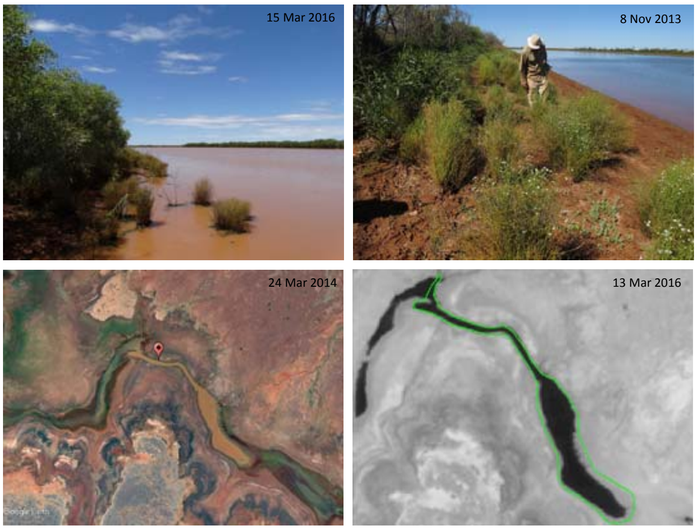


Site FV28. Un-named claypan on Balfour Downs Station. This site and site FV24 (the other dark area on the Landsat image) are amongst the last areas to dry within a local area of interconnected claypans and flats. Aerial photo by Beren Spencer.



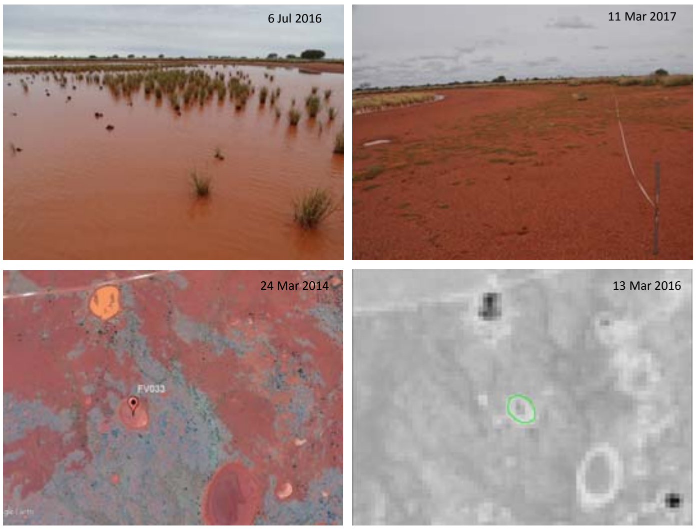
Site FV29. Un-named pool on small anabranch of the Fortescue River on Ethel Creek Station. As can be seen in the photo at top right the pool margin had been heavily used by cattle for drinking water, but the riparian vegetation was not heavily grazed. Google Earth image © Google and Digital Globe 2017.

Site FV30. Meecardagunna Pool on Jigalong Creek on Ethel Creek Station.

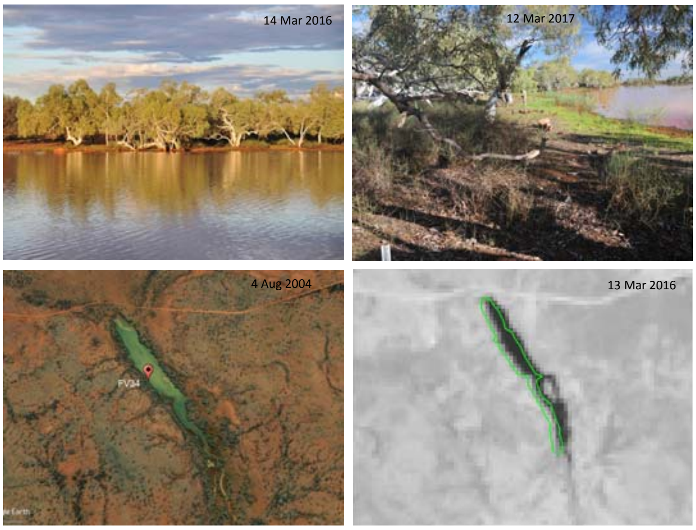


Site FV31. Moorimoordinina Pool on Roy Hill Station. Riparian image by Adrienne Markey (DBCA). Google Earth image © Google and Digital Globe 2017.

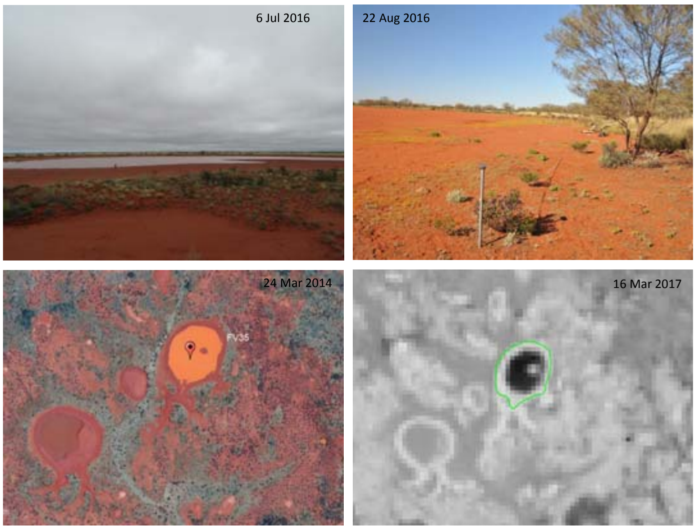
Site FV32. 14 Mile Pool on Roy Hill Station. Riparian image by Adrienne Markey (DBCA). Google Earth image © Google and Digital Globe 2017.



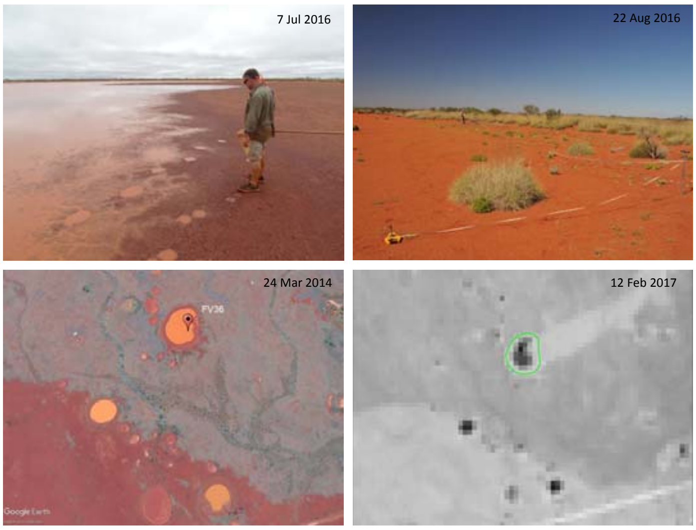
Site FV33. Un-named claypan on Roy Hill Station just south of Perkililly Dam south of the Roy Hill-Munjina Road. Both the basin *Eriachne* grassland (FV33A) and basin fringe (FV33B – image top right) were sampled for flora. Google Earth image © Google and Digital Globe 2017.



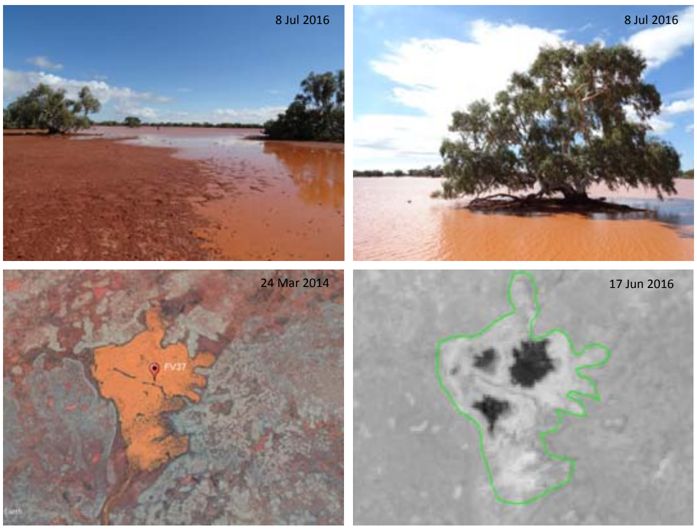
Site FV34. Coondiner Pool on Coondiner Creek within the boundary of the Fortescue Marsh Strategy Area. This pool usually has some water but dries occasionally. Google Earth image © Google and Digital Globe 2017.



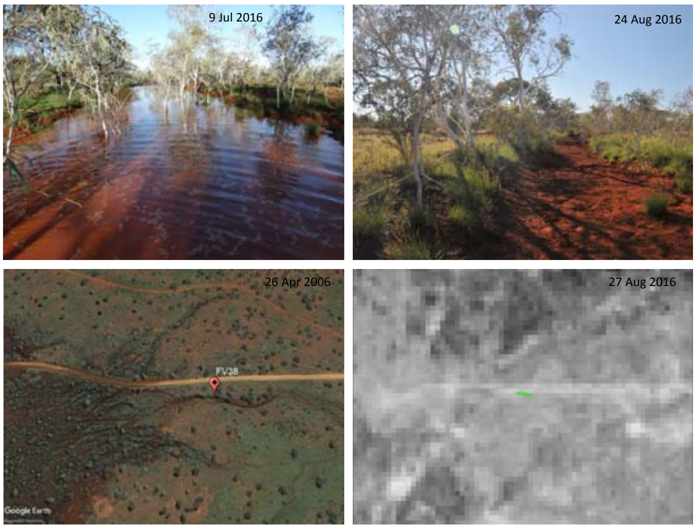
Site FV35. Un-named claypan on Roy Hill Station south of Perkililly Dam south of the Roy Hill-Munjina Road. This was very similar to FV33 except for the lack of *Eragrostis* on the claypan floor. The basin slope was sampled for flora. Google Earth image © Google and Digital Globe 2017.



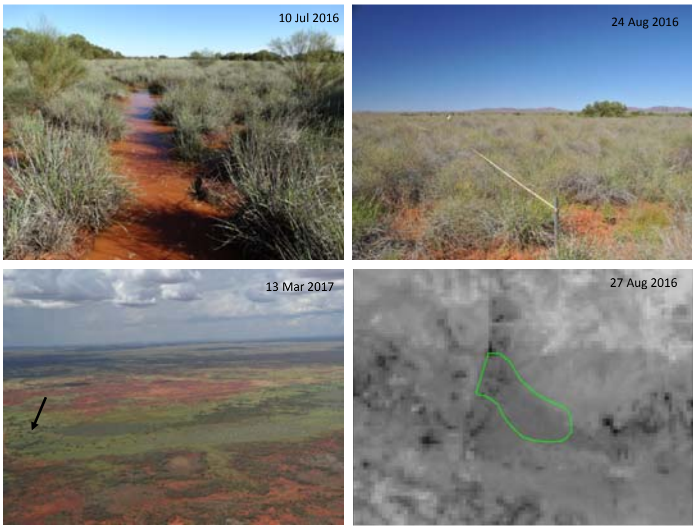
Site FV36. Un-named claypan on Roy Hill Station just north of the Roy Hill-Munjina Road. Previously sampled as PSW039 during the Pilbara Biological Survey. Vegetation is absent from the floor of this shallow ephemeral claypan. The slope above the basin was sampled for plants. Google Earth image © Google and Digital Globe 2017.



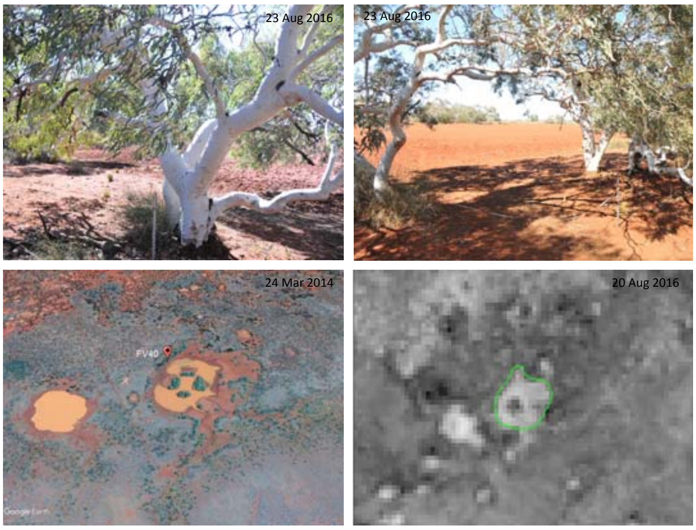
Site FV37. Un-named claypan on Roy Hill Station north-east of Bakers Dam. This site was very shallow (<3cm) when visited. Google Earth image © Google and Digital Globe 2017.



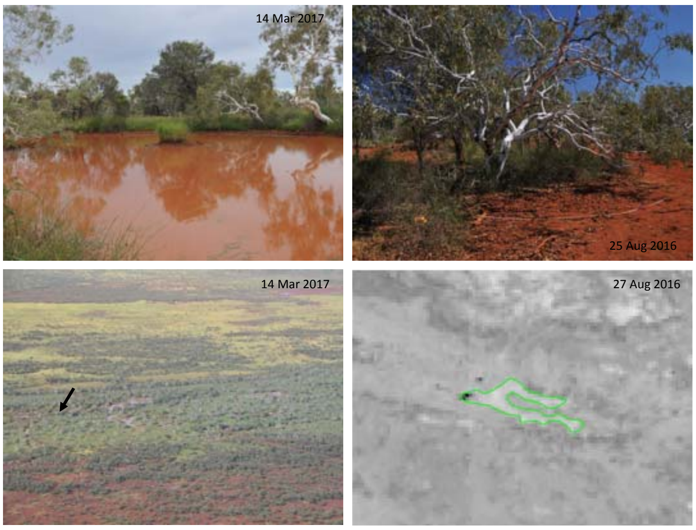
Site FV38. Un-named creek on Mulga Downs Station along the homestead road flowing into the Koodjeepindarranna system. The top right photo shows the creek dry 6 weeks after it was full in the photo at top left. Google Earth image © Google and Digital Globe 2017.



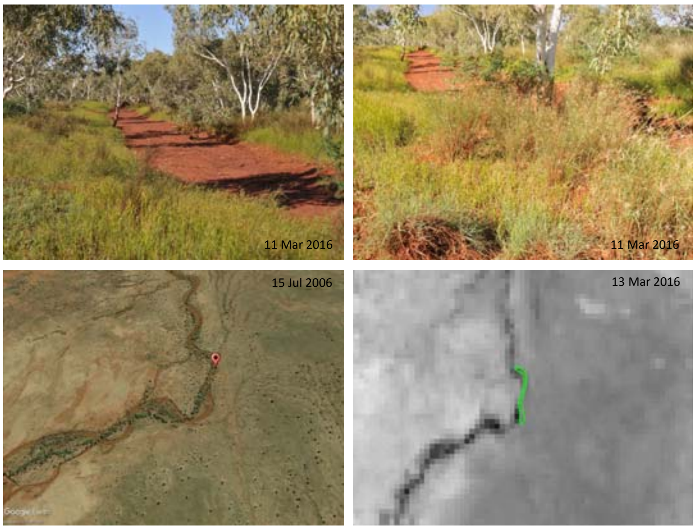
Site FV39. Fortescue floodplain at the crossing of the Roebourne-Wittenoom Road on Mulga Downs Station. Arrow on aerial photograph indicates approximate sampling position. Gilgai (crabhole) development was significant at sites within the floodplain with regular/prolonged water ponding (cf. site FV3).



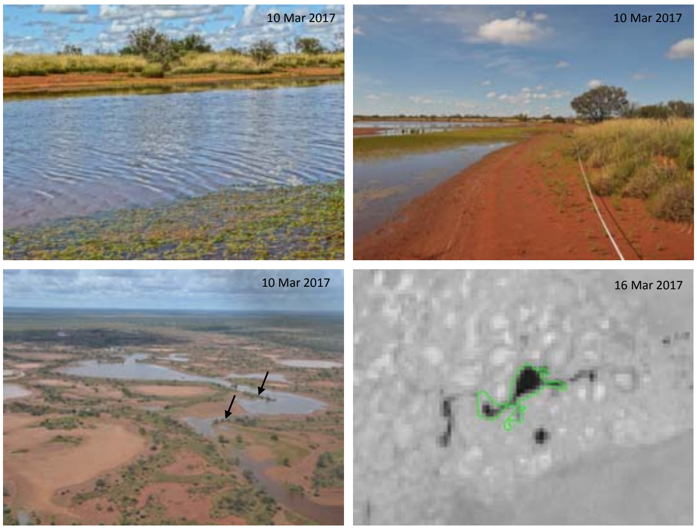
Site FV40. Howards Dam on Roy Hill Station. A modified claypan with an excavated central dam. Google Earth image © Google and Digital Globe 2017.



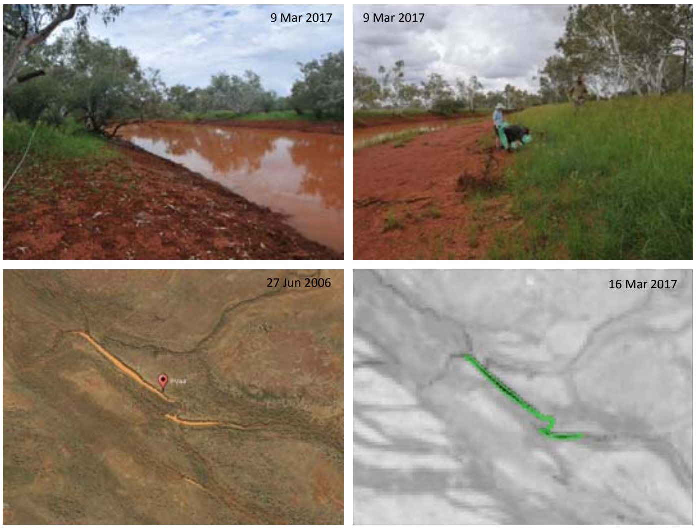
Site FV41. Powellinna Pool on the Fortescue River on the Mount Florence/Mulga Downs boundary. The river here is still an ill-defined floodplain rather than channelised. The arrow on the aerial photo (which is taken looking south) indicates the approximate sampling location.



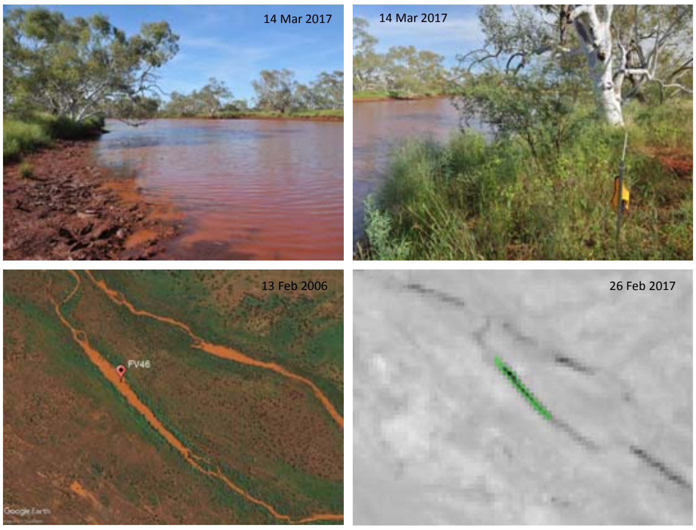
Site FV42. Un-named ephemeral pool on Fortescue River on Ethel Creek Station. Google Earth image © Google and Digital Globe 2017.



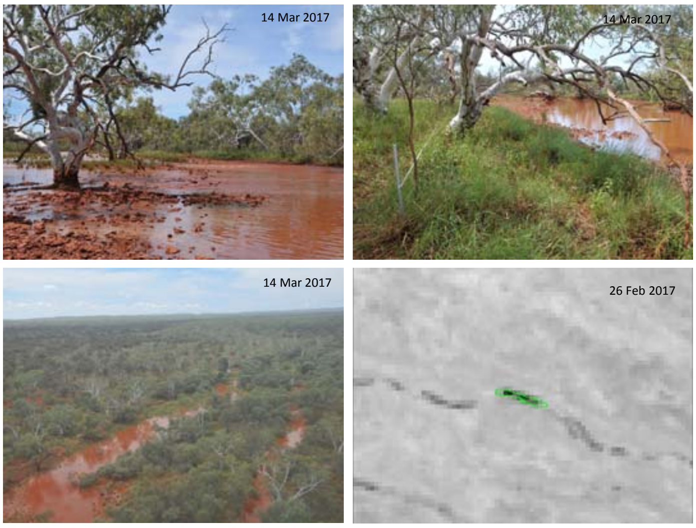
Site FV43. Un-named claypan in large complex fed by overflows from Kondy Creek on Roy Hill Station. Arrows on aerial image are the flora quadrat location (left arrow) and the area sampled for invertebrates (right arrow).



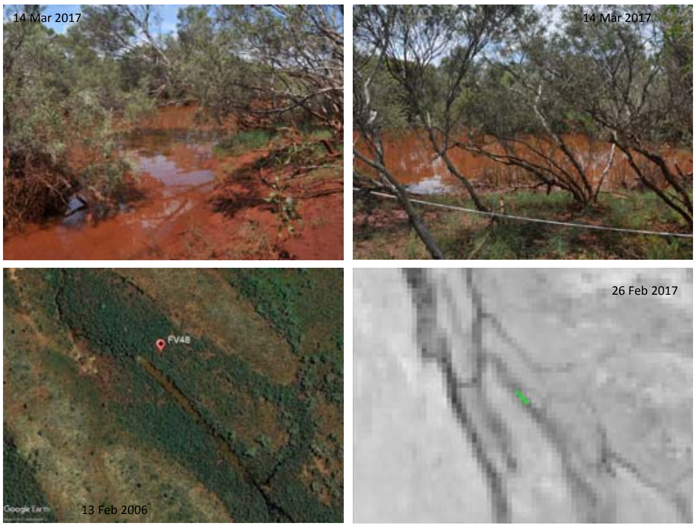
Site FV44. Yunera Pool on the Fortescue River on Roy Hill Station. Google Earth image © Google and Digital Globe 2017.



Site FV46. Un-named pool on braided section of Fortescue River on Mount Florence Station. Google Earth image © Google and Digital Globe 2017.



Site FV47. Un-named pool on braided section of Fortescue River on Mount Florence Station. The depth of this pool increased significantly while we were sampling as flood waters entered the pool from upstream.



Site FV48. Un-named pool on braided section of Fortescue River on Mount Florence Station. Stygofaunal species in this pool, the presence of flow despite the channel being dry upstream, and elevated salinity indicate groundwater influence. Google Earth image © Google and Digital Globe 2017.

Appendix 3. List of sites sampled for this project and the Pilbara Biological Survey (Lyons et al. 2015 and Pinder et al. 2010).

For locations, descriptions and survey dates for the flora quadrats see Appendix 7

FaunaSite Code	Flora Quadrat Codes	Wetland Latitude (GDA94)	Wetland Longitude (GDA94)	Name or descriptor	Tenure	Wetland type	Dates sampled for invertebrates		
FV01		-22.3622	118.9810	Mulga Downs Outcamp Claypan overflow	Mulga Downs	Partially wooded overflow from large claypan	26 Apr 2015		
FV02	FV02A	-22.3000	118.8257	Chaddelinna Pool	Mulga Downs	Open wetland on grassy floodplain	29 Jul 2015	13 Mar 2017	
FV03	FV03A	-22.3000	118.8342	Tussock grassland east of Chaddelinna Pool	Mulga Downs	Floodplain			
FV04	FV04A	-22.3497	118.9846	*Tecticornia* flat north of Mulga Downs Outcamp Claypan	Mulga Downs	Floodplain			
FV05	FV05A	-22.3601	118.9791	Mulga Downs Outcamp Claypan	Mulga Downs	Large partially wooded claypan	30 Jul 2015	12 Mar 2017	
FV06	FV06A	-22.3598	118.9800	Mulga Downs Outcamp Claypan	Mulga Downs	Large partially wooded claypan			
FV07	FV07A	-22.3384	118.8745	Mungthannannie Pool (south)	Mulga Downs	Large partially wooded claypan	31 Jul 2015		
FV08	FV08A	-22.3386	118.8746	Mungthannannie Pool (south)	Mulga Downs	Large partially wooded claypan			
FV09	FV09A	-22.2948	118.8537	Creek pool 1.8km east of Bernies Bore	Mulga Downs	Intermittent creek pool	13 Mar 2017		
FV10	FV10A	-22.3232	118.8767	Mungthannannie Pool (north)	Mulga Downs	Large partially wooded claypan	01 Aug 2015	13 Mar 2017	
FV11	FV11A	-22.3210	118.8761	Mungthannannie Pool (north) inflow channel	Mulga Downs	Large partially wooded claypan			
FV12		-22.3217	118.8739	*Tecticornia verrucosa* marsh connected to Mungthannannie Pool	Mulga Downs	Vegetated overflow from large claypan	01 Aug 2015		
FV13	FV13A	-22.2960	118.8204	Vegetated channel in *Eriachne* Tussock grassland	Mulga Downs	Floodplain			
FV14	FV14A	-22.1604	118.4685	Gnalka Gnoona claypan	Mulga Downs	Large partially wooded claypan	02 Aug 2015		
FV15	FV15A	-22.2261	118.6606	Un-named claypan 1.1km south of Maddina Well	Mulga Downs	Small vegetated claypan	03 Aug 2015		
FV16	FV16A	-22.2468	118.7085	Gidyea Pool	Mulga Downs	Small vegetated claypan	03 Aug 2015	13 Mar 2017	
FV17	FV17A	-22.1296	118.4012	Koodjeepindarranna claypan complex	Mulga Downs	Large treed claypan	04 Aug 2015	15 Mar 2017	
FV18	FV18A	-22.1254	118.4002	Channel within Koodjeepindarranna claypan complex	Mulga Downs	Claypan channel	04 Aug 2015	15 Mar 2017	
FV19	FV19A	-22.1654	118.4729	Gnalka Gnoona claypan	Mulga Downs	Large partially wooded claypan	04 Aug 2015		
FV20	FV20A,B	-22.8728	120.2870	Un-named claypan 3.7km south-west of Bullina Bore	Balfour Downs	Small wooded claypan	09 Mar 2016		
FV21	FV21A	-22.7876	120.2040	Un-named creek pool on Jigalong/Fortescue Floodplain	Roy Hill	Semi-isolated intermittent creek pool	09 Mar 2016		
FV22	FV22A	-22.7327	120.1004	Un-named pool near Battle Hill	Roy Hill	Intermittent river pool	09 Mar 2016		
FV23	FV23A	-22.8552	120.3023	Un-named claypan 1km south-west of Bullina Bore	Balfour Downs	Small wooded claypan	09 Mar 2016		
FV24	FV24A,B	-22.8372	120.2692	Un-named claypan 2.4km north-east of Windy Corner Bore	Balfour Downs	Partially wooded claypan	11 Mar 2016		
FV25	FV25A	-22.8482	120.2392	Un-named claypan 2.2km south-west of Windy Corner Bore	Ethel Creek	Claypan channel	11 Mar 2016		
FV26	FV26A	-22.8484	120.3079	Un-named claypan next to Bullina Bore	Balfour Downs	Small bare claypan	12 Mar 2016		
FV27	FV27A,B	-22.9806	120.2469	Jinerabar Pool on Jimblebar Creek	Ethel Creek	Intermittent river pool	12 Mar 2016		
FV28	FV28A,B	-22.8390	120.2746	Un-named claypan 1.7km east-north-east of Windy Corner Bore	Balfour Downs	Small wooded claypan	13 Mar 2016		
FV29	FV29A	-22.8501	120.2100	Northern un-named pool on Fortescue River anabranch	Ethel Creek	Intermittent creek pool	13 Mar 2016		
FV30	FV30A	-22.8028	120.2292	Meecardagunna Pool on Jigalong Creek	Roy Hill	Intermittent river pool	13 Mar 2016		
FV31	FV31A	-22.5120	119.7643	Moorimoordinina Pool on Fortescue River	Roy Hill	Permanent river pool	15 Mar 2016		
FV32	FV32A	-22.5536	119.8636	14 Mile Pool on Fortescue River	Roy Hill	Permanent river pool	15 Mar 2016		
FV33	FV33A,B	-22.6917	119.8102	Un-named claypan 700m south of Perkililly Dam	Roy Hill	Small vegetated claypan	06 Jul 2016	11 Mar 2017	
FV34	FV34A	-22.7290	119.6558	Coondiner Pool on Coondiner Creek	UCL	Intermittent creek pool	16 Mar 2016		
FV35	FV35A	-22.7076	119.8171	Un-named claypan 2.7km south of Perkililly Dam	Roy Hill	Small bare claypan	07 Jul 2016	11 Mar 2017	
FV36	FV36A	-22.6747	119.8109	Un-named claypan north of Perkililly Dam (= PSW039 of Pinder et al. 2010)	Roy Hill	Small bare claypan	07 Jul 2016		
FV37	FV37A	-22.6424	119.7357	Un-named claypan 4.4km north-east of Bakers Dam	Roy Hill	Large wooded claypan	08 Jul 2016		
FV38	FV38A	-22.1091	118.4187	Un-named creek pool 900m east of 2 Mile Well	Mulga Downs	Intermittent creek pool	09 Jul 2016		
FV39	FV39A,B	-22.1256	118.3437	Fortescue floodplain at Roebourne Wittenoom Road	Mulga Downs	Floodplain	09 Jul 2016		
FV40	FV40A	-22.6559	119.8038	Howards Dam	Roy Hill	Partially wooded stock water supply dam			
FV41	FV41A	-22.1069	118.2272	Powellinna Pool on Fortescue River	Mulga Downs	Vegetated floodplain channels	12 Mar 2017		
FV42	FV42A	-22.8731	120.2104	Southern un-named pool on Fortescue River anabranch (see F29)	Ethel Creek	Intermittent creek pool on anabranch			
FV43	FV43A	-22.7593	120.2043	Un-named claypan in complex south of Kondy Creek	Roy Hill	Small bare claypan	10 Mar 2017		
FV44	FV44A	-22.6882	120.0239	Yunera Pool on Fortescue River	Roy Hill	Permanent river pool	10 Mar 2017		
FV46	FV46A	-21.8977	117.9385	Un-named pool near Toweranna Well	Mount Florence	Permanent river pool	14 Mar 2017		
FV47	FV47A	-21.9278	117.9929	Un-named pool south-west of Burgess Well	Mount Florence	Intermittent river pool	14 Mar 2017		
FV48	FV48A	-21.9848	118.0411	Un-named pool north-east of Salt Spring Well	Mount Florence	Permanent river pool	14 Mar 2017		
P1	P01A	-22.7240	119.6558	Coondiner Pool on Coondiner Creek (same pool as F34)	UCL	Intermittent creek pool	15 Aug 2003	23 May 2004	
P2	P02A,B	-22.5081	119.7781	Fortescue Marsh east	Roy Hill	Episodic salt marsh	16 Aug 2003	23 Apr 2006	
P3A		-22.3167	119.1494	Fortescue Marsh west (creek)	Mulga Downs	Episodic salt marsh	17 Aug 2003	29 Apr 2006	
P3B	P03A,B	-22.3280	119.1880	Fortescue Marsh west (marsh)	Mulga Downs	Episodic salt marsh	29 Apr 2006		
P4	P04A,B	-22.1540	118.4750	Gnalka Gnoona Claypan (near F14 and F19)	Mulga Downs	Large partially wooded claypan	18 Aug 2003	24 May 2004	30 Aug 2006
P5	P05A	-22.1206	118.3952	Koodjeepindarranna Pool (near F18)	Mulga Downs	Claypan channel	18 Aug 2003	24 May 2004	30 Aug 2006
P39	P39A	-22.6750	119.8110	Un-named claypan north of Perkililly Dam (= FV036)	Roy Hill	Small bare claypan	23 May 2004	26 Aug 2005	
P40	P40A	-22.3606	118.9788	Mulga Downs Outcamp Claypan	Mulga Downs	Large partially wooded claypan	26 May 2004	31 Aug 2006	
P41	P41A	-22.8256	120.2589	Un-named claypan 2km north of Windy Corner Bore	Ethel Creek	Partially wooded claypan	01 Jun 2004	27 Aug 2005	
P42	P42A	-22.8514	120.2354	Un-named claypan 2.75km south-west of Windy Corner Bore (near F25)	Ethel Creek	Claypan channel	02 Jun 2004	27 Aug 2005	

Appendix 4. List of flora quadrats sampled for this project (FV codes) and the Pilbara Biological Survey (P codes) (Lyons et al. 2015).

Quadrat locations are based on WGS 84.

Flora Site Code	Quadrat Latitude	Quadrat Longitude	Name or descriptor	Quadrat location	Vegetation Description	Wetland type	Dates sampled for flora			Cluster site group
FV02A	-22.299773	118.825095	Chaddelinna Pool	Intermittenly flooded grassland margin	Low isolated trees of Eucalyptus victrix over grassland of Eriachne flaccida, E. benthamii over low sparse sedgeland of Cyperus iria, Schoenoplectus laevis over very sparse herbs of Alternanthera angustifolia	Open wetland on grassy floodplain	29 Jul 2015	25 Aug 2016	13 Mar 2017	9
FV03A	-22.300044	118.834172	Tussock grassland east of Chaddelinna Pool	Floodplain upper margin	Low isolated trees of Eucalyptus victrix over grassland of Eriachne flaccida, E. benthamii over low isolated sedges of Cyperus iria, C. difformis	Floodplain	29 Jul 2015	26 Aug 2016		9
FV04A	-22.349716	118.984651	*Tecticornia* flat north of Mulga Downs Outcamp Claypan	Upper floodplain margin	Open shrubland of Eremophila spongiocarpa, Tecticornia auriculata, Tecticornia halocnemoides over low open shrubland of Frankenia pauciflora, Maireana luehmannii over low isolated grasses of Eragrostis dielsii, Paspalidium clementii	Floodplain	30 Jul 2015			1
FV05A	-22.359811	118.980595	Mulga Downs Outcamp Claypan	Claypan low dune/berm	Tall open shrubland of Melaleuca glomerata, Acacia stenophylla over sparse shrubland of Duma florulenta, Tecticornia indica subsp. bidens, Frankenia pauciflora over low open tussock grassland of Sporobolus mitchellii, Eragrostis tenellula, Eragrostis setifolia	Large partially wooded claypan	30 Jul 2015	12 Mar 2017		10
FV06A	-22.359823	118.980007	Mulga Downs Outcamp Claypan	Claypan basin floor	Tall open shrubland of Acacia stenophylla over isolated shrubs of Duma florulenta	Large partially wooded claypan	30 Jul 2015	12 Mar 2017		6
FV07A	-22.338556	118.874660	Mungthannannie Pool (south)	Slope of linear dune	Low open woodland of Eucalyptus victrix over open shrubland of Melaleuca glomerata, Acacia stenophylla over low sparse sedgeland of Cyperus bifax, Eragrostis setifolia	Large partially wooded claypan	31 Jul 2015	26 Aug 2016		3
FV08A	-22.338556	118.874660	Mungthannannie Pool (south)	Lower slope of linear dune (backwater edge)	Low isolated trees of Eucalyptus victrix over low isolated shrubs of Aeschynomene indica over low sparse forbland of Alternanthera denticulata, Centipeda minima	Large partially wooded claypan	31 Jul 2015	26 Aug 2016		10
FV09A	-22.294848	118.853712	Creek pool 1.8km east of Bernies Bore	Sandy wash beside creek channel	Low isolated trees of Eucalyptus victrix over tall open shrubland of Acacia tetragonophylla, Acacia synchronicia over low sparse sedgeland of Cyperus iria over mixed open forbs	Intermittent creek pool	01 Aug 2015	26 Aug 2016	13 Mar 2017	9
FV10A	-22.321214	118.875840	Mungthannannie Pool (north)	Slope of linear dune	Low open woodland of Eucalyptus victrix over tall shrubland of Melaleuca glomerata, Acacia tetragonophylla over low grassland of Cenchrus ciliaris, Eragrostis dielsii, E. cumingii, Setaria verticellata over sparse sedgeland of Cyperus bifax	Large partially wooded claypan	01 Aug 2015	26 Aug 2016	13 Mar 2017	3
FV11A	-22.320995	118.876122	Mungthannannie Pool (north) inflow channel	Flat beside inflow channel to large claypan	Low isolated shrubs of Aeschynomene indica over sparse tussock grassland/sedgeland of Leptochloa fusca, Eragristis leptocarpa, E. tennellula, Cyperus hamulosus, C. iria over low open forbland of Centipeda pleiocephala, Centipeda thespidioides, Drosera finlaysoniana	Large partially wooded claypan	01 Aug 2015	26 Aug 2016	13 Mar 2017	10
FV13A	-22.296027	118.820373	Vegetated channel in *Eriachne* Tussock grassland	Bed of shallow linear depression	Low isolated trees of Eucalyptus victrix, Acacia distans over sparse tussock grassland of Eriachne flaccida, Eriachne benthamii over low open sedgeland of Schoenoplectus laevis, Schoenoplectus dissachanthus	Floodplain channel	02 Aug 2015	26 Aug 2016	13 Mar 2017	9
FV14A	-22.160169	118.468721	Gnalka Gnoona claypan	Broad fringe to bed of claypan	Low isolated shrubs of Tecticornia verrucosa over low open tussock grassland of Echinochloa colona, Leptochloa fusca over low sparse forbland of Peplidium sp. C, Bergia sp.	Large partially wooded claypan	02 Aug 2015	24 Aug 2016		6
FV15A	-22.222599	118.659432	Un-named claypan 1.1km south of Maddina Well	Shallow inudated bed and margin	Low isolated trees of Eucalyptus victrix over isolated shrubs of Acacia synchronicia over low open tussock grassland of Eriachne flaccida	Very small vegetated claypan	03 Aug 2015	25 Aug 2016		6
FV16A	-22.246706	118.708601	Gidyea Pool	Shallow inudated bed and margin	Grassland of Eriachne benthamii/flaccida	Small vegetated claypan	03 Aug 2015	13 Mar 2017		12
FV17A	-22.131170	118.401458	Koodjeepindarranna claypan complex	Margin of small rise in claypan complex	Low open woodland of Eucalyptus victrix over sparse shrubland of Acacia distans, Acacia stenophylla and Duma florulenta over low open shrubland of Eleocharis pallens	Large treed claypan	04 Aug 2015	24 Aug 2016	15 Mar 2017	9
FV18A	-22.126076	118.400501	Channel within Koodjeepindarranna claypan complex	Damp margin	Low isolated trees of Eucalyptus victrix over isolated shrubs of Acacia stenophylla over open tussock grassland of Leptochloa fusca over isolated forbs of Peplidium sp. C	Claypan channel	04 Aug 2015	24 Aug 2016	15 Mar 2017	9
FV19A	-22.165711	118.472574	Gnalka Gnoona claypan	Broad upper riparian zone within bed	Low open woodland of Eucalyptus victrix over tall sparse shrubland of Acacia stenophylla over low isolated grasses of Sporobolus mitchellii	Large partially wooded claypan	04 Aug 2015	24 Aug 2016		6
FV20A	-22.872767	120.286817	Un-named claypan 3.7km south-west of Bullina Bore	Upper margin at edge of inundation	Low woodland of Eucalyptus victrix over grassland of Eriachne benthamii, Eriachne flaccida over open sedgeland of Eleocharis pallens over low sparse sedgeland of Schoenoplectus laevis, Schoenoplectus dissachanthus	Small wooded claypan	09 Mar 2016			8
FV20B	-22.872539	120.286981	Un-named claypan 3.7km south-west of Bullina Bore	Inundated margin with crabholes	Sedgeland of Eleocharis pallens over low sparse sedgeland of Schoenoplectus laevis, Schoenoplectus dissachanthus over low closed fernland of Marsilea sp.	Small wooded claypan	09 Mar 2016			8
FV21A	-22.787450	120.203950	Un-named creek pool on Jigalong/Fortescue Floodplain	Creek bank	Low woodland of Eucalyptus victrix over low open tussock grassland of Echinocloa colona, Chloris pectinata, Eriachne benthamii over low sparse forbland of Centipeda minima subsp. macrocephala	Semi-isolated intermittent creek pool	09 Mar 2016	10 Mar 2017		7
FV22A	-22.732833	120.100517	Un-named pool near Battle Hill	Creek bank	Low isolated trees of Eucalyptus victrix over isolated shrubs of Vachellia farnesiana over low closed sedgeland of Cyperus bifax over low open grassland of Sporobolus mitchellii	Intermittent river pool	09 Mar 2016	10 Mar 2017		7
FV23A	-22.854667	120.302617	Un-named claypan 1km south-west of Bullina Bore	Slope at edge of inundation	Low woodland of Eucalyptus victrix over isolated shrubs of Vachellia farnesiana over low sparse sedgeland of Eleocharis pallens, Schoenoplectus laevis, Schoenoplectus dissachanthus	Small wooded claypan	09 Mar 2016			8
FV24A	-22.837367	120.269183	Un-named claypan 2.4km north-east of Windy Corner Bore	Slope at edge of inundation	Low woodland of Eucalyptus victrix over sparse sedgeland of Eleocharis pallens over low sparse sedgeland of mixed annual sedges over low closed fernland of Marsilea sp.	Partially wooded claypan	11 Mar 2016	28 Aug 2016		8
FV24B	-22.838848	120.268707	Un-named claypan 2.4km north-east of Windy Corner Bore	Flat above inundation	Low open woodland of Eucalyptus victrix, Corymbia candida over low open tussock grassland/sedgeland of Eriachne flaccida, Eleocharis pallens over low open fernland of Marsilea crenata, M. costulifera	Partially wooded claypan	11 Mar 2016	28 Aug 2016		8
FV25A	-22.848183	120.239217	Un-named claypan 2.2km south-west of Windy Corner Bore	Flat subject to inundation	Isolated shrubs of Vachellia farnesiana over tall open tussock grassland of Eragrostis australasica	Claypan channel	11 Mar 2016	28 Aug 2016		5
FV26A	-22.848110	120.308595	Un-named claypan next to Bullina Bore	Slope at edge of inundation	Low woodland of Eucalyptus victrix over low isolated sedges of Schoenoplectus laevis, Schoenoplectus dissachanthus, Eleocharis pallens over low closed fernland of Marsilea costulifera, Marsilea sp. indet.	Small bare claypan	12 Mar 2016	28 Aug 2016		8
FV27A	-22.980283	120.246950	Jinerabar Pool on Jimblebar Creek	Upper slope of bank	Low open forest of Eucalyptus victrix over low woodland of Acacia distans, Acacia tetragonophylla over low open grassland of Cenchrus ciliaris and C. setiger	Intermittent river pool	12 Mar 2016	28 Aug 2016		7
FV27B	-22.980283	120.246950	Jinerabar Pool on Jimblebar Creek	Lower slope of bank	Low woodland of Eucalyptus victrix over low open sedgeland of Cyperus bifax over low open forbland of Alternanthera denticulata over low open fernland of Marsilea costulifera	Intermittent river pool	12 Mar 2016	28 Aug 2016		7
FV28A	-22.838883	120.274283	Un-named claypan 1.7km east-north-east of Windy Corner Bore	Slope at edge of inundation	Low open woodland of Eucalyptus victrix over low open sedgeland of Eleocharis pallens over low fernland of Marsilea costulifera	Small wooded claypan	13 Mar 2016	28 Aug 2016		8
FV28B	-22.838233	120.275433	Un-named claypan 1.7km east-north-east of Windy Corner Bore	Flat above inundation	Low open woodland of Eucalyptus victrix over low tussock grassland of Eriachne flaccida, Eriachne benthamii over low isolated forbs of Goodenia lamprosperma	Small wooded claypan	13 Mar 2016	28 Aug 2016		8
FV29A	-22.850033	120.209817	Northern un-named pool on Fortescue River anabranch	Bank slope	Low open woodland of Eucalyptus victrix over isolated tussock grasses of Leptochloa digitata over sedgeland of Cyperus bifax	Intermittent creek pool	13 Mar 2016	29 Aug 2016		7
FV30A	-22.802783	120.229200	Meecardagunna Pool on Jigalong Creek	Bank slope	Low woodland of Eucalyptus victrix over low sparse sedgeland of Cyperus bifax over low sparse forbland of Alternanthera denticulata	Intermittent river pool	13 Mar 2016	27 Aug 2016		7
FV31A	-22.511986	119.763718	Moorimoordinina Pool on Fortescue River	Bank slope	Dense woodland Eucalyptus camaldulensis subsp. obtusa over shrubland of Acacia ampliceps, Samolus sp. Fortescue Marsh (A. Markey & R. Coppen FM 9702) over sparse herbland of Centipeda minima subsp. macrocephala, C. crateriformis subsp. crateriformis	Permanent river pool	11 Aug 2013	28 Jul 2014	15 Mar 2016	4
FV32A	-22.553536	119.863516	14 Mile Pool on Fortescue River	Bank slope	Shrubland of Acacia ampliceps over shrubland of Sesbania cannabina, Solanum nigrum, Samolus sp. Fortescue Marsh (A. Markey & R. Coppen FM 9702) over herbfield of Centipeda minima subsp. macrocephala, C. crateriformis subsp. crateriformis	Permanent river pool	31 Aug 2013	27 Jun 2014	15 Mar 2016	4
FV33A	-22.691700	119.809883	Un-named claypan 700m south of Perkililly Dam	Claypan basin	Low open tussock grassland of Eriachne benthamii/flaccida	Small vegetated ephemeral claypan	16 Mar 2016	22 Aug 2016	11 Mar 2017	12
FV33B	-22.691252	119.809459	Un-named claypan 700m south of Perkililly Dam	Slope above small shallow circular claypan	Low isolated shrubs of Sclerolaena costata, S. cuneata, Solanum lasiophyllum over low sparse forbland of Portulaca sp. over low isolated clumps of grasses of Aristida contorta and Eragrostis dielsii	Small vegetated ephemeral claypan	22 Aug 2016	11 Mar 2017		2
FV34A	-22.727100	119.656633	Coondiner Pool on Coondiner Creek	Riparian slope at waters edge	Low open forest of Eucalyptus victrix over low open shrubland of Duma florulenta over low isolated mixed annual sedges over low closed fernland of Marsilea costulifera	Intermittent creek pool	16 Mar 2016	22 Aug 2016	11 Mar 2017	10
FV35A	-22.708499	119.814026	Un-named claypan 2.7km south of Perkililly Dam	Slope at edge of small shallow circular claypan	Low isolated shrubs of Sclerolaena costata, S. cuneata over low sparse forbland of Gnephosis brevifolia, Trianthema triquetrum	Small bare ephemeral claypan	16 Mar 2016	22 Aug 2016		2
FV36A	-22.674920	119.809122	Un-named claypan north of Perkililly Dam (= PSW039 Lyons, 2015)	Slope at edge of small shallow circular claypan	Low isolated shrubs of Sclerolaena, Acacia synchronicia, Solanum lasiophyllum over low sparse forbland of Gnephosis brevifolia, Trianthema triquetrum, over low isolated clumps of grasses of Aristida contorta and Eragrostis dielsii	Small bare ephemeral claypan	11 Mar 2017	22 Aug 2016		2
FV37A	-22.640200	119.732879	Un-named claypan 4.4km north-east of Bakers Dam	Slope at claypan edge	Low woodland of Eucalyptus victrix over low open woodland of Melaleuca glomerata over low sparse shrubland of Duma florulenta over open tussock grassland of Eragrostis dielsii, Eragrostis setifolia	Large wooded claypan	10 Mar 2017			3
FV38A	-22.109102	118.418860	Un-named creek pool 900m east of 2 Mile Well	Bank slope	Low open woodland of Eucalyptus victrix over low tussock grassland of over low isolated forbs of Goodenia lamprosperma	Intermittent creek pool	24 Aug 2016			7
FV39A	-22.125320	118.343661	Fortescue floodplain at Roebourne Wittenoom Road	Crabhole (gilgai) flat	Tussock grassland of Eriachne flaccida, Eriachne benthamii over low sparse forbland of mixed annuals	Vegetated floodplain	24 Aug 2016	11 Mar 2017		11
FV39B	-22.126061	118.344353	Fortescue floodplain at Roebourne Wittenoom Road	Crabhole (gilgai) flat	Shrubland of Duma florulenta over open tussock grassland of Eriachne flaccida, Eriachne benthamii over low sparse forbland of mixed annuals	Vegetated floodplain	24 Aug 2016	11 Mar 2017		11
FV40A	-22.655935	119.803837	Howards Dam	Bank slope	Low woodland of Eucalyptus victrix over tall open shrubland of Acacia stenophylla, A distans over over low sparse shrubland of Duma florulenta over low sparse tussock grassland of Eriachne flaccida, Echinochloa sp.	Partially wooded stock water supply dam	23 Aug 2016			5
FV41A	-22.106925	118.227239	Powellinna Pool	Margin of small rise beside channel	Low woodland of Eucalyptus victrix over tall open shrubland of Acacia tetragonophylla over low sparse shrubland of Vachellia farnesiana over low sparse forbland of mixed annuals	Vegetated floodplain channels	25 Aug 2016	12 Mar 2017		9
FV42A	-22.873186	120.210401	Southern un-named pool on Fortescue River anabranch	Bank slope	Low open woodland of Eucalyptus victrix over low isolated tress of Melaeuca glomerata over isolated shrubs od Duma florulenta over open tussock grassland of Dicanthium serium, Leptochloa digiata over sedgeland of Cyperus bifax	Intermittent creek pool on anabranch	11 Mar 2016	29 Aug 2016		7
FV43A	-22.759173	120.201547	Un-named claypan in complex south of Kondy Creek	Claypan upland fringe	Low isolated grasess of Eriachne flaccida, Eragrsiris dielsii, E. setifolia, E. crateriformis over sparse low sedgeland of Cyperius iria and C. squarrosus	Small bare ephemeral claypan	10 Mar 2017			3
FV44A	-22.688527	120.024281	Yunera Pool on Fortescue River	Bank slope	Low open woodland of Eucalyptus victrix over low open shrubland of Vachellia farnesiana over low grassland of Setaria deilsii, Panicum levinode, Dichanthium sericeum subsp. humilis over low forbland of Malvasatrum americanum and Rostellularia adscendens var. clementii	Permanent river pool	10 Mar 2017			7
FV46A	-21.897615	117.938699	Un-named pool near Toweranna Well	Bank slope	Low open woodland of Eucalyptus victrix over low open shrubland of Vachellia farnesiana, Duma florulenta over low grassland of Setaria deilsii, Cenchrus ciliaris, C. setigera over mixed low sparse forbland of mixed annuals	Permanent river pool	14 Mar 2017			7
FV47A	-21.927874	117.994351	Un-named pool south-west of Burgess Well	Bank slope	Low woodland of Eucalyptus victrix over low woodland of Melaleuca glomerata, Acacia coriacea subsp. pendens, over low grassland of Eriachne benthamii, Malvalstrum americanum,	Intermittent river pool	14 Mar 2017			7
FV48A	-21.985228	118.041563	Un-named pool north-east of Salt Spring Well	Bank slope	Tall shrubland of Melaleuca glomerata overopen low grassland of Sporobolus mitchellii	Permanent river pool	14 Mar 2017			1
P01A	-22.725556	119.656556	Coondiner Pool on Coondiner Creek (same pool as FV034)	Riparian slope at waters edge	Low woodland of Eucalyptus victrix over isolated shrubs Duma florulenta over low isolated mixed annual sedges over low closed fernland of Marsilea costulifera	Intermittent creek pool	06 Sep 2003	25 Apr 2004		10
P02A	-22.509139	119.776944	Fortescue Marsh (east)	Broad Samphire Marsh	Open low shrubland of Muellerolimon salicorniaceum over isolated shrubs of Tecticornia pergranulata subsp. pergranulata over dense forbland of Mimulus aff. gracilis, Swainsona thompsoniana and Cressa australis	Episodic salt marsh	06 Sep 2003	23 Apr 2004	16 Aug 2006	4
P02B	-22.508528	119.779611	Fortescue Marsh (east)	Broad Samphire Marsh	Isolated shrubls of Muellerolimon salicorniaceum over isolated shrubs of Tecticornia pergranulata subsp. pergranulata, T. auriculata over dense low sedgeland of Eleocharis papillosa	Episodic salt marsh	06 Sep 2003	23 Apr 2004	16 Aug 2006	4
P03A	-22.316194	119.149944	Fortescue Marsh (west)	Broad Samphire Marsh	Shrubland of Muellerolimon salicorniaceum over low shrubland of Tecticornia indica, Tecticornia pergranulata subsp. pergranulata, T. auriculata over forbland of Mimulus aff. Repens	Episodic salt marsh	05 Sep 2003	28 Apr 2006	17 Aug 2006	1
P03B	-22.313194	119.152972	Fortescue Marsh (west)	Broad Samphire Marsh	Low shrubland of Tecticornia indica, T. auriculata, T. pergranulata subsp. pergranulata over low open grassland of Eragrostis dielsii over sparse forbland of Mimulus aff. repens. Nicotiana rostulata subsp. rostulata over sparse sedgeland of Eleocharis papillosa	Episodic salt marsh	05 Sep 2003	28 Apr 2006	17 Aug 2006	1
P04A	-29.153000	118.491972	Gnalka Gnoona Claypan (near FV014 and FV019)	Broad fringe at edge claypan	Open woodland of Euclyptus victrix over isolated tall shrubs Acacia distans, A. stenophylla over isolated shrubs of Duma florulenta over mixed open forbland	Large partially wooded claypan	04 Sep 2003	26 May 2004		6
P04B	-29.154639	118.475139	Gnalka Gnoona Claypan (near FV014 and FV019)	Broad upper slope	Low isolated shrubs of Tecticornia verrucosa over isolated grasses of Sporobolus mitchellii over low sparse forbland of Bergia perennis	Large partially wooded claypan	04 Sep 2003	26 May 2004		6
P05A	-22.120250	118.395167	Channel within Koodjeepindarranna claypan complex (near F18)	Channel bank and flat	Open woodland of Euclyptus victrix, Acacia distans over isolated shrubs of Duma florulenta over dense low forbland of Centipeda minima, C. thespidioides, Alternathera nodiflora, Bergia spp. over low sedgeland of Cyperus iria, C. difformis	Claypan channel	04 Sep 2003	26 May 2004	19 Aug 2006	9
P39A	-22.675028	119.811056	Un-named claypan north of Perkililly Dam (=FV036 current study)	Flat above small shallow circular claypan	Low grassland of Eragrostis cumingii, E, dielsii, E, leptocarpa, E. tenellula over mixed open low forbland	Small bare claypan	20 May 2004	20 Aug 2005		5
P40A	-22.361889	118.976278	Mulga Downs Outcamp Claypan (near FV005, FV006)	Claypan low dune/berm	Sparse shrubland of Acacia stenophylla, Melaeuca glomerata over isolated low shrubs of Duma florulenta over open low tussock grassland of Eragrostis setifolia, E. cumingii, E. leptocarpa over mixed open low forbland	Large partially wooded claypan	01 Jun 2004	31 Aug 2005		10
P41A	-22.823444	120.258694	Un-named claypan 2km north of Windy Corner Bore	Low rise at claypan edge	Low isolated trees of Eucalyptus victrix over sparse grasssland of Eriachne flaccida, Eulalia aurea, Eriochloa pseudoacrotricha over isolated sedges of Cyperus difformis over low sedgeland of Schoenoplectus dissachanthus, S. laevis and S. lateriflorus	Partially wooded claypan	01 Jun 2004	27 Aug 2005		8
P42A	-22.850194	120.235639	Un-named claypan 2.75km south-west of Windy Corner Bore (near FV02	Flat at claypan edge	Sparse low grasses of Eragrostis dielsii, E, leptocarpa, E. tenellula over low sparse forbland of mixed annuals	Claypan channel	02 Jun 2004	31 Aug 2005		5

Appendix 5. Aquatic environmental data

Aquatic environmental data collected during the current project ('F' sites) and the Pilbara Biological Survey ('P' sites) by Pinder et al. (2010)

NC = not collected   '<' or '>' = below or above detection limits   Macrophytes: 0=absent, 1=1-20%, 2=21-40%, 3=41-60%, 4=61-80%, 5=>80%

					Sediments																Anion composition				Cation composition				
SiteCode	Date	Inundation period	Area of fill	Depth (cm)	% Bedrock and Boulder	%Stones	% Sand	% Silt	% Clay	pH	Temperature (°C)	Turbidity (NTU)	Field Conductivity (mS/m)	Total filterable nitrogen (mg/L)	Total filterable phosphorus (mg/L)	Total nitrogen (mg/L)	Total phosphorus (mg/L)	Chlorophyll-a (mg/L)	Phaeophytin-a (mg/L)	Alkalinity (mg/L)	%Meq Na^{+}	% Meq Ca^{2+}	% Meq Mg^{2+}	% Meq K^{+}	% Meq Cl^{-}	% Meq SO_4^{2-}	% Meq HCO_3^{-}	% Meq CO_3^{2-}	% Cover of submerged macrophytes
FV01	26 Apr 2015	5	3.5	5	0	NC	NC	NC	NC	8.88	30.4	840	4.1			0.41	0.17	NC	NC	17.0	69.7	4.5	11.5	14.3	43.6	19.3	35.5	1.7	1
FV02	13 Mar 2017	56	5.6	34	0	0.2	36.9	27.4	35.4	9.15	25.1	96	16.8			1.60	0.18	0.0280	0.0170	75.0	81.4	1.8	3.5	13.3	22.5	6.8	69.9	0.8	0
FV02	29 Jul 2015	144	5.6	33	0	0.2	36.9	27.4	35.4	8.74	15.9	310	9.9			0.92	0.17	0.0090	0.0005	40.0	79.5	1.9	5.1	13.6	27.7	14.6	56.5	1.2	1
FV05	12 Mar 2017	347	346	64	0	<0.1	18.5	43.0	38.5	7.58	25.9	340	31.1			0.57	0.06	0.0036	0.0015	53.0	67.7	13.2	7.0	12.2	51.4	11.4	36.6	0.6	4
FV05	30 Jul 2015	225	206	17	0	<0.1	18.5	43.0	38.5	7.90	28.4	760	37.7			1.40	0.29	0.0005	0.0005	56.0	78.9	6.2	4.1	10.9	49.3	13.5	36.7	0.5	0
FV07	31 Jul 2015	148	261	28	0	0.7	18.4	39.7	41.2	8.00	26.1	2300	16.1			1.70	0.54	0.0010	0.0005	47.0	83.7	4.3	2.2	9.8	25.4	8.6	64.8	1.2	0
FV09	13 Mar 2017	56	0.1	12	0	NC	NC	NC	NC	7.85	29	2400	35.9			3.00	0.14	0.0064	0.0063	113.0	58.3	20.2	9.5	12.0	25.1	7.4	67.0	0.5	0
FV10	13 Mar 2017	60	320	61	0	4.6	39.6	24.8	31.0	8.38	20.9	1400	13.2			0.98	0.25	0.0014	0.0006	46.0	71.5	7.5	7.2	13.8	23.7	20.0	55.2	1.0	0
FV10	01 Aug 2015	148	261	27	0	4.6	39.6	24.8	31.0	7.90	25.6	2400	15.3			1.70	0.56	0.0005	0.0005	51.0	81.4	4.5	3.5	10.6	24.8	9.2	65.0	1.0	0
FV12	01 Aug 2015	99	261	6	0	1.7	19.7	48.2	30.5	9.27	30.7	2100	22.3			1.80	0.59	0.0070	0.0005	72.0	79.5	4.9	4.3	11.3	33.5	9.9	55.3	1.3	0
FV14	02 Aug 2015	91	149	6	0	<0.1	55.5	13.5	31.0	8.62	26.2	2600	27.2			3.90	0.65	0.0030	0.0020	131.0	82.7	4.7	2.7	9.9	42.3	13.1	42.3	2.3	0
FV15	03 Aug 2015	12	0.5	3	0	NC	NC	NC	NC	8.39	17.9	NC	10.3			NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	0
FV16	13 Mar 2017	42	0.4	3	0	14.8	26.4	34.1	24.7	9.00	36	660	53.8			3.20	0.17	0.0042	0.0045	164.0	87.8	2.3	2.1	7.8	33.5	7.1	59.1	0.3	3
FV16	03 Aug 2015	12	0.4	5	0	14.8	26.4	34.1	24.7	8.38	21.3	24000	86.2			0.80	0.17	0.0700	0.0190	127.0	88.9	3.6	1.4	6.1	56.8	6.8	33.5	2.8	0
FV17	15 Mar 2017	42	130	8	0	3.5	29.0	35.7	31.8	7.80	27.3	6900	17.4			3.70	0.36	0.0170	0.0460	75.0	67.7	8.7	11.8	11.8	21.6	26.0	51.9	0.6	0
FV17	04 Aug 2015	102	117	8	0	4.6	26.2	33.9	35.3	8.00	16.3	3200	15.3			2.90	0.63	0.0060	0.0030	40.0	58.6	7.7	19.3	14.3	33.4	15.5	50.0	1.0	0
FV18	15 Mar 2017	42	0.3	50	0	10	18.0	32.4	39.6	8.23	25.6	1900	11.4			2.40	0.27	0.0016	0.0018	48.0	63.0	9.8	15.7	11.4	23.5	26.0	49.6	0.9	1
FV18	04 Aug 2015	203	0.25	35	0	22.8	25.1	22.8	29.3	7.66	21.2	2700	13.7			4.40	0.65	0.0010	0.0005	37.0	61.3	8.3	17.9	12.5	29.1	38.5	31.7	0.7	0
FV19	04 Aug 2015	91	149	15	0	0.1	46.0	15.0	39.0	8.40	21	1600	36.1			1.90	0.47	0.0080	0.0020	99.0	80.9	4.3	3.3	11.5	36.6	12.4	49.3	1.7	0
FV20	09 Mar 2016	36	3.6	40	0	22.4	32.2	8.9	36.5	7.68	24.1	280	21.5			1.20	0.09	0.0039	0.0039	80.0	24.8	27.6	32.5	15.1	14.6	8.8	75.8	0.8	0
FV21	09 Mar 2016	36	0.4	55	0	0.2	39.4	7.0	53.4	7.49	26.8	760	21.4			1.70	0.12	0.0230	0.0230	86.0	17.8	37.4	26.7	18.2	13.9	8.4	77.0	0.7	0
FV22	09 Mar 2016	36	0.5	55	0	24.4	42.3	5.7	27.6	8.72	34.1	130	31.2			0.95	0.05	0.0085	0.0093	108.0	32.5	37.3	21.2	8.9	20.2	8.8	70.5	0.5	0
FV23	09 Mar 2016	36	8.8	50	0	3.1	34.9	9.7	52.3	9.54	32.8	160	10.5			0.63	0.05	0.0024	0.0013	52.0	28.9	33.1	26.1	11.9	10.7	9.5	78.5	1.3	5
FV24	11 Mar 2016	38	7.4	55	0	0.1	22.0	13.5	64.4	8.15	28.7	310	20.8			0.96	0.08	0.0075	0.0038	77.0	27.0	33.0	26.4	13.6	16.4	8.1	74.7	0.8	1
FV25	11 Mar 2016	38	0.8	35	0	0.1	27.5	25.0	47.5	7.73	30.5	7800	38.8			6.10	0.39	0.0007	0.0009	89.0	68.7	10.9	11.0	9.4	26.3	20.0	53.2	0.5	0
FV26	12 Mar 2016	39	3	45	0	1.4	38.0	8.4	52.3	8.00	27	140	18.0			0.74	0.05	0.0027	0.0033	64.0	26.8	33.7	25.8	13.7	20.6	10.9	67.7	0.9	1
FV27	12 Mar 2016	39	6.2	90	0	1.3	72.5	6.4	19.7	7.65	35.1	150	23.0			1.40	0.07	0.0043	0.0055	72.0	39.8	25.7	23.8	10.7	29.0	5.6	64.6	0.7	0
FV28	13 Mar 2016	40	0.8	35	0	0.4	25.9	14.4	59.3	8.12	25.9	520	31.1			1.10	0.11	0.0064	0.0140	104.0	27.8	33.9	28.4	9.9	22.7	7.0	69.8	0.6	1
FV29	13 Mar 2016	40	0.1	40	0	0.3	34.9	12.5	52.3	9.08	35.3	58	35.5			2.10	0.16	0.0640	0.0220	139.0	23.6	33.8	31.7	11.0	16.7	0.3	82.5	0.5	0
FV30	13 Mar 2016	40	4.2	55	0	0.1	10.0	24.0	65.9	8.23	35.3	630	33.5			1.50	0.12	0.0160	0.0069	103.0	18.2	38.9	30.1	12.8	13.0	0.4	85.9	0.7	0
FV31	15 Mar 2016	permanent	176	85	0	0.9	30.2	16.8	52.0	8.23	35.2	110	24.5			1.10	0.07	0.0050	0.0030	113.0	56.3	24.6	12.5	6.6	53.5	21.9	24.5	0.2	0
FV32	15 Mar 2016	semi-permanent	73.2	85	0	9.9	34.7	17.1	38.3	8.83	31.7	76	27.7			0.56	0.05	0.0120	0.0032	93.0	38.2	29.1	22.6	10.2	22.5	9.8	67.1	0.6	0
FV33	11 Mar 2017	24	0.7	4	0	9.2	19.5	25.9	45.4	7.49	26.6	3200	35.3			1.70	0.47	NC	NC	36.0	78.4	2.0	11.4	8.1	73.5	6.7	19.4	0.4	0
FV33	06 Jul 2016	13	0.7	10	0	9.2	19.5	25.9	45.4	8.90	16.6	3600	9.2			2.80	0.34	0.0015	0.0010	33.0	86.9	1.0	11.5	0.6	86.5	0.6	12.6	0.3	0
FV34	16 Mar 2016	46	11	96	30	20.5	36.1	3.0	10.4	7.85	33	430	9.6			0.77	0.11	0.0052	0.0024	37.0	34.9	25.8	18.3	21.0	23.7	5.8	68.9	1.6	4
FV35	11 Mar 2017	55	7.6	3	0	15.1	12.7	14.4	57.7	8.22	23.8	>100000	80.2			12.00	4.30	NC	NC	308.0	95.9	1.0	0.6	2.5	47.6	0.1	52.2	0.1	0
FV35	07 Jul 2016	60	7.6	9	0	15.1	12.7	14.4	57.7	8.71	13.5	19000	77.4			3.90	0.85	0.0005	<0.0002	37.0	89.8	0.8	9.1	0.3	87.6	0.7	11.5	0.3	0
FV36	07 Jul 2016	31	2.5	5	0	1.5	21.2	25.1	52.2	8.61	17.3	30000	115.9			6.20	0.81	0.0003	<0.0002	77.0	90.3	0.8	8.7	0.2	83.5	0.6	15.7	0.2	0
FV37	08 Jul 2016	32	15.4	5	0	<0.1	12.0	23.5	64.5	8.23	22.5	37000	22.6			0.33	0.08	<0.0001	0.0024	75.0	60.8	4.6	31.5	3.1	23.3	3.2	72.6	0.8	0
FV38	09 Jul 2016	33	0.5	38	0	10	36.0	14.9	39.2	8.25	19.3	670	4.8			0.55	0.12	0.0021	0.0005	23.0	39.2	34.1	22.5	4.2	24.9	2.5	70.0	2.5	0
FV39	09 Jul 2016	35	60?	28	0	2.9	20.4	22.3	54.4	8.48	8.3	550	15.8			7.60	0.68	0.0015	0.0012	25.0	63.7	20.3	13.2	2.8	61.9	0.9	36.0	1.2	0
FV41	12 Mar 2017	30	3	13	0	0.4	25.4	27.4	46.8	7.88	24.5	1200	11.6			1.10	0.07	0.0031	0.0038	45.0	53.0	12.7	16.7	17.7	25.9	17.8	55.2	1.0	0
FV43	10 Mar 2017	58	5.1	25	0	0.1	50.0	20.5	29.5	9.72	23	8.6	17.3	0.85	0.02	1.60	0.05	0.0011	0.0015	57.0	58.6	20.2	5.8	15.5	30.2	0.6	68.2	1.0	5
FV44	10 Mar 2017	permanent	3.8	85	0	0.3	29.9	11.0	58.8	7.84	26.2	360	12.6			0.86	0.08	0.0270	0.0280	53.0	25.4	39.7	22.6	12.3	15.2	1.6	81.9	1.3	0
FV46	14 Mar 2017	permanent	2.3	103	10	2.3	14.5	25.0	48.3	8.28	23.5	36	269.0	0.14	<0.01	0.46	0.05	0.0074	0.0023	93.0	58.9	13.4	24.7	3.0	69.6	23.2	7.1	0.1	2
FV47	14 Mar 2017	94	1.1	80	75	10.6	4.9	3.5	6.0	8.24	24.7	80	129.0	0.09	<0.01	0.23	0.02	0.0040	0.0036	82.0	56.7	17.2	22.2	3.9	64.4	22.1	13.4	0.1	1
FV48	14 Mar 2017	permanent	0.1	120	0	1.4	47.3	28.6	22.7	7.61	24.5	24	640.0	0.20	<0.01	0.90	0.05	0.0014	0.0004	51.0	65.4	11.5	19.6	3.4	66.2	31.1	2.7	0.0	3
P01	23 May 2004	515	10.6	86	1	11.9	57.9	7.0	22.2	7.73	20.6	210	10.4	0.38	0.11			0.003	<0.001	44.0	28.9	19.5	32.2	19.4	19.9	2.0	78.1	2.9	4
P01	15 Aug 2003	233	6.1	60	1	25.5	60.2	4.8	8.4	8.29	22	0.3	38.8	0.65	0.02			0.003	0.002	150.0	25.7	22.6	37.4	14.2	16.3	1.2	82.5	0.9	4
P02	23 Apr 2006	82	25?	10	0	0.0	29.0	52.5	18.5	9.46	31.5	42	411.0	0.40	<0.01			0.001	4	55.0	58.9	11.6	25.5	4.0	57.4	38.9	3.6	0.1	3
P02	16 Aug 2003	200	58?	15	0	1.3	48.4	25.2	25.2	8.60	26.3	2	1925.0	0.43	<0.01			0.003	0.002	60.0	66.1	13.2	17.7	3.0	69.6	29.9	0.5	0.0	3
P03A	29 Apr 2006	88	6000	75	0	6.1	37.6	38.1	18.3	8.28	20	4.2	433.0	0.23	<0.01			0.001	<0.001	60.0	56.8	11.5	27.5	4.2	63.9	33.8	2.3	0.1	4
P03B	29 Apr 2006	88	6000	40	0	0.0	65.0	20.5	14.5	8.81	26.6	4.1	761.0	1.10	0.01			0.001	<0.001	80.0	42.3	11.9	41.3	4.5	44.6	53.6	1.8	0.0	3
P03	17 Aug 2003	201	341	55	0	6.1	37.6	38.1	18.3	9.55	25.4	0.8	808.0	0.25	<0.01			0.001	<0.001	40.0	30.3	9.6	56.0	4.1	30.7	68.4	0.8	0.0	5
P04	24 May 2004	100	532	62	0	1.9	54.7	16.0	27.4	8.10	24.7	340	20.1	0.84	0.03			0.003	<0.001	87.0	58.6	7.3	15.1	19.0	14.7	3.0	82.3	1.6	0
P04	18 Aug 2003	203	519	35	0	21.7	43.8	11.0	23.5	9.33	25.6	0.7	24.6	1.00	0.01			<0.001	0.13	110.0	61.4	8.9	11.8	17.9	13.2	1.1	85.7	1.3	4
P04	30 Aug 2006	230	1240	60	0	12.2	49.0	13.4	25.3	9.21	23.9	7	12.1	0.43	0.02			<0.001	<0.001	50.0	41.9	13.5	24.5	20.2	12.3	1.7	85.9	2.8	1
P05	24 May 2004	100	1.1	104	0	3.1	30.1	27.1	39.7	7.72	28	400	12.7	0.39	0.02			0.005	<0.001	62.0	59.9	10.1	19.0	11.0	18.9	4.9	76.1	2.0	0
P05	18 Aug 2003	242	0.6	70	1	1.2	44.0	21.5	32.3	8.09	22.5	490	241.8	1.70	0.21			<0.001	0.025	115.0	64.8	9.1	17.7	8.4	10.8	1.5	87.7	1.3	1
P05	30 Aug 2006	230	300?	150	0	2.1	37.3	24.4	36.2	9.13	24.4	2.1	13.3	0.57	0.02			<0.001	<0.001	55.0	57.6	11.6	18.4	12.4	13.4	2.5	84.1	0.0	5
P39	23 May 2004	100	2.5	9	0	0.4	14.8	14.9	69.9	8.35	26.2	36000	63.4	3.30	0.45			<0.001	<0.001	79.0	86.1	6.4	1.1	6.4	74.2	2.5	23.3	0.5	0
P39	26 Aug 2005	46	2.5	8	0	0.4	14.8	14.9	69.9	8.53	26.1	200000	68.3			4.70	1.40	NC	NC	28.0	88.3	3.9	5.3	2.4	39.5	3.4	57.1	0.5	0
P40	26 May 2004	92	206	28	0	0.2	19.0	46.4	34.5	8.24	20.9	590	35.0	0.41	0.03			0.005	<0.001	78.0	76.5	4.1	7.9	11.6	29.6	19.0	51.2	1.1	0
P40	31 Aug 2006	231	152	15	0	0.2	19.0	46.4	34.5	8.69	23.7	5.6	209.5	1.10	0.02			<0.001	<0.001	70.0	69.0	8.5	15.7	6.8	68.6	23.7	7.7	0.2	5
P41	01 Jun 2004	110	9.6	14	0	0.2	59.9	2.5	37.4	10.18	29.6	21	19.7	0.90	0.03			<0.001	<0.001	38.0	31.5	22.9	29.7	15.9	40.3	10.6	48.9	2.1	3
P41	27 Aug 2005	47	11.4	12	0	0.2	59.9	2.5	37.4	7.29	24.2	3700	28.1			2.00	0.04	NC	NC	210.0	33.0	24.1	29.5	13.4	20.7	18.7	60.3	1.4	2
P42	02 Jun 2004	111	0.9	46	0	0.2	71.9	7.0	21.0	8.33	14.5	13000	19.5	3.20	0.24			0.19	<0.001	88.0	77.9	8.2	8.5	5.3	19.5	4.8	75.7	1.4	0
P42	27 Aug 2005	47	0.3	29	0	0.2	71.9	7.0	21.0	8.40	16.3	4400	19.8			1.70	0.35	NC	NC	90.0	77.3	11.2	4.5	7.0	10.8	3.2	86.0	1.6	0

Appendix 6. Flora environmental data

Environmental data collected from riparian flora quadrats during the current project ('FV' sites) and the Pilbara Biological Survey ('P' sites) by Lyons et al. (2010). Soils data for FV31 & FV32 are sourced from Markey (2016).

Site code	Site group	Riverine code riverine = 1 lacustrine = 2	EC (1:5) mS/m	pH (H2O)	Sand fraction %	Silt fraction %	Clay fraction %	OrgC (WB) %	N tot %	P total mg/kg	Ca ex cmol(+)/kg	Mg ex cmol(+)/kg	Na ex cmol(+)/kg	K ex cmol(+)/kg	Longitude (WGS 84)	Latitude (WGS 84)	Survey code FV=Fortescue vegetation P=PBS
Limit of reporting			1	0.1	0.5	0.5	0.5	0.05	0.005	10	0.0	0.02	0.02	0.02			
FV02A	9	2	5	6.9	62.5	14	23.5	0.34	0.036	980	2.1	1.8	0.81	1.2	118.825095	-22.299773	FV
FV03A	9	2	4	7	49	19	32	0.34	0.037	940	2.4	1.6	1.1	1.2	118.834172	-22.300044	FV
FV04A	1	2	400	7.5	42.5	30.5	27	0.31	0.031	340	10.0	1.6	0.94	3.1	118.984651	-22.349716	FV
FV05A	10	2	10	7.2	83.5	5	11.5	0.41	0.034	570	2.8	1.3	1.2	1.5	118.980595	-22.359811	FV
FV06A	3	2	6	9.1	18.5	43	38.5	0.17	0.021	460	6.6	2.1	1.6	2.9	118.874660	-22.338556	FV
FV07A	6	2	23	7.7	85.5	3.5	11	0.45	0.031	800	5.8	2.7	1.7	2.4	118.980007	-22.359823	FV
FV08A	10	2	4	7	71.5	9.5	19	0.93	0.058	640	6.1	2.6	0.65	1.7	118.874660	-22.338556	FV
FV09A	9	1	9	7.8	67	6.5	26.5	0.45	0.038	180	7.2	2.4	0.64	0.96	118.853712	-22.294848	FV
FV10A	3	2	3	7.4	92.5	2.5	5	0.4	0.03	490	3.4	1.3	0.19	0.88	118.875840	-22.321214	FV
FV11A	10	2	3	7.3	86	4.5	9.5	0.97	0.058	370	4.3	1.2	0.43	0.82	118.876122	-22.320995	FV
FV13A	9	2	3	6.6	37.5	22.5	40	0.53	0.054	710	3.6	2.9	0.44	1.2	118.820373	-22.296027	FV
FV14A	6	2	5	8.5	50	15.5	34.5	0.3	0.038	1100	4.8	1.6	1.3	2.8	118.468721	-22.160169	FV
FV15A	6	2	5	8.5	36.5	26	37.5	0.31	0.033	380	6.5	1.8	2.6	2.5	118.659432	-22.222599	FV
FV16A	12	2	7	8.9	22	32.5	45.5	0.21	0.027	410	6.2	1.3	3.3	3.4	118.708601	-22.246706	FV
FV17A	9	2	8	6.7	46.8	18.8	34.4	0.89	0.075	616	5.9	2.99	0.73	1.28	118.401458	-22.131170	FV
FV18A	9	2	4	6.5	38.5	22.5	39	1.56	0.109	440	8.8	4	0.69	1.1	118.400501	-22.126076	FV
FV19A	6	2	6	7.6	46	13.5	40.5	0.57	0.051	750	8.1	3.8	1.2	2.7	118.472574	-22.165711	FV
FV20A	8	2	3	6.2	64.5	6.5	29	1.44	0.112	290	4.3	2.7	0.08	0.72	120.286817	-22.872767	FV
FV20B	8	2	2	7.4	43	10	47.5	0.28	0.034	260	6.3	6.3	0.29	1.3	120.286981	-22.872539	FV
FV21A	7	1	5	7.2	37.5	9.5	53	0.88	0.087	290	9.9	5.3	0.21	2.3	120.203950	-22.787450	FV
FV22A	7	1	4	7.5	35	14.5	50.5	0.72	0.062	260	12.0	6.4	0.28	1.8	120.100517	-22.732833	FV
FV23A	8	2	5	6.2	31	13	56	1.38	0.119	310	9.0	5.4	0.15	1.1	120.302617	-22.854667	FV
FV24A	8	2	3	7	63.5	9.5	27	0.82	0.07	250	5.8	2.8	0.23	0.86	120.269183	-22.837367	FV
FV24B	8	2	4	6.8	45	18	37	0.74	0.071	360	6.0	4	0.24	1	120.268707	-22.838848	FV
FV25A	5	2	4	7.6	47	11.5	41.5	0.3	0.029	270	6.5	5.8	0.93	1.1	120.239217	-22.848183	FV
FV26A	8	2	2	6.5	79.5	2	18.5	0.52	0.049	250	3.1	1.5	0.05	0.49	120.308595	-22.848110	FV
FV27A	7	1	11	6.8	77.5	8	14.5	3.79	0.288	460	12.0	2.8	0.15	1.3	120.246950	-22.980283	FV
FV27B	7	1	6	5.7	80.5	5	14.5	3	0.221	270	5.1	1.6	0.11	0.47	120.246950	-22.980283	FV
FV28A	8	2	3	7	59.5	8	32.5	0.7	0.065	320	5.4	3.4	0.2	1	120.274283	-22.838883	FV
FV28B	8	2	4	6.9	51.5	16	32.5	0.77	0.067	290	6.2	3.7	0.25	1	120.275433	-22.838233	FV
FV29A	7	1	4	7.6	33	16.5	50.5	0.89	0.079	270	13.0	6.6	0.33	1.7	120.209817	-22.850033	FV
FV30A	7	1	4	6.3	66	6.5	27.5	1.32	0.098	240	5.4	2.6	0.06	0.89	120.229200	-22.802783	FV
FV31A	4	1	3	8.5	50.5	28	21.5	0.45	0.066	410	6.3	2.625	2.84	2.95	119.763718	-22.511986	FV
FV32A	4	1	96	6.7	97.5	0.1	2.5	0.45	0.013	410	2.7	1.45	5.75	2.35	119.863516	-22.553536	FV
FV33A	12	2	24	9	14.5	26	59	0.17	0.023	270	3.7	1.8	9.2	3.4	119.809883	-22.691700	FV
FV33B	2	2	17	8	77	5	18	0.12	0.008	130	1.6	1.1	2.3	1.3	119.809459	-22.691252	FV
FV34A	10	1	3	6.3	51.5	11.5	37	1.39	0.109	690	6.8	2.5	0.16	1	119.656633	-22.727100	FV
FV35A	2	2	170	6.8	74	4	22	0.13	0.009	170	1.8	3.1	1.4	1.2	119.814026	-22.708499	FV
FV36A	2	2	130	7	77	3	20	0.11	0.007	140	3.3	2.3	1.1	1.3	119.809122	-22.674920	FV
FV37A	3	2	30	6.6	55	5.5	39.5	0.39	0.028	420	4.5	4.2	0.45	1.7	119.732879	-22.640200	FV
FV38A	7	1	7	8.2	40.5	18.5	41	0.75	0.057	230	19.0	5.6	0.57	0.97	118.418860	-22.109102	FV
FV39A	11	2	4	8.1	19.5	22.5	58	0.36	0.035	240	16.0	10	1.9	1.4	118.343661	-22.125320	FV
FV39B	11	2	7	8.7	23.5	29	47.5	0.28	0.033	230	23.0	5.5	0.79	1.2	118.344353	-22.126061	FV
FV40A	5	2	5	6.6	78	2.5	19.5	0.75	0.056	230	3.0	2.2	0.13	1.1	119.803837	-22.655935	FV
FV41A	9	2	20	6.1	37	25	38	1.99	0.15	540	7.0	3.8	0.77	1.3	118.227239	-22.106925	FV
FV42A	7	1	5	7.7	33	22	45	0.72	0.061	270	13.0	7.6	0.63	1.1	120.210401	-22.873186	FV
FV43A	3	2	4	8.1	89	2.5	8.5	0.16	0.01	170	1.5	0.7	0.44	0.48	120.201547	-22.759173	FV
FV44A	7	1	7	7.3	24.5	19.5	56	1.4	0.122	460	14.0	7.3	0.33	3.4	120.024281	-22.688527	FV
FV46A	7	1	24	7.5	33	37	30	2.19	0.168	450	12.0	6.1	0.41	2.3	117.938699	-21.897615	FV
FV47A	7	1	22	7	22	39	39	2.4	0.166	410	8.9	5.9	0.73	1.3	117.994351	-21.927874	FV
FV48A	1	1	350	8.3	39	51	20	2.8	0.209	370	10.0	12	4.4	2.9	118.041563	-21.985228	FV
P01A	10	1	8	6.4	56.5	12	31.5	1.55	0.131	640	6.3	2.75	0.33	1.18	119.656556	-22.725556	P
P02A	4	2	140	7.4	34	32	34	0.37	0.044	450	7.1	3.13	3.41	3.56	119.776944	-22.509139	P
P02B	4	2	150	7.9	63	15.5	21.5	0.52	0.055	370	5.5	2.12	2.27	2.34	119.779611	-22.508528	P
P03A	1	2	290	7.9	49	32.5	18.5	0.49	0.067	350	15.0	3.02	1.64	4.12	119.149944	-22.316194	P
P03B	1	2	770	8.2	49.5	31	19.5	0.78	0.082	240	9.3	6.54	3.32	5	119.152972	-22.313194	P
P04A	6	2	8	6.5	44	19.5	36.5	0.9	0.073	480	10.8	4.64	0.46	2.02	118.491972	-22.153000	P
P04B	6	2	8	6.5	44	19.5	36.5	0.9	0.073	480	10.8	4.64	0.46	2.02	118.475139	-29.154639	P
P05A	9	2	11	6.3	36	22	42	1	0.101	520	10.2	4.42	0.63	2.03	118.395167	-22.120250	P
P39A	5	2	5	7.8	95	1	4	0.16	0.015	93	0.7	0.45	0.49	0.46	119.811056	-22.675028	P
P40A	10	2	39	7.3	58.5	13	28.5	0.21	0.029	460	5.4	2.41	1.42	2.7	118.976278	-22.361889	P
P41A	8	2	8	7.4	53.5	15.5	31	0.27	0.04	840	5.5	1.74	0.81	2.57	120.258694	-22.823444	P
P42A	5	2	17	7.7	55	9	36	0.11	0.02	220	6.7	3.79	1.69	0.77	120.235639	-22.850194	P

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

			FV01 26/04/2015	FV02 13/03/2017	FV02 29/07/2015	FV05 12/03/2017	FV05 30/07/2015	FV07 31/07/2015	FV09 13/03/2017	FV10 13/03/2017	FV10 01/08/2015	FV12 01/08/2015	FV14 02/08/2015	FV15 03/08/2015	FV16 13/03/2017	FV16 03/08/2015	FV17 15/03/2017	FV17 04/08/2015	FV18 15/03/2017	FV18 04/08/2015	FV19 04/08/2015	FV20 09/03/2016	FV21 09/03/2016	FV22 09/03/2016	FV23 09/03/2016	FV24 11/03/2016	FV25 11/03/2016	FV26 12/03/2016	FV27 12/03/2016	FV28 13/03/2016	FV29 13/03/2016	FV30 13/03/2016	FV31 15/03/2016	FV32 15/03/2016	FV33 11/03/2017	FV33 06/07/2016	FV34 16/03/2016	FV35 11/03/2017	FV35 07/07/2016	FV36 07/07/2016	FV37 08/07/2016	FV38 09/07/2016	FV39 09/07/2016	FV41 12/03/2017	FV43 10/03/2017	FV44 10/03/2017	FV46 14/03/2017	FV47 14/03/2017	FV48 14/03/2017
Protozoans																																																		
Arcellinida	Arcellidae	*Arcella discoides*																		1		1		1									1				1											1	
		Arcella megastoma																						1				1	1				1																
		Arcella sp. (medium, domed)																																1															
	Centropyxidae	*Centropyxis aculeata*																						1																									
		Centropyxis ecornis																				1											1				1												
		Centropyxis sp.																						1									1			1													1
	Difflugiidae	*Difflugia gramen*																					1	1					1		1			1															
		Difflugia corona																					1						1					1			1							1	1	1			
		Difflugia australis																	1																														
		Difflugia capreolata																											1																				
		Difflugia fallax				1																										1		1												1	1		
		Difflugia globulosa																																1															
		Difflugia sp. a										1				1								1																									
		Difflugia sp. b										1																																					
		Difflugia sp. c																							1				1																				
		Difflugia cf. *manicata*																					1																										
		Difflugia sp. d																											1																				
	Lesquereusidae	*Lesquereusia modesta*																					1					1																					
Euglyphida	Euglyphidae	Euglypha sp.																					1																										
Sponges																																																		
		Spongillidae																																										1		1			
Flatworms																																																		
		Turbellaria		1		1		1	1					1									1						1						1	1	1		1	1	1		1	1					
Nemertea																																																		
		Nemertini													1																																		
Roundworms (Nematoda)																																																		
		Nematoda	1	1		1			1					1			1		1	1		1	1	1	1	1	1	1		1		1	1	1	1		1		1	1	1	1	1	1				1	
Rotifers																																																		
Bdelloidea	Habrotrochidae	Habrotrocha sp.																					1								1																		
		Bdelloidea				1									1							1													1				1			1	1						1
Flosculariacea	Conochilidae	*Conochilus hippocrepis*																																										1					
		Conochilus dossuarius						1			1						1			1	1											1	1	1								1				1			
	Filiniidae	*Filinia pejleri*																						1																									
		Filinia longiseta		1	1																		1											1															
		Filinia sp.															1																																
	Flosculariidae	*Sinantherina socialis*													1																																		
		Lacinularia cf. racemovata																	1					1	1				1	1							1												
	Hexarthridae	*Hexarthra mira*							1	1							1																							1				1		1			
		Hexarthra sp.					1												1				1	1		1	1	1	1	1		1	1	1		1			1								1	1	
	Testudinellidae	*Testudinella patina*		1											1	1				1		1	1	1	1	1	1	1	1	1	1	1		1		1	1								1	1	1	1	
		Testudinella n. sp. P4										1																		1																			
Ploimida	Asplanchnidae	*Asplanchna brightwelli*		1	1		1		1	1	1					1	1							1	1					1	1		1											1		1			
		Asplanchna nr brightwelli						1																																									
		Asplanchna n. sp.																	1																														
		Asplanchnopus multiceps													1		1																																
	Brachionidae	*Anuraeopsis coelata*																					1																										
		Brachionus angularis																				1	1	1	1	1		1	1	1	1	1	1	1												1	1		
		Brachionus bidentatus																						1							1															1	1		
		Brachionus budapestinensis																													1															1			
		Brachionus calyciflorus															1																																
		Brachionus dichotomus																						1							1			1															
		Brachionus falcatus																													1			1												1			
		Brachionus quadridentatus		1		1						1		1	1	1						1		1				1																1			1		
		Brachionus quadridentatus minor																																1			1												
		Brachionus calyciflorus dorcas																																1						1		1							
		Brachionus cf. pineenaus		1																																													
		Brachionus cf bennini																															1																
		Brachionus n. sp. P3 (nr *budapestensis)*																					1																										
		Brachionus sp. a												1		1																																	
		Brachionus sp. b																		1				1																									
		Keratella australis			1						1					1																																	
		Keratella procurva		1																			1	1	1	1		1	1	1	1	1	1	1								1				1		1	
		Keratella slacki																															1																
		Keratella tropica																						1		1		1	1			1	1	1												1			
		Keratella n. sp.						1			1	1																																					
		Plationus patulus																	1														1	1										1		1			
		Platyias quadricornis																				1		1																									
	Lepadellidae	*Colurella adriatica*																																															1
		Colurella sp.		1																																													
		Lepadella sp.		1																			1																										
		Lepadella cf. rhomboides										1											1	1																									
	Dicranophoridae	Dicranophorus n. sp.										1																																					
	Epiphanidae	*Epiphanes brachionus*																																								1							
	Euchlanidae	*Euchlanis dilatata*																																										1					
		Euchlanis sp. a		1																				1										1		1	1										1		
		Euchlanis sp. b				1																			1			1			1																		
		Tripleuchlanis plicata																																															1

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

			FV01 26/04/2015	FV02 13/03/2017	FV02 29/07/2015	FV05 12/03/2017	FV05 30/07/2015	FV07 31/07/2015	FV09 13/03/2017	FV10 13/03/2017	FV10 01/08/2015	FV12 01/08/2015	FV14 02/08/2015	FV15 03/08/2015	FV16 13/03/2017	FV16 03/08/2015	FV17 15/03/2017	FV17 04/08/2015	FV18 15/03/2017	FV18 04/08/2015	FV19 04/08/2015	FV20 09/03/2016	FV21 09/03/2016	FV22 09/03/2016	FV23 09/03/2016	FV24 11/03/2016	FV25 11/03/2016	FV26 12/03/2016	FV27 12/03/2016	FV28 13/03/2016	FV29 13/03/2016	FV30 13/03/2016	FV31 15/03/2016	FV32 15/03/2016	FV33 11/03/2017	FV33 06/07/2016	FV34 16/03/2016	FV35 11/03/2017	FV35 07/07/2016	FV36 07/07/2016	FV37 08/07/2016	FV38 09/07/2016	FV39 09/07/2016	FV41 12/03/2017	FV43 10/03/2017	FV44 10/03/2017	FV46 14/03/2017	FV47 14/03/2017	FV48 14/03/2017
	Gastropodidae	*Ascomorpha* sp.				1																	1						1		1		1																
	Lecanidae	*Lecane arcuata*														1																																	
		Lecane bulla		1		1																1			1									1													1		
		Lecane closterocerca														1																																	
		Lecane flexilis										1																																					
		Lecane grandis																																															1
		Lecane hamata														1																																	
		Lecane hastata																					1	1	1																							1	
		Lecane ludwigii		1								1				1																												1					
		Lecane luna		1								1			1							1			1	1																							
		Lecane papuana																					1	1	1						1			1												1	1	1	
		Lecane quadridentata				1									1	1						1			1	1		1															1	1		1			
		Lecane signifera		1		1																			1								1																
		Lecane cf flexilis																																												1			
		Lecane plesia																																															1
		Lecane (*Lecane*) sp.																	1			1		1														1											
		Lecane (*Monostyla*) sp.																				1		1																			1						
		Lecane sp.										1																																					
		Lecane 'bulloid' (undescribed)																													1																		
	Mytilinidae	*Mytilina ventralis*																							1	1		1																	1				
	Notommatidae	*Cephalodella gibba*										1		1		1																																	
		Cephalodella sp.										1							1																														1
		Notommata copeus		1																																								1	1				
		Notommata pachyura				1																																											
		Notommata sp.		1																											1																		
		Enteroplea cf. *laucustri*																																										1			1		
		Eosphora ehrenbergi																																															1
		Eosphora najas																																													1	1	
		Eosphora cf. anthadis																	1																														
		Pleurata cf. uroglenae n. sp.													1																																		
	Proalidae	Proales sp.		1																	1																												
	Synchaetidae	Polyarthra sp.		1					1								1		1			1	1	1	1	1			1	1	1	1	1											1		1	1	1	
		Polyarthra n. sp.										1																																					
	Trichocercidae	*Trichocerca bicristata*										1																																					
		Trichocerca insignis										1																																					
		Trichocerca pusilla																												1																1			
		Trichocerca similis		1	1				1			1			1		1					1							1			1		1										1		1			
		Trichocerca chattoni										1																																					
		Trichocerca sp.		1							1											1		1																					1				
	Trichotriidae	Macrochaetus sp. a		1																																													
		Macrochaetus sp. b		1																																													
		Wolga spinifera										1							1																														
Snails (Mollusca)																																															
Neotaeniglossa	Bithyniidae	Gabbia sp.														1																											1						
Basommatophora	Ancylidae	Ferrissia sp.																																1			1									1			
	Planorbidae	Isidorella/Glyptophysa sp.	1		1	1	1	1		1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1			1				1		1	1	1	1		1	
Aquatic earthworms																																															
Tubificida	Naididae	*Dero furcata*				1				1												1	1	1	1	1	1	1	1	1	1	1	1				1												
		Dero pectinata																															1																
Enchytraeida	Enchytraeidae	Achaeta sp.																																								1							
		Enchytraeidae				1		1			1																																						
		Enchytraeidae sp. 1					1			1	1																						1	1									1						1
		Enchytraeidae sp. 2																																									1						
		Enchytraeidae sp. 3																																								1	1						
Tubificida	Pristinidae	*Pristina aequiseta*																															1																
		Pristina leidyi																	1																														
Polychaetes																																															
Phyllodocida	Nereidae	*Nammanereis pilbarensis*																																															1
Water mites																																															
Acariformes	Hydrachnidae	Hydrachna sp.	1																			1			1	1	1	1	1	1	1													1					
	Eylaidae	Eylais sp.				1	1						1		1	1	1		1			1			1		1	1		1			1																
	Hydrodromidae	Hydrodroma sp.		1											1		1											1						1			1										1		
	Limnesiidae	*Limnesia solida*																																														1	
		Limnesia maceripalpis																						1		1					1																		
		Limnesia parasolida																							1	1			1		1			1			1									1	1		1
	Hygrobatidae	Australiobates sp.								1																																							
		Australiobates sp. P4																																												1			
		Coaustraliobates minor																																														1	
	Unionicolidae	Koenikea sp. 2/3																								1																				1		1	
		Neumania sp.		1																				1				1		1	1			1			1							1				1	1
		Recifella doomba		1																																											1		
		Recifella tinka							1																																								
		Unionicola neoaffinis																							1									1			1											1	
		Unionicola flabelliseta																																1															
		Unionicola sp.				1																																											
		Unionicola sp. FVS1																																										1					
		Unionicolidae																																										1					
	Pionidae	*Piona cumberlandensis*																											1																				
		Piona sp. P2 (nr australica)																				1			1	1		1	1	1		1																	

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

			FV01 26/04/2015	FV02 13/03/2017	FV02 29/07/2015	FV05 12/03/2017	FV05 30/07/2015	FV07 31/07/2015	FV09 13/03/2017	FV10 13/03/2017	FV10 01/08/2015	FV12 01/08/2015	FV14 02/08/2015	FV15 03/08/2015	FV16 13/03/2017	FV16 03/08/2015	FV17 15/03/2017	FV17 04/08/2015	FV18 15/03/2017	FV18 04/08/2015	FV19 04/08/2015	FV20 09/03/2016	FV21 09/03/2016	FV22 09/03/2016	FV23 09/03/2016	FV24 11/03/2016	FV25 11/03/2016	FV26 12/03/2016	FV27 12/03/2016	FV28 13/03/2016	FV29 13/03/2016	FV30 13/03/2016	FV31 15/03/2016	FV32 15/03/2016	FV33 11/03/2017	FV33 06/07/2016	FV34 16/03/2016	FV35 11/03/2017	FV35 07/07/2016	FV36 07/07/2016	FV37 08/07/2016	FV38 09/07/2016	FV39 09/07/2016	FV41 12/03/2017	FV43 10/03/2017	FV44 10/03/2017	FV46 14/03/2017	FV47 14/03/2017	FV48 14/03/2017
		Pionidae							1																																				1		1		
	Aturidae	*Albia rectifrons*																																	1															
		Axonopsella sp.																																															|1|
	Arrenuridae	*Arrenurus (Dividuacarus) tripartitus*																						1			1	1		1																				1	
		Arrenurus (Megaluacarus) vanderpalae																									1																							
		Arrenurus (Megaluacarus) nr vanderpalae																																									1						
		Arrenurus (Arrenurus) mantoniensis																												1																			
		Arrenurus (Brevicaudaturus) tricornutus													1																																		
		Arrenurus sp.																					1									1																	
		Arrenurus sp. 15 (nr *fissipetiolus)*				1								1				1				1								1	1						1															
		Acarina (unidentified)																				1													1														
		Trombidioidea																1																								1							1
Parasitiformes		*Mesostigmata*								1																															1							
Fairy shrimps (Anostraca)																																																		
	Thamnocephalidae	*Branchinella affinis*																																				1	1	1									
		Branchinella lyrifera																								1																							
		Branchinella occidentalis								1									1																				1											
		Branchinella halsei	1		1	1	1	1		1	1		1			1	1	1		1	1																													
		Branchinella sp.																																	1														
Shield shrimps (Notostraca)																																																		
	Triopsidae	*Triops australiensis australiensis*	1										1								1																1			1	1									
Clam shrimps (Conchostraca)																																																		
	Cyzicidae	*Ozestheria nr sarsi*	1							1									1																														
		Ozestheria packardi		1	1	1			1	1		1	1		1		1		1	1	1	1	1	1		1		1	1	1	1	1	1	1			1					1	1	1	1	1	1	1	
		Ozestheria sp.													1																																		
		Eocyzicus argillaquus				1	1			1	1		1				1	1	1		1	1		1						1															1					
	Limnadiidae	*Paralimnadia* sp.				1																																											
		Conchostraca (unidentified)														1																			1				1	1									
Water fleas (Cladocera)																																																		
	Sididae	*Diaphanosoma excisum*								1					1													1	1	1	1	1	1	1		1	1		1	1		1		1	1	1	1	1	
		Diaphanosoma hamatum	1		1		1	1			1							1		1		1	1	1	1	1	1												1										
		Latonopsis brehmi										1																																				
		Latonopsis sp.														1																																
		Latonopsis nr australis							1													1																	1		1	1	1		1				
	Chydoridae	*Alona rectangula novaezealandiae*					1				1																																						
		Alona sp.																															1		1			1										
		Alona rigidicaudis s.l.																							1																							
		Alona cf. intermedia																						1					1																			
		Celsinotum n. sp.																																										1				
		Chydorus sp.																				1																										
		Dunhevedia crassa																				1																										
		Ephemeroporus barroisi s.l.		1																									1																1				
		Kurzia sp.																					1																									
		Leberis cf. diaphanus													1																															1		
		Leydigia sp.																					1				1																					
		Australospilus elongatus																																	1													
		Pseudomonospilus diporus		1	1						1																																						
		Karualona karua													1																																		
		Armatalona macrocopa			1																																							1				
		Coronatella sp.					1						1													1																							
		Anthalona harti																																										1				
		Chydoridae				1				1												1		1							1																		
	Daphniidae	*Ceriodaphnia cornuta*		1		1			1						1				1			1						1		1		1	1	1			1	1	1	1	1			1	1	1		1	
		Ceriodaphnia sp.					1																										1																
		Daphnia carinata					1						1							1	1																						1						
		Daphnia cephalata					1						1					1			1																												
		Daphnia projecta					1	1		1	1							1		1	1		1			1	1		1	1																			
		Daphnia sp.			1																																												
		Simocephalus heilongjiangensis																						1																				1				
	Macrotrichidae	*Macrothrix capensis*																																										1				
		Macrothrix flabelligera										1	1																																				
		Macrothrix sp.					1												1	1			1								1	1		1		1													
	Moinidae	*Moina micrura s.l.*	1	1	1	1			1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1				1		1			
		Moina sp.																																	1						1							
	Neotrichidae	*Neothrix armata*																1		1																												
Seed shrimps (Ostracoda)																																																		
	Limnocytheridae	*Limnocythere dorsosicula*											1								1																										1		
		Limnocytheridae n.gen. sp 419						1							1																					1													
	Ilyocyprididae	*Ilyocypris FVS3 (=sp.837)*																					1																									
		Ilyocypris FVS4 (=sp. 838)																																	1													
		Ilyocypris sp. 836 (=FVS2 = australiensis)		1		1							1		1	1	1	1	1									1																	1					
		Ilyocypris sp. 835								1				1									1	1	1	1		1	1	1	1	1	1														1	1	
		Ilyocypris sp.					1													1															1			1										
	Candonidae	*Candonidae*																																														1
	Cyprididae	*Bennelongia coondinerensis*		1	1	1	1	1		1	1	1	1		1	1		1	1	1	1	1	1		1	1	1	1	1	1		1					1								1				
		Bennelongia koendersae		1						1																									1										1				
		Bennelongia dedeckkeri					1	1			1	1	1		1					1	1					1	1	1				1		1															
		Bennelongia pinderi								1						1			1				1										1				1								1					
		Bennelongia FVS2 s.l.				1							1					1			1	1			1	1	1	1	1	1		1		1															

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

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		Bennelongia n. sp. (nr nimala)							1							1							1										1											1					1
		Bennelongia sp.																										1													1		1						
		Cypretta sp. 924 (=BOS594)			1																																												
		Cypretta sp. 917 (=BOS593)			1	1		1							1	1	1	1	1	1																								1					
		Cypretta sp. 861																					1	1	1						1	1													1				
		Cypretta sp. 870																						1																									
		Cypretta sp. 872		1					1																				1							1													
		Cypretta sp. 875																				1																											
		Cypretta sp. 863																				1		1		1			1	1	1	1		1			1												
		Cypretta sp. 865		1																						1			1																				
		Cypretta sp. 866																								1																							
		Cypretta sp. 867		1		1									1	1																					1												
		Cypretta sp. 869														1							1							1							1						1						
		Cypretta sp. 916		1					1	1																																							
		Cypretta sp. 922																																					1										
		Cypretta sp.				1	1												1		1	1		1	1	1	1	1	1	1	1	1		1			1	1			1		1	1					
		Hemicypris megalops																						1	1	1					1	1			1											1			
		Heterocypris sp. 853)												1																																			
		Heterocypris sp. FVS3 (cf tatei)							1										1				1			1		1																					
		Heterocypris sp. 936																																															1
		Heterocypris sp.																	1																														
		Strandesia sp 466																					1	1																					1				
		Zonocypretta kalimna						1		1	1	1				1																																	
		Ilyodromus sp. 845							1													1	1	1		1	1	1		1	1	1	1	1			1									1			
		Ilyodromus sp. 847		1					1	1					1				1								1																	1					
		Ilyodromus sp. 850																													1																		
		Ilyodromus sp. 933																																	1									1			1		
		Ilyodromus sp.				1		1																																									
		Ampullacypris? sp. nov. 469																																		1	1		1	1	1								
		Cypricercus sp. 911																	1	1				1		1	1	1	1			1	1	1			1												
		Cypricercus sp. 841								1									1				1		1					1																			
		Cypricercus sp. 444									1																																						
		Cypricercus sp. 415 s.l.			1	1		1														1		1		1		1		1													1					1	
		Stenocypris major			1		1	1			1	1	1					1		1	1	1			1	1		1		1			1	1			1												
		Ostracoda (n. gen. n. sp.)																																									1						
	Leptocytheridae	*Leptocythere lacustris*																																									1						
	Notodromadidae	*Newnhamia fenestrata*																				1																											
Copepods																																															
	Centropagidae	*Boeckella triarticulata*					1						1					1		1	1	1	1			1	1	1	1	1	1	1					1	1		1			1	1		1		1	
		Calamoecia halsei															1																			1		1	1	1	1								
		Calamoecia ultima																	1																									1		1		1	
		Calamoecia baylyi (Cue form)	1	1	1	1	1	1			1	1	1	1		1		1		1	1															1					1								
		Calamoecia ampulla var P1	1				1						1					1		1	1																												
		Calamoecia nr ampulla				1													1								1											1											
	Diaptomidae	*Eodiaptomus lumholtzi*																					1	1						1	1		1	1			1									1	1	1	
		Calanoida (unidentified)							1																										1												1		
	Cyclopidae	*Microcyclops varicans*		1	1	1	1	1				1			1	1	1	1		1	1			1				1														1	1		1				
		Metacyclops mortoni																																															1
		Metacyclops superincidentis	1													1																																	
		Mesocyclops notius																						1							1		1	1			1										1		
		Mesocyclops brooksi		1	1	1	1	1	1	1	1	1			1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1						1	1	1	1		1	1
		Mesocyclops sp.											1																									1											
		Thermocyclops decipiens		1					1								1		1										1	1								1								1	1	1	
		Thermocyclops nr emini				1													1					1		1		1		1													1	1		1		1	
		Pescecyclops sp. 442	1				1	1				1	1					1		1	1																												
		Pescecyclops sp.												1																											1	1	1						
		Cyclopoida (unidentified)																																	1	1		1	1	1									
	Canthocamptidae	Mesochra sp. P1											1																																				
Amphipods																																															
	Paramelitidae	Pilbarus sp. B06																																															1
Beetles (Coleoptera)																																															
	Haliplidae	*Haliplus fortescuensis*						1																	1	1		1					1	1															
		Haliplus pinderi																																															1
		Haliplus pilbarensis																																													1	1	1
		Haliplus halsei		1											1		1				1	1		1	1	1		1	1	1	1	1	1	1			1							1			1	1	
		Haliplidae (unidentified)			1																	1																							1				
	Dytiscidae	*Laccophilus sharpi*		1					1						1		1		1																									1					
		Laccophilus sp.																				1			1				1	1																			
		Hyphydrus elegans		1													1								1	1			1	1	1	1		1										1		1	1		
		Hyphydrus lyratus		1	1	1			1						1	1	1		1	1	1	1		1	1	1	1	1	1	1	1	1	1				1							1	1		1	1	1
		Hyphydrus sp.																					1																										
		Hydroglyphus orthogrammus		1					1								1							1				1																					1
		Hydroglyphus leai				1									1																		1				1												1
		Hydroglyphus grammopterus		1	1				1			1			1		1		1			1	1	1	1	1	1	1		1	1		1	1										1	1				1
		Allodessus bistrigatus	1	1	1			1		1		1	1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1		1							1			1			1	
		Tiporus tambreyi		1																																											1	1	1
		Tiporus lachlani																																															1
		Sternopriscus multimaculatus		1		1																					1																						
		Sternopriscus sp.			1											1				1													1											1	1				

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

			FV01 26/04/2015	FV02 13/03/2017	FV02 29/07/2015	FV05 12/03/2017	FV05 30/07/2015	FV07 31/07/2015	FV09 13/03/2017	FV10 13/03/2017	FV10 01/08/2015	FV12 01/08/2015	FV14 02/08/2015	FV15 03/08/2015	FV16 13/03/2017	FV16 03/08/2015	FV17 15/03/2017	FV17 04/08/2015	FV18 15/03/2017	FV18 04/08/2015	FV19 04/08/2015	FV20 09/03/2016	FV21 09/03/2016	FV22 09/03/2016	FV23 09/03/2016	FV24 11/03/2016	FV25 11/03/2016	FV26 12/03/2016	FV27 12/03/2016	FV28 13/03/2016	FV29 13/03/2016	FV30 13/03/2016	FV31 15/03/2016	FV32 15/03/2016	FV33 11/03/2017	FV33 06/07/2016	FV34 16/03/2016	FV35 11/03/2017	FV35 07/07/2016	FV36 07/07/2016	FV37 08/07/2016	FV38 09/07/2016	FV39 09/07/2016	FV41 12/03/2017	FV43 10/03/2017	FV44 10/03/2017	FV46 14/03/2017	FV47 14/03/2017	FV48 14/03/2017
		Necterosoma wollastoni						1														1				1																			
		Necterosoma regulare																							1					1												1	1		
		Necterosoma sp.			1																																										
		Megaporus howittii													1										1																						
		Copelatus sp.																																						1							
		Eretes australis		1		1		1	1	1	1			1	1	1	1	1	1	1		1	1	1			1			1	1				1				1				1	1					
		Hydaticus consanguineus																				1	1																								
		Rhantaticus congestus		1																																1							1					
		Cybister tripunctatus		1					1	1					1		1		1			1			1	1	1	1			1	1			1									1					
		Exocelina sp. P1																																							1						
		Bidessini																																1					1		1						
	Gyrinidae	*Dineutus australis*		1		1			1	1					1		1		1			1					1			1	1													1	1		1		
		Gyrinidae																				1						1									1											
	Hydrophilidae	*Spercheus* sp.																															1														
		Berosus approximans		1	1											1						1			1	1		1	1	1			1											1					
		Berosus dallasae																																											1	1	
		Berosus macumbensis																													1																
		Berosus nutans	1										1									1																											
		Berosus pulchellus		1	1							1			1	1					1	1						1																					
		Berosus vijae												1										1																								
		Berosus sp.		1	1		1									1						1	1			1					1		1		1	1				1		1		1				1
		Berosus 'Pilbara sp. 4'																			1						1			1																	
		Regimbartia attenuata												1		1					1			1		1																					1
		Enochrus elongatulus				1						1			1	1	1										1	1																1	1				
		Enochrus maculiceps														1																															
		Enochrus deserticola		1					1							1	1																														
		Enochrus sp.																			1																									1	
		Helochares foveicollis															1																														
		Paracymus spenceri		1											1	1	1								1																						1	
		Hydrophilus brevispina																					1						1			1																
		Sternolophus immarginatus																			1						1																				
		Hydrophilidae (unidentified)																																													1
	Hydraenidae	*Hydraena* sp.																													1															1	
		Ochthebius sp. 'P3'														1																															
	Hydrochidae	*Hydrochus eurypleuron*													1																												1					1
		Hydrochus interioris																																													1
		Hydrochus obscuroaeneus																1																													
		Hydrochus sp.																								1																					
Flies (Diptera)																																															
	Tipulidae	*Tipulidae type A*						1																																	1							
		Tipulidae type I																											1																			
	Chaoboridae	*Chaoboridae (unidentified)*																																										1	1	1	
	Culicidae	*Anopheles annulipes s.l.*				1																1								1															1				1
		Anopheles amictus				1			1						1				1																														
		Anopheles sp.																													1														1	1	
		Aedes nigrithorax/sagax	1																																												
		Aedes pseudonormanensis																																								1						
		Aedes alternans												1																																		
		Aedes sp.																																							1							
		Culex australicus																						1																		1		1				
		Culex annulirostris				1									1																																	
		Culex starkae													1																																	
		Culex sp.																																									1					
		Culicidae (unidentified)										1																																			
	Ceratopogonidae	Bezzia sp.				1											1	1	1	1			1	1									1				1							1			1	1	1
		Culicoides sp.		1	1			1		1			1							1	1		1		1								1															1	
		Monohelea sp.				1	1	1	1		1	1	1		1		1	1	1	1	1	1	1	1		1			1	1	1	1	1	1										1	1	1	1	1	1
		Nilobezzia sp.		1	1	1	1	1	1	1			1		1		1		1	1		1	1	1	1	1		1	1	1	1	1	1	1			1							1	1	1	1	1	1
		Atrichopogon sp. P1					1										1	1			1							1																				
		Atrichopogon sp.																								1																					
		Forcypomyia sp. P1																				1																									
		Forcyipomyia sp. P6																																							1	1						
		Ceratopogonidae (unidentified)	1											1		1											1	1																					
	Tabanidae	*Tabanidae*																																													1
	Stratiomyidae	*Stratiomyidae*				1																																									
	Dolichopodidae	*Dolichopodidae*										1									1																				1	1						
	Ephydridae	*Ephydridae*																																	1												
		Ephydridae sp. 4																											1																			
		Ephydridae sp. 16																									1																					
	Muscidae	Muscidae sp. L																																													1
		Muscidae sp. P2															1																	1										1		1	1	
		Diptera sp. F																																													1
		Diptera (unidentified)		1				1								1						1							1										1				1						
	Chironomidae	*Coelopynia pruinosa*		1	1	1		1	1	1							1	1	1	1	1		1	1		1	1		1	1		1	1	1			1							1	1	1		1	
		Procladius sp.		1	1	1	1		1	1		1	1		1	1	1		1	1	1	1	1	1	1		1	1	1	1	1	1	1	1			1							1	1	1	1	1	1
		Ablabesmyia hilli		1															1	1		1											1															1	
		Ablabesmyia notabilis		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1	1	1			1							1	1	1			
		Paramerina sp. A (parva?)				1			1	1									1						1	1		1	1	1						1							1				1	
		Paramerina sp. C															1																														

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

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		Larsia albiceps		1	1	1									1		1					1		1	1			1	1	1		1	1	1			1							1	1			1	
		Tanypodinae												1																																			
		Pentaneurini sp. P1																												1																			
		Nanocladius sp. 1 (VCD7)																						1																							1		
		Cricotopus albitarsus									1																																				
		Compterosmittia sp. P1						1			1																									1													
		Compterosmittia sp. P2									1																																				
		Cladotanytarsus aff K4							1	1												1	1	1	1	1		1		1	1	1	1	1			1									1	1	1	
		Tanytarsus fuscithorax										1																																			
		Tanytarsus sp.												1																																	
		Tanytarsus sp. C (?bispinosus)																																										1				
		Tanytarsus sp. H																				1					1																					1	
		Tanytarsus sp. P1			1		1						1					1			1																												
		Tanytarsus 'K12'		1		1				1					1		1		1			1	1		1			1		1	1		1	1			1							1	1		1	1	
		Tanytarsus sp. P5			1																	1		1						1																			
		Tanytarsus sp. P6		1																		1	1		1			1																					
		Tanytarsus sp. P7																							1						1																		
		Tanytarsus sp. P9														1												1																					
		Tanytarsus fuscithorax/semibarbitarsus											1			1					1								1																				1
		Stenochironomus cf watsoni		1		1		1		1							1	1	1	1				1	1			1				1	1	1			1							1		1	1	1	
		Chironomus tepperi									1					1													1																1				1
		Chironomus sp.								1							1																															1	
		Chironomus aff. alternans (V24)		1			1		1			1																1	1															1					
		Xenochironomus sp P2																	1		1																												
		Dicrotendipes jobetus		1		1	1	1			1	1	1				1				1		1	1			1	1		1		1	1	1			1							1				1	1
		Dicrotendipes sp.				1													1																														
		Dicrotendipes 'CA1' Pilbara type 3																				1			1		1										1									1		1	
		Dicrotendipes 'CA1' Pilbara type 2		1	1		1					1	1		1													1																	1				
		Dicrotendipes 'CA1' Pilbara type 1			1																							1																			1		
		Dicrotendipes P6				1				1													1	1		1	1			1		1	1	1			1									1			
		Kiefferulus intertinctus																					1	1	1						1		1	1															
		Polypedilum leei				1																															1										1	1	1
		Polypedilum nubifer				1						1										1			1			1			1														1				
		Polypedilum sp.					1																																										
		Polypedilum sp. S1		1					1								1		1								1	1	1		1	1	1	1			1							1		1		1	
		Polypedilum sp. K1																																								1	1						
		Paraborniella tonnoiri	1															1			1	1	1				1	1		1						1						1	1						
		Cryptochironomus griseidorsum		1		1	1			1	1	1	1		1		1			1	1	1	1	1	1		1		1	1	1		1	1			1				1								
		Microchironomus sp P1							1						1								1								1	1														1	1		
		Harnischia sp.																							1																								
		Harnischia K1																1																														1	
		Harnischia sp. P1																					1	1					1		1	1	1													1			
		Paracladopelma sp.					1																																										
		Paracladopelma 'M3'										1																															1						
		Parachironomus 'K2'		1							1	1			1	1		1		1	1				1	1	1			1		1	1	1															
		Parachironomus 'K1'				1																			1																								
		Chironomini genus K2							1																																								
		Chironomini (unidentified)												1																																			
Mayflies (Ephemeroptera)																																																	
	Baetidae	*Cloeon nr 'RedStripe'*																				1	1					1		1				1															
		Cloeon sp.		1		1						1	1				1		1		1																								1		1		
		Baetidae			1		1													1				1		1	1		1		1		1				1											1	
	Caenidae	*Tasmanocoenis arcuata*							1								1		1	1				1			1		1		1		1	1			1							1		1	1	1	
		Tasmanocoenis sp.		1																	1																									1			
		Tasmanocoenis sp. M			1																										1		1	1															
		Tasmanocoenis sp. P																																														1	
		Caenidae (unidentified)																1																															
		Ephemeroptera (unidentified)												1																																			
Water bugs (Hemiptera)																																																	
	Gerridae	*Limnogonus fossarum gilguy*				1	1		1						1				1			1								1	1									1				1		1	1		1
		Limnogonus sp.																						1		1	1																						
		Gerridae (unidentified)																																											1				
	Nepidae	*Ranatra diminuta*																																													1	1	
	Belostomatidae	*Lethocerus distinctifemur*															1																					1											
	Corixidae	*Agraptocorixa eurynome*			1																								1																				
		Agraptocorixa parvipunctata			1		1		1				1			1		1		1	1	1						1																1					
		Agraptocorixa sp.		1										1	1		1		1																														
		Micronecta robusta						1					1			1						1													1					1	1								
		Micronecta gracilis		1	1			1						1					1			1	1		1	1	1	1		1		1			1														
		Micronecta annae illiesi																							1						1																		
		Micronecta lansburyi															1																																
		Micronecta virgata		1											1		1																														1		
		Micronecta sp.				1	1								1		1	1			1			1																	1								1
		Corixidae (unidentified)										1																					1							1					1	1			
	Notonectidae	*Anisops thienemanni*											1		1						1																												
		Anisops hyperion															1					1						1		1																			
		Anisops gratus			1		1	1		1	1	1					1	1		1	1										1																		
		Anisops hackeri		1										1	1					1																								1					
		Anisops canaliculatus			1			1						1		1																																	

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

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		Anisops nasutus		1	1	1			1						1		1		1	1		1	1	1	1	1	1	1	1	1		1												1					
		Anisops semitus													1																																		
		Anisops stali	1	1	1	1	1		1	1	1				1	1	1	1	1	1		1	1				1		1	1		1			1									1					
		Anisops sp. FVS				1			1						1																																		
		Anisops sp.	1		1		1	1			1	1	1			1		1															1					1							1				
	Pleidae	Paraplea sp.																											1																				
		Paraplea n. sp. (ANIC 6)		1															1							1																		1			1	1	1
		Hemiptera sp. (unidentified)			1																																												
Moth larvae (Lepidoptera)																																															
	Pyralidae	*Pyralidae*		1												1																															
Dragonflies and damselflies																																															
	Coenagrionidae	*Argiocnemis rubescens*																																													1
		Austroagrion sp.		1	1		1	1		1					1		1		1	1					1	1		1		1														1	1				
		Ischnura aurora aurora			1		1	1				1	1			1					1	1			1	1	1	1		1							1											1	1
		Pseudagrion aureofrons																																													1		1
		Pseudagrion microcephalum																																														1	
		Xanthagrion erythroneurum		1	1	1	1								1		1				1				1																			1					
		Coenagrionidae (unidentified)																1														1											1						
	Isostictidae	*Eurysticta coolawanyah*																						1					1					1			1										1	1	1
	Lestidae	*Austrolestes aridus*		1	1	1	1		1	1		1	1			1	1	1	1	1	1						1	1							1									1					
	Aeshnidae	*Hemianax papuensis*		1	1	1	1						1		1		1	1		1	1	1				1																		1	1				
		Aeshnidae (unidentified)																																															1
	Gomphidae	*Austroepigomphus gordoni*																																													1		1
	Libellulidae	*Diplacodes haematodes*																																															1
		Diplacodes bipunctata\trivialis		1	1								1		1	1									1																				1				
		Orthetrum caledonicum		1	1	1									1				1					1	1	1		1	1	1	1	1	1	1			1							1	1				1
		Pantala flavescens		1											1				1																														
		Tramea stenoloba/loewii																							1			1																					
		Libellulidae (unidentified)							1																																								
	Lindeniidae	*Ictinogomphus dobsoni*																											1				1	1			1										1		
	Hemicorduliidae	*Hemicordulia tau*		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1			1	1			1	1	1	1	1	1	1			1							1	1	1	1	1	
		Epiproctophora *(unidentified)*																				1	1				1																						
Caddisflies (Trichoptera)																																															
	Hydroptilidae	Orthotrichia sp.																																			1										1	1	1
	Ecnomidae	*Ecnomus pilbarensis*		1	1	1				1	1				1		1			1			1	1	1					1	1	1	1	1			1							1	1	1	1	1	1
		Ecnomus sp.						1																				1	1					1			1												
	Leptoceridae	*Oecetis* sp. Pilbara 1					1	1																																									
		Oecetis sp. Pilbara 9			1		1	1			1	1	1			1		1		1	1																												
		Oecetis sp.		1		1			1	1					1		1		1			1	1	1	1	1	1	1	1	1	1	1	1	1			1							1	1	1	1	1	1
		Triplectides australicus																								1		1	1	1																			
		Triplectides australis		1		1		1		1							1						1										1											1					1
		Triplectides sp.															1		1			1	1				1	1	1			1																	
		Leptoceridae (unidentified)																			1																												
NUMBER OF SPECIES			19	99	60	78	54	46	52	49	37	57	47	21	76	61	75	45	71	53	55	88	79	87	80	68	58	89	75	80	71	59	80	77	21	23	68	14	19	17	17	23	38	80	57	59	62	71	59

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

Order	Family	Taxon	FV01 26/04/2015	FV02 13/03/2017	FV02 29/07/2015	FV05 12/03/2017	FV05 30/07/2015	FV07 31/07/2015	FV09 13/03/2017	FV10 13/03/2017	FV10 01/08/2015	FV12 01/08/2015	FV14 02/08/2015	FV15 03/08/2015	FV16 13/03/2017	FV16 03/08/2015	FV17 15/03/2017	FV17 04/08/2015	FV18 15/03/2017	FV18 04/08/2015	FV19 04/08/2015	FV20 09/03/2016	FV21 09/03/2016	FV22 09/03/2016	FV23 09/03/2016	FV24 11/03/2016	FV25 11/03/2016	FV26 12/03/2016	FV27 12/03/2016	FV28 13/03/2016	FV29 13/03/2016	FV30 13/03/2016	FV31 15/03/2016	FV32 15/03/2016	FV33 11/03/2017	FV33 06/07/2016	FV34 16/03/2016	FV35 11/03/2017	FV35 07/07/2016	FV36 07/07/2016	FV37 08/07/2016	FV38 09/07/2016	FV39 09/07/2016	FV41 12/03/2017	FV43 10/03/2017	FV44 10/03/2017	FV46 14/03/2017	FV47 14/03/2017	FV48 14/03/2017
Protozoans																																																	
Arcellinida	Arcellidae	*Arcella discoides*																		1		1		1									1				1											1	
		Arcella megastoma																						1				1	1				1																
		Arcella sp. (medium, domed)																															1															
	Centropyxidae	*Centropyxis aculeata*																						1																									
		Centropyxis ecornis																				1											1				1												
		Centropyxis sp.																						1									1			1													1
	Difflugiidae	*Difflugia gramen*																				1	1					1		1				1															
		Difflugia corona																				1						1					1			1							1	1	1			
		Difflugia australis																	1																												
		Difflugia capreolata																										1																			
		Difflugia fallax				1																										1		1												1	1		
		Difflugia globulosa																															1															
		Difflugia sp. a										1				1								1																									
		Difflugia sp. b										1																																					
		Difflugia sp. c																							1				1																				
		Difflugia cf. *manicata*																				1																										
		Difflugia sp. d																										1																			
	Lesquereusidae	*Lesquereusia modesta*																				1					1																				
Euglyphida	Euglyphidae	Euglypha sp.																				1																										
Sponges																																																	
		Spongillidae																																									1		1			
Flatworms																																																	
		Turbellaria		1		1		1	1					1									1						1							1	1	1		1	1	1		1	1					
Nemertea																																																	
		Nemertini													1																																		
Roundworms (Nematoda)																																																	
		Nematoda	1	1		1			1					1			1		1	1		1	1	1	1	1	1	1		1		1	1	1	1		1		1	1	1	1	1	1				1	
Rotifers																																																	
Bdelloidea	Habrotrochidae	Habrotrocha sp.																				1								1																		
		Bdelloidea				1									1							1													1				1			1	1						1
Flosculariacea	Conochilidae	*Conochilus hippocrepis*																																								1					
		Conochilus dossuarius						1			1						1			1	1											1	1	1								1				1			
	Filiniidae	*Filinia pejleri*																					1																									
		Filinia longiseta		1	1																		1											1															
		Filinia sp.															1																															
	Flosculariidae	*Sinantherina socialis*													1																																	
		Lacinularia cf. racemovata																	1					1	1				1	1								1											
	Hexarthridae	*Hexarthra mira*							1	1							1																							1				1		1			
		Hexarthra sp.					1												1				1	1		1	1	1	1	1		1	1	1		1			1								1	1	
	Testudinellidae	*Testudinella patina*		1											1	1				1		1	1	1	1	1	1	1	1	1	1	1		1		1	1								1	1	1	1	
		Testudinella n. sp. P4										1																		1																		
Ploimida	Asplanchnidae	*Asplanchna brightwelli*		1	1		1		1	1	1					1	1							1	1					1	1		1											1		1			
		Asplanchna nr brightwelli						1																																								
		Asplanchna n. sp.																	1																													
		Asplanchnopus multiceps													1		1																															
	Brachionidae	*Anuraeopsis coelata*																				1																										
		Brachionus angularis																			1	1	1	1	1		1	1	1	1	1	1	1													1	1		
		Brachionus bidentatus																					1							1															1	1		
		Brachionus budapestinensis																												1															1			
		Brachionus calyciflorus															1																															
		Brachionus dichotomus																					1							1			1															
		Brachionus falcatus																												1			1												1			
		Brachionus quadridentatus		1		1						1		1	1	1						1		1				1																1			1		
		Brachionus quadridentatus minor																															1			1												
		Brachionus calyciflorus dorcas																															1						1		1							
		Brachionus cf. pineenaus		1																																												
		Brachionus cf bennini																														1																
		Brachionus n. sp. P3 (nr *budapestensis)*																				1																										
		Brachionus sp. a												1		1																																
		Brachionus sp. b																		1				1																								
		Keratella australis			1						1					1																																
		Keratella procurva		1																			1	1	1	1		1	1	1	1	1	1	1								1				1		1	
		Keratella slacki																														1																
		Keratella tropica																					1		1		1	1			1	1	1												1			
		Keratella n. sp.						1			1	1																																				
		Plationus patulus																	1													1	1										1		1			
		Platyias quadricornis																				1		1																									
	Lepadellidae	*Colurella adriatica*																																														1
		Colurella sp.		1																																											
		Lepadella sp.		1																			1																									
		Lepadella cf. rhomboides										1											1	1																								
	Dicranophoridae	Dicranophorus n. sp.										1																																				
	Epiphanidae	*Epiphanes brachionus*																																								1							
	Euchlanidae	*Euchlanis dilatata*																																									1					
		Euchlanis sp. a		1																				1										1		1	1										1		
		Euchlanis sp. b				1																			1			1			1																		
		Tripleuchlanis plicata																																														1

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

			FV01 26/04/2015	FV02 13/03/2017	FV02 29/07/2015	FV05 12/03/2017	FV05 30/07/2015	FV07 31/07/2015	FV09 13/03/2017	FV10 13/03/2017	FV10 01/08/2015	FV12 01/08/2015	FV14 02/08/2015	FV15 03/08/2015	FV16 13/03/2017	FV16 03/08/2015	FV17 15/03/2017	FV17 04/08/2015	FV18 15/03/2017	FV18 04/08/2015	FV19 04/08/2015	FV20 09/03/2016	FV21 09/03/2016	FV22 09/03/2016	FV23 09/03/2016	FV24 11/03/2016	FV25 11/03/2016	FV26 12/03/2016	FV27 12/03/2016	FV28 13/03/2016	FV29 13/03/2016	FV30 13/03/2016	FV31 15/03/2016	FV32 15/03/2016	FV33 11/03/2017	FV33 06/07/2016	FV34 16/03/2016	FV35 11/03/2017	FV35 07/07/2016	FV36 07/07/2016	FV37 08/07/2016	FV38 09/07/2016	FV39 09/07/2016	FV41 12/03/2017	FV43 10/03/2017	FV44 10/03/2017	FV46 14/03/2017	FV47 14/03/2017	FV48 14/03/2017
	Gastropodidae	*Ascomorpha* sp.				1																	1						1		1		1																
	Lecanidae	*Lecane arcuata*														1																																	
		Lecane bulla		1		1																1			1									1												1		
		Lecane closterocerca														1																																	
		Lecane flexilis										1																																					
		Lecane grandis																																															1
		Lecane hamata														1																																	
		Lecane hastata																					1	1	1																							1	
		Lecane ludwigii		1								1				1																												1					
		Lecane luna		1								1			1							1			1	1																							
		Lecane papuana																					1	1	1						1			1												1	1	1	
		Lecane quadridentata				1									1	1						1			1	1		1															1	1		1			
		Lecane signifera		1		1																			1								1																
		Lecane cf flexilis																																												1			
		Lecane plesia																																															1
		Lecane (*Lecane*) sp.																	1			1		1													1												
		Lecane (*Monostyla*) sp.																				1		1																			1						
		Lecane sp.										1																																					
		Lecane 'bulloid' (undescribed)																													1																		
	Mytilinidae	*Mytilina ventralis*																							1	1		1																	1				
	Notommatidae	*Cephalodella gibba*										1		1		1																																	
		Cephalodella sp.										1							1																														1
		Notommata copeus		1																																								1	1				
		Notommata pachyura				1																																											
		Notommata sp.		1																											1																		
		Enteroplea cf. *laucustri*																																										1			1		
		Eosphora ehrenbergi																																															1
		Eosphora najas																																													1	1	
		Eosphora cf. anthadis																	1																														
		Pleurata cf. uroglenae n. sp.													1																																		
	Proalidae	Proales sp.		1																	1																												
	Synchaetidae	Polyarthra sp.		1					1								1		1			1	1	1	1	1			1	1	1	1	1											1		1	1	1	
		Polyarthra n. sp.										1																																					
	Trichocercidae	*Trichocerca bicristata*										1																																					
		Trichocerca insignis										1																																					
		Trichocerca pusilla																												1																1			
		Trichocerca similis		1	1				1			1			1		1					1							1			1		1										1		1			
		Trichocerca chattoni										1																																					
		Trichocerca sp.		1							1											1		1																					1				
	Trichotriidae	Macrochaetus sp. a		1																																													
		Macrochaetus sp. b		1																																													
		Wolga spinifera										1							1																														
Snails (Mollusca)																																															
Neotaeniglossa	Bithyniidae	Gabbia sp.														1																										1							
Basommatophora	Ancylidae	Ferrissia sp.																																1			1									1			
	Planorbidae	Isidorella/Glyptophysa sp.	1		1	1	1	1		1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1			1				1		1	1	1	1		1	
Aquatic earthworms																																															
Tubificida	Naididae	*Dero furcata*				1				1												1	1	1	1	1	1	1	1	1	1	1	1				1												
		Dero pectinata																															1																
Enchytraeida	Enchytraeidae	Achaeta sp.																																								1							
		Enchytraeidae				1		1			1																																						
		Enchytraeidae sp. 1					1			1	1																						1	1									1						1
		Enchytraeidae sp. 2																																									1						
		Enchytraeidae sp. 3																																								1	1						
Tubificida	Pristinidae	*Pristina aequiseta*																															1																
		Pristina leidyi																	1																														
Polychaetes																																															
Phyllodocida	Nereidae	*Nammanereis pilbarensis*																																															1
Water mites																																															
Acariformes	Hydrachnidae	Hydrachna sp.	1																			1			1	1	1	1	1	1	1													1					
	Eylaidae	Eylais sp.				1	1						1		1	1	1		1			1			1		1	1		1			1																
	Hydrodromidae	Hydrodroma sp.		1											1		1											1						1			1										1		
	Limnesiidae	*Limnesia solida*																																														1	
		Limnesia maceripalpis																						1		1					1																		
		Limnesia parasolida																							1	1			1		1			1			1									1	1		1
	Hygrobatidae	Australiobates sp.								1																																							
		Australiobates sp. P4																																												1			
		Coaustraliobates minor																																														1	
	Unionicolidae	Koenikea sp. 2/3																								1																				1		1	
		Neumania sp.		1																				1				1		1	1			1			1							1				1	1
		Recifella doomba		1																																											1		
		Recifella tinka							1																																								
		Unionicola neoaffinis																							1									1			1											1	
		Unionicola flabelliseta																																1															
		Unionicola sp.				1																																											
		Unionicola sp. FVS1																																										1					
		Unionicolidae																																										1					
	Pionidae	*Piona cumberlandensis*																											1																				
		Piona sp. P2 (nr australica)																				1			1	1		1	1	1		1																	

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

			FV01 26/04/2015	FV02 13/03/2017	FV02 29/07/2015	FV05 12/03/2017	FV05 30/07/2015	FV07 31/07/2015	FV09 13/03/2017	FV10 13/03/2017	FV10 01/08/2015	FV12 01/08/2015	FV14 02/08/2015	FV15 03/08/2015	FV16 13/03/2017	FV16 03/08/2015	FV17 15/03/2017	FV17 04/08/2015	FV18 15/03/2017	FV18 04/08/2015	FV19 04/08/2015	FV20 09/03/2016	FV21 09/03/2016	FV22 09/03/2016	FV23 09/03/2016	FV24 11/03/2016	FV25 11/03/2016	FV26 12/03/2016	FV27 12/03/2016	FV28 13/03/2016	FV29 13/03/2016	FV30 13/03/2016	FV31 15/03/2016	FV32 15/03/2016	FV33 11/03/2017	FV33 06/07/2016	FV34 16/03/2016	FV35 11/03/2017	FV35 07/07/2016	FV36 07/07/2016	FV37 08/07/2016	FV38 09/07/2016	FV39 09/07/2016	FV41 12/03/2017	FV43 10/03/2017	FV44 10/03/2017	FV46 14/03/2017	FV47 14/03/2017	FV48 14/03/2017
		Pionidae							1																																				1		1		
	Aturidae	*Albia rectifrons*																																	1															
		Axonopsella sp.																																															1	
	Arrenuridae	*Arrenurus (Dividuacarus) tripartitus*																							1			1	1		1																		1	
		Arrenurus (Megaluacarus) vanderpalae																										1																						
		Arrenurus (Megaluacarus) nr vanderpalae																																											1					
		Arrenurus (Arrenurus) mantoniensis																													1																			
		Arrenurus (Brevicaudaturus) tricornutus													1																																		
		Arrenurus sp.																						1									1																	
		Arrenurus sp. 15 (nr *fissipetiolus)*			1								1				1				1							1	1					1															
		Acarina (unidentified)																				1												1														
		Trombidioidea																1																									1						1
Parasitiformes		*Mesostigmata*								1																															1							
Fairy shrimps (Anostraca)																																																
	Thamnocephalidae	*Branchinella affinis*																																					1	1	1								
		Branchinella lyrifera																									1																						
		Branchinella occidentalis								1								1																					1										
		Branchinella halsei	1		1	1	1	1		1	1		1			1	1	1		1	1																												
		Branchinella sp.																																		1													
Shield shrimps (Notostraca)																																																
	Triopsidae	*Triops australiensis australiensis*	1										1								1															1			1	1									
Clam shrimps (Conchostraca)																																																
	Cyzicidae	*Ozestheria nr sarsi*	1							1								1																															
		Ozestheria packardi		1	1	1			1	1		1	1		1		1		1	1	1	1	1	1		1		1	1	1	1	1	1	1			1					1	1	1	1	1	1	1	
		Ozestheria sp.													1																																		
		Eocyzicus argillaquus				1	1			1	1		1				1	1	1		1	1		1						1														1					
	Limnadiidae	*Paralimnadia* sp.				1																																											
		Conchostraca (unidentified)														1																			1				1	1									
Water fleas (Cladocera)																																																
	Sididae	*Diaphanosoma excisum*								1					1													1	1	1	1	1	1	1		1	1		1	1		1		1	1	1	1	1	
		Diaphanosoma hamatum	1		1		1	1			1							1		1		1	1	1	1	1	1											1											
		Latonopsis brehmi										1																																					
		Latonopsis sp.														1																																	
		Latonopsis nr australis							1													1																	1		1	1	1		1				
	Chydoridae	*Alona rectangula novaezealandiae*					1				1																																						
		Alona sp.																																1		1			1										
		Alona rigidicaudis s.l.																								1																							
		Alona cf. intermedia																							1					1																			
		Celsinotum n. sp.																																											1				
		Chydorus sp.																				1																											
		Dunhevedia crassa																				1																											
		Ephemeroporus barroisi s.l.		1																								1																	1				
		Kurzia sp.																					1																										
		Leberis cf. diaphanus													1																																1		
		Leydigia sp.																					1				1																						
		Australospilus elongatus																																		1													
		Pseudomonospilus diporus		1	1						1																																						
		Karualona karua													1																																		
		Armatalona macrocopa			1																																								1				
		Coronatella sp.					1						1													1																							
		Anthalona harti																																											1				
		Chydoridae				1				1												1		1							1																		
	Daphniidae	*Ceriodaphnia cornuta*		1		1			1						1				1			1						1		1		1	1	1			1	1	1	1	1			1	1	1		1	
		Ceriodaphnia sp.					1																										1																
		Daphnia carinata					1						1							1	1																						1						
		Daphnia cephalata					1						1					1			1																												
		Daphnia projecta					1	1		1	1							1		1	1		1			1	1		1	1																			
		Daphnia sp.			1																																												
		Simocephalus heilongjiangensis																							1																				1				
	Macrotrichidae	*Macrothrix capensis*																																											1				
		Macrothrix flabelligera										1	1																																				
		Macrothrix sp.					1												1	1			1								1	1		1		1													
	Moinidae	*Moina micrura s.l.*	1	1	1	1			1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1				1		1			
		Moina sp.																																		1						1							
	Neotrichidae	*Neothrix armata*																1		1																													
Seed shrimps (Ostracoda)																																																
	Limnocytheridae	*Limnocythere dorsosicula*											1								1																										1		
		Limnocytheridae n.gen. sp 419						1							1																					1													
	Ilyocyprididae	*Ilyocypris FVS3 (=sp.837)*																					1																										
		Ilyocypris FVS4 (=sp. 838)																																		1													
		Ilyocypris sp. 836 (=FVS2 = australiensis)		1		1							1		1	1	1	1	1								1																	1					
		Ilyocypris sp. 835								1				1									1	1	1	1		1	1	1	1	1	1														1	1	
		Ilyocypris sp.					1													1															1			1											
	Candonidae	*Candonidae*																																															1
	Cyprididae	*Bennelongia coondinerensis*		1	1	1	1	1		1	1	1	1		1	1		1	1	1	1	1	1		1	1	1	1	1	1		1					1								1				
		Bennelongia koendersae		1						1																									1										1				
		Bennelongia dedeckkeri					1	1			1	1	1		1					1	1					1	1	1				1		1															
		Bennelongia pinderi								1						1			1				1										1				1							1					
		Bennelongia FVS2 s.l.				1							1					1			1	1			1	1	1	1	1	1		1		1															

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

			FV01 26/04/2015	FV02 13/03/2017	FV02 29/07/2015	FV05 12/03/2017	FV05 30/07/2015	FV07 31/07/2015	FV09 13/03/2017	FV10 13/03/2017	FV10 01/08/2015	FV12 01/08/2015	FV14 02/08/2015	FV15 03/08/2015	FV16 13/03/2017	FV16 03/08/2015	FV17 15/03/2017	FV17 04/08/2015	FV18 15/03/2017	FV18 04/08/2015	FV19 04/08/2015	FV20 09/03/2016	FV21 09/03/2016	FV22 09/03/2016	FV23 09/03/2016	FV24 11/03/2016	FV25 11/03/2016	FV26 12/03/2016	FV27 12/03/2016	FV28 13/03/2016	FV29 13/03/2016	FV30 13/03/2016	FV31 15/03/2016	FV32 15/03/2016	FV33 11/03/2017	FV33 06/07/2016	FV34 16/03/2016	FV35 11/03/2017	FV35 07/07/2016	FV36 07/07/2016	FV37 08/07/2016	FV38 09/07/2016	FV39 09/07/2016	FV41 12/03/2017	FV43 10/03/2017	FV44 10/03/2017	FV46 14/03/2017	FV47 14/03/2017	FV48 14/03/2017
		Bennelongia n. sp. (nr nimala)							1							1							1										1											1					1
		Bennelongia sp.																										1													1		1						
		Cypretta sp. 924 (=BOS594)			1																																												
		Cypretta sp. 917 (=BOS593)			1	1		1							1	1	1	1	1	1																								1					
		Cypretta sp. 861																					1	1	1						1	1														1				
		Cypretta sp. 870																						1																									
		Cypretta sp. 872		1					1																				1							1													
		Cypretta sp. 875																				1																											
		Cypretta sp. 863																				1		1		1			1	1	1	1		1			1												
		Cypretta sp. 865		1																						1			1																				
		Cypretta sp. 866																								1																							
		Cypretta sp. 867		1		1									1	1																					1												
		Cypretta sp. 869														1							1							1							1						1						
		Cypretta sp. 916		1					1	1																																						
		Cypretta sp. 922																																					1										
		Cypretta sp.				1	1												1		1	1		1	1	1	1	1	1	1	1	1		1			1	1			1		1	1					
		Hemicypris megalops																					1	1	1					1	1			1											1			
		Heterocypris sp. 853)												1																																		
		Heterocypris sp. FVS3 (cf tatei)							1										1				1			1		1																				
		Heterocypris sp. 936																																														1
		Heterocypris sp.																	1																														
		Strandesia sp 466																					1	1																					1				
		Zonocypretta kalimna						1		1	1	1				1																																	
		Ilyodromus sp. 845							1													1	1	1		1	1	1		1	1	1	1	1			1									1			
		Ilyodromus sp. 847		1					1	1						1				1								1																1					
		Ilyodromus sp. 850																													1																		
		Ilyodromus sp. 933																																	1									1			1		
		Ilyodromus sp.				1		1																																									
		Ampullacypris? sp. nov. 469																																		1	1		1	1	1								
		Cypricercus sp. 911																	1	1				1		1	1	1	1			1	1	1			1												
		Cypricercus sp. 841								1									1				1		1					1																			
		Cypricercus sp. 444									1																																						
		Cypricercus sp. 415 s.l.			1	1		1														1		1		1		1		1													1					1	
		Stenocypris major			1		1	1			1	1	1					1		1	1	1			1	1		1		1			1	1			1												
		Ostracoda (n. gen. n. sp.)																																								1						
	Leptocytheridae	*Leptocythere lacustris*																																								1						
	Notodromadidae	*Newnhamia fenestrata*																				1																											
Copepods																																															
	Centropagidae	*Boeckella triarticulata*					1						1					1		1	1	1	1			1	1	1	1	1	1	1					1	1		1			1	1		1		1	
		Calamoecia halsei															1																			1		1	1	1	1								
		Calamoecia ultima																	1																									1		1		1	
		Calamoecia baylyi (Cue form)	1	1	1	1	1	1			1	1	1	1		1		1		1	1																1					1								
		Calamoecia ampulla var P1	1				1						1					1		1	1																												
		Calamoecia nr ampulla				1													1								1											1											
	Diaptomidae	*Eodiaptomus lumholtzi*																					1	1						1	1		1	1			1									1	1	1	
		Calanoida (unidentified)							1																										1												1		
	Cyclopidae	*Microcyclops varicans*		1	1	1	1	1				1			1	1	1	1		1	1			1				1														1	1		1				
		Metacyclops mortoni																																														1
		Metacyclops superincidentis	1													1																																	
		Mesocyclops notius																						1							1		1	1			1											1		
		Mesocyclops brooksi		1	1	1	1	1	1	1	1	1			1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1						1	1	1	1		1	1
		Mesocyclops sp.											1																									1											
		Thermocyclops decipiens		1					1								1		1										1	1									1								1	1	1	
		Thermocyclops nr emini				1													1					1		1		1		1													1	1		1		1	
		Pescecyclops sp. 442	1				1	1				1	1						1		1	1																												
		Pescecyclops sp.												1																											1	1	1						
		Cyclopoida (unidentified)																																	1	1		1	1	1									
	Canthocamptidae	Mesochra sp. P1											1																																				
Amphipods																																															
	Paramelitidae	Pilbarus sp. B06																																														1
Beetles (Coleoptera)																																															
	Haliplidae	*Haliplus fortescuensis*						1																	1	1		1					1	1															
		Haliplus pinderi																																														1
		Haliplus pilbarensis																																												1	1	1
		Haliplus halsei		1											1		1				1	1		1	1	1		1	1	1	1	1	1	1			1							1			1	1	
		Haliplidae (unidentified)			1																	1																							1				
	Dytiscidae	*Laccophilus sharpi*		1					1						1		1		1																									1					
		Laccophilus sp.																				1			1				1	1																			
		Hyphydrus elegans		1													1								1	1			1	1	1	1		1										1		1	1		
		Hyphydrus lyratus		1	1	1			1						1	1	1		1	1	1	1		1	1	1	1	1	1	1	1	1	1				1							1	1		1	1	1
		Hyphydrus sp.																					1																										
		Hydroglyphus orthogrammus		1					1								1							1				1																					1
		Hydroglyphus leai				1									1																		1				1												1
		Hydroglyphus grammopterus		1	1				1			1			1		1		1			1	1	1	1	1	1	1		1	1		1	1										1	1				1
		Allodessus bistrigatus	1	1	1			1		1		1	1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1		1							1			1			1	
		Tiporus tambreyi		1																																										1	1	1
		Tiporus lachlani																																														1
		Sternopriscus multimaculatus		1		1																					1																						
		Sternopriscus sp.			1											1				1													1											1	1				

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

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		Necterosoma wollastoni							1																		1				1																		
		Necterosoma regulare																											1					1												1	1		
		Necterosoma sp.				1																																											
		Megaporus howittii														1										1																							
		Copelatus sp.																																										1							
		Eretes australis		1		1		1	1	1	1			1	1	1	1	1	1	1		1	1	1			1			1	1				1				1				1	1					
		Hydaticus consanguineus																				1	1																										
		Rhantaticus congestus		1																																	1							1					
		Cybister tripunctatus		1					1	1					1		1		1			1			1	1	1	1			1	1			1									1					
		Exocelina sp. P1																																									1						
		Bidessini																																		1					1		1						
	Gyrinidae	*Dineutus australis*		1		1			1	1					1		1		1			1					1			1	1													1	1		1		
		Gyrinidae																					1						1										1										
	Hydrophilidae	*Spercheus* sp.																																	1														
		Berosus approximans		1	1											1						1			1	1		1	1	1			1											1					
		Berosus dallasae																																													1	1	
		Berosus macumbensis																															1																
		Berosus nutans	1										1									1																											
		Berosus pulchellus		1	1							1			1	1					1	1						1																					
		Berosus vijae													1										1																								
		Berosus sp.		1	1		1										1						1	1			1					1		1		1	1				1		1		1				1
		Berosus 'Pilbara sp. 4'																				1						1			1																		
		Regimbartia attenuata													1		1					1			1		1																						1
		Enochrus elongatulus				1						1			1	1	1										1	1																1	1				
		Enochrus maculiceps														1																																	
		Enochrus deserticola		1					1							1	1																																
		Enochrus sp.																				1																										1	
		Helochares foveicollis															1																																
		Paracymus spenceri		1											1	1	1								1																							1	
		Hydrophilus brevispina																						1						1			1																
		Sternolophus immarginatus																				1						1																					
		Hydrophilidae (unidentified)																																															1
	Hydraenidae	*Hydraena* sp.																															1															1	
		Ochthebius sp. 'P3'														1																																	
	Hydrochidae	*Hydrochus eurypleuron*													1																													1					1
		Hydrochus interioris																																															1
		Hydrochus obscuroaeneus																	1																														
		Hydrochus sp.																									1																						
Flies (Diptera)																																															
	Tipulidae	*Tipulidae type A*						1																																		1							
		Tipulidae type I																												1																			
	Chaoboridae	*Chaoboridae (unidentified)*																																												1	1	1	
	Culicidae	*Anopheles annulipes s.l.*				1																1								1															1				1
		Anopheles amictus				1			1						1				1																														
		Anopheles sp.																															1														1	1	
		Aedes nigrithorax/sagax	1																																														
		Aedes pseudonormanensis																																									1						
		Aedes alternans												1																																			
		Aedes sp.																																								1							
		Culex australicus																							1																		1		1				
		Culex annulirostris				1									1																																		
		Culex starkae													1																																		
		Culex sp.																																										1					
		Culicidae (unidentified)										1																																					
	Ceratopogonidae	Bezzia sp.				1											1	1	1	1			1	1									1				1							1			1	1	1
		Culicoides sp.		1	1			1		1			1							1	1		1		1								1															1	
		Monohelea sp.				1	1	1	1		1	1	1		1		1	1	1	1	1	1	1	1		1			1	1	1	1	1	1										1	1	1	1	1	1
		Nilobezzia sp.		1	1	1	1	1	1	1			1		1		1		1	1		1	1	1	1	1		1	1	1	1	1	1	1			1							1	1	1	1	1	1
		Atrichopogon sp. P1					1										1	1			1							1																					
		Atrichopogon sp.																									1																						
		Forcypomyia sp. P1																					1																										
		Forcyipomyia sp. P6																																								1	1						
		Ceratopogonidae (unidentified)	1											1		1											1	1																					
	Tabanidae	*Tabanidae*																																															1
	Stratiomyidae	*Stratiomyidae*				1																																											
	Dolichopodidae	*Dolichopodidae*										1									1																					1	1						
	Ephydridae	*Ephydridae*																																			1												
		Ephydridae sp. 4																												1																			
		Ephydridae sp. 16																										1																					
	Muscidae	Muscidae sp. L																																															1
		Muscidae sp. P2															1																		1										1		1	1	
		Diptera sp. F																																															1
		Diptera (unidentified)		1				1								1						1							1										1				1						
	Chironomidae	*Coelopynia pruinosa*		1	1	1		1	1	1							1	1	1	1	1		1	1		1	1		1	1		1	1	1			1							1	1	1		1	
		Procladius sp.		1	1	1	1		1	1		1	1		1	1	1		1	1	1	1	1	1	1		1	1	1	1	1	1	1	1			1							1	1	1	1	1	1
		Ablabesmyia hilli		1															1	1		1											1															1	
		Ablabesmyia notabilis		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1		1	1	1		1	1	1			1							1	1	1			
		Paramerina sp. A (parva?)				1			1	1									1						1	1		1	1	1							1							1				1	
		Paramerina sp. C															1																																

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		Larsia albiceps		1	1	1									1		1					1		1	1			1	1	1		1	1	1			1							1	1			1	
		Tanypodinae												1																																		
		Pentaneurini sp. P1																												1																			
		Nanocladius sp. 1 (VCD7)																						1																						1		
		Cricotopus albitarsus									1																																					
		Compterosmittia sp. P1						1			1																									1													
		Compterosmittia sp. P2									1																																					
		Cladotanytarsus aff K4							1	1												1	1	1	1	1		1		1	1	1	1	1			1									1	1	1	
		Tanytarsus fuscithorax										1																																				
		Tanytarsus sp.												1																																		
		Tanytarsus sp. C (?bispinosus)																																										1				
		Tanytarsus sp. H																				1					1																					1	
		Tanytarsus sp. P1			1		1						1					1			1																											
		Tanytarsus 'K12'		1		1				1					1		1		1			1	1		1			1		1	1		1	1			1							1	1		1	1	
		Tanytarsus sp. P5			1																	1		1						1																			
		Tanytarsus sp. P6		1																		1	1		1			1																					
		Tanytarsus sp. P7																							1						1																		
		Tanytarsus sp. P9														1												1																					
		Tanytarsus fuscithorax/semibarbitarsus											1			1					1								1																				1
		Stenochironomus cf watsoni		1		1		1		1							1	1	1	1				1	1			1				1	1	1			1							1		1	1	1	
		Chironomus tepperi									1					1													1																1				1
		Chironomus sp.								1							1																														1	
		Chironomus aff. alternans (V24)		1			1		1			1																1	1															1					
		Xenochironomus sp P2																	1		1																											
		Dicrotendipes jobetus		1		1	1	1			1	1	1				1				1		1	1			1	1		1		1	1	1			1							1				1	1
		Dicrotendipes sp.				1													1																													
		Dicrotendipes 'CA1' Pilbara type 3																				1			1		1										1									1		1	
		Dicrotendipes 'CA1' Pilbara type 2		1	1		1					1	1		1													1																	1				
		Dicrotendipes 'CA1' Pilbara type 1			1																							1																			1		
		Dicrotendipes P6				1				1													1	1		1	1			1		1	1	1			1									1			
		Kiefferulus intertinctus																					1	1	1						1		1	1															
		Polypedilum leei				1																															1										1	1	1
		Polypedilum nubifer				1						1										1			1			1			1														1				
		Polypedilum sp.					1																																									
		Polypedilum sp. S1		1					1								1		1								1	1	1		1	1	1	1			1							1		1		1	
		Polypedilum sp. K1																																							1	1						
		Paraborniella tonnoiri	1															1			1	1	1				1	1		1						1						1	1						
		Cryptochironomus griseidorsum		1		1	1			1	1	1	1		1		1			1	1	1	1	1	1		1		1	1	1		1	1			1				1								
		Microchironomus sp P1							1						1								1								1	1														1	1		
		Harnischia sp.																							1																							
		Harnischia K1																1																												1	
		Harnischia sp. P1																					1	1					1		1	1	1													1			
		Paracladopelma sp.					1																																									
		Paracladopelma 'M3'										1																															1						
		Parachironomus 'K2'		1							1	1			1	1		1		1	1				1	1	1			1		1	1	1															
		Parachironomus 'K1'				1																			1																							
		Chironomini genus K2							1																																							
		Chironomini (unidentified)												1																																		
Mayflies (Ephemeroptera)																																																
	Baetidae	*Cloeon nr 'RedStripe'*																			1	1					1		1				1															
		Cloeon sp.		1		1						1	1				1		1		1																								1		1		
		Baetidae			1		1													1				1		1	1		1		1		1				1											1	
	Caenidae	*Tasmanocoenis arcuata*							1								1		1	1				1			1		1		1		1	1			1							1		1	1	1	
		Tasmanocoenis sp.		1																	1																									1			
		Tasmanocoenis sp. M			1																										1		1	1															
		Tasmanocoenis sp. P																																														1	
		Caenidae (unidentified)																1																														
		Ephemeroptera (unidentified)												1																																		
Water bugs (Hemiptera)																																																
	Gerridae	*Limnogonus fossarum gilguy*				1	1		1						1				1			1								1	1										1				1		1	1		1
		Limnogonus sp.																						1		1	1																					
		Gerridae (unidentified)																																										1				
	Nepidae	*Ranatra diminuta*																																												1	1	
	Belostomatidae	*Lethocerus distinctifemur*															1																					1										
	Corixidae	*Agraptocorixa eurynome*			1																								1																			
		Agraptocorixa parvipunctata			1		1		1				1			1		1		1	1	1						1																1					
		Agraptocorixa sp.		1										1	1		1		1																													
		Micronecta robusta						1					1			1						1													1						1	1							
		Micronecta gracilis		1	1			1						1					1			1	1		1	1	1	1		1		1			1														
		Micronecta annae illiesi																							1						1																		
		Micronecta lansburyi															1																															
		Micronecta virgata		1											1		1																														1		
		Micronecta sp.				1	1								1		1	1			1			1																	1								1
		Corixidae (unidentified)										1																					1							1					1	1			
	Notonectidae	*Anisops thienemanni*											1		1						1																											
		Anisops hyperion															1					1						1		1																			
		Anisops gratus			1		1	1		1	1	1					1	1		1	1										1																		
		Anisops hackeri		1										1	1					1																								1					
		Anisops canaliculatus			1			1						1		1																																

Appendix 7. Aquatic invertebrate data collected for the Pilbara Corridors Project

			FV01 26/04/2015	FV02 13/03/2017	FV02 29/07/2015	FV05 12/03/2017	FV05 30/07/2015	FV07 31/07/2015	FV09 13/03/2017	FV10 13/03/2017	FV10 01/08/2015	FV12 01/08/2015	FV14 02/08/2015	FV15 03/08/2015	FV16 13/03/2017	FV16 03/08/2015	FV17 15/03/2017	FV17 04/08/2015	FV18 15/03/2017	FV18 04/08/2015	FV19 04/08/2015	FV20 09/03/2016	FV21 09/03/2016	FV22 09/03/2016	FV23 09/03/2016	FV24 11/03/2016	FV25 11/03/2016	FV26 12/03/2016	FV27 12/03/2016	FV28 13/03/2016	FV29 13/03/2016	FV30 13/03/2016	FV31 15/03/2016	FV32 15/03/2016	FV33 11/03/2017	FV33 06/07/2016	FV34 16/03/2016	FV35 11/03/2017	FV35 07/07/2016	FV36 07/07/2016	FV37 08/07/2016	FV38 09/07/2016	FV39 09/07/2016	FV41 12/03/2017	FV43 10/03/2017	FV44 10/03/2017	FV46 14/03/2017	FV47 14/03/2017	FV48 14/03/2017
		Anisops nasutus		1	1	1			1						1		1		1	1		1	1	1	1	1	1	1	1	1		1												1					
		Anisops semitus													1																																		
		Anisops stali	1	1	1	1	1		1	1	1				1	1	1	1	1	1		1	1				1		1	1		1			1									1					
		Anisops sp. FVS				1			1						1																																		
		Anisops sp.	1		1		1	1			1	1	1			1		1															1					1							1				
	Pleidae	Paraplea sp.																											1																				
		Paraplea n. sp. (ANIC 6)		1															1							1																		1			1	1	1
		Hemiptera sp. (unidentified)			1																																												
Moth larvae (Lepidoptera)																																															
	Pyralidae	*Pyralidae*		1												1																																	
Dragonflies and damselflies																																															
	Coenagrionidae	*Argiocnemis rubescens*																																													1
		Austroagrion sp.		1	1		1	1		1					1		1		1	1					1	1		1		1														1	1				
		Ischnura aurora aurora			1		1	1				1	1			1					1	1			1	1	1	1		1							1											1	1
		Pseudagrion aureofrons																																											1		1
		Pseudagrion microcephalum																																												1	
		Xanthagrion erythroneurum		1	1	1	1								1		1				1					1																			1					
		Coenagrionidae (unidentified)																1															1											1						
	Isostictidae	*Eurysticta coolawanyah*																						1					1					1			1										1	1	1
	Lestidae	*Austrolestes aridus*		1	1	1	1		1	1		1	1			1	1	1	1	1	1						1	1							1									1					
	Aeshnidae	*Hemianax papuensis*		1	1	1	1						1		1		1	1		1	1	1				1																		1	1				
		Aeshnidae (unidentified)																																													1
	Gomphidae	*Austroepigomphus gordoni*																																											1		1
	Libellulidae	*Diplacodes haematodes*																																													1
		Diplacodes bipunctata\trivialis		1	1								1		1	1									1																				1				
		Orthetrum caledonicum		1	1	1									1				1					1	1	1		1	1	1	1	1	1	1			1							1	1				1
		Pantala flavescens		1											1				1																													
		Tramea stenoloba/loewii																						1			1																				
		Libellulidae (unidentified)							1																																						
	Lindeniidae	*Ictinogomphus dobsoni*																									1				1	1			1										1		
	Hemicorduliidae	*Hemicordulia tau*		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1			1	1			1	1	1	1	1	1	1			1							1	1	1	1	1	
		Epiproctophora *(unidentified)*																			1	1				1																					
Caddisflies (Trichoptera)																																															
	Hydroptilidae	Orthotrichia sp.																																	1										1	1	1
	Ecnomidae	*Ecnomus pilbarensis*		1	1	1				1	1				1		1			1			1	1	1					1	1	1	1	1			1							1	1	1	1	1	1
		Ecnomus sp.						1																				1	1					1			1											
	Leptoceridae	*Oecetis* sp. Pilbara 1					1	1																																								
		Oecetis sp. Pilbara 9			1		1	1			1	1	1			1		1		1	1																											
		Oecetis sp.		1		1			1	1					1		1		1			1	1	1	1	1	1	1	1	1	1	1	1	1			1							1	1	1	1	1	1
		Triplectides australicus																								1		1	1	1																		
		Triplectides australis		1		1		1		1							1						1										1											1					1
		Triplectides sp.														1		1			1	1				1	1	1			1																	
		Leptoceridae (unidentified)																		1																												
NUMBER OF SPECIES			19	99	60	78	54	46	52	49	37	57	47	21	76	61	75	45	71	53	55	88	79	87	80	68	58	89	75	80	71	59	80	77	21	23	68	14	19	17	17	23	38	80	57	59	62	71	59

Appendix 8. List of taxa recorded from the current survey and Pilbara Biological Survey (Lyons, 2015). See appendix 8 for the separate survey ocurrences of each taxon.

Superscript '1' against taxon name denotes pairs of infraspecific taxa analysed at specific rank.

Family		Taxon	Conservation code	Notable records
Acanthaceae		*Rostellularia adscendens* var. *clementii*		
Aizoaceae		*Trianthema triquetrum*		
Amaranthaceae		*Alternanthera angustifolia*		
		Alternanthera denticulata		
		Alternanthera nana		
		Alternanthera nodiflora		
		Amaranthus cuspidifolius		
		Gomphrena affinis [1]		
		Gomphrena affinis subsp. *pilbarensis* [1]		
		Ptilotus chamaecladus		
		Ptilotus gomphrenoides		
		Ptilotus macrocephalus		
		Ptilotus murrayi		
		Ptilotus nobilis subsp. *nobilis*		
		Ptilotus polystachyus		
Asteraceae		*Angianthus tomentosus*		
	*	*Bidens bipinnata*		
		Blumea tenella		
		Calocephalus francisii		
		Calocephalus knappii		
		Calotis multicaulis		
		Calotis plumulifera		
		Calotis porphyroglossa		
		Calotis porphyroglossa		
		Centipeda crateriformis subsp. *craterilformis*		
		Centipeda minima [1]		
		Centipeda minima subsp. *macrocephala* [1]		
		Centipeda minima subsp. *minima* [1]		
		Centipeda pleiocephala		
		Centipeda thespidioides		
	*	*Flaveria trinervia*		
	*	*Gnaphalium polycaulon*		New weed record for Pilbara
		Gnephosis brevifolia		
		Helichrysum luteoalbum		
		Helichrysum oligochaetum	P3	
		Iotasperma sessilifolium	P3	
		Myriocephalus oldfieldii		
		Myriocephalus rudallii		
		Myriocephalus scalpellus	P1	
		Pluchea dunlopii		
		Pluchea rubelliflora		
		Pluchea tetranthera		
		Pterocaulon sphacelatum		
		Rhodanthe ascendens	P1	
	*	*Sonchus sp. indet.*		
		Streptoglossa adscendens		
		Streptoglossa liatroides		
		Streptoglossa odora		
		Vittadinia eremaea		
Boraginaceae		*Heliotropium ammophilum*		
		Heliotropium curassavicum		
		Heliotropium ovalifolium		
		Cardamine aff. *paucijuga*		Major range extenion from SW
		Lepidium muelleri-ferdinandii		
Campanulaceae		*Wahlenbergia tumidifructa*		
Caryophyllaceae		*Spergularia diandroides*		New record for Pilbara
Chenopodiaceae		*Atriplex amnicola*		
		Atriplex flabelliformis		
		Chenopodium auricomum		
		Dysphania melanocarpa forma *melanocarpa*		
		Dysphania plantaginella		
		Dysphania platycarpa		
		Dysphania pumilio		
		Dysphania rhadinostachya subsp. *inflata*		
		Dysphania rhadinostachya subsp. *rhadinostachya*		
		Enchylaena tomentosa var. *tomentosa*		
		Maireana luehmannii		
		Maireana sp. claypans FV		
		Salsola australis		
		Salsola tragus		
		Sclerolaena cornishiana		
		Sclerolaena costata		
		Sclerolaena cuneata		
		Sclerolaena ericantha		
		Sclerolaena minuta		
		Tecticornia auriculata		
		Tecticornia auriculata		

Appendix 8. List of taxa recorded from the current survey and Pilbara Biological Survey (Lyons, 2015). See appendix 8 for the separate survey ocurrences of each taxon.

Superscript '1' against taxon name denotes pairs of infraspecific taxa analysed at specific rank.

Family		Taxon	Conservation code	Notable records
		Tecticornia halocnemoides		
		Tecticornia indica [1]		
		Tecticornia indica subsp. *bidens* [1]		
		Tecticornia pergranulata subsp. *pergranulata*		
		Tecticornia sp. Christmas Creek (K.A. Shepherd & T.Colmer et al. KS 1063)		
		Tecticornia verrucosa		
		Salsola australis		
Cleomaceae		*Cleome viscosa*		
Convolvulaceae		*Convolvulus clementii*		
		Cressa australis		
		Duperreya commixta		
		Evolvulus alsinoides var. *villosicalyx*		
		Ipomoea coptica		
		Ipomoea diamantinensis		
		Ipomoea muelleri		
		Ipomoea plebeia		
		Ipomoea polymorpha		
		Operculina aequisepala		
Cucurbitaceae		*Cucumis melo*		
Cyperaceae		*Bulbostylis barbata*		
		Bulbostylis burbidgeae		
		Bulbostylis microcarya		
		Bulbostylis turbinata		
		Cyperus bifax		
		Cyperus bulbosus		
		Cyperus concinnus		
		Cyperus difformis		
	*	*Cyperus hamulosus*		New weed record for Pilbara
		Cyperus hesperius		
		Cyperus iria		
		Cyperus macrostachyos		
		Cyperus nervulosus		3rd Pilbara record
		Cyperus pygmaeus		
		Cyperus rigidellus		
		Cyperus squarrosus		
		Eleocharis pallens		
		Eleocharis papillosa	P3	
		Fimbristylis depauperata		
		Fimbristylis dichotoma		
		Fimbristylis microcarya		
		Isolepis cernua		Major range extenion from SW
		Isolepis congrua		Ist Pilbara record
		Lipocarpha microcephala		
		Schoenoplectus dissachanthus		
		Schoenoplectus laevis		
		Schoenoplectus lateriflorus		
		Schoenoplectus subulatus		
Droseraceae		*Drosera finlaysoniana*		
Elatinaceae		*Bergia ammannioides*		
		Bergia pedicellaris		
		Bergia perennis [1]		
		Bergia perennis subsp. *exigua* [1]		
		Bergia perennis subsp. *perennis* [1]		
		Bergia trimera		
Euphorbiaceae		*Euphorbia biconvexa*		
Euphorbiaceae		*Euphorbia* sp. Claypans FV		
Fabaceae		*Acacia ampliceps*		
		Acacia citrinoviridis		
		Acacia coriaceae subsp. *pendens*		
		Acacia distans		
		Acacia stenophylla		
		Acacia synchronicia		
		Acacia tetragonophylla		
		Aeschynomene indica		
		Alysicarpus muelleri		
		Crotalaria novea-hollandiae		
		Cullen cinereum		
		Cullen graveolens		
		Indigofera linifolia		
		Indigofera pilifera		
		Lotus cruentus		
		Neptunia dimorphantha		
		Rhynchosia minima		
		Senna artemisioides subsp. *oligophylla*		
		Sesbania cannabina		
		Swainsona kingii		
		Swainsona tanamiensis		

Appendix 8. List of taxa recorded from the current survey and Pilbara Biological Survey (Lyons, 2015). See appendix 8 for the separate survey ocurrences of each taxon.

Superscript '1' against taxon name denotes pairs of infraspecific taxa analysed at specific rank.

Family		Taxon	Conservation code	Notable records
		Swainsona thompsoniana	P3	
		Trigonella suavissima		
	*	*Vachellia farnesiana*		
		Vigna sp. Hamersley Clay (A.A. Mitchell PRP 113)		
Frankeniaceae		*Frankenia ambita*		
		Frankenia cinerea s.l.		
		Frankenia pauciflora s.l.		
Gentianaceae		*Schenkia clementii*		
Goodeniaceae		*Goodenia lamprosperma*		
		Goodenia pascua		
Haloragaceae		*Haloragis gossei*		
Juncaginaceae		*Triglochin hexagona*		
Lamiaceae		*Basilicum polystachyos*		
		Teucrium racemosum		
Linderniaceae		*Lindernia tectanthera*		
Loranthaceae		*Amyema sanguinea*		
		Angianthus milnei		
Lythraceae		*Ammannia auriculata*		
		Ammannia multiflora		
		Lythrum wilsonii		Ist Pilbara record, range extension from Carnarvon Basin
		Rotala diandra		
Malvaceae		*Abutilon lepidum*		
		Abutilon macrum		
		Abutilon otocarpum		
		Corchorus tridens		
		Corchorus trilocularis		
		Hibiscus verdcourtii		
	*	*Malvastrum americanum*		
		Sida arsiniata		
		Sida fibulifera		
		Sida laevis		
		Sida spinosa		
Marsileaceae		*Marsilea costulifera*		
		Marsilea crenata		
		Marsilea exarta		
		Marsilea hirsuta		
		Marsilea spp. indet.		
Molluginaceae		*Glinus lotoides*		
Myrtaceae		*Corymbia candida*		
		Eucalyptus camaldulensis subsp. *obtusa*		
		Eucalyptus victrix		
		Melaleuca glomerata		
Nyctaginaceae		*Boerhavia burbidgeana*		
		Boerhavia coccinea		
		Boerhavia schomburgkiana		
Onagraceae		*Ludwigia perennis*		
Phrymaceae		*Elacholoma hornii*		
		Glossostigma diandrum		
		Mimulus gracilis		
		Mimulus aff. *repens* (Fortescue Marsh entity)		
		Peplidium aithocheilum		
		Peplidium sp. C. Evol. Fl. Fauna Arid Aust. (N.T. Burbidge & A. Kanis 8158)		
		Peplidium sp. E Evol. Fl. Fauna Arid Aust. (A.S. Weston 12768)		
Phyllanthaceae		*Phyllanthus maderaspatensis*		
Plantaginaceae		*Stemodia kingii*		
		Stemodia viscosa		
Plumbaginaceae		*Muellerolimon salicorniaceum*		
Poaceae		*Aristida contorta*		
		Aristida holathera var. *holathera*		
		Bothriochloa ewartiana		
	*	*Cenchrus ciliaris*		
	*	*Cenchrus setiger*		
		Chloris pectinata		
		Chloris pumilio		
		Chrysopogon fallax		
		Cynodon convergens		
	*	*Cynodon dactylon*		
		Cynodon prostratus		
		Dactyloctenium radulans		
		Dichanthium sericeum subsp. *humilis*		
		Dichanthium sericeum subsp. *polystachyum*		
	*	*Echinochloa colona*		
	*	*Echinochloa microstachya*		
		Elytrophorus spicatus		
		Enteropogon ramosus		
		Eragraostis eriopoda		

Appendix 8. List of taxa recorded from the current survey and Pilbara Biological Survey (Lyons, 2015). See appendix 8 for the separate survey ocurrences of each taxon.

Superscript '1' against taxon name denotes pairs of infraspecific taxa analysed at specific rank.

Family		Taxon	Conservation code	Notable records
		Eragrostis australasica		
		Eragrostis crateriformis	P3	
		Eragrostis cumingii		
		Eragrostis dielsii		
		Eragrostis leptocarpa		
		Eragrostis pergracilis		
	*	*Eragrostis pilosa*		
		Eragrostis setifolia		
		Eragrostis tenellula		
		Eragrostis xerophila		
		Eriachne benthamii		
		Eriachne flaccida		
		Eriacnhe aristidea		
		Eriochloa pseudoacrotricha		
		Eulalia aurea		
		Iseilema membranaceum		
		Iseilema vaginiflorum		
		Lachnagrostis filiformis		Ist Pilbara record
		Leptochloa digitata		
		Leptochloa fusca subsp. *fusca*		
		Leptochloa fusca subsp. *muelleri*		
		Panicum laevinode		
		Paspadalium clementii		
		Paspadalium jubiflorum		
		Paspalidium clementii		
		Perotis rara		
		Setaria dielsii		
	*	*Setaria verticillata*		
		Sorghum plumosum var. plumosum		
		Sporobolus australasicus		
		Sporobolus mitchellii		
		Triodia angusta		
		Triodia epactia		
		Triodia longiceps		
		Triodia pungens		
		Urochloa occidentalis var. *ciliata*		
		Urochloa occidentalis var. *occidentalis*		
		Urochloa piligera		
		Xerochloa laniflora		
Polygonaceae		*Duma florulenta*		
		Polygonum plebeium		New weed record for Pilbara
Portulacaceae		*Calandrinia eremaea*		
		Calandrinia ptychosperma		
		Calandrinia pumila		
		Calandrinia stagnensis		
		Calocephalus francisii		
		Portulaca conspicua[1]		
		Portulaca cyclophylla/conspicua[1]		
		Portulaca intraterranea		
		Portulaca oleraceae		
	*	*Portulaca pilosa*		
Primulaceae		*Samolus* sp. Fortescue Marsh (A. Markey & R. Coppen FM 9702)	P1	
		Samolus junceus		
Rubiaceae		*Oldenlandia galioides*		
Sapindaceae		*Atalaya hemiglauca*		
Scrophulariaceae		*Eremophila cuneifolia*		
		Eremophila spongiocarpa	P1	
Solanaceae	*	*Datura leichhardtii*		
		Nicotiana heteranthera		
		Nicotiana occidentalis[1]		
		Nicotiana occidentalis subsp. *obliqua*[1]		
		Nicotiana rostulata		
		Solanum austropiceum		
		Solanum lasiophyllum		
	*	*Solanum nigrum*		
Zygophyllaceae		*Tribulus macrocarpus*		
		Tribulus occidentalis		

Appendix 9. Plant species by quadrat (presence/absense) matrix.

Taxon	FV02A	FV03A	FV04A	FV05A	FV06A	FV07A	FV08A	FV09A	FV10A	FV11A	FV13A	FV14A	FV15A	FV16A	FV17A	FV18A	FV19A	FV20A	FV20B	FV21A	FV22A	FV23A	FV24A	FV24B	FV25A	FV26A	FV27A	FV27B	FV28A	FV28B	FV29A	FV30A	FV31A	FV32A	FV33A	FV33B	FV34A	FV35A	FV36A	FV37A	FV38A	FV39A	FV39B	FV40A	FV41A	FV42A	FV43A	FV44A	FV46A	FV47A	FV48A	P01A	P02A	P02B	P03A	P03B	P04A	P04B	P05A	P39A	P40A	P41A	P42A	# quadrats	# FV quadrats
Abutilon lepidum		1							1	1																																																									3	3
Abutilon macrum																																					1									1																						2	2
Abutilon otocarpum																																																												1				1	0
Acacia ampliceps																																	1	1																			1										1			4	3
Acacia citrinoviridis																											1												1																									2	2
Acacia coriaceae subsp. pendens																																																		1															1	1
Acacia distans											1				1												1																			1													1		1					6	4
Acacia stenophylla				1	1	1	1								1	1	1																											1				1							1				1			11	9
Acacia synchronicia		1						1					1																										1										1																5	5
Acacia tetragonophylla								1	1					1											1		1	1		1												1																					8	8
Aeschynomene indica	1	1					1		1	1	1			1	1	1		1			1	1	1	1		1		1		1		1					1			1				1		1	1	1	1			1	1						1		1		29	25
Alternanthera angustifolia	1								1			1								1																					1				1	1		1										1			1	1		1	12	8
Alternanthera denticulata	1	1		1			1	1	1			1						1		1			1		1	1	1	1	1		1	1	1	1			1								1			1					1	1								1	1		26	22
Alternanthera nana																										1																																									1	1
Alternanthera nodiflora		1		1							1				1	1					1				1									1	1												1		1				1				1			1	1	1				1	17	12
Alysicarpus muelleri																																																	1																1	1
Amaranthus cuspidifolius																																					1																														1	1
Ammannia auriculata				1																																																														1	1
Ammannia multiflora	1							1		1								1	1							1									1							1			1				1							1		1		1	13	9
Amyema sanguinea																													1			1																																	2	2
Angianthus milnei																																																								1									1	0
Angianthus tomentosus						1																																																												1	1
Aristida contorta		1								1																										1			1																					1				5	4
Aristida holathera var. holathera																																				1																							1				2	1
Atalaya hemiglauca																																1																1		1														3	3
Atriplex amnicola						1																										1																											1			3	2
Atriplex flabelliformis																																		1																																1	1
Basilicum polystachyos																																					1										1																	2	2
Bergia ammannioides																																																													1			1	0
Bergia pedicellaris								1												1																								1																				3	3
Bergia perennis	1										1	1		1	1	1							1																																	1	1	1				1	11	7
Bergia trimera				1																																																					1		1		1			4	1
Bidens bipinnata																											1																																					1	1
Blumea tenella								1																																					1					1															3	3
Boerhavia burbidgeana															1																						1																												2	2
Boerhavia coccinea									1	1																												1																												3	3
Boerhavia schomburgkiana																																1																1																	2	2
Bothriochloa ewartiana								1																																									1	1																3	3
Bulbostylis barbata																																									1						1												1				3	2
Bulbostylis burbidgeae																																																				1													1	0
Bulbostylis microcarya									1																												1		1	1																									4	4
Bulbostylis turbinata																																					1																														1	1
Calandrinia eremaea																																																												1				1	0
Calandrinia ptychosperma				1						1																																																							2	2
Calandrinia pumila		1									1																																	1																		1	4	3
Calandrinia stagnensis																																							1																				1				2	1
Calocephalus francisii		1						1																																																			1				3	2
Calocephalus knappii																																																												1				1	0
Calotis multicaulis			1	1			1	1		1																																																							5	5
Calotis plumulifera																																																									1		1	1			1	4	0
Calotis porphyroglossa	1	1									1																					1								1		1					1																	7	7

Taxon	FV02A	FV03A	FV04A	FV05A	FV06A	FV07A	FV08A	FV09A	FV10A	FV11A	FV13A	FV14A	FV15A	FV16A	FV17A	FV18A	FV19A	FV20A	FV20B	FV21A	FV22A	FV23A	FV24A	FV24B	FV25A	FV26A	FV27A	FV27B	FV28A	FV28B	FV29A	FV30A	FV31A	FV32A	FV33A	FV33B	FV34A	FV35A	FV36A	FV37A	FV38A	FV39A	FV39B	FV40A	FV41A	FV42A	FV43A	FV44A	FV46A	FV47A	FV48A	P01A	P02A	P02B	P03A	P03B	P04A	P04B	P05A	P39A	P40A	P41A	P42A	# quadrats	# FV quadrats
Cardamine paucijuga																																					1																													1	1
Cenchrus ciliaris							1	1																			1	1					1				1				1				1				1	1	1									1					12	11
Cenchrus setiger																																									1								1	1														3	3
Centipeda crateriformis subsp. crateriformis																									1		1	1		1		1	1													1																		1	8	7
Centipeda minima	1	1		1				1			1	1				1				1				1	1			1				1	1	1			1				1	1	1	1	1			1				1					1	1	1	1	1	1	1	29	21
Centipeda pleiocephala				1			1			1																												1																											4	4
Centipeda thespidioides				1			1			1	1																		1									1																	1							1		1	1		10	6
Chenopodium auricomum																															1																																	1	1
Chloris pectinata		1						1												1																			1											1	1				1	1			1			1			1	11	6
Chloris pumilio								1																																																							1	1
Chrysopogon fallax																																																	1																1	1
Cleome viscosa									1						1						1						1											1			1									1												1				8	7
Convolvulus clementii																												1																																					1	1
Corchorus tridens								1	1																												1													1														4	4
Corchorus trilocularis																																									1																								1	1
Corymbia candida																								1																																								1	1
Cressa australis																																		1																					1	1										3	1
Crotalaria novea-hollandiae																											1																																					1	1
Cucumis melo									1																												1											1	1																4	4
Cullen cinereum																1				1											1	1	1																	1						1										7	6
Cullen graveolens																															1										1	1			1																		1	5	4
Cynodon convergens																																																	1																1	1
Cynodon dactylon																																		1																															1	1
Cynodon prostratus																																				1		2	1																												4	4
Cyperus bifax				1		1			1	1										1	1		1			1	1	1			1	1																	1		1	1	1											1	1		18	16
Cyperus bulbosus																																																			1		1	1	1	1								5	1
Cyperus concinnus																		1					1	1						1							1																	1									1		7	5
Cyperus difformis	1	1							1	1	1				1	1			1	1																							1			1															1			1		13	11
Cyperus hamulosus										1																																																							1	1
Cyperus hesperius																																																												1				1	0
Cyperus iria	1	1		1				1	1	1	1	1				1			1	1			1			1			1								1			1					1		1	1	1	1		1	1				1		1	1	1	1		28	21
Cyperus macrostachyos																																													1																				1	1
Cyperus pygmaeus															1	1										1										1											1																	5	5
Cyperus rigidellus				1					1																				1				1		1																									1			6	5
Cyperus squarrosus				1			1	1		1																											1				1						1													1	1			9	7
Dactyloctenium radulans								1	1	1																										1	1	1	1											1		1											1			1	11	9
Datura leichhardtii																																																	1																1	1
Dichanthium sericeum subsp. humilis																					1										1									1						1																		4	4
Dichanthium sericeum subsp. polystachyum																															1									1	1				1																		4	4
Drosera finlaysoniana										1																																																							1	1
Duma florulenta				1	1	1			1							1																			1				1			1	1		1		1				1									1		1		1			15	12
Duperreya commixta																											1																																					1	1
Dysphania melanocarpa forma melanocarpa																																					1											1																	2	2
Dysphania plantaginella				1		1																											1																															3	3
Dysphania platycarpa				1					1																																																	1			1	4	2
Dysphania pumilio																																																1																	1	1
Dysphania rhadinostachya subsp. inflata										1																																																	1			1	3	1
Dysphania rhadinostachya subsp. rhadinostachya						1																																																						1				2	1
Echinochloa colona	1	1			1			1			1	1	1		1	1	1	1		1				1			1	1													1				1			1	1	1										1					21	20
Echinochloa microstachya															1																													1																				2	2
Elacholoma hornii																																					1														1													2	1
Eleocharis pallens											1				1	1		1	1			1	1	1		1			1	1											1																	1			1		14	12
Eleocharis papillosa				1																												1																					1	1	1									5	2
Elytrophorus spicatus	1						1			1						1	1																										1														1			1		8	6

Taxon	FV02A	FV03A	FV04A	FV05A	FV06A	FV07A	FV08A	FV09A	FV10A	FV11A	FV13A	FV14A	FV15A	FV16A	FV17A	FV18A	FV19A	FV20A	FV20B	FV21A	FV22A	FV23A	FV24A	FV24B	FV25A	FV26A	FV27A	FV27B	FV28A	FV28B	FV29A	FV30A	FV31A	FV32A	FV33A	FV33B	FV34A	FV35A	FV36A	FV37A	FV38A	FV39A	FV39B	FV40A	FV41A	FV42A	FV43A	FV44A	FV46A	FV47A	FV48A	P01A	P02A	P02B	P03A	P03B	P04A	P04B	P05A	P39A	P40A	P41A	P42A	# quadrats	# FV quadrats
Enchylaena tomentosa var. tomentosa						1		1																																																								2	2
Enteropogon ramosus								1																																									1															2	2
Eragraostis eriopoda																																																												1				1	0
Eragrostis australasica																									1																																							1	1
Eragrostis crateriformis																				1	1																										1																	3	3
Eragrostis cumingii				1				1	1	1						1												1																																1	1			8	6
Eragrostis dielsii	1	1	1	1		1	1	1	1	1			1			1	1																1			1		1	1	1	1						1				1			1	1	1	1			1			1	26	20
Eragrostis leptocarpa								1		1						1																		1																			1	1						1	1		1	9	4
Eragrostis pergracilis																																																1																1	1
Eragrostis pilosa																																																												1			1	2	0
Eragrostis setifolia				1		1														1																	1			1	1		1	1			1													1	1			11	9
Eragrostis tenellula	1	1		1			1	1		1					1	1				1	1		1									1	1				1						1		1	1	1	1				1		1					1	1	1		1	25	19
Eragrostis xerophila																																																												1				1	0
Eremophila cuneifolia																																						1																										1	1
Eremophila spongiocarpa		1	1			1			1																																															1								5	4
Eriachne benthamii	1	1									1			1				1		1	1	1	1						1	1	1	1			1	1						1	1		1				1	1														20	20
Eriachne flaccida	1	1						1			1		1					1					1	1					1	1		1									1		1	1			1															1		16	15
Eriacnhe aristidea																																																												1				1	0
Eriochloa pseudoacrotricha																					1					1	1	1	1		1	1		1												1		1														1		11	10
Eucalyptus camaldulensis subsp. obtusa																																		1																														1	1
Eucalyptus victrix	1	1				1	1	1	1		1		1		1	1	1	1		1	1	1	1	1		1	1	1		1	1	1					1				1					1		1	1	1		1					1		1			1		33	29
Eulalia aurea																					1									1							1						1		1				1	1												1		8	7
Euphorbia biconvexa																																					1																											1	1
Euphorbia sp.																					1										1																																	2	2
Evolvulus alsinoides var. villosicalyx									1																		1										1	1							1					1														6	6
Fimbristylis depauperata																																															1																	1	1
Fimbristylis dichotoma																																				1																												1	1
Fimbristylis microcarya				1				1			1							1				1															1		1						1				1	1											1			11	10
Flaveria trinervia																																																			1					1								2	1
Frankenia ambita						1			1																								1	1																				1	1									6	4
Frankenia pauciflora			1	1																																																		1										3	2
Glinus lotoides															1										1	1											1							1										1			1		1				1	9	5
Glossostigma diandrum	1																																																			1												2	1
Gnaphalium polycaulon																																																				1												1	0
Gnephosis brevifolia																																						1	1																									2	2
Gomphrena affinis subsp. pilbarensis	1	1		1				1																																									1															5	5
Goodenia lamprosperma	1	1									1							1	1				1	1		1				1																1											1			1		1		13	10
Goodenia pascua							1						1																												1																							3	3
Haloragis gossei																																																									1							1	0
Helichrysum luteoalbum						1	1			1					1																	1	1	1																		1							1					9	7
Helichrysum oligochaetum																																									1																		1					2	1
Heliotropium ammophilum																																																1																1	1
Heliotropium curassavicum																																	1	1																			1	1										4	2
Heliotropium ovalifolium																																									1																1							2	1
Hibiscus verdcourtii																															1																																	1	1
Indigofera linifolia																																																		1														1	1
Indigofera pilifera																																					1																											1	1
Iotasperma sessilifolium																																									1		1																					2	2
Ipomoea coptica								1		1																																							1				1	1										5	3
Ipomoea diamantinensis															1																1																												1					3	2
Ipomoea muelleri													1										1				1	1	1														1																1					7	6
Ipomoea plebeia																																																											1					1	0
Ipomoea polymorpha															1																																																	1	1
Iseilema membranaceum																					1																																											1	1

Taxon	FV02A	FV03A	FV04A	FV05A	FV06A	FV07A	FV08A	FV09A	FV10A	FV11A	FV13A	FV14A	FV15A	FV16A	FV17A	FV18A	FV19A	FV20A	FV20B	FV21A	FV22A	FV23A	FV24A	FV24B	FV25A	FV26A	FV27A	FV27B	FV28A	FV28B	FV29A	FV30A	FV31A	FV32A	FV33A	FV33B	FV34A	FV35A	FV36A	FV37A	FV38A	FV39A	FV39B	FV40A	FV41A	FV42A	FV43A	FV44A	FV46A	FV47A	FV48A	P01A	P02A	P02B	P03A	P03B	P04A	P04B	P05A	P39A	P40A	P41A	P42A	# quadrats	# FV quadrats
Iseilema vaginiflorum																						1										1										1								1															4	4
Isolepis cernua				1																																																														1	1
Isolepis congrua										1																										1																												2	2
Lachnagrostis filiformis																																						1																1													2	1
Lepidium muelleri-ferdinandii																												1																																				1	1
Leptochloa digitata																									1						1																1																			3	3
Leptochloa fusca subsp. fusca																1																												1		1																				3	3
Leptochloa fusca subsp. muelleri		1			1			1			1	1	1			1										1										1										1																	1		1	12	10
Lindernia tectanthera				1			1			1																										1																												4	4
Lipocarpha microcephala																																						1								1																	1	1			4	2
Lotus cruentus										1																																	1	1																							3	3
Ludwigia perennis																																																												1	1				2	0
Lythrum wilsonii							1																																					1	1																							3	3
Maireana luehmannii			1																																																														1	1
Maireana sp. claypans FV																																					1																												1	1
Malvastrum americanum									1						1				1							1						1				1						1							1	1	1															10	10
Marsilea costulifera																								1		1		1	1								1																													5	5
Marsilea crenata																								1																																										1	1
Marsilea exarta	1	1									1												1						1																																				5	5
Marsilea hirsuta		1								1																																1	1			1																				5	5
Marsilea sp. indet.				1													1	1			1	1			1			1										1												1							1	1	1					1		1	1	1	16	9
Melaleuca glomerata				1		1			1																								1						1	1				1					1												1			9	8
Mimulus gracilis	1	1		1			1	1		1	1				1					1	1																						1	1			1			1											1		1			16	14
Mimulus repens																																																						1	1	1	1									4	0
Muellerolimon salicorniaceum																																		1																				1	1	1											4	1
Myriocephalus oldfieldii	1									1	1					1									1				1					1					1								1																1						10	9
Myriocephalus rudallii	1			1			1								1																																										1	1			1			7	4
Myriocephalus scalpellus																																						1																1													2	1
Neptunia dimorphantha									1																	1																	1														1										4	3
Nicotiana heteranthera																																			1	1																															2	2
Nicotiana occidentalis			1	1			1		1																				1											1										1					1				1													9	9
Nicotiana rostulata subsp. rostulata																																																								1	1	1								3	0
Oldenlandia galioides										1											1														1								1																					4	4
Operculina aequisepala																																																1																1	1
Panicum laevinode																1				1																							1		1		1			1	1															1	8	7
Paspadalium clementii																																						1			1						1					1															4	4
Paspadalium jubiflorum																																									1			1	1																		1			4	3
Paspalidium clementii			1			1			1																																																								3	3
Peplidium aithocheilum	1																																																								1	1			1		1	5	1
Peplidium sp. C. Evol. Fl. Fauna Arid Aust. (N.T. Burbidge & A. Kanis 8158)	1	1		1			1	1		1	1	1				1	1			1			1		1	1																												1												15	14
Peplidium sp. E Evol. Fl. Fauna Arid Aust. (A.S. Weston 12768)																																																						1	1					1					3	0
Perotis rara																																							1																										1	1
Phyllanthus maderaspatensis																																									1		1							1																3	3
Pluchea dunlopii		1						1																																																				1				3	2
Pluchea rubelliflora		1						1	1																																																			1				4	3
Pluchea tetranthera													1																																											1								2	1
Polygonum plebeium																											1	1					1	1																																4	4
Portulaca conspicua																																							1																										1	1
Portulaca cyclophylla/conspicua																																					1			1																												2	2
Portulaca intraterranea									1						1	1																						1	1	1									1																7	7
Portulaca oleraceae								1												1	1				1											1											1	1															1		1	9	7
Portulaca pilosa									1																												1																												2	2
Pterocaulon sphacelatum		1																																																											1				2	1
Ptilotus chamaecladus																																																													1				1	0

Taxon	FV02A	FV03A	FV04A	FV05A	FV06A	FV07A	FV08A	FV09A	FV10A	FV11A	FV13A	FV14A	FV15A	FV16A	FV17A	FV18A	FV19A	FV20A	FV20B	FV21A	FV22A	FV23A	FV24A	FV24B	FV25A	FV26A	FV27A	FV27B	FV28A	FV28B	FV29A	FV30A	FV31A	FV32A	FV33A	FV33B	FV34A	FV35A	FV36A	FV37A	FV38A	FV39A	FV39B	FV40A	FV41A	FV42A	FV43A	FV44A	FV46A	FV47A	FV48A	P01A	P02A	P02B	P03A	P03B	P04A	P04B	P05A	P39A	P40A	P41A	P42A	# quadrats	# FV quadrats
Ptilotus gomphrenoides		1						1												1	1				1	1						1					1				1							1						1			1			1			1	14	10
Ptilotus macrocephalus																																																												1				1	0
Ptilotus murrayi										1																																																						1	1
Ptilotus nobilis subsp. nobilis				1																																																								1	1			3	1
Ptilotus polystachyus																																																												1				1	0
Rhodanthe ascendens																																																											1					1	0
Rhynchosia minima																																					1				1									1							1							4	3
Rostellularia adscendens var. clementii																				1	1						1	1			1	1									1					1		1	1	1														11	11
Rotala diandra																																					1								1							1												3	2
Salsola australis							1																		1																																							2	2
Salsola tragus																																																												1				1	0
Samolus sp. Fortescue Marsh (A. Markey & R. Coppen FM 9702)																																	1	1																														2	2
Samolus junceus																																																			1													1	1
Schenkia clementii																																		1																						1								2	1
Schoenoplectus dissachanthus	1										1							1	1	1		1	1			1		1	1		1						1								1							1					1	1	1		1	1		19	13
Schoenoplectus laevis	1							1			1							1	1	1		1	1	1		1			1																1							1										1		14	12
Schoenoplectus lateriflorus																																																				1										1		2	0
Schoenoplectus subulatus																																																			1													1	1
Sclerolaena cornishiana																																						1																										1	1
Sclerolaena costata																																				1			1																					1				3	2
Sclerolaena cuneata																																				1		1	1																									3	3
Sclerolaena ericantha																																						1																										1	1
Sclerolaena minuta																																							1																									1	1
Senna artemisioides subsp. oligophylla																											1																																					1	1
Sesbania cannabina																																	1																															1	1
Setaria dielsii																											1																					1	1															3	3
Setaria verticillata									1							1																																									1		1					4	2
Sida arsiniata																																																												1				1	0
Sida fibulifera																1																									1																							2	2
Sida laevis																																											1																					1	1
Sida spinosa															1																																	1	1	1									1					5	4
Solanum austropiceum																											1																																					1	1
Solanum lasiophyllum									1																								1			1			1																									4	4
Solanum nigrum																											1	1					1																															3	3
Sonchus sp. indet.																															1		1													1																		3	3
Sorghum plumosum var. plumosum																											1																																					1	1
Spergularia diandroides										1																																																						1	1
Sporobolus australasicus								1	1				1			1				1														1			1												1												1			9	8
Sporobolus mitchellii		1		1	1	1	1		1			1			1		1				1												1																1		1						1	1	1		1			17	13
Stemodia kingii																																										1	1																					2	2
Stemodia viscosa								1		1																																																						2	2
Streptoglossa adscendens																																																															1	1	0
Streptoglossa liatroides																																																												1			1	2	0
Streptoglossa odora																																																												1				1	0
Swainsona kingii																																																								1								1	0
Swainsona tanamiensis																																																					1	1										2	0
Swainsona thompsoniana																																																1																1	1
Tecticornia auriculata			1																																																			1		1								3	1
Tecticornia halocnemoides			1																																																			1		1								3	1
Tecticornia indica			1	1																																																			1	1								4	2
Tecticornia pergranulata subsp. pergranulata																																		1																			1	1										3	1
Tecticornia sp. Christmas Creek (K.A. Shepherd & T.Colmer et al. KS 1063)																																	1																															1	1
Tecticornia verrucosa		1		1								1					1																																					1		1		1						7	4
Teucrium racemosum																																								1	1		1		1																			4	4

Taxon	FV02A	FV03A	FV04A	FV05A	FV06A	FV07A	FV08A	FV09A	FV10A	FV11A	FV13A	FV14A	FV15A	FV16A	FV17A	FV18A	FV19A	FV20A	FV20B	FV21A	FV22A	FV23A	FV24A	FV24B
Trianthema triquetrum			1	1		1	1	1	1	1														
Tribulus macrocarpus																								
Tribulus occidentalis																								
Triglochin hexagona																								
Trigonella suavissima																								
Triodia angusta																								
Triodia epactia																								
Triodia longiceps																								
Triodia pungens																								
Urochloa occidentalis var. ciliata																								
Urochloa occidentalis var. occidentalis																								
Urochloa piligera																								
Vachellia farnesiana																					1	1	1	
Vigna sp. Hamersley Clay (A.A. Mitchell PRP 113)																								
Vittadinia eremaea																								
Wahlenbergia tumidifructa						1	1			1														
Xerochloa laniflora																								
Quadrat species richness	#	#	#	#	5	#	#	#	#	#	#	#	#	2	#	#	8	#	9	#	#	#	#	#
Cluster group	9	9	1	#	6	3	#	9	3	#	9	6	6	#	9	9	6	8	8	7	7	8	8	8

Taxon	FV25A	FV26A	FV27A	FV27B	FV28A	FV28B	FV29A	FV30A	FV31A	FV32A	FV33A	FV33B	FV34A	FV35A	FV36A	FV37A	FV38A	FV39A	FV39B	FV40A	FV41A	FV42A	FV43A	FV44A	FV46A	FV47A	FV48A
Trianthema triquetrum												1		1	1	1							1				
Tribulus macrocarpus																											
Tribulus occidentalis			1																								
Triglochin hexagona																											
Trigonella suavissima									1	1												1					
Triodia angusta															1												
Triodia epactia																											
Triodia longiceps															1												
Triodia pungens												1			1								1				
Urochloa occidentalis var. ciliata													1												1		
Urochloa occidentalis var. occidentalis			1																		1				1	1	
Urochloa piligera																									1		
Vachellia farnesiana	1		1				1	1	1								1			1		1		1	1		
Vigna sp. Hamersley Clay (A.A. Mitchell PRP 113)							1																				
Vittadinia eremaea																			1								
Wahlenbergia tumidifructa			1	1			1											1	1		1						
Xerochloa laniflora																											
Quadrat species richness	#	#	#	#	#	#	#	#	#	#	2	#	#	#	#	#	#	#	#	9	#	#	#	#	#	#	#
Cluster group	5	8	7	7	8	8	7	7	4	4	#	2	#	2	2	3	7	#	#	5	9	7	3	7	7	7	1

Taxon	P01A	P02A	P02B	P03A	P03B	P04A	P04B	P05A	P39A	P40A	P41A	P42A	# quadrats	# FV quadrats
Trianthema triquetrum									1				13	12
Tribulus macrocarpus									1				1	0
Tribulus occidentalis													1	1
Triglochin hexagona				1									1	0
Trigonella suavissima												1	4	3
Triodia angusta													1	1
Triodia epactia									1				1	0
Triodia longiceps									1				2	1
Triodia pungens													3	3
Urochloa occidentalis var. ciliata													2	2
Urochloa occidentalis var. occidentalis													4	4
Urochloa piligera													1	1
Vachellia farnesiana												1	14	13
Vigna sp. Hamersley Clay (A.A. Mitchell PRP 113)													1	1
Vittadinia eremaea													1	1
Wahlenbergia tumidifructa									1				10	9
Xerochloa laniflora			1										1	0
Quadrat species richness	#	#	#	9	#	#	8	#	#	#	#	#		
Cluster group	#	4	4	1	1	6	6	9	5	#	8	5		