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Aquatic Invertebrate Fauna Survey of Deefor Road Claypan, October 2021.

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Cover image Deefor Site A, ‘open’ and ‘sapling’ habitats/ D.Cale Aug 2022

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Acknowledgments

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Summary

Deefor Road claypan is located in the Wandoo National Park approximately 25 km from York. It was surveyed for aquatic invertebrates in October 2021 to determine if it was faunistically similar to vegetated ephemeral claypans already identified as a subgroup of wetlands identified as Threatened Ecological Communities.

When sampled it had an inundated area of 5.5 ha, but its full extent may be as great as 10 ha. The wetland was fresh with *circum* neutral pH and depth up to 32cm but mostly < 20cm. Habitat formations were less well defined and less discretely arranged than apparent at other vegetated ephemeral claypans suggesting a smaller differential of drying times across the lakebed.

Aquatic invertebrate species richness was high with total richness at the wetland exceeding that of other vegetated ephemeral claypans. Richness within samples was very similar to that of Brixton Street wetlands, ‘Julimar’ claypan and Little Darkin swamp and comparable but slightly higher than other vegetated ephemeral claypans. The fauna had a high proportional richness of insects most of which have ubiquitous distributions and are adapted to ephemeral wetlands by virtue of their high dispersal capability.

Despite a large component of the fauna being quite common, the composition of the community was similar to other vegetated ephemeral claypans at least from the Wandoo National Park and further north and distinct from high richness, fresh water wetlands from higher rainfall zones further south. In particular, Deefor shared with other northern vegetated ephemeral claypans 5 of 7 target management species for the iconic vegetated ephemeral claypans at Drummond Nature Reserve. Deefor also shared 6 of 9 species indicative of northern vegetated ephemeral claypans by virtue of: i) the high proportion of their occurrences restricted to these northern wetlands and ii) the high number of samples from these wetlands in which they occurred.

With similar richness and composition including a suite of relatively exclusive species it is reasonable to consider Deefor Rd claypan a relatively typical vegetated ephemeral claypan with the caution that this group is not homogenous or without variation.

1 Introduction

This report is the latest of a series of unpublished reports documenting the aquatic invertebrate fauna of vegetated ephemeral claypans. These claypans include two in Drummond Nature Reserve (DNR) (Cale, 2005; Jones *et al.*, 2009; Pinder, Cale & Leung, 2011; Pinder *et al.*, 2013), Goonaping Swamp (Cale & Pinder, 2020), Little Darkin Swamp (Cale, 2020), Dobaderry Swamp (Jones *et al.*, 2009) and 'Julimar' Claypan (Cale, 2023). All lie on the plateau at the top of the Darling Scarp. These vegetated ephemeral claypans are shallow flat basins, with a clay-based substrate. They fill intermittently and are covered in vegetation. The vegetation typically comprises a series of vegetation formations arranged from the centre of the lake to the outer margin according to the duration of the period of inundation (e.g. Shahrestani, 2017). At the centre of the wetland the vegetation is dominated by an overstorey species; e.g. *Melaleuca lateritia* (Gibson *et al.*, 2005) or *M. viminea* (Cale, 2023).

The vegetated ephemeral claypans support a high diversity of aquatic invertebrates. Species richness ranges from 38 to 82 for a single sample of aquatic invertebrates excluding rotifera and protista (e.g. Figure 1; Cale, 2023). Where a wetland of this type has been sampled over multiple years cumulative richness is up to 145 % of a single sample (e.g. Table 3; Cale, 2020).

With many destroyed or modified by land clearing, clay-based wetlands have been identified as a Threatened Ecological Community (TEC) with conservation status ranging from "Priority 1" to "Endangered" (Department of Parks and Wildlife, 2015). The wetland type labelled here as ephemeral vegetated claypans was originally defined floristically as a subgroup (group 3) of clay-based wetlands (Gibson *et al.*, 2005) and described as "claypans with shrubs over herbs" with respect to TEC's; for example 'Julimar claypan' (occurrence #101; 108; Id JB20), Drummond Nature Reserve (occurrence #99,100; Id JB26,JB18) and Goonaping Swamp (occurrence #111).

Deefor Road claypan (31°59'12.58"S 116°34'27.88"E), lies within the Wandoo National Park near the junction of Deefor Rd and West Talbot Rd approximately 25 km from York. Unlike other vegetated ephemeral claypans surveyed for aquatic invertebrates, this wetland has an overstorey of *Eucalyptus rudis*. The wetland was sampled on 12 October 2021 with the intention of determining whether it was faunistically like other vegetated ephemeral claypans.

2 Sampling and Analysis

Two sampling sites were established at the Deefor Rd wetland. Site A (31°59'6.60"S 116°34'31.10"E) was located at the northern end of the wetland and influenced by the canopy of stands of *Eucalyptus rudis* on the lakebed. This site included a shallow sump (possibly an old well) which would contain water after the remainder of the lake had dried. This sump was included in the sampling of aquatic invertebrates but not in water chemistry samples. Site B (31°59'20.10"S 116°34'32.70"E) was at the southern end of the wetland and was not influenced by and overstorey canopy. Both sites were sampled for aquatic invertebrates, water chemistry and habitat variables on the 12 October 2021.

Habitat structure was described using a hierarchical system with area (%cover) of formations as the first level followed by the %cover of components of each formation as a second level. The components of habitat formations were overstorey canopy, emergent stems (including tree and sedge), submergent macrophytes, leaflitter (including sticks and logs), senescent inundated sedge, organic sediments (mulch) and inorganic sediments (essentially bare clay). Because some of these components could overlay each other it was possible to get >100% cover in some formations.

Water chemistry was measured *in situ* using a YSI ProDSS meter to measure electrical conductivity (EC), total dissolved solids (TDS), pH, dissolved oxygen (DO) and temperature (T) of wetland water at each site.

At each site aquatic invertebrates were sampled in a benthic sample collected using a 250 µm mesh D-net to vigorously disturb substrates, and a plankton sample using a 53 µm mesh D-net in the water column and macrophytes. Both comprised a broken sampling path of approximately 50 m aimed at sampling all habitats within a path of about 200 m. Samples were preserved in General Laboratory Reagent (GLR) grade 100% ethanol. Both invertebrate samples were sorted in the laboratory under a dissecting microscope to extract all species and to estimate their abundance on a log scale. Protista and Rotifera, which have typically been collected in other vegetated ephemeral claypan surveys (e.g., at Drummond; Cale 2005, Goonaping, Cale & Pinder 2020 and Little Darkin; Cale 2020) using this protocol, were not collected in this study. These two groups typically comprise a significant proportion of species richness, they were not included because species composition varies greatly and over very short time frames, they require specialist taxonomists for identification and greatly add to the processing time of collected samples. Taxa identified from benthic and plankton samples were combined in the laboratory to provide the total sample species list for each site. Taxa were identified to the lowest level possible (LowestID), usually species. Where taxa could not be identified to a described species they were attributed to a morphological species (morpho-species) routinely used within the wetlands lab at DBCA (Pinder *et al.*, 2004, 2013; Pinder & Quinlan, 2015) and which are uniquely identified by a LowestID National Code. No morpho species specific to this survey were aquired. Some groups were not identified beyond a higher (e.g., Class) taxonomic level for example Turbellaria, Nematoda and mites of the families Oribatidae and Mesostigmatidae.

For comparison with richness at Deefor, richness data were collated for Little Darkin swamp and ‘Julimar’ claypan. Data sources were the species list (excluding Rotifera and Protista) appended in Cale (2020) for Little Darkin, and unpublished analyses for samples collected in 2021 (Cale, 2023) at ‘Julimar’ claypan

The species composition of the macroinvertebrate community at Deefor was compared with six wetlands previously described as vegetated ephemeral claypans (Cale, 2020, 2023). Five of these wetlands are from wandoo and mixed woodlands of the western parts of the plateau at the top of the Darling Scarp. These are; Dobaderry swamp sampled in 2009 (Jones et al., 2009), Goonaping swamp sampled repeatedly between 1998 -2006 (Cale & Pinder, 2020), Drummond Nature Reserve claypans sampled by various authors between 2004 and 2014 (Cale, 2005; Jones et al., 2009; Pinder et al., 2011, 2013), Little Darkin swamp sampled in 2019 (Cale, 2020) and Julimar claypan sampled in 2021 (Cale, 2023). Brixton Street wetland was sampled in 2007 (Pinder and Quinlan DPAW unpublished data) and lies at the bottom of the Darling Scarp. Additionally three wetlands of similar richness and freshwater conditions but different community composition (Cale, 2020) to the above group of vegetated ephemeral claypans were included for comparison. These were Nalyerin Lake sampled in 1998 and Darkin swamp (Pinder *et al.*, 2005), and Lake Pleasant View sampled multiple years between 1999 and 2009 (Cale & Pinder, 2019).

To compare community composition across this suite of wetlands it was necessary to ‘match’ presence/absence species lists so that spurious species were not added because of different levels of identification at each wetland. This required some combining or deletion of taxa until an equitable combined list was arrived at. All rotifer and protist taxa were removed from the analysis. Individual sample species lists were used in the analysis to afford equal sampling effort in wetlands with one or multiple collected samples.

Analysis of community composition was performed on the R statistical platform v.3.5.2 (R Development Core Team, 2019). A non-metric multidimensional scaling (NMDS) method was used to perform an ordination of the wetlands according to the dissimilarity (Bray Curtis) of composition between wetlands. This ordination was conducted using the metaMDS method in the vegan package (Oksanen et al., 2013). Hierarchical clustering (UPGMA) was performed using hclust from the R core package. Indicator species analysis (ISA) was conducted using the library indicspecies v1.7.14 and method multipatt with parameters *dulag* and *func* set to “*TRUE*” and “*IndVal.g*” respectively (De Caceres & Legendre, 2009). The grouping of sites used in ISA was supported by the cluster analysis but was simply a division between those purported to be vegetated ephemeral claypans (*sensu* Cale, 2023) including Deefor and those which were not.

3 Results and Discussion

3.1 Site Characteristics

The Deefor Rd claypan is roughly oval shaped with the long axis orientated almost north - south. Based on vegetation cover the regularly inundated area is approximately 5.5 ha but a 'bare' margin which is probably water-logged but less frequently inundated extends a further 40 m and extends the total area to approximately 10 ha. At the time of sampling this bare portion of the wetland was not inundated, but the remainder was.

Table 1 Water chemistry at the time of invertebrate sampling at both sites at Deefor Rd and at other vegetated ephemeral wetlands for comparison. Where a wetland has been sampled multiple times, median values are reported.

Wetland	Deefor A	Deefor B	Julimar claypan	Little Darkin Swamp	Dobaderry Swamp	Goonaping Swamp	Drummond NR
Date	12/10/2021	12/10/2021	7/10/2021	7/10/2019	14/09/2007	1997-2008	2010 - 2014
Depth (m)	0.27	0.32	0.25	0.41	0.3	0.2	0.25
Conductivity (µS/cm)	158.5	123.7	100	104.5	88.6	257	278.5
Field pH	6.96	7.07	6.85	7.84	6.81	7.175	6.375
Temperature (°C)	15.1	22	20.9	18.8	18.8	22	19.2

Water was fresh with an electrical conductivity (EC) of 158.5 µS/cm at site A and 123.7 µS/cm at site B. At site A water was coloured (darkly stained from plant leachates) but not turbid, while the opposite was true at site B where colour was not apparent but some turbidity due to suspended clay was apparent. Water temperature differed between sites (Table 1); 15.1 °C was recorded at site A and 22 °C at site B. Temperature at site A was influenced by shading from the tree overstorey but was also measured 3 hours earlier than at site B. The influence of colour and turbidity on temperature at each site may also be a factor. Water pH was circum-neutral but differed between sites with 6.96 at site A and 7.07 at site B. This difference is small and probably in response to shading, temperature and time of day and their collective effect on photosynthesis of aquatic plants.

The two sampling sites had different habitat structure (Table 2). Two habitats occurred at both sites. “Open” was used to describe areas dominated by open water with little (typically 5% cover) emergent vegetation. This formation had 90% cover of submergent macrophytes at site A, but at site B submergent macrophytes were largely replaced by emergent species which had not grown much beyond the sediment surface and occupied <50% of water depth. The second habitat at both sites was “Sedge-beds” which were characterised by a high cover >75% of emergent sedges in dense clumps within a matrix of bare sediments, leaf litter and submergent macrophytes. Both Open and Sedge-bed habitats occurred from 0 – 20 cm depth and in interspersed blocks.

Two additional habitats were observed at site A, based on *E. rudis* as a dominant structural element. “Mature-trees” occurred at depths 20 – 27 cm with sparse large diameter trunks occupying approximately 10% cover within a matrix of emergent sedges and organic sediment and leaf litter. This habitat had an overstorey canopy of 30% cover. “Sapling-trees” occurred at the same depth and was similar in structure but with denser cover (40%) of tree trunks of much smaller diameter, and higher overstorey canopy cover (40%) creating a denser and shadier habitat. Paradoxically, submergent macrophytes replaced (covered) much of the bare organic sediment observed in the Mature tree formation, despite the apparent reduced light.

Finally, an additional formation was observed at site B. “Sparse-sedge” was structurally between Open and Sedge-beds and is possibly a successional stage between these habitats. However, with 50% cover of emergent sedges and 40% cover of submergent macrophytes which were evenly intermixed this formation is denser than Open and sparser than Sedge-bed habitats.

The spatial arrangement of the habitat formations was less zoned and concentric than observed in Julimar claypan (Cale, 2023) or Little Darkin Swamp (Shahrestani, 2017). At these wetlands the uniform increase in depth toward the wetlands centre is an important driver of the zonation of habitats. At Deefor depth change appeared to be smaller overall and it is likely that only the small crescent of deepest water toward the northeast corner persisted for much longer than water across the rest of the lakebed. It is in this small area of deepest water that E. *rudis* has become established. At Deefor it is possible that conditions when dry are equally important in structuring vegetation formations. The area of bare sediments between sedge beds is for example probably in response to the drying, oxidation and windblown removal of fine organic material. The establishment of E. *rudis* on the lakebed may also be in response to drying since this species while tolerant of water logging does not recruit when flooded.

3.2 Invertebrate Species Richness

A total of 97 taxa (Appendix 1) were collected from the Deefor Rd claypan. This included 17 previously established morpho-species and 9 higher taxa some of which (e.g. Nematoda) may include multiple species. As was the case at other claypans (Cale, 2023) the ostracod genus *Ilyodromus* was represented by multiple species

*Table 2 Habitat composition for the two invertebrate sampling paths. *In the open habitat at site B 80% of the cover of submergent plants could be attributed to emergent species which occupied < 50 % of water depth. This was structurally dissimilar from the habitat at site A.*

	Site A				Site B			
Habitat	Open	Sedge beds	Mature trees	Sapling thicket	Open	Sedge beds	Sparse sedge	Bare clay
Proportion of site (%)	35	35	20	10	30	30	30	10
Median depth (cm)	14	18	23	23	26	15	23	10
% cover overstorey			30	40				
% cover emergent stems	5	75	45	45	10	90	50	
% cover submergent macrophytes	90	5		40	90*		40	
% cover senescent sedge		15				5		
% cover woody debris	5	5	5	5				
% cover bare organic sediments			50	10		5		
% cover bare inorganic sediments							10	100

which could not be reliably separated causing further under-estimation of richness. Several taxa, while confidently designated a single species could not be identified beyond genus because of the material available.

Total richness at Deefor was higher than richness of 82, 82, and 87 reported by Cale (2023) for Drummond Nature Reserve claypans, Little Darkin swamp and 'Julimar' claypan respectively. However, the richness of individual samples at Deefor was very similar to sample richness at these wetlands and Brixton Street claypan (Fig. 1) and higher than other vegetated ephemeral claypans.

Eighty-two species were collected at Deefor site B compared to 76 at site A. The habitat structure of the two sites was very different with site B having: no overstorey, more of the water column free of plant material, less organic detritus and a greater extent of deeper water (Table 2). While these differences may have contributed to differences in richness, small differences in water chemistry noted above may also play a part.

Insects and crustaceans accounted for 54% and 27% of richness respectively (Table 3). Within the insects the Diptera (true flies) accounted for 24% of richness and included 18 species of chironomid. In conjunction with Coleoptera (beetles) at 15% of richness these two taxa were the most diverse insect groups. Fourteen species of Cladocera (water fleas) represented 14% of richness and was the most diverse crustacean group. Cladocera were the most diverse crustacean group at Julimar (14 species) and little Darkin swamp (18 species) where they represented 16 and 22 5 % of richness respectively.

Insects as a dominant component of richness at vegetated ephemeral claypans has been noted before (Cale, 2023) and was postulated to result from their generally higher dispersive capability which increases access to ephemeral wetlands. Moorehead (1998) noted that dispersive insects increased in abundance as part of the succession of communities across the period of inundation in ephemeral playas, while non dispersive crustacea typically had higher abundance in early stages of the succession. While insect dominance of richness has been observed at Drummond Nature Reserve, Julimar claypan and now Deefor, at Little Darkin Swamp insects and crustacea comprised a similar proportion of total richness (Cale, 2020). Deefor, like Julimar and Drummond, is smaller, shallower, and likely to have a shorter hydroperiod than Little Darkin. These factors favour insects over crustaceans, particularly considering that an October sample at Deefor is probably from a later successional stage than the same sample from Little Darkin where drying is likely to occur later.

Pinder *et al.* (2004) described a series of 10 aquatic invertebrate assemblages from the Western Australian agricultural zone (Wheatbelt) based on their co-occurrence in wetlands with similar water chemistry and environmental conditions. Species of seven of these assemblages were present at Deefor (Table 4). Assemblage A is associated with freshwater and was represented by 7 taxa. An additional 2 taxa with a freshwater preference belonged to assemblage C which is associated with freshwater wetlands in northern parts of the Wheatbelt. The largest portion of richness (80%) was ascribed to assemblages E (24 taxa) and F (17 taxa) which are dominated by insects of fresh to subsaline tolerances and in the case of assemblage E ubiquitous distributions. As discussed above the dispersive capability of insects favours their colonisation of Deefor and with broad tolerances and ubiquitous distributions in assemblage E it would be expected that this assemblage would be well represented. Like other vegetated ephemeral claypans Deefor did not include any species with saline preferences.

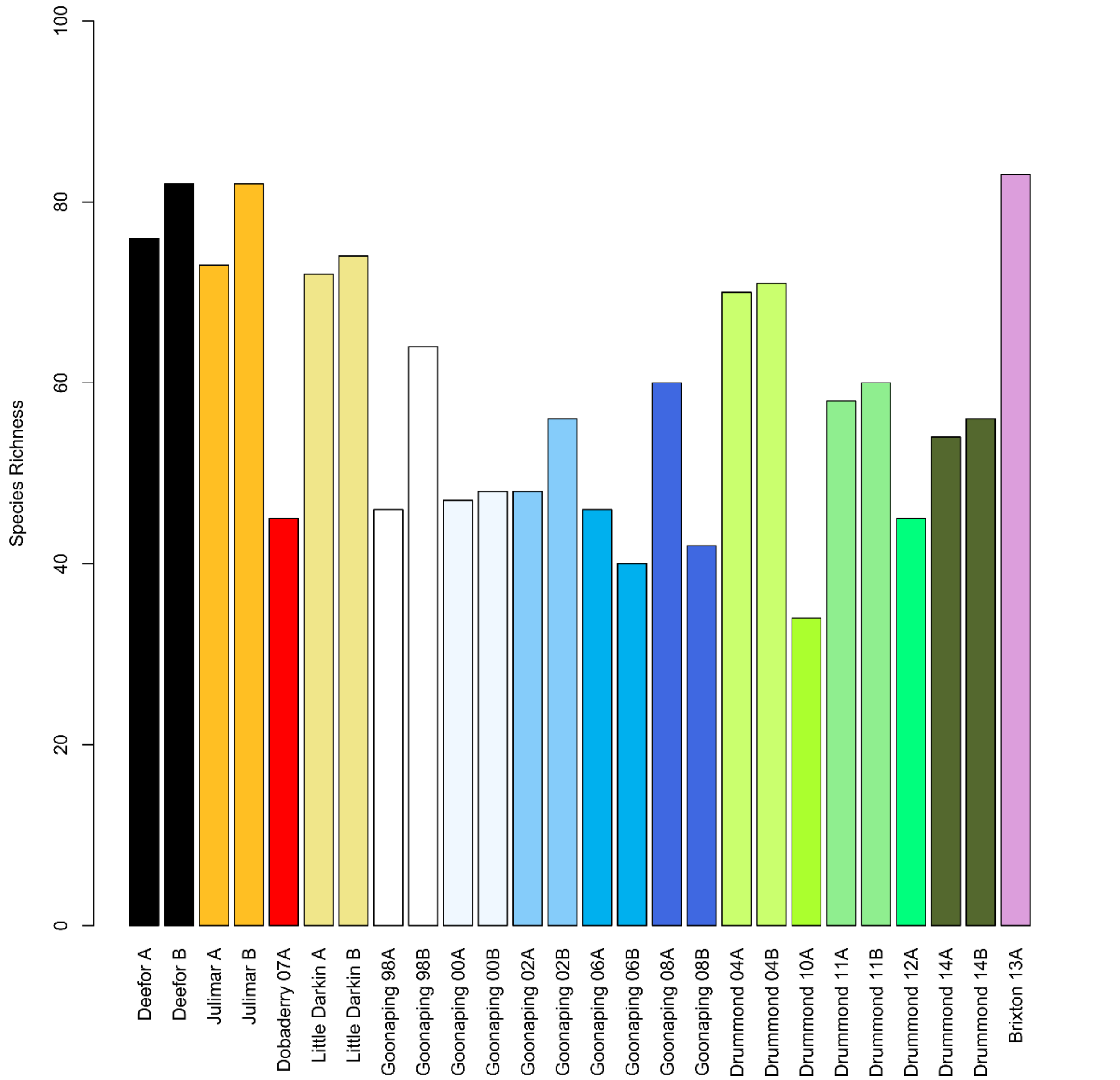

Figure 1 Species richness (excluding Protista and Rotifera) for individual samples at Deefor claypan and six comparative vegetated ephemeral claypans.

Table 3 Richness of major taxonomic groups at Deefor Rd wetland, Julimar claypan and Little Darkin Swamp (LDS). See methods for data sources.

	Deefor	Julimar	LDS	Deefor	Julimar	LDS
	Richness	Richness	Richness	%	%	%
other	5	2	4	5	2	5
Mollusca	3	2	2	3	2	2
Oligochaeta	4	2	2	4	2	2
Acarina	7	6	6	7	7	7
CRUSTACEA	**26**	**28**	**34**	**27**	**32**	**43**
Conchostraca	1	1	1	1	1	1
Cladocera	14	14	18	14	16	22
Ostracoda	4	7	9	4	8	11
Copepoda	6	6	5	6	7	6
Isopoda	1	0	2	1	0	2
INSECTA	**52**	**47**	**33**	**54**	**54**	**40**
Coleoptera	15	14	12	15	16	15
Diptera	5	9	5	5	10	6
Chironomidae	18	11	9	19	13	11
Hemiptera	6	6	2	6	7	2
Odononata	5	5	3	5	6	4
Trichoptera	3	2	2	3	2	2

Table 4 Taxon richness of assemblages sensu *Pinder (2004) at Deefor Rd wetland, Julimar claypan and Little Darkin Swamp. See methods for data sources.*

Assemblage	Deefor	Julimar	LDS
A	7	7	13
B	0	0	1
C	2	1	1
D	1	0	
E	25	23	8
F	17	12	14
J	0	1	1
U	45	43	44

3.3 Community composition

The main aim of this survey was to determine whether Deefor was faunistically similar to other northern vegetated ephemeral claypans i.e. Drummond, Goonaping, Little Darkin and Julimar. To this end the ordination performed by Cale (2020) was repeated with the addition of community data for Julimar and Deefor wetlands. This ordination (Fig. 2) again shows the disjunction between southern, semi-permanent lake Pleasant View to the right of the first axis and the northern vegetated ephemeral claypans including Deefor to the left. The southern claypan, Nalyerin, and Darkin swamp lie between these two larger groups of samples with a fauna that includes species from both groups, as well as unique species, reflecting different habitat availability and biogeographic effects.

Comparing across all three axes community composition at Deefor is most like that of Julimar, Little Darkin and Brixton Street. Goonaping and Drummond form separate but closely related subgroups. This arrangement of community similarity is confirmed by a cluster dendogram (Fig. 3) showing the order in which the wetlands pair up with their most similar cluster of samples. Deefor is most similar to Julimar and this pair is in turn most similar to a cluster formed between Little Darkin and Brixton street. These four wetlands have high species richness which is responsible for reducing similarity with Goonaping swamp, a near neighbour but with lower richness and therefore fewer opportunities for shared species which are the basis of similarity. Goonaping swamp forms a cluster which is then joined to the Deefor cluster before finally joining with a cluster of the samples from Drummond. The Dobaderry sample is added to this large cluster of northern vegetated ephemeral claypans but may not properly represent its relationship with the other wetlands since it is of low richness possibly as a result of a poor year for sampling (Cale, 2023). The Drummond sample from 2010 is also an outlier forming a cluster of its own because of the very low species richness in what was the driest sample so far collected at this wetland. These northern ephemeral vegetated claypans are distinct from the other three wetlands which form two distinct clusters, Darkin swamp on its own and Pleasant View and Nalyerin clustered together in a southern, probably more mesic group.

This analysis seems to confirm that Deefor is faunistically similar to the other northern claypans, but also points out that this group does not have homogenous community composition, but rather individual wetlands provide a substructure to the group. This sub structure is in part provided by the presence of species peculiar to particular wetlands. For example, the ostracod *Newnhamia* sp. DR4 (Cale, 2005), and the water mites *Arrenurrus* sp 2 and *Acercella* n.sp (Pinder *et al.*, 2013) are currently only known from Drummond NR claypans.

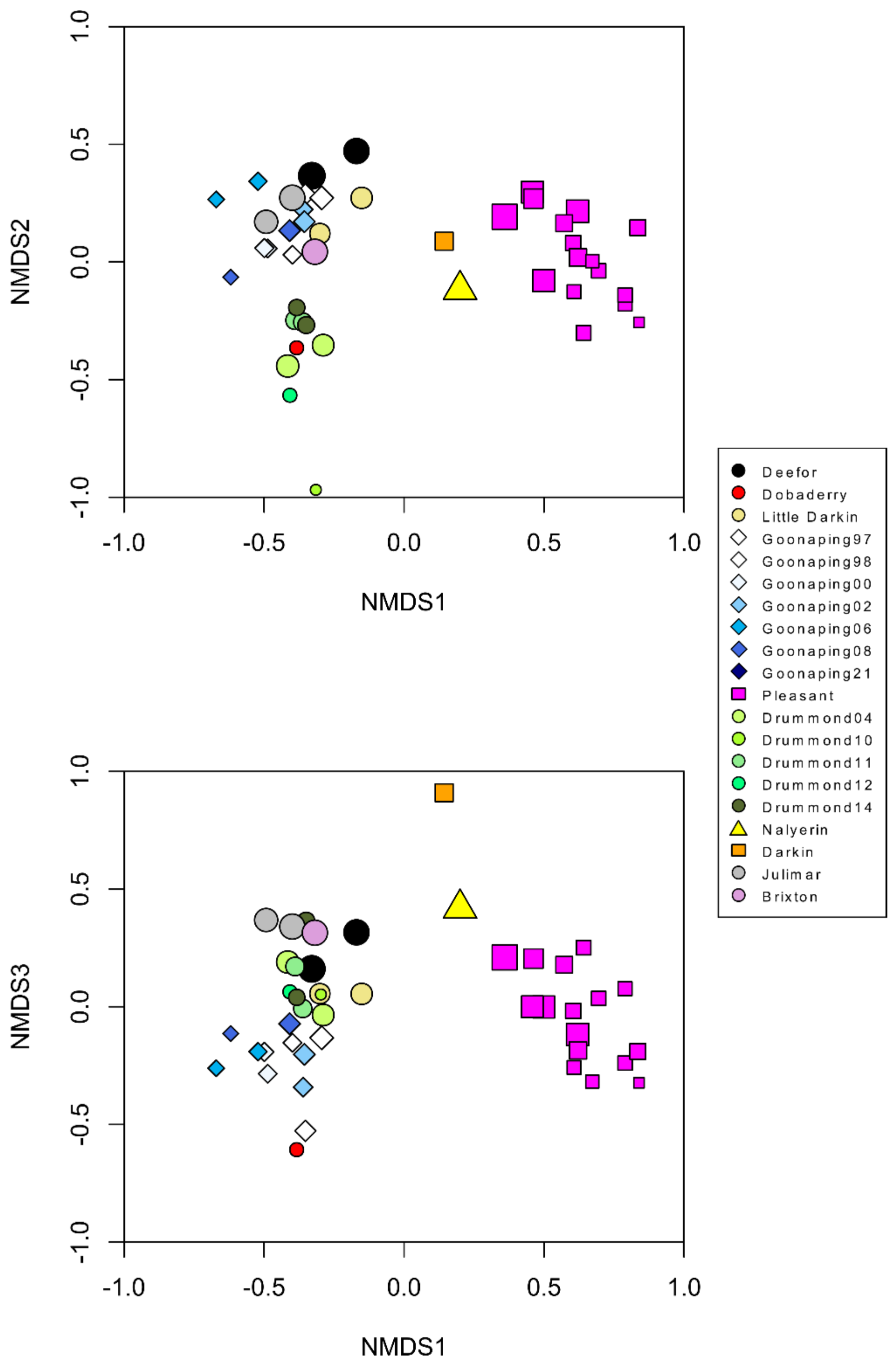

Figure 2 An ordination of community composition (presence/absence) of individual samples at Deefor and a series of comparison wetlands (see methods for descriptions). Plotted points are scaled according to invertebrate richness and Goonaping and Drummond samples include a suffix representing the year of sampling between 1998 and 2014. (NMDS, stress = 0.13).

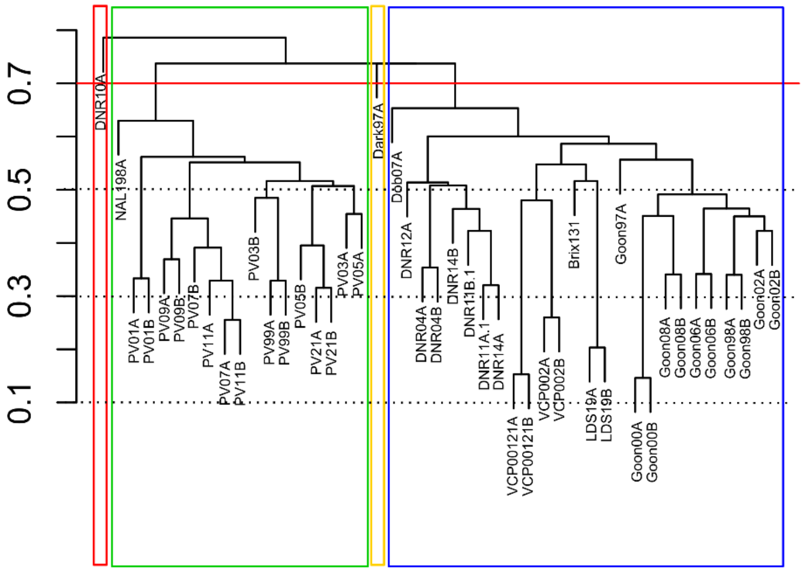

Figure 3 UPGMA hierarchical cluster dendogram of aquatic invertebrate community similarity: DNR Drummond Nature Reserve, NAL Nalyerin claypan, PV Lake Pleasant View, Dark Darkin Swamp, Dob Dobaderry claypan, VCP001 'Julimar' claypan, VCP002 Deefor Rd claypan,Brix Brixton St claypan, LDS Little Darkin swamp, Goon Goonaping swamp.

3.3.1 Diagnostic species

Diagnostic species were determined for the northern claypan groups using Indicator species Analysis (ISA) to compare this group (blue square in Fig. 3) with a group comprised of all other samples. Diagnostic species (equivalent to indicator species) use the preferences of species to make predictions about the similarity of environment at sites where they have a high occurrence (De Caceres & Legendre, 2009).

While thirty-one species were statistically significant indicators of the northern claypan group, only 5 species with IV (indicator value) scores >0.8 are proposed as strong indicators. This is considerably higher than the 0.5 (25%) value suggested as minimum for a strong indicator by Dufrene & Legendre (1997), a necessary conservatism, given the likelihood that this analysis does not include sufficient wetlands or types of wetlands to properly delimit the preferences of species. The indicator species discussed below are clear, strong indicators of northern vegetated claypans relative to the southern group, but how general this is remains to be tested.

Table 5 Statistics; A (specificity[1]), B (fidelity[2]) and Indicator Value (IV) for i) the five species with IV >0.8 and associated with the northern vegetated ephemeral claypans (bold) and ii) six species mentioned elsewhere as possibly typical of the fauna of this wetland type.

Species	A	B	IV	p	At Deefor
Lynceus tatei	**1.000**	**0.963**	**0.981**	**0.005****	**Yes**
Latonopsis brehmi	**1.000**	**0.926**	**0.962**	**0.005****	**Yes**
Berrosus approximans	**0.933**	**0.778**	**0.852**	**0.005****	**Yes**
***Ilyodromus* spp**	**0.762**	**0.889**	**0.823**	**0.005****	**Yes**
***Rak* spp**	**0.9268**	**0.704**	**0.808**	**0.005****	**Yes**
Bennelongia 'australis lineage'	0.667	0.889	0.770	0.010**	Yes
Promochlonyx australis	0.842	0.592	0.706	0.010**	No
Australocyclops palustrium	1.000	0.407	0.638	0.015*	Yes
Paroster spp	1.000	0.370	0.609	0.005**	Yes
Lacrimicypris "drummond"	1.000	0.333	0.577	0.020*	No
Glacidorbis occidentalis	0.869	0.370	0.568	0.050*	No

The clam shrimp *Lynceus tatei* and water flea *Latonopsis brehmi* had very high specificity to samples from northern vegetated ephemeral claypans (Table 5). They were collected from all northern vegetated ephemeral claypans, but not from Pleasant View, Nalyerin or Darkin. These species also had high fidelity to northern claypans occurring in > 90% of samples from these wetlands. In conjunction with *L.tatei* and *L.brehmi*, the beetle *Berosus approximans* is one of 7 taxa recommended as target species for management planning for the Drummond NR claypans (Department of Environment and Conservation, 2011) and was present only at northern claypans except for a single sample at Pleasant View. This beetle, however, had relatively lower fidelity with six samples from the northern group not including the species. While the ostracod *Ilyodromus* spp. had a high IV and fidelity, present in 24 of 27 samples, to the northern group, it had low specificity with roughly

[1] Specificity is the proportion of all samples occupied by a species that are within the group. A value of 1 suggesting the species occurs only in the indicated group.

[2] Fidelity is the proportion of samples within the group occupied by the species. A value of 1 would indicate it occurred in every sample of the group

25% of occurrences outside the group. This is a taxon combining multiple undetermined species from a genus frequently encountered in freshwater wetlands. Its value as an indicator is hampered by our lack of understanding of the taxonomy of the genus. The water flea *Rak* spp was present at all northern claypan group wetlands except Brixton and was collected from Nalyerin but not the other two non-northern wetlands. It is believed that all specimens of *Rak* spp were in fact *Rak labrosus,* but they have been combined in this analysis until greater confidence in this identification is achieved.

Three species with high specificity to the northern claypan group; the cyclopoid *Australocyclops palustrium*, beetle *Paroster* spp. and ostracod *Lacrimicypris* sp.'Drummond' (Table 5) have been mentioned in previous reports as potentially indicative of the claypan fauna. Species with high specificity to a group are especially good diagnostic species with both their presence and their absence informative about a sampled group. However, when fidelity is low such as for all three of these species, they are useful when present but if absent do not inform discussion of a wetland's affinities. Their low fidelity to the group in this analysis was underpinned by their absence from some wetlands in the group. For example *Lacrimicypris* sp,'Drummond' occurred only at Drummond, Julimar and Brixton, while *A. palustrium* was present at all northern sites except these three suggesting its association is more closely related to the region of the Wandoo National Park. *Paroster* spp. is one of the 7 target species for Drummond NR management but was of low occurrence even when present at a wetland and has not been recorded at Julimar and Brixton. These and other species with low fidelity in the northern claypan group contribute to the substructure of the group (i.e., Fig. 3) and provide a warning that community composition is not homogenous across member wetlands.

Two other members of the 7 species included as target species in the Drummond Nature Reserve management plan were *Bennelongia* 'australis lineage' and *Calamoecia attenuata*. Both were outside the arbitrary range of IV values determined to be good indicators for the northern group (Table 5) and *C. attenuata* was not indicative of either the southern group or the northern vegetated ephemeral claypans. Both occurred widely in both wetland groups and in many samples. This probably reflects a preference for freshwater wetlands irrespective of hydroperiod or latitudinal position and is a reminder that the two wetland groups share some similarities in environment.

In terms of its aquatic invertebrate fauna, the Deefor Rd claypan is like other vegetated ephemeral claypans. This claypan included all 5 species indicative of other vegetated ephemeral claypans (Table 5), and 5 of the 7 target species for the recovery plan for Drummond Nature Reserve (Department of Environment and Conservation, 2011). This wetland also had richness at least as high as other wetlands in the northern vegetated ephemeral claypans group and clusters with these wetlands in terms of community composition. Only habitat structure is conspicuously different from other vegetated ephemeral claypans; with the presence of a tall eucalypt overstorey rather than a shorter *Melaleuca* overstorey, and a less round basin with poorly defined zonation of habitats based on period of inundation.

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Appendices

Appendix 1 Deefor Rd (VCP002) Species List 12/10/2021

LowestIDNC	Lowest ID	VCP002 A	VCP002 B	Assemblage
Hydrazoa				
IB010199	*Hydra* sp.	2	3	
Platyhelminthes (flat worms)				
IF999999	Turbellaria	2	2	
IF9999A0	Microturbellaria	1	2	
Nematoda (round worms)				
II999999	Nematoda	1	2	
Bryozoa (pipe moss)				
IO999999	Bryozoa (Ectoprocta)	2	2	
Gastropoda (snails)				
KG060199	*Ferrissia* sp.	1		
KG070299	*Glyptophysa* sp	2	1	
KG070399	*Isidorella* sp.	2	2	F
Annelida (aquatic earthworms)				
LO030503	*Insulodrilus bifidus*	2	3	A
LO050701	*Chaetogaster diastrophus*		2	A
LO089999	Enchytraeidae	2		
LO150107	*Pristina leidyi*	2	3	
Acarina (water mites)				
MM0101A0	*Hydrachna* nr. *approximata* (SAP)		1	E
MM020101	*Limnochares australica*	1	1	F
MM030199	*Eylais* sp.		1	E
MM120101	*Limnesia dentifera*	3	2	E
MM170101	*Acercella falcipes*	2	2	E
MM9999A2	Mesostigmata	2	2	
MM999999	Oribatida	2	2	
Diplostraca(clam shrimp)				
OF040101	*Lynceus tatei*	2	3	
Cladocera (waterfleas)				

LowestIDNC	Lowest ID	VCP002 A	VCP002 B	Assemblage
OG010201	*Latonopsis brehmi*		1	F
OG030212	*Alona rigidicaudis*	2		E
OG030213	*Alona affinis*	3	3	
OG0302B1	*Alona* cf. *longinqua* (CB)		2	
OG030899	*Celsinotum* sp.	3	3	
OG0315A0	*Graptoleberis* cf. *testudinaria*		2	
OG0327A4	*Rak* cf. *labrosus* (SAP)	3	3	
OG033401	*Armatalona macrocopa*	1	2	
OG034101	*Flavalona setigera*	2	3	
OG040103	*Ceriodaphnia dubia*	3	3	
OG040506	*Simocephalus gibbosus*	3	3	A
OG050105	*Ilyocryptus spinifer*		1	
OG0501A0	*Ilyocryptus* cf. *smirnovi* (SAP)	1	1	
OG090301	*Neothrix armata*		1	F
Ostracoda (seed shrimp)				
OH080316	*Bennelongia* (australis lineage) *gwelupensis*	4	3	
OH080599	*Cypretta* sp.	3	3	
OH081999	*Ilyodromus* spp.	3	3	
OH149999	Cytheroidea	3	3	
Copepoda (copepods)				
OJ110101	*Boeckella triarticulata* s.l.	2	3	E
OJ310101	*Microcyclops varicans*	2	4	F
OJ310302	*Australocyclops similis*	3		D
OJ310303	*Australocyclops palustrium*		4	A
OJ310703	*Mesocyclops brooksi*		4	F
OJ610101	*Canthocamptus australicus*	2	2	A
Isopoda				
OR259999	Oniscidae	1	1	
Coleoptera (beetles)				
QC060104	*Haliplus fuscatus*	1	1	E
QC091002	*Limbodessus shuckhardi*	1	1	
QC091006	*Limbodessus inornatus*		1	

LowestIDNC	Lowest ID	VCP002 A	VCP002 B	Assemblage
QC091101	*Allodessus bistrigatus*	1	1	E
QC091499	*Paroster* sp.		1	
QC091805	*Sternopriscus multimaculatus*	1	1	E
QC092199	*Megaporus* sp.	1	1	
QC092399	*Rhantus* sp.	1		
QC093302	*Spencerhydrus pulchellus*	1		A
QC093401	*Onychohydrus scutellaris*	1	1	F
QC110404	*Berosus approximans*	1	1	E
QC110904	*Anacaena littoralis*		1	F
QC111102	*Enochrus eyrensis*		1	F
QC111401	*Limnoxenus zelandicus*	1	1	F
QC111601	*Paracymus pygmaeus*	1	1	F
QC209999	Scirtidae	1		
Diptera (flies)				
QD070101	*Anopheles annulipes* s.l.	1	2	E
QD070799	*Culex* sp.	1	1	
QD0919A3	*Monohelea* sp. 4 (SAP)	1		
QD0927A1	*Atrichopogon* sp. 3 (SAP)	1	2	
QD7899A6	Ephydridae sp. 2 (SAP)	1	1	E
QDAE0803	*Procladius paludicola*	2	2	E
QDAE08A2	*Procladius* sp. (normal claws)		2	
QDAE1102	*Ablabesmyia notabilis*	1	1	E
QDAE1201	*Paramerina levidensis*	2	2	F
QDAF06A2	*Corynoneura* sp. (V49) (SAP)	2	2	
QDAF1202	*Paralimnophyes pullulus* (V42)		2	F
QDAF21A1	*Allotrissocladius*? sp. M (SAP)	2	2	A
QDAF99A0	*Gymnometriocnemus* sp.=ortho sp A (SAP)	2	2	E
QDAF99B4	Orthocladiinae SO3 sp. A (SAP)	2	2	E
QDAH04B9	*Tanytarsus* nr *bispinosus* (SAP)		1	
QDAH04D8	*Tanytarsus fuscithorax/semibarbitarsus*	2		
QDAI0299	*Stenochironomus* sp.	2		
QDAI0414	*Chironomus tepperi*	3	3	E

LowestIDNC	Lowest ID	VCP002 A	VCP002 B	Assemblage
QDAI04A0	*Chironomus* aff. *alternans* (V24) (CB)	2	2	E
QDAI0603	*Dicrotendipes conjunctus*	1		E
QDAI0703	*Kiefferulus martini*	1		C
QDAI0804	*Polypedilum nubifer*	1		E
QDAI1701	*Paraborniella tonnoiri*	2		F
QDAI25A0	*Parachironomus* sp. 1 (VSCL35) (SAP)	2	2	C
Hemiptera (striders, boatmen and backswimmers)				
QH560101	*Microvelia* (*Pacificovelia*) *oceanica*	1		F
QH600201	*Saldula brevicornis*	1		
QH650299	*Sigara* sp.		1	
QH650302	*Agraptocorixa parvipunctata*		2	E
QH650399	*Agraptocorixa* sp.	2		
QH670401	*Anisops thienemanni*		2	E
QH670402	*Anisops hyperion*		2	E
QH670499	*Anisops* sp.	2		
Odonata (dragonflies)				
QO029999	Coenagrionidae		1	
QO050101	*Austrolestes analis*	1	1	F
QO050105	*Austrolestes io*		1	E
QO121204	*Anax papuensis*	2	2	
QO300102	*Hemicordulia tau*	2	1	E
Trichoptera (caddisflies)				
QT030410	Hellyethira *litua*	1		F
QT250799	*Oecetis* sp.	1	1	
QT251103	*Triplectides australis*	1	2	E

Appendix 2 Habitat Photographs

Original photographs taken at the time of sampling were accidentally deleted. The photographs presented here from the same locations were taken in August 2022 at approximately the same wetland depth.

Site A
Top: adjacent images showing open, sedge and mature tree habitats
Middle: open , sedge
Bottom: open and sapling thicket habitats, mature trees, sedge and open matrix






Site B
Top: adjacent images showing extent of sedge
Middle: sedge, sparse sedge
Bottom: sedge and sparse sedge matrix, open and sparse sedge matrix