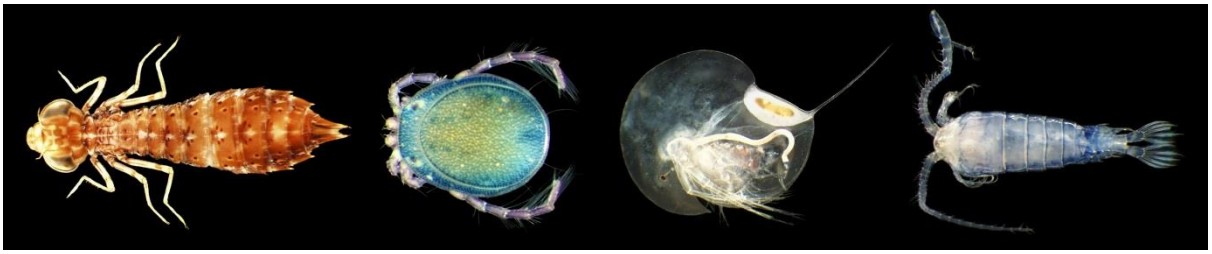
Identifying Priority Species Within the South-western Australian Aquatic Invertebrate Fauna



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Contents

Appendices

Figures

Tables

Summary

This project aimed to 1) develop a protocol for assessing how many freshwater invertebrates from south-western Australia may be candidates for listing on the Western Australian Priority Fauna list and 2) provide an overview on a selection of those species for listing.

Formal listing of species for protection is an important step in the process of prioritising conservation activities and must be undertaken as objectively as possible. Diverse groups, such as invertebrates, pose problems for listing because criteria of 'rarity' and 'threat' are often confounded. For most part, knowledge of the extent of the distribution, habitat requirements, population sizes, lifecycles and population biology for aquatic invertebrates are not well known. There is also often little historical or time-series data, as many records are from once off surveys or opportunistic sampling, making determination of population trends and responses to threats unpredictable. However, it is known that wetland and river ecosystems in south-western Australia have been extensively altered as a result of human activity and a drying climate, which is likely to have had a dramatic effect of on aquatic fauna, including invertebrates, in this region.

Currently (as of Feb 2018), very few aquatic fauna are listed as threatened or priority species in Western Australia (16 of 215 priority species and 22 of 249 threatened species). Many of these are freshwater crayfish or stygofauna, mainly occurring in the Pilbara or South Coast regions of the state.

Here, a rapid assessment approach has been developed to identify species which may be of conservation concern. Due to time and budgetary constraints, invertebrate information used for this assessment was mainly limited to Department of Biodiversity, Conservation and Attractions (DBCA) aquatic invertebrate records and Australian Living Atlas (ALA) records, with some consultation with relevant specialists. The approach taken was to formulate a rapid assessment process using this data and apply some International Union for Conservation of Nature (IUCN) criteria to quickly assess and highlight species which are rare or likely to be short range endemics (SRE) to south-western Australia.

This project focussed on identifying Priority species rather than fully assessing threat status using IUCN criteria, as the latter would require more data and time than this project would allow, but the process has identified some species requiring further assessment with a view to listing as threatened.

Using DBCA data, 49 species were identified as candidate priority species. Five species already listed in Western Australia as threatened or priority species in the analysis area were included in the rapid assessment (*Westralunio carteri*, *Pseudohydryphantes doegi, Parartemia contracta, Daphnia jollyi* and *Glacidorbis occidentalis*). Six of the candidate priority species are red listed by IUCN as Vulnerable, however all except for *Archaeosynthemis spiniger* and *Armagomphus armiger* are listed under criterion D2 (restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to critically endangered or extinct in a very short time). The Commonwealth *Environment*

Protection and Biodiversity Conservation Act 1999 (EPBC Act) does not include the provision for listing a threatened species under criterion D2 at the national level, but at the Western Australian state level species can be listed under this criterion. Further investigation and knowledge is required to fully assess the conservation status of these potentially threatened species. This evaluation provided evidence the rapid assessment method is detecting species known to be a conservation priority and also provided a re-assessment of some currently listed priority species.

The candidate priority species identified here were derived from DBCA data and limited to south-west endemic species which had taxonomically accepted names, restricted distributions and had some published information available regarding population information and threats. The list is by no means comprehensive and there are many more south-west aquatic species that require further investigation on their conservation status. Many species were excluded during the rapid assessment process as they had; a limited number of records (mainly due to survey effort), little knowledge on their populations or biology, they are not formally described or have taxonomical issues. Fifteen south-west Australia endemic species, which have been listed (at the state, national or international level) as threatened or priority species, had no DBCA records and so were not included in this assessment. Additionally, several researchers (Timms, 2014; Sutcliffe, 2003; Hawking & Theischinger, 2004) have suggested other south-west endemic species to be of conservation concern which were not assessed in this report as they have not been recorded by DBCA.

The rapid assessment approach identified 49 candidate priority species and provides a starting point to more formal conservation assessment of aquatic invertebrates in south-west Australia. The project has provided an opportunity to re-assess some species already on the Priority Fauna list and provided DBCA with a process to continue to assess conservation status of aquatic invertebrate species over time.

Introduction

Freshwater ecosystems are considered to be in decline, suffering from extensive exploitation and habitat modification (Dudgeon *et al.*, 2006). Large declines or extinctions of many freshwater invertebrates have already occurred (Vaughn & Taylor, 1999; Lydeard *et al.*, 2004; Taylor *et al.*, 2007; Vorosmarty *et al.*, 2010; Collen *et al.*, 2012; Bland, 2017; Collen *et al.*, 2014), and the pressures that humans are placing on the world's fresh waters are increasing (Jackson *et al*. 2001; Malmqvist and Rundle 2002; Postel 2003), suggesting that declines and extinctions will become more severe. Even though there has recently been more focus on freshwater conservation, our understanding of risks to freshwater invertebrates is limited by of the low level of public and scientific attention (Cardoso *et al.*, 2011; Collier, Probert & Jeffries, 2016; Taylor *et al.*, 2018), and inadequate data on species' population status, distribution and demography (Diniz-Filho, De Marco Jr & Hawkins, 2010).

Freshwater invertebrate conservation faces several challenges. The problems of freshwater invertebrate conservation arise from three characteristics of freshwater habitats themselves. Firstly, freshwaters occupy small areas of the landscape. Even if a freshwater species has a large extent of occurrence it will only occur within the waterbodies within this area, so the largest possible geographic area of freshwater invertebrates is much smaller than that of terrestrial and marine invertebrates. Secondly, freshwater habitats are more-or-less isolated from each other (so they are like islands) and many species of freshwater invertebrates must disperse across dry land to extend their range to other lakes and drainage basins. Even within drainage networks, the specific habitats that individual species occupy (e.g. river riffles, spring-fed headwater streams, profundal lake sediments) are often isolated, accentuating the insular nature of freshwater habitats. Thirdly, freshwater habitats derive much of their character from their catchment and surrounding terrestrial landscape. Many catchments have been badly degraded by human activities, having strong effects on the freshwater fauna and the fragmentation of fresh waters, making it difficult for freshwater invertebrates to disperse across the fragmented landscape to adjust their geographic ranges in response to changing conditions (e.g. salinization and climate change).

Many Australian invertebrates are unique because they represent ancient lineages. In particular, the south-west of Western Australia has a unique suite of freshwater fish and invertebrates (Wardell-Johnson & Horwitz, 1996; Trayler *et al.*, 1996). For example, 82 % of the native fish (Beatty & Morgan, 2013), 75 % of dragonflies and all of the native crayfish found in the south-west, except the yabbie (*Cherax destructor*), are endemic (Belk, 1998). This high level of endemism in the south-west region of WA has led to Conservation International recognising the region as one of 34 global biodiversity hotspots and by the World Wildlife Fund (WWF) as one of the world's 53 most biologically outstanding freshwater habitats. The rivers and streams in the South-west are also one of 28 freshwater habitats identified by the WWF as a 'Global Ecoregion', considered to have a critical or endangered conservation status.

The Southwest Australia Ecoregion (SWAE) contains 38 river systems and a diverse range of wetlands, including granite rock pools, peat swamps, naturally saline and riverine systems, groundwater-dependent ecosystems and subterranean karst systems, all of which shape and influence regional aquatic diversity and ecosystems across the ecoregion (Gole, 2006). These aquatic assets are distinctive and include eight Ramsar wetlands (wetlands of international importance) and 71 wetlands of national significance. With respect to freshwater fauna, the region appears to be significant for richness and high endemism for groups with drought resistant life-stages, especially crustaceans, (Pusey & Edward, 1990; Bayly, 1992; Horwitz, 1994; Trayler *et al.*, 1996; Pinder *et al.*, 2004; Belk, 1998). Many aquatic ecosystems in the region are highly threatened by the impacts of climate change, in particular reduced rainfall and groundwater levels since the 1970s, water abstraction and diversion for human use, salinisation of land and waterways and other degradation caused by human activities, including physical destruction and pollution. It is estimated that more than 80 % of wetlands on the Swan Coastal Plain have been lost or degraded (Halse, 1988; Environmental Protection Authority, 2007). An even greater percentage of ephemeral wetlands and seasonal damplands have been similarly affected.

As many of the wetland and riverine ecosystems in south-western Australia have been extensively altered as a result of human activities and a drying climate, this is likely to have had a dramatic effect on aquatic fauna, including invertebrates. Unfortunately, there is little historical data to quantify this as most survey effort has only occurred during the last 30 years. One example of significant range decline is the WA endemic Carter's freshwater mussel (*Westralunio carteri*) which has been shown to have declined in range by 50 % over the last century (Klunzinger et al., 2015) and is listed as Vulnerable in Western Australia and nationally under the EPBC Act. Many less well known species are likely to have suffered the same fate. Future changes in the composition of aquatic fauna will also go undetected unless current distributions of the existing species are well documented.

Despite their great diversity and high levels of endemism, very few aquatic invertebrate species are listed as threatened or priority species in Western Australia. Aquatic invertebrates account for only 16 of the 215 priority fauna and 22 of the 249 listed threatened fauna in Western Australia (as listed Feb 2018) and most of these are stygofauna rather than surface water species. This is partly because, until recently, there has been insufficient survey effort to draw conclusions about distributions and threats and existing data has not been summarised to assess the conservation status of aquatic invertebrates. The Department of Biodiversity Conservation and Attractions (DBCA) holds over 75,000 records of surface water species sampled across more than 1000 sites. This, together with other published and unpublished data, forms a good starting point for assessing the conservation status of Western Australian aquatic invertebrates. Our data suggests that many aquatic invertebrates have restricted contemporary distributions (whether natural or due to range contraction/fragmentation) but there has been little analysis to quantify conservation status. While we are unlikely to have sufficient data (and time) to support more rigorous threatened species nominations there are likely to be

numerous species with sufficient data to flag them as being species of concern through listing as Priority species.

The aims of this project were two-fold: 1) formulate a rapid assessment process (using DBCA records) for narrowing the focus to south west species likely to be short-range endemics (SRE) based on their known occurrence and 2) summarise known and likely distributions, and vulnerability to threats of for a selection of these candidate priority species which we have sufficient knowledge to assess whether they should be listed as Priority species.

This project has focussed on identifying candidate priority species rather than more formally assessing threatened status using all IUCN criteria, as the latter would require more data and time than available for this project, but the process will identify some species requiring further assessment with a view to listing as threatened. The information provided will improve knowledge of freshwater aquatic invertebrates in the south west of Western Australia.

Methods

Due to the short time frame and budgetary constraints of this project, an attempt to provide a detailed and comprehensive overview of the conservation status of a large and diverse group such as aquatic invertebrates, in Western Australia is impractical. The approach taken was to narrow the focus using a rapid assessment process to quickly assess and highlight species which are rare or likely to be short range endemics (SRE) in south-western Australia. To this end the DBCA records were used as they were easily accessible and contain some of the most comprehensive occurrence records for aquatic invertebrates for Western Australia (over 75,000 records of 2500 surface water species across more than 1000 sites). Even though other aquatic invertebrate records are available through the Western Australian Museum, CSIRO, universities, specialists collections etc. these records were only examined if available through the Australian Living Atlas portal (ALA). Consequently, the analysis provided here will review many species which have insufficient data to fully evaluate their conservation status and as not all species have been recorded by DBCA, some species may be missed because of this data limitation. However, this process will provide a starting point for assessing the conservation status of Western Australian aquatic invertebrates and to flag species which may be of conservation concern and require listing as priority species in Western Australia.

Using DBCA records, a search was conducted to find species which only occurred in the south-west region of Australia. This analysis region was defined as west of a line between Shark Bay and Cape Arid, with at area of 450,626 km^2 (Figure 1). This area encompasses the Southwest Australia Ecoregion (SWAE) and WWF Global 200 Freshwater Ecoregion ('Southwest Australia rivers and streams').

Within this region, there was good spatial representation of aquatic invertebrate records (1800 samples, across 620 sites) which were collected during surveys and monitoring of various wetland habitats (e.g. lakes, rivers, claypans, rock pools, peat swamps, ephemeral streams, mound springs).

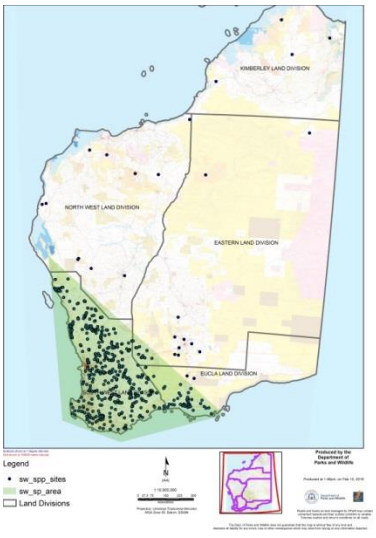


Figure 1 South west analysis area showing DBCA record locations.

To identify and refine the list of candidate species for conservation priority as objectively as possible, a rapid assessment approach was taken. The process is shown in Figure 2 and described below. As there are a large number of aquatic species in this region, the following steps and criteria were applied during the process to refine the number of species to be assessed for conservation priority.

- **Step 1: Retain only species which have all their records in south-western Australia**
- **Step 2: Exclude major taxonomic groups with poorly known distributions**
    - Rotifers and protozoans were removed as the broader Australian distributions are not well understood for many species and excluded.
- **Step 3: Retain only species with naming that is consistent across projects (Step 3)**
    - Some records were of invertebrates at higher levels identifications (e.g. Genus, Order and Family level) were removed.
    - Some taxa from poorly known groups have been given morphospecies codes but not consistently across projects (e.g. the mite Trombidiodea sp1. could be a different a species for different projects).These records were removed from the analysis.
- **Step 4: Retain species that are restricted in distribution**
    - Geographical ranges (EOO, AOO and number of locations) were calculated. Species with restricted distribution had at least one of the following criteria; EOO < 20,000 km^2, AOO < 2,000 km^2 or number of locations < 10.
- **Step 5: Retain only species that are formally described or that have nationally accepted names.**
    - Includes three caddisfly larvae of south-west endemic species in published keys (Leptoceridae Genus A sp. AV1, *Lectrides* sp. AV1 and *Diplectrona* sp. AV9)
- **Step 6: Exclude species with insufficient or uncertain records**.
    - Species known from < 3 locations in DBCA data and which have no supporting information to suggest they are genuinely restricted were excluded.
    - Exclude species with inaccurate record information (e.g. missing or incorrect co-ordinates) or taxonomic issues.

The next step (**Step 7: identifying candidate priority species**) involved gathering additional information and records on the species remaining after steps 1-6, by searching Australia Living Atlas (ALA), Australian Fauna Directory (AFD), Global Biodiversity Information Facility (GBIF), International Union for Conservation of Nature (IUCN) and publications to assist in determining the conservation status of these potential priority species. As a result of this searching, some species were found to have additional records outside the analysis area and some records had data uncertainty (e.g. taxonomic uncertainty or incorrect location co-ordinates), so

records were updated and the criteria (steps 1-6) were applied to this updated species data. The species remaining at the end of this last process were listed as candidate priority species. To decide an order of priority to these species they were ranked using the IUCN criteria for EOO, then AOO and then number of locations. Further information was collected for a suite of the candidate priority species and species profiles (including biology, habitat, distribution and population information) were complied.

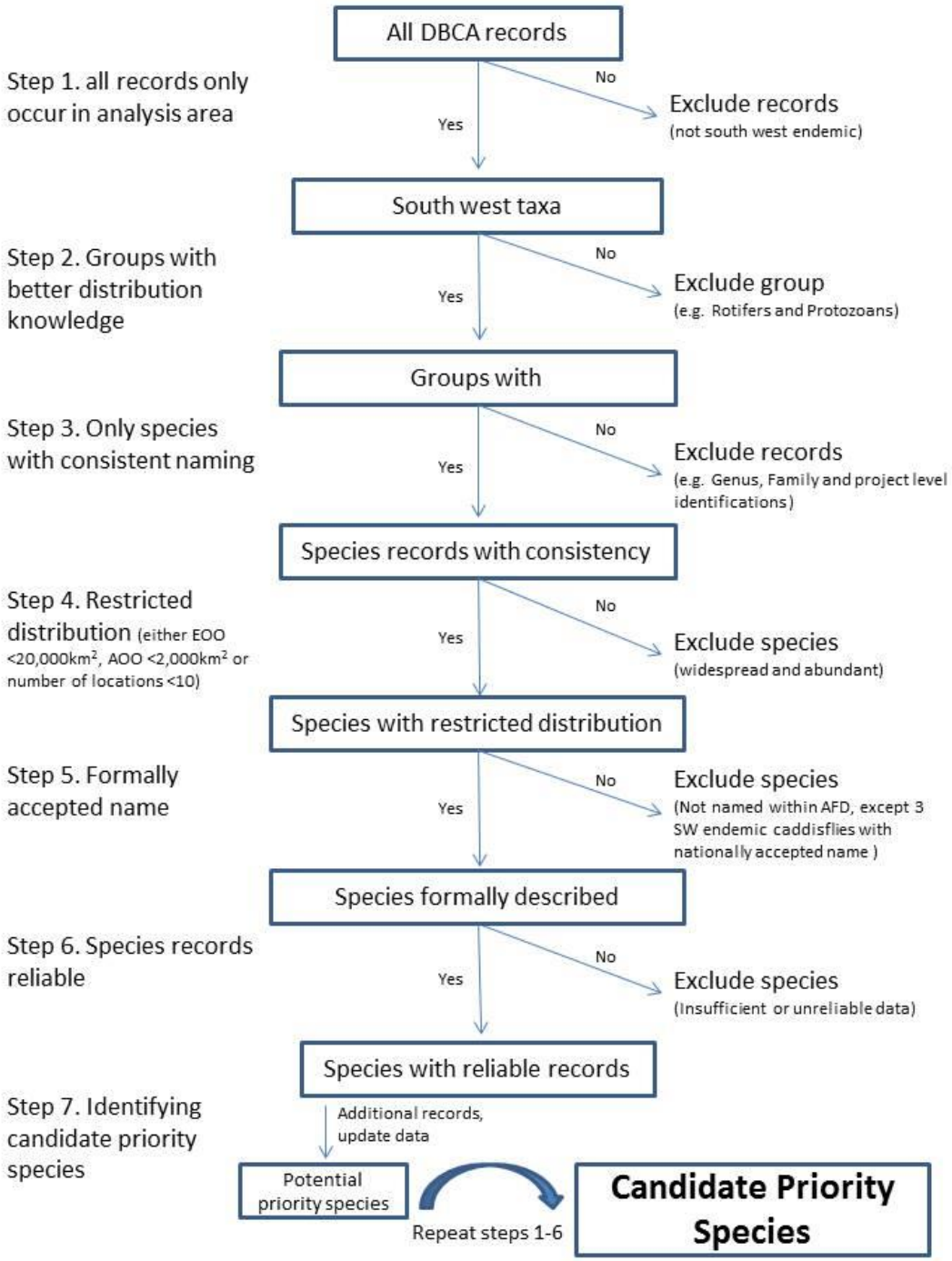


Figure 2 Rapid assessment process for determining candidate Priority species

Results

The rapid assessment process described in the methods, determined 49 species to be candidate priority species and require further investigation (Table 1). Of the species already listed in Western Australia as threatened or priority species in the analysis area, five had records in the DBCA data (*Westralunio carteri*, *Pseudohydryphantes doegi, Parartemia contracta, Daphnia jollyi* and *Glacidorbis occidentalis*) and were included in the rapid assessment. Table 2 shows the assessment results and notes for these species. Six of the candidate priority species are red listed by IUCN as Vulnerable, but not listed as priority or threatened species in Western Australia. Four of these species (*Boeckella bispinosa*, *Boeckella geniculata, Boeckella shieli* and *Hemiboeckella powellensis)* are listed under criterion D2 (restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to critically endangered or extinct in a very short time) and in Australia the EPBC Act does not include the provision for listing a threatened species nationally under D2, but in Western Australia a species can be listed under this criterion at state level. Western Australian aquatic invertebrates currently listed (under Western Australian legislation, DBCA Priority Fauna List, EPBC Act or IUCN Red List) are listed in Appendix 1. Twenty six species currently listed are recorded in the analysis area. Despite over 650 sites being sampled in the analysis area by DBCA, 15 of the currently listed species have no DBCA records and so were not included in this rapid assessment. These were mainly stygofauna and freshwater crayfish. The remaining 11 species currently listed were identified by the rapid assessment process.

To order these candidate species according to potential conservation status, they were ranked using the IUCN criteria for EOO, AOO and number of locations. Additional records from ALA were examined and any additional published information on the ecology and biology for these species is presented in Table 2. For some species little information is available on their habitat requirements or biology, so more generic descriptions are given. Several of the candidate priority species (which have more available data) have been further investigated and species profiles have been produced to assist with listing these species (see Appendix 2).

This list is by no means comprehensive. Not all species have records within the data analysed and the rapid assessment was limited to rare and short range endemics to south-western Australia which are taxonomically recognised and have some knowledge about their populations. Considering the degree of habitat loss and modification in Western Australia and that invertebrates can occur in a very small area and experience large fluctuations in numbers, there may be many more south-west aquatic species that require further investigation on their conservation status.

*Table 1 Candidate priority species identified by the rapid assessment method (listed by class). * IUCN red listed.* ***Bold*** *species profile complied (see Appendix 2)*

Class/Order	Family	Species name (authority)
Acarina	Pionidae	*Larri laffa* (Harvey, 1996)
Coleoptera	Dytiscidae	***Paroster pallescens*** (Sharp 1882)
Coleoptera	Dytiscidae	***Batrachomatus nannup*** (Watts 1978)
Coleoptera	Dytiscidae	*Sternopriscus wattsi (Pederzani, 1999)*
Coleoptera	Dytiscidae	*Paroster michaelseni* (Régimbart, 1908)
Coleoptera	Dytiscidae	*Paroster baylyi* (Hendrich & Fery, 2008)
Coleoptera	Dytiscidae	*Antiporus mcraeae* (Watts & Pinder 2000)
Coleoptera	Dytiscidae	*Sternopriscus eikei* (Hendrich & Watts, 2007)
Coleoptera	Dytiscidae	*Rhantus simulans* (Régimbart, 1908)
Coleoptera	Dytiscidae	*Brancuporus gottwaldi* (Hendrich 2001)
Coleoptera	Dytiscidae	*Brancuporus pennifoldae (Hendrich 2001)*
Coleoptera	Dytiscidae	*Paroster ellenbrookensis (Watts & Leys, 2008)*
Coleoptera	Hygrobiidae	*Hygrobia wattsi* (Hendrich 2001)
Crustacea	Amphisopidae	***Paramphisopus palustris*** (Glauert, 1924)
Crustacea	Branchipodidae	*Parartemia purpurea* (Timms 2010)
Crustacea	Centropagidae	*Hemiboeckella andersonae* (Bayly, 1974)
Crustacea	Centropagidae	*Boeckella bispinosa* (Bayly, 1967) *
Crustacea	Centropagidae	*Boeckella geniculata* (Bayly, 1964) *
Crustacea	Centropagidae	*Boeckella shieli* (Bayly, 1985) *
Crustacea	Centropagidae	*Hemiboeckella powellensis* (Bayly, 1979) *
Crustacea	Chydoridae	*Pseudomonospilus biocellatus* (Smirnov 1994)
Crustacea	Cypretidae	*Australocypris beaumonti* (Halse & McRae 2004)
Crustacea	Cypretidae	*Australocypris mongerensis* (Halse & McRae 2004)
Crustacea	Cyzicidae	*Ozestheria mariae* (Olesen & Timms, 2005)
Crustacea	Limnadiidae	*Eulimnadia feriensis* (Dakin, 1914)
Crustacea	Limnadiidae	*Eulimnadia palustera* (Timms 2015)
Crustacea	Limnadiidae	*Eulimnadia vinculuma* (Timms 2015)
Crustacea	Paramelitidae	*Uroctena setosa* (Nicholls, 1926)
Crustacea	Parastacidae	*Cherax crassimanus* (Riek 1967)
Crustacea	Thamnocephalidae	*Branchinella complexidigitata* (Timms 2002)
Crustacea	Thamnocephalidae	*Branchinella kadjikadji* (Timms 2002)

Table 1 (cont.)

Class/Order	Family	Species name (authority)
Diptera	Chironomidae	*Botryocladius bibulmun* (Cranston & Edward, 1999)
Hemiptera	Notonectidae	*Notonecta handlirschi* (Kirkaldy, 1897)
Mollusca	Sphaeriidae	*Musculium kendricki* (Kuiper, 1983)
Odonata	Gomphidae	***Armigomphus armiger*** (Tillyard 1913) *
Odonata	Gomphidae	*Zephyrogomphus lateralis* (Selys, 1873)
Odonata	Libellulidae	*Nannophya occidentalis* (Tillyard, 1908)
Odonata	Oxygastridae	***Hesperocordulia berthoudi*** (Tillyard, 1911)
Odonata	Synthemistidae	*Archaeosynthemis leachii* (Selys 1871)
Odonata	Synthemistidae	***Archaeosynthemis spiniger*** (Tillyard, 1913) *
Trichoptera	Hydrobiosidae	***Apsilochorema urdalum*** (Neboiss, 1962)
Trichoptera	Hydropsychidae	***Diplectrona* sp. AV9**
Trichoptera	Leptoceridae	*Leptoceridae Genus A* sp. AV1
Trichoptera	Leptoceridae	*Lectrides* sp. AV1
Trichoptera	Leptophlebiidae	***Kaninga gwabbalitcha*** (Dean 2000)
Trichoptera	Philopotamidae	*Hydrobiosella michaelseni* (Ulmer 1908)
Trichoptera	Philorheithridae	*Kosrheithrus boorarus* (Neboiss, 1982)
Trichoptera	Plectrotarsidae	***Plectrotarsus minor*** (Mosely 1953)
Trichoptera	Polycentropodidae	*Plectrocnemia eximia* (Neboiss, 1982)

Table 2 Information on threatened and priority aquatic invertebrates in Western Australia (as of Feb 2018) assessed by rapid assessment process. IUCN category shown for EOO, AOO and number of location criteria.

Class/Order	Family	Species name	Current Conservation status	Number locations		Number records for calc	AOO (km^2)		EOO (km^2)		EOO_AOO map	In Cons. Area	RAMSAR /DIW	Threats	Habitat Preference	Notes	References
Acarina	Hydryphantidae	*Pseudohydryphantes doegi*	WA P2	3	EN	11	12	EN	2.6	CR		Muir NP	Muir, Byenup	change to water levels, acidification	acid peat swamp surrounded by *Melaleuca*.	Population declining? All records from Muir wetlands. All records pre-1998. Not collected from Muir wetlands in 2003/04 or 2014/16	
Mollusca	Glacidorbidae	*Glacidorbis occidentalis*	IUNC VU, WA P2	10	VU	22	40	EN	9509.7	VU		y	Drummond, Muir	Land clearing, Salinity, change to water levels	streams throughout the northern Jarrah forest. The species is largely restricted to forest streams with intermittent flow regimes and does not occur in lowland rivers west of the Darling Range. The association of this species with intermittently-flowing streams is typical of the genus and cannot be attributed to differences in stream morphology or water chemistry.	Population declining? Bunn et al 1989 widespread in streams in northern jarrah forest, but WRM 2012 only recorded from Foster Brook, DBCA not recorded in jarrah forest streams, but Drummond NR	Bunn et al 1989, WRM 2012
Crustacea	Branchipodidae	*Parartemia contracta*	WA P1, IUCN VU	10 +		15	48	EN	31036.56 - see notes			y		secondary salinisation, change to water permanancy	Saline lakes	widespread - southern Wheatbelt and adjacent areas of the northern Wheatbelt. Not as rare as previously thought. Timms has more location data.	Timms et al 2009
Mollusca	Hyriidae	*Westralunio carteri*	WA P2, IUCN VU	?		30	80	EN	48862.51 - see notes			y		Salinisation, change to water levels	Restricted to freshwater streams, rivers, reservoirs and lakes within 50-100 km of the coast	widespread but declining populations due to habitats loss and threats	Klunzinger at al 2015
Crustacea	Daphniidae	*Daphnia jollyi*	WA P1, IUCN VU	9	VU	20	40	EN	55672.64 - see notes						Granite rock pools	Widespread but rare <10 populations. Benziel et al 1996- may represent a separate and ancient lineage within the subgenus, presently found only in granite rock pools of slightly acid pH (6.0–6.5) in a restricted region of south-western Australia	Smirnov & Timms 1983, Benziel et al 1996

Table 3 Information on candidate priority species. Ranked in order according to IUCN criteria for EOO, AOO and number of locations. ***Bold*** *species profile complied (see Appendix 2)*

Class/order	Family	Species name	Current Cons. status	Number locations		Number records for calc	AOO (km^2)		EOO (km^2)		EOO_AOO map	In Cons. Area	RAMSAR/ DIW	Threats	Habitat Preference	Notes	References
Coleoptera	Dytiscidae	*Antiporus mcraeae*		1	CR	1	4	CR	Insufficient unique locations - see notes	CR				Drying climate, Fire	Restricted to slightly acidic (ph 6.0), fresh *Melaleuca* peat swamps	Known only from type locality - Kodjinup Melaleuca Swamp	Watts and Pinder 2000
Crustacea	Cyprididae	*Australocypris beaumonti*		1	CR	1	4	CR	Insufficient unique locations - see notes	CR		Beaumont NR			Beaumont NR Salt Lake	Known only from type locality - Beaumont NR Salt Lake	Halse and McRae 2004
Crustacea	Cyprididae	*Australocypris mongerensis*		1	CR	1	4	CR	Insufficient unique locations - see notes	CR					Lake Monger	Known only from type locality - Mongers samphire pan	Halse and McRae 2004
Crustacea	Thamnocephalidae	*Branchinella complexidigitata*		1	CR	2	4	CR	Insufficient unique locations - see notes	CR					Moderate to highly turbid waters	Only known from type locality - Arro Lake	Timms 2002, 2004
Coleoptera	Dytiscidae	*Brancuporus pennifoldae*		1	CR	1	4	CR	Insufficient unique locations - see notes	CR		Muir NP	Muir	Drying climate, Fire	Restricted to fresh (0.2ppt), sedge filled peat swamp suurounded by *Melaleuca*	Formerly *Antiporus pennifoldae* .Highly endemic only recorded at type locality- Lake Pooringup	Watts and Pinder 2002, Hendrich, Toussaint and Balke 2014
Crustacea	Limnadiidae	*Eulimnadia feriensis*		1	CR	1	4	CR	Insufficient unique locations - see notes	CR					Freshwater pools	Rarely collected. type material not designated ? near Northam. Timms 2015 have not found species at Northam locality but redescribed with Neotype specimens found near Bremer Bay. DBCA record Kau Rock. Timms 2016 some specimens now considered to be *Eulimnadia gnammaphila* sp. nov	Dakin 1914, Timms 2015, Timms 2016
Crustacea	Centropagidae	*Hemiboeckella powellensis*	IUNC VU	1	CR	1	4	CR	Insufficient unique locations - see notes	CR					Shallow freshwater swamp	Only found at type locality, Lake Powell. Bayly (1979) found no females over several sampling occassions	Bayly 1979. Mayly et al 1997, Bayly 1992, IUCN red list
Trichoptera	Plectrotarsidae	***Plectrotarsus minor***		3	EN	1	4	CR	more locations - see notes					Sedimentation, Drying climate, fire	Unknown	Type location: Albany. Few known specimens. Neboiss 1982 has location at Nornalup 1958. DBCA record Swamp Myalgelup Rd, highly restricted, Sutcliffe 2003 classified as EN	Neboiss 1982, Sutcliffe 2003, Armstrong et al 2005

Table 3 (cont.)

Class/order	Family	Species name	Current Cons. status	Number locations		Number records for calc	AOO (km^2)		EOO (km^2)	EOO_AOO map	In Cons. Area	RAMSAR/ DIW	Threats	Habitat Preference	Notes	References
Coleoptera	Dytiscidae	*Sternopriscus eikei*		4	EN	1	4	CR	more locations - see notes		D'Entrecasteaux NP.		Drying climate, Fire	acid peat swamp surrounded by *Melaleuca*	DBCA record Cobertup Swamp, Hendrich and Watts 2007, 3 locations all 5-15km S Northcliffe.inc. D'Entrecasteaux NP.	Hendrich and Watts 2007
Crustacea	Paramelitidae	*Uroctena setosa*		5	EN	2	4	CR	more locations - see notes		Two Peoples Bay		Drying climate, Fire	Freshwater permanent pools	Rarely collected, West Gully TPB1990,1991, type data: reservoir at Katanning - do not exist in WAM collection. Barnard and Williams examined material from either Kalamunda, Mundaring, Swan River or Moora.Straškraba 1964 specimen from Canning river. Bunn 1988 has some lifehistory on *Uroctena sp* . from Wungong catchment.	Barnard and Williams 1995, Williams and Barnard 1988, Straškraba 1964, Bunn 1988
Crustacea	Limnadiidae	*Eulimnadia vinculuma*		5	EN	9	8	CR	more locations - see notes		Goonaping			Both coastal in sandy locations and inland in upland swamps east of the Darling Scarp.	Type location: Goonaping Swamp. Timms 2015 Goonaping, NW GinGin, Perth Airport North Wetland, 2.5km E Lake Muir	Timms 2015
Crustacea	Thamnocephalidae	*Branchinella kadjikadji*		2	EN	2	8	CR	Insufficient unique locations					Claypans?		
Coleoptera	Dytiscidae	*Brancuporus gottwaldi*		2	EN	2	8	CR	Insufficient unique locations		Muir, Doggerup	Muir-Byenup, Doggerup Creek system	Drying climate, Fire	Restricted to southern acid peatland swamps	Formerly *Antiporus gottwaldi*. Doggerup Swamp and Cobertup Swamp	
Crustacea	Branchipodidae	*Parartemia purpurea*		2	EN	2	8	CR	more locations - see notes		Beaumont NR		Salinisation, Decreased pH, Changes to water permanency	Alkaline saline lakes in Esperance Hinterland. Generally it occurs in late winter- spring as lakes fill with winter-spring rains, reproduces in September and October with purple coloured females actively swimming in the shallows and depositing eggs. Occasionally summer rains fill the lakes, in which case P. purpurea sp. nov.responds as it does to a winter filling (Timms, 2009b). Females are easily predated upon by waders (mainly Stilts, Avocets) as they swim	Esperance Hinterland, Timms 2010 more locations, synonomus with Parartemia n sp a Timms and Savage, 2004, mature females distict purple colour	Timms 2009, 2010, Parartemia n sp a Timms and Savage, 2004,
Coleoptera	Dytiscidae	*Paroster baylyi*		4	EN	2	8	CR	more locations - see notes					Temporary water filled granite rock holes(gnammas). Breeds in gnammas	Inland south-western Australia, northwest of a line from Perth to Cue. Another 2 locations in Hendrich and Fery 2008. All in Perenjori/Wubin area.	Watts and Leys 2008, Henrich And Fery 2008, Timms et al 2009

Table 3 (cont.)

Class/order	Family	Species name	Current Cons. status	Number locations		Number records for calc	AOO (km^2)		EOO (km^2)		EOO_AOO map	In Cons. Area	RAMSAR/ DIW	Threats	Habitat Preference	Notes	References
Crustacea	Chydoridae	*Pseudomonospilus biocellatus*		2	EN	2	8	CR	Insufficient unique locations	CR					rock pools (Gnammas) ?	Wannara Rock	
Coleoptera	Dytiscidae	*Paroster ellenbrookensis*		2	EN	3	8	CR	Insufficient unique locations	CR		Ellen Brook NR	Ellen Brook	Drying climate, Fire	unknown, Ernie Rd is a tempoary pool	Ellen Brook and Ernie Rd (east of Collie)	
Trichoptera	Hydropsychidae	***Diplectrona* sp. AV9**		2	EN	8	8	CR	Insufficient unique locations - see notes	CR		Greater Hawke NP		Sedimentation, Drying climate, Fire	Small forest streams. Restrcited to Donnelly River Catchment? Stirling Track (Carey Brook) and Record Brook, (Growns 1994) Carey Brook. Not present after logging and sedimentaions levels high in stream.Larvae appear to be predaceous and they construct retreats and silk capture nets on and between stones or wood in medium to fast currents	netspinning caddisfly. Larvae described by Dean (1999), no *Diplectrona* adults have been identified very far west of the Great Dividing Range - Several earlier described species of Diplectrona are now recognised as new genera -more work is needed on this species	Growns 1994, Sutcliffe 2003, Dean 1999
Crustacea	Centropagidae	*Boeckella shieli*	IUNC VU	6?	EN	1	4	CR	Insufficient unique locations - see notes	EN					Restrcited to shallow temporary waters north of Esperance	Pabellup South Swamp, IUNC assessmant has 6 sites	Mayly et al 1997, Bayly 1985, IUCN red list
Trichoptera	Leptophlebiidae	***Kaninga gwabbalitcha* (*larvae Kaniga* sp. AV1)**		3	EN	7	16	EN	146.6	EN		Greater Hawke NP		Drying climate, Fire	Restricted to small and medium size forest streams in south-western Australia (Dean 2000)	restricited to Donnelly river catchment? ALA record location incorrect, Dean 2000 has more records. Cook et al 2008 Record from Gardner River report CENRM079 but no eastern catchments.	Dean 2000
Coleoptera	Dytiscidae	***Batrachomatus nannup***		6	VU	21	28	EN	866.22	EN		Blackwood River NP		Sedimentation, Drying climate, Fire, Salinity?	Larger (6–10 m^2) and deeper (40–80 cm depth) sandy pools in the floodzone of the river or among floating roots, rotten twigs and logs in shallow water of protected embayments of the slow flowing river.	30km stretch of Blackwood River main channel between Sues Bridge to near Boyup Brook. No recent records for upriver of Bridgetwon..	CERNM 2004
Trichoptera	Philorheithridae	*Kosrheithrus boorarus*		5	EN	10	20	EN	1019.73	EN		Greater Hawke NP		Drying climate, Fire	Lotic waters (Trayler et al 1996).	Record Brook, Stirling track, Boxhall Creek. Highly restricted, Sutcliffe 2003 classified as EN	Sutcliffe 2003
Acarina	Pionidae	*Larri laffa*		3	EN	26	16	EN	2669.87	EN		Muir, D'Entrecasteau?	Muir-Byenup	Drying climate, Fire	peat swamps?	all pre 1990 records?	
Trichoptera	Leptoceridae	*Leptoceridae Genus A* sp. AV1		5	EN	26	20	EN	2683.82	EN		Lane Poole, Beedelup NP,Greater Hawke NP		Drying climate, Fire, Redcued water flow	small-medium size forest streams, with rapid flow.Restrcited to areas with high rainfall >1000mm or more	collected DBCA forest stream sites but only in high flow areas. Known only from larval morphospecies. Seems to have 2 cluster groups Lane Poole Re and Warren nr Beedelup/Carey Brrok	Sutcliffe 2003, St Clair 2000

Table 3 (cont.)

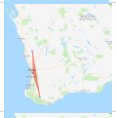
Class/order	Family	Species name	Current Cons. status	Number locations		Number records for calc	AOO (km^2)		EOO (km^2)		EOO_AOO map	In Cons. Area	RAMSAR/ DIW	Threats	Habitat Preference	Notes	References
Coleoptera	Dytiscidae	*Sternopriscus wattsi*		13		20	52	EN	2942.24	EN		Muir NR	Muir	Drying climate, Fire	inhabits either lentic sites such as well vegetated small farm dams and ponds beside larger streams or lotic sites such as small pools in seasonal woodland streams	mainly within Muir wetland suite	
Crustacea	Amphisopidae	***Paramphisopus palustris***		9	VU	35	44	EN	3762.53	EN		y	Ellen Brook, Brixton Street, Lake Wannamal, Twin Swamps	Drying climate, changes in groundwater	Ground-water fed wetlands on Swan Coastal Plain. Amphisopodidae are constained by narrow habitat requirements (Wilson and Johnson 1999), SRE Harvey 2002	1 ALA record Bulter's swamp Clarement NSW, should be Claremont Lake (formerly Bulters Swamp, Claremont WA), several ALA records without co-ords Mongers Lake, Guilford, Pinjarra, Wattle Grove Welshpool	Nichols 1924, Wilson and Johnson 1999, Henbree and George 1978,Gouws and Stewart 2007
Odonata	Gomphidae	***Armagomphus armiger***	IUNC VU	9	VU	64	40	EN	3814.02	EN		Shannon NP,Wungong Regional Park, Lane Poole Cons.Res		Climate change,Fire, reduced flow permanancy	Found buried deeply in sand and/ or leaf litter in permanent rapid streams (Watson 1962). Lotic waters (Trayler et al 1996). Inhabits clear rapid streams, burrowing deeply in coarse sand, often below leaf litter (Thieschinger 2000).	IUCN redlist (criteria B1ab(iii).) Monotypic Genera confined to SW WA. Sutcliffe 2003 classified as VU, Hawking classified as VU (1999, 2004)	Sutcliffe 2003, IUCN relist, Hawking and Theisinger
Diptera	Chironomidae	*Botryocladius bibulmun*		7	VU	35	40	EN	4726.16	EN		y		Drying climate, Fire, Reduced water flow	Cooler, shaded, running waters.	only 2005 and 2006 records. Evidence that this Genera has Gondwanan hertitage (Cranston and Edward 1999) - More locations in Cranston paper	Cranston and Edward 1999
Crustacea	Limnadiidae	*Eulimnadia palustera*		4	EN	4	16	EN	WA 7357.61 - see notes	VU		Muir	Muir	Drying climate, Fire	freshwater marsh	Type locality: Lake Muir. Timms 2015,only known from Muir locality and Finders Is, TAS. DBCA record from Campamouro Swamp checked by Timms in 2016.	Timms 2015
Crustacea	Parastacidae	*Cherax crassimanus*		6	VU	6	24	EN	7440.52 - see notes	VU			Muir	Drying climate, Fire		needs to check other records as DBCA incomplete - Stephen Beatty Murdoch	
Odonata	Libellulidae	*Nannophya occidentalis*			EN	5	16	EN	8046.55	VU				Drying climate, Fire, Reduced flow	Found in mud and weed tussocks in boggy swamps (Watson 1962). Lentic waters (Trayler et al 1996). Breeds exclusively in lentic waters (Sutcliffe 2003)	Sutcliffe 2003 classified as EN. Rarely encountered, restricted to high rainfall areas, breeds only in lentic waters	Sutcliffe 2003
Crustacea	Centropagidae	*Hemiboeckella andersonae*		9	VU	12	40	EN	8207.95	VU		y	Muir, Ellen Brook	Drying climate, Fire, Reduced water permanency	permanent and temporary ponds	Mayly et al 1997 - around Perth area	Mayly et al 1997, Edwards et al 1997, Bayly 1992

Table 3 (cont.)

Class/order	Family	Species name	Current Cons. status	Number locations		Number records for calc	AOO (km^2)		EOO (km^2)		EOO_AOO map	In Cons. Area	RAMSAR/ DIW	Threats	Habitat Preference	Notes	References
Coleoptera	Dytiscidae	***Paroster pallescens***		6	VU	10	24	EN	12078.62	VU				Urbanisation	shallow, seasonally flooded areas on the coastal sand plain between Perth and Geraldton		Watts and Leys 2008, Hendrich and Balke, 2016, Hendrich and Fery 2008
Crustacea	Centropagidae	*Boeckella bispinosa*	IUNC VU	7	VU	18	36	EN	13195.02	VU		y	Twin Swamps, Ellen Brook, Brixton Street	Drying climate, Fire	Restrcited to shallow temporary waters	Rare, fewer than 10 populations, All records with co-ords from DBCA and ALA only show WA locations. Bayly 1967 Two subpopulations, Perth area WA and Cambell Town TAS (type locality), Bayly 1979 specimens examined 19km S of Perth (Tasmania) coll. By W.D. Morton 25/8/1974. Only 3 records since 1998.	Mayly et al 1997, Bayly 1967, Bayly 1979, Bayly 1992
Trichoptera	Polycentropodidae	*Plectrocnemia eximia*		4	EN	6	16	EN	13945.03	VU				Drying climate, Fire	Lentic waters (Trayler et al 1996).	Sutcliffe 2003 classified as EN	Sutcliffe 2003, Neboiss 1982
Odonata	Gomphidae	*Zephyrogomphus lateralis*		13		32	60	EN	16352.6	VU		y		Drying climate, Fire, Reduced water permanency	Under stones and leaf litter in permanent rapid streams (Watson 1962). Lotic and lentic waters (Trayler et al 1996). Inhabits streams, possibly swamps (Theischinger 2000).		Sutcliffe 2003
Trichoptera	Leptoceridae	*Lectrides* sp. AV1		15		42	72	EN	16424.37	VU		y	Muir-Byenup, Drummond	Drying climate, Fire	Temporary lentic habitats that hold water for several months of the year (St Clair 2000).	Sutcliffe (2003) suggested as Vulnerable	Sutcliffe 2003
Odonata	Oxygastridae	***Hesperocordulia berthoudi***		13		35	76	EN	18493.27	VU		y- Blackwood		Drying climate, Fire, habitat destruction (mining)	Found under stones and litter in permanent rapid streams (Watson 1962). Lotic water (Trayler et al 1996).Prefereance for pernament water and high flow habiats (e.g. riffles and near waterfalls)	4 ALA records Worona NSW should be Waroona WA. Monotypic Genera confined to SW WA, Sutcliffe 2003 classified as NT, Hawking classified as VU (1999, 2004), Moore (1997) suggested as Priority species.Bush et al 2014 predicts no suitable habiata by 2055.	Moore 1997, Sutcliffe 2003, Hawking & Theisinger 2004, Bush 2014, Watson 1962
Coleoptera	Hygrobiidae	*Hygrobia wattsi*		8	VU	12	32	EN	19774.94	VU		Muir NR,	Muir, Lake Pleasantview	Drying climate, Fire, Drainage, Increased salinity	Apprears restricted to peatlands swamps and lakes		Hendrich 2001
Trichoptera	Philopotamidae	*Hydrobiosella michaelseni*		11		26	44	EN	21895.14			?		Drying climate, Fire, Urbanisation	Appear to be restricted to small forest streams (Dean & Bunn 1989). Larvae of this genus mainly found in faster flowing streams (Cartwright 1997).	Type Brunswick yallingup 1950s	Dean and Bunn 1989, Cartwright 1997, Sutcliffe 2003, Neboiss 1982

Table 3 (cont.)

Class/order	Family	Species name	Current Cons. status	Number locations		Number records for calc	AOO (km^2)		EOO (km^2)	EOO_AOO map	In Cons. Area	RAMSAR/ DIW	Threats	Habitat Preference	Notes	References
Trichoptera	Hydrobiosidae	***Apsilochorema urdalum***		12		27	48	EN	22327.73		y		Drying climate, Fire	Stony substrate in small perennial and intermittently flowing streams. Less abundant than T. pallescens. Appear to be restricted to Jarrah forest streams of the Darling Range and the Karri streams of the lower SW (Dean & Bunn 1989). Lotic waters (Trayler et al 1996).	All ALA records pre1985	Dean and Bunn 1989, Nebooiss1982, Sutcliffe 2003
Crustacea	Cyzicidae	*Ozestheria mariae*		5	EN	5	16	EN	27135.33					Gnammas in Wheatbelt and Goldfields, it has not been found in other temporary pools. (e.g. claypans, vegetated pools, samphire pans, salinas) in the area. Normally is found crawling on the rocky bottom of the pools and not on the softer sediments, and appears to scrape algae from the rocky surface.	Formally *Caenestheriella mariae* , Oelsen and Timms 2005. In gnammas in Wheatbelt and Goldfields, WA	Olesen & Timms, 2005
Odonata	Synthemistidae	***Archaeosynthemis spiniger***	IUNC VU	23		42	92	EN	31554.79 - see notes		Y		Drying climate, Fire, Reduced water permanency	Found under stones and litter in permanent rapid streams (Watson 1962).	Sutcliffe 2003 classified as EN	Sutcliffe 2003
Coleoptera	Dytiscidae	*Rhantus simulans*		5	EN	6	24	EN	32781.44 - see notes		Muir, D'Entrecasteau NP		Drying climate, Fire	Coastal plains and swamps southwest of a line Perth to Albany	widely distibuted but rarely collected with few historical records (Balke et al 2000). Old records (Balke 1993) from Rockingham and Swan River. Recent records Muir & D'Entrecasteau NP	Balke et al 2000, Balke 1993, Watts 1998
Hemiptera	Notonectidae	*Notonecta handlirschi*		27		70	112	EN	40489.46 - see notes		Muir NR, Lake Pleasantview NR	Muir Byenup, Lake Pleasantview Sysytem	Drying climate, Fire	unknown, but Muir and Pleasantview locations peat swamps	Declining population?all records pre 1988. All records except 3 (1 Hovea in 1934; 2 Blackwood/Karridale) are within Muir wetlands and Lake Pleasantview. These 3 records extend the EOO >20,000km^2	
Mollusca	Sphaeriidae	*Musculium kendricki*		7	VU	18	48	EN	64857.83 - see notes				Drying climate, Fire	Lakes and lagoons	Formally *Sphaerium kendricki* . Widespread but all records pre 1999. Type location (drain though Roselea nursey, North Beach Rd, Osborne Park) is most likely lost due to housing in this area. Other locations within the Perth area (e.g. Lake Monger, Hersdman Lake, Lake Nowergup) may no longer have populations due to human impact?	Korniushin 2000
Crustacea	Centropagidae	*Boeckella geniculata*	IUCN VU	7	VU	15	32	EN	69129.4 - see notes		y	Byenup, Drummond ++	Drying climate, Fire	Shallow temporary pools? Claypans and *Melaleuca* swamps	Rare - 7 populations. Near Perth and Northcliffe (Mayly et al 1997)	Mayly et al 1997, Bayly 1992
Coleoptera	Dytiscidae	*Paroster michaelseni*		13		16	52	EN	140778.36 - see notes					All specimens were collected in different ephemeral pools on isolated granite outcrops in the Wheatbelt (see Pinder 2000)	Widespread but restricted to Granite outcrops in the Wheatbelt and Mallee of south-western Australia. East of the Great Northern Highway and south of a line from Wubin to Boorabbin	Hendrich and Fery 2008Pinder 2000

Discussion

Despite progress in recent decades, the conservation of invertebrates in Australia is challenging and remains a formidable task against a background of poor taxonomic and biological knowledge, limited resources (funds and scientific expertise) and a relatively low level of community engagement, education and awareness (Taylor *et al.*, 2018; New & Samways, 2014; Cardoso *et al.*, 2011).

Despite their great diversity and high levels of endemism, very few aquatic invertebrates are listed as threatened or priority species in Western Australia. They account for only 16 of the 215 priority fauna and 22 of the 249 listed threatened fauna in Western Australia (as listed Feb 2018). Only six species (*Cherax tenuimanus, Engaewa pseudoreducta, Kumonga exleyi, Engaewa reducta, Engaewa walpolea, Westralunio carteri*) are listed at the National level under the EPBC Act. An attempt to provide a detailed and comprehensive overview of the conservation status of all aquatic invertebrates in Western Australia is beyond the scope of this project. This project focussed on identifying species of conservation concern (Priority species) that are endemic to south-western Australia and are rare or have restricted distributions.

Of the species already listed in Western Australia (as threatened or priority) in the analysis area, five had records in the DBCA data (*Westralunio carteri*, *Pseudohydryphantes doegi, Parartemia contracta, Daphnia jollyi, Glacidorbis occidentalis*) and were included in the rapid assessment. *Westralunio carteri, Parartemia contracta* and *Daphnia jollyi* were found to be widespread (EOO > 20,000 km^2) but were classified as Endangered using IUCN criteria for AOO (< 500 km^2) and Vulnerable based on < 10 locations. *Westralunio carteri* is currently listed as threatened due to declining populations (Klunzinger *et al.*, 2015). *Parartemia contracta* is known to occur in more locations than used in the analysis (see Timms, Pinder & Campagna, 2009), so this species may need to be re-assessed as more data becomes available. *Daphnia jollyi* has very little further information available and seems to be rare (< 10 locations) and restricted to granite rock pools (Benziel & Bayly, 1996). *Pseudohydryphantes doegi* and *Glacidorbis occidentalis* may need to be assessed as threatened fauna based on EOO < 20,000 km^2, AOO < 500 km^2, number of locations < 10 and information suggesting these populations are declining (*Table 2*). This information shows that the rapid assessment method is detecting species known to be a conservation priority and provides additional information on currently listed priority species.

The rapid assessment process identified an additional 49 candidate priority species that require further assessment to determine if they should be listed as priority or threatened fauna (*Table 2* and*Table 3*). Six of the candidate priority species identified are currently red listed by IUCN as Vulnerable but not listed as Priority or Threatened species in WA. Four of these (*Boeckella bispinosa*, *Boeckella geniculata, Boeckella shieli* and *Hemiboeckella powellensis)* are listed under criterion D2 (restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to critically endangered or extinct in a very short time) and

in Australia the EPBC Act does not include the provision for listing a nationally threatened species under D2, but in Western Australia a species can be listed under this criterion at state level. These species require further investigation to gain population information and responses to threats to fully determine their conservation status and list them as threatened species in Australia. This highlights some of the challenges that occur when trying to formally list invertebrates as threatened species. The other two IUNC red listed species from the candidate priority list, are *Archaeosynthemis spiniger* and *Armagomphus armiger.* These species have enough information to classify them as Vulnerable using IUCN criteria (see species profiles in appendix) and it is recommended that they are nominated as Threatened fauna in Western Australia.

To fully assess the conservation state of the candidate priority species listed in this project, further knowledge on the specie distributions may be needed before assessment as priority or threatened can be carried out. Some information on each of the candidate species is listed in *Table 3*. It should be noted that only records from DBCA and ALA were used for the distribution calculations (EOO, AOO and number of locations) and further records may be available (some are mentioned under notes in *Table 3*). Several species (e.g. *Antiporus mcraeae*, *Australocypris beaumonti*, *Australocypris mongerensis, Brancaporus pennifoldae*, *Branchinella complexidigitata, Hemiboeckella powellensis*) have only been found from a single location and will be critically endangered if that location is threatened, however little information is known about their biology or population status. On the other hand, some species, such as *Batrachotmatus nannup, Archaeosynthemis spiniger* and *Armagomphus armiger,* are suggested to be restricted or threatened by other authors and there is possibly enough information presently available in the literature for further assessment and nomination as threatened (see species profiles in Appendix 2).

The list of candidate priority species presented here is by no means comprehensive and there may be many more south west aquatic species that require further investigation on their conservation status. Not all known south-west species have records within the data analysed and many species were excluded during the rapid assessment process as they had a limited number of records (mainly due to survey effort), taxonomical issues or were not restricted to the south-west region analysed. It was noted that 15 south-west Australia endemic species, which have been listed (under Western Australian listing, EPBC Act or IUCN red list) as threatened or priority species, had no records in the DBCA data and so were not included in this assessment (see Appendix 1). Several other south-west endemic species not recorded in the data analysed, have also been noted by other researchers to be of conservation concern. These species seem to be restricted to a habitat type or are rare. For example; Timms (2010; 2014) suggested that the brine shrimps *Parartemia bicorna, P. boomeranga and P. mouritz*, which are restricted to a few Wheatbelt or Goldfield lakes that episodically fill and are increasingly threatened by salinisation, should be listed as priority species. Hawking and Theischinger (2004), Bush et al.(2014b) and Sutcliffe (2003) have highlighted several dragonfly species including *Petalura hesperia*, which is restricted to permanently wet bog areas and

known from less than 9 locations, as being of conservation concern. These latter authors also suggested *Lathrocordulia metallica*, which had records in the DBCA and ALA data, but is widely distributed (EOO > 20,000 km^2) and had more than 10 locations, so was removed during the rapid assessment process. It has been suggested that the stonefly species *Dinotoperla sp*. (Mingenew) maybe extinct (Hynes & Bunn, 1984; Mynott, Suter & Theischinger, 2017). It was described in 1963 from 3 specimens collected near Mingenew (held in the Bishop Museum, Honolulu) but there have been no further records. Sampling was undertaken by Hynes and Bunn (1984) in the area of the listed location but did not provide any additional specimens. DBCA has collected from several sites in this area (Hutt River, near Indindie Spring, Kockatea Gully and Winmilla Creek) but no stoneflies have been recorded from these samples. This region is now highly cleared and salinized which may have eliminated this species. The only records of stoneflies north of the Perth region were recorded during the Monitoring River Health Initiative (MRHI) when the family Griptopterygdae (to which *Dinotoperla* belongs) were recorded from 3 sites in the nearby Moore River Hills catchment (identifications were only to family level). This is the only record of *Dinotoperla* in Western Australia. It has been suggested that it may be related to *D. bassae* (found in NSW and Vic) because of its ability to breed in temporary ponds (Hynes & Bunn, 1984), however all other griptopterygid species from WA are endemic to the state (Mynott, Suter & Theischinger, 2017). Further searching for this species is required to determine if it is still exists or is extinct. These examples show there is still a lot of knowledge yet to be collected on freshwater aquatic invertebrates in Western Australia.

For a species to be assessed as threatened, information on population status and threats is required. Due to time restraints a full assessment of threats and population status for each candidate priority species was not possible. For many of the species this information is not directly known as there is little historical or time-series data. However, some population declines can be inferred as there is knowledge that many south-west aquatic habitats are at risk, along with their associated invertebrate fauna. With reduced rainfall resulting in decreased flow rates and reduced water levels, some streams and rivers which were permanent are now seasonal, and seasonal wetlands are now dry for several years before being refilled. Hydroperiods are becoming shorter and water levels may not persist long enough for many invertebrates to complete their breeding cycles. Consequently, this has affected many riverine species which rely on water flow or permanency. For example, there have been changes in the invertebrate composition in the northern Jarrah forest streams (Aquatic Research Laboratory, 2009). This threat could be affecting several of the candidate priority species which are known to only occur in high rainfall areas in habitats with fast flows (e.g. *Hesperocordulia berthoudi*, *Archaeosynthemis spiniger, Hydrobiosella michaelseni*, Leptoceridae Genus A sp., *Lectrides* sp. AV1). There has also been altered hydrology with a reduction in groundwater levels and groundwater becoming disassociated from the surface water, resulting in flow reduction and changes in salinity (Barron *et al.*, 2012; Kinal & Stoneman, 2012; CSIRO., 2006). Some wetlands, in areas with underlying acid sulphate soils, are now experiencing acidification events which effect acid-sensitive species such as molluscs and crustaceans; including one of the candidate species, *Paramphisopus*

palustris (Sommer & Horwitz, 2009; McCullough & Horwitz, 2010). With the long-term trend to hotter and drier conditions in Western Australia there has been an increase in both frequency and intensity of wildfires (Steffen, Hughes & Pearce, 2015) which are known to effect wetland habitats (Horwitz, Pemberton & Ryder, 1996; Blake *et al.*, 2012; Horwitz & Smith, 2005). These disturbances and environmental changes cause aquatic invertebrate range extensions or declines in species with narrow environmental ranges or tolerances and poor powers of dispersal. Many of these threats are acting synergistically to accelerate population decline towards extinction. For example, the drying climate and changing fire regimes, is altering habitats in wet refugial zones and threatening many aquatic invertebrates (Robson, Chester & Austin, 2011; Davis *et al.*, 2015).

Bush *et al.* (2014) assessed the risk posed by climate change to Australian odonates. They predicted that 56 – 69 % (153 – 187 species) of the Australian odonates modelled will experience a decline in habitat extent by 2085, including a number of potential extinctions in the medium and long term. Species in south-western Australia were predicted to be vulnerable and at high risk to climate change with significant within-region decline and species becoming restricted to pockets of suitable habitats. It was predicted that the habitat area of several south-west endemic species (e.g. *Lathrocordulia metallica* and *Hesperocordulia berthoudi*) would either contract substantially or become significantly less suitable, to the level of near-extinction (Bush *et al.*, 2014b)

Considering the degree of habitat loss and modification in Western Australia, there are likely to be many more aquatic invertebrates of conservation concern than indicated by the list produced here. However, the rapid assessment approach has identified candidate priority species and provides a starting point to more formal conservation assessment of aquatic invertebrates in south-west Australia. The project has provided an opportunity to re-assess some species already on the Priority Fauna list and provided DBCA with a process to continue to assess conservation status of aquatic invertebrate species over time.

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Appendices

Appendix 1 Western Australian aquatic invertebrates listed as threatened or priority fauna (current as Feb 2018). Bold – DBCA record, Shaded – Within analysis area

Class/ Order	Species	Authority	WA status and criteria	EPBC Act	IUCN Red List category and criteria	DBCA Region	Habitat, Threats and notes
Acarina	*Acercella poorginup*	Harvey 1996	P2			Warren	Restricted to acid peat swamps
Acarina	***Pseudohydryphantes doegi***	Harvey 1987	P2			Warren	
Crustacea	*Hurleya* sp. (WAM 642-97)		CR A2+3+4ac, B1+2ab(v), C1+2a(ii,iii), D			Swan	Stygofauna.
Crustacea	***Cherax tenuimanus***	Smith 1912	CR B1+2ab(i,ii,iii,v)	CR	CR B2ab(ii,iii,v)	South west	
Crustacea	*Bunderia misophaga*	Jaume & Humphreys, 2001	CR B1+2ab(iii)			Pilbara	
Crustacea	*Stygocyclopia australis*	Jaume, Boxshall, & Humphreys, 2001	CR B1+2ab(iii)			Pilbara	stygofauna, cave dweller, Cape Range
Crustacea	*Engaewa pseudoreducta*	Horwitz & Adams, 2000	CR B1+2c	CR	CR B1ab(iii)	South west	
Crustacea	*Kumonga exleyi*	Yager & Humphreys, 1996	CR B1+2ce	VU		Pilbara	Stygofauna, remipedia
Crustacea	*Engaewa walpolea*	Horwitz & Adams, 2000	EN B1+2ab(iii)	EN	EN B1ab(i,iii)	Warren	
Crustacea	*Liagoceradocus branchialis*	Bradbury & Williams, 1996	EN B1+2ab(iii)			Pilbara	Stygofauna, cave dweller
Crustacea	*Engaewa reducta*	Riek, 1967	EN B1+2ac	CR	CR B1ab(iii,iv)	South west	
Crustacea	*Abebaioscia troglodytes*	Vandel, 1973	VU D2			South Coast	Stygofauna
Crustacea	*Abebaioscia troglodytes*	Vandel, 1973	VU D2			South Coast	Stygofauna
Crustacea	*Bogidomma australis*	Bradbury & Williams, 1996	VU D2			Pilbara	Burrow Is., cave dweller, freshwater, known only from type locality

Class/ Order	Species	Authority	WA status and criteria	EPBC Act	IUCN Red List category and criteria	DBCA Region	Habitat, Threats and notes
Crustacea	*Bogidomma australis*	Bradbury & Williams, 1996	VU D2			Pilbara	Burrow Is., cave dweller, freshwater, known only from type locality
Crustacea	*Nedsia fragilis*	Bradbury & Williams, 1996	VU D2			Pilbara	Burrow Is., cave dweller, freshwater, known only from type locality
Crustacea	*Nedsia humphreysi*	Bradbury & Williams, 1996	VU D2			Pilbara	Burrow Is., cave dweller, freshwater, known only from type locality
Crustacea	*Nedsia hurlberti*	Bradbury & Williams, 1996	VU D2			Pilbara	Burrow Is., cave dweller, freshwater, known only from type locality
Crustacea	*Nedsia sculptilis*	Bradbury & Williams, 1996	VU D2			Pilbara	Burrow Is., cave dweller, freshwater, known only from type locality
Crustacea	*Nedsia straskraba*	Bradbury & Williams, 1996	VU D2			Pilbara	Burrow Is., cave dweller, freshwater, known only from type locality
Crustacea	*Nedsia urifimbriata*	Bradbury & Williams, 1996	VU D2			Pilbara	Burrow Is., cave dweller, freshwater, known only from type locality
Crustacea	*Branchinella apophysata*	Linder 1941	P1		VU D2	Goldfields	
Crustacea	*Branchinella basispina*	Geddes 1981	P1		VU D2	South Coast	
Crustacea	***Branchinella denticulata***	Linder 1941	P1		VU D2	Midwest, Goldfields	
Crustacea	***Branchinella simplex***	Bernard 1924	P1		VU D2	Goldfields	
Crustacea	***Branchinella wellardi***	Milner 1929	P1		VU D2	Midwest	
Crustacea	*Calamoecia elongata*	Bayly 1979	P1		VU D2	Warren	Temporary pools near Northcliffe
Crustacea	***Daphnia jollyi***	Petkovski 1973	P1		VU D2	Wheatbelt	
Crustacea	*Daphnia occidentalis*	Benzie 1986	P1		VU D2	Warren	

Class/ Order	Species	Authority	WA status and criteria	EPBC Act	IUCN Red List category and criteria	DBCA Region	Habitat, Threats and notes
Crustacea	*Paraplatyarthrus subterraneus*	Javidkar & King, 2015	P1			Pilbara	Subterranean, Murchison/Laverton area
Crustacea	***Parartemia contracta***	Linder 1941	P1		VU D2	Wheatbelt	
Crustacea	*Fibulacamptus bisetosus*	Hamond, 1987	P2		VU D2	Warren	
Crustacea	*Nedsia chevronia*	Bradbury 2002	P2			Pilbara	Groundwater Barrow Is.
Crustacea	***Stygiocaris stylifera***	Holthuis, 1986	P4		VU D2	Pilbara	Stygofauna
Crustacea	***Boeckella bispinosa***	Bayly 1967			VU D2	Swan	Fewer than 10 populations, Perth. Only known from 2 localities Perth, WA and Campbelltown Tas.
Crustacea	***Boeckella geniculata***	Bayly 1964			VU D2	South coast	Only known from pool 60km NNE Esperance
Crustacea	***Boeckella shieli***	Bayly 1985			VU D2	South West	
Crustacea	*Caridina spelunca*	Choy, 1996			VU D2	Kimberley	Only known from a single cave
Crustacea	***Hemiboeckella powellensis***	Bayly 1979			VU D2	South coast	Only known from Lake Powell
Crustacea	***Stygiocaris lancifera***	Holthuis, 1986			VU D2	Pilbara	Cape Range
Decapoda	***Pycneus morsitans***	Holthuis, 1986			NT	Pilbara	Cave dweller shrimp, known from 3 caves in Gibson Desert
Diptera	*Austroconops mcmillani*	Wirth & Lee, 1959	P2			Swan	
Mollusca	***Westralunio carteri***	Iredale, 1934	VU A2c+4c	VU	VU A2c	Swan , South West, Wheatbelt, South Coast, Warren	Population declining
Mollusca	*Austroassiminea letha*	Solem, Girardi, Slack-Smith & Kendrick, 1982	VU D2		EN B1ab(iii,v)	South West	Coastal springs and seepages

Class/ Order	Species	Authority	WA status and criteria	EPBC Act	IUCN Red List category and criteria	DBCA Region	Habitat, Threats and notes
Mollusca	***Glacidorbis occidentalis***	Bunn & Stoddard 1983	P2		VU D2	Swan	
Odonata	***Antipodogomphus hodgkini***	Watson 1969	P2			Pilbara	
Odonata	***Agriocnemis kunjina***	Watson 1969			VU B1ab(iii)	Midwest	
Odonata	***Archaeosynthemis spiniger***	Tillyard, 1913			VU B1ab(iii); D2	South West	
Odonata	*Archiargiolestes parvulus*	Watson 1977			NT	South West	No recent records (all pre 1970)
Odonata	*Argiolestes pusillissimus*	Kennedy 1925			NT	South West	No recent records (most pre 1970, one record 1978)
Odonata	***Armagomphus armiger***	Tillyard, 1913			VU	South West	IUCN priority species monotypic genera restricted to one country
Odonata	***Austroagrion pindrina***	Watson 1969			VU	Pilbara	
Odonata	***Eurysticta coolawanyah***	Watson 1969			NT	Pilbara	
Odonata	***Hemicordulia koomina***	Watson 1969			NT	Pilbara	
Odonata	***Ictinogomphus dobsoni***	Watson 1969			NT	Pilbara	< 10 locations
Odonata	***Nososticta pilbara***	Watson 1969			EN	Pilbara	Only known from Millstream - most restricted Australian Odonate
Polychaeta	*Prionospio thalanji*	Wilson 2001	CR B1+2ab(iii)			Pilbara	marine, only known from type locality

Appendix 2 Species Profiles

Archaeosynthemis spinger

Armagomphus armiger

Apsilochorema urdalum

Batrachomatus nannup

Diplectrona spAV9

Hesperocordulia berthoudi

Kaninga gwabbalitcha

Paramphisopus palustris

Paroster pallescens

Plectrotarsus minor

Archaeosynthemis spiniger (Tillyard 1913) Spiny Tigertail

Figure 1. Archaeosynthemis spiniger
(Photo by J. Taylor)

Phylum: Arthropoda Class: Insecta Order: Odonata
Family: Synthemistidae Subfamily:
Scientific name: *Archaeosynthemis spiniger* (Tillyard 1913)
Common name: Spiny Tigertail
Australian National code: QO230103

CURRENT CONSERVATION STATUS:

Archaeosynthemis spiniger is currently not listed under any State or Commonwealth legislation.

Archaeosynthemis spiniger is listed on the 2018 IUCN Red List of Threatened Species. Assessment of the IUNC categorisation for the species is Vulnerable using criteria B1ab(iii), 2.(Dow, 2017)

Archaeosynthemis spiniger was suggested as a priority species by Moore (1997), as Vulnerable in Hawking (1999) and Hawking & Theischinger (2004) and as Endangered by Sutcliffe (2003).

BIOLOGICAL OVERVIEW:

Archaeosynthemis spiniger is only known from the south-west of Western Australia, where it has been recorded from twenty three locations, but there have been few records since 2007. It is possible the species requires permanent water as many locations have not had records since drying out in 2007. Bush fires are a threat throughout its range. Bauxite mining is a threat at one location and urban expansion is a potential threat at another. In the longer-term, habitat shifts and alteration due to climate change are predicted to become an issue for this species by 2055. This species was identified as a candidate priority species for Western Australia.

DESCRIPTION:

Archaeosynthemis spiniger, known as the Spiny Tigertail, is a small-sized, black dragonfly marked with yellow. It is usually seen settled on logs in the riverbed or nearby. See Hawking & Theischinger (2006) and Waston (1962) for full descriptions.

Larvae have sparse hair. Total length of larvae: 22 mm. See Waston (1962), Theischinger (1998) and Hawking & Theischinger (2006) for a description.

DISTRIBUTION:

An endemic species to south-western Australia.

Some locations are within Conservation areas: Lane Poole Res, Blackwood River Conservation Reserve, Greater Hawke NP

Type location: Waroona, Western Australia 1913.

AREA OF EXTENT (EOO):31,555 km^2
AREA OF OCCUPANCY (AOO): 92 km^2
Number of locations: 23

Number of records used for calculation: 42

HABITAT:

It inhabits streams and rapid rivers. Larvae are found under stones and litter in permanent rapid streams (Watson 1962).

POPULATION:

This species has been recorded at 21 forest stream locations monitored annually by DBCA between 2005 and 2011. Six of these locations were also monitored in 2013 and 2016. Between 2005 and 2006 this species was recorded from 21 sites. 2007 was a very dry winter in this region and many locations were dry in spring when sampling occurred and only 3 locations had records. Between 2007 and 2010 there were less than 3 sites per year with records of this species. In 2013 and 2016, there were no records. One location which had consistent records between 2006 and 2010 is a tributary of the Blackwood River which historically had permanent flow due to ground water springs in the area. However this site was dry in 2010 and no further records of this species have been recorded at this site.

THREATS, LIMITING FACTORS AND MANAGEMENT ISSUES:

Forestry activities, bauxite mining, and bush fires present clear threats to this species. Many of the locations are within logging areas and the impact of forestry activities on this species is unknown. Extensive bauxite mining operations are taking place around Waroona with some of the known locations for this species close to these operations. One location (near North Dandalup) is now within the bauxite mining area. Mining is allowed in the Lane Pool Conservation Reserve, where one of the known populations is, although the exact impact of the mining operations on the species needs to be investigated. One of the known sites is in the Roleystone area near Perth, and housing development is a potential threat in this area. Bush fires are a general threat and wildfires have occurred at several locations since 2004. Reduce rainfall in the region maybe be having an impact on this species. After many locations dried out in 2007, the number of records reduced dramatically. It is possible that this species needs permanent water as suggested by Watson (1962). In the longer-term, modelling of sensitivity to climate change in Bush et al. (2014: Table S2) predicts that under a high emissions scenario this species will be vulnerable to the effects of climate change by 2055. Modelling of sensitivity to climate change in Bush *et al.* (2014) predicts that under a high emissions scenario this species will have no suitable habitat left by 2055, so that presumably even under a medium emissions scenario climate change is likely to be threat to this species.

SOURCE MATERIALS

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Armagomphus armiger (Tillyard 1913) Armourtail

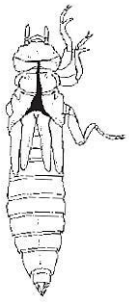

Figure 1 Armagomphus armiger.
(Photo from dragonflypix, larva from (Theischinger & Endersby, 2014)

Phylum: Arthropoda Class: Insecta Order: Odonata
Family: Gomphidae Subfamily:
Scientific name: *Armagomphus armiger* (Tillyard 1913)
Common name: Armourtail
Australian National code: QO130508

CURRENT CONSERVATION STATUS:

Armagomphus armiger is currently not listed under any State or Commonwealth legislation.

Armagomphus armiger is listed on the 2018 IUCN Red List of Threatened Species. Assessment of the IUNC categorisation for the species is Vulnerable using criteria B1ab(iii) (Dow, 2017).

Armagomphus armiger was suggested as a priority species by Moore (1997), as Vulnerable in Hawking (1999) and Hawking & Theischinger (2004) and as Near Threatened by Sutcliffe (2003).

BIOLOGICAL OVERVIEW:

Armagomphus armiger is only known from the south-west of Western Australia, where it has only been recorded from nine locations. Its extent of occurrence (EOO) is < 20, 000 km² and its distribution falls into two clusters. Bauxite mining is a threat at some of the locations in the cluster nearer Perth, and fire is a general threat. Although some known locations are in protected areas, mining occurs within one of these and fires have already impacted another. Modelling suggests that climate change is serious threat to this species, with a predicted loss of all suitable habitat by 2055 under a high emissions scenario. With only nine known locations, a limited extent of occurrence (EOO), definite threats, and a decline in both area and quality of habitat due to bauxite mining and fires, the species qualified for Vulnerable status under IUCN criterion B (VU B1ab(iii)) (Dow, 2017). This species was identified as a candidate priority species for Western Australia.

DESCRIPTION:

Armagomphus armiger, known as the Armourtail, is a small-sized, black dragonfly marked with yellow. Legs are black with the base of the femora yellow. Total length: 41-43mm. It is usually seen settled on logs in the riverbed or nearby. See Hawking & Theischinger (2006) and Waston (1962) for full descriptions.

Larvae have a strong, elongate claw on the fore and middle leg. Total length of larvae: 21.5-24.4 mm. See Waston (1962), Theischinger (1998) and Hawking & Theischinger (2006) for a full description.

Armagomphus is a monotypic genus with only one species. *Tillyard (1913)* suggested that the new species *armiger* would probably form a new genus because of its great differences.

Armagomphus armiger was originally placed in the family Austrogomphus and then Hemigomphus before being placed into its own genus.

DISTRIBUTION:

An endemic species to south-western Australia

Some locations are within Conservation areas: Shannon National Park, Wungong Regional Park and Lane Pool Conservation Reserve

Type location: Waroona, Western Australia 1911.

AREA OF EXTENT (EOO): 3,814 km2
AREA OF OCCUPANCY (AOO): 40 km2
Number of locations: 9
Number of records used for calculation: 64

The known locations fall into two clusters, most locations are in a cluster extending south from Perth with most or all locations in the Darling Range; the other cluster, of two locations, is further south. Bush *et al.* (2014b:Table S2) give an estimate of the current extent of suitable habitat for this species as 6,818 km².

HABITAT:

It inhabits clear rapid streams and rivers. Larvae found buried deeply in sand and/ or leaf litter in permanent rapid streams (Watson 1962; Thieschinger 2000).

POPULATION:

Armagomphus armiger appears to be restricted to the extreme highest rainfall regions of the south-west and are generally not encountered as often as other species (Sutcliffe, 2003). This appears to be a scarce and local species, but judging by the numbers of specimens in some series, for instance the type series of three males and nine females from Waroona (Tillyard 1913) it may be less scarce at the right times and places. The great majority of records seen date from before 1976, but this may be due to insufficient sampling. One site monitored by DBCA in Lane Poole Reserve had records in 2005 and 2007 but there have been no recent records from this site. This site is now in close proximity to bauxite mining and was burnt by a wildfire in 2015.

THREATS, LIMITING FACTORS AND MANAGEMENT ISSUES:

Bauxite mining and bush fires present clear threats to this species. Extensive bauxite mining operations are taking place in the Darling Range south of Perth with some of the known locations for this species close to these operations. Mining is allowed in the Lane Pool Conservation Reserve, where one of the known populations is. Several protected areas where the species has been recorded (e.g. Shannon National Park and Lane Pool Reserve) have already been affected by bush fires and fires are a general problem in the region. Urban expansion may also threaten sites close to Perth. Modelling of sensitivity to climate change in Bush *et al.* (2014) predicts that under a high emissions scenario this species will have no suitable habitat left by 2055, so that presumably even under a medium emissions scenario climate change is likely to be threat to this species.

SOURCE MATERIALS

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Apsilochorema urdalum (Neboiss 1962)

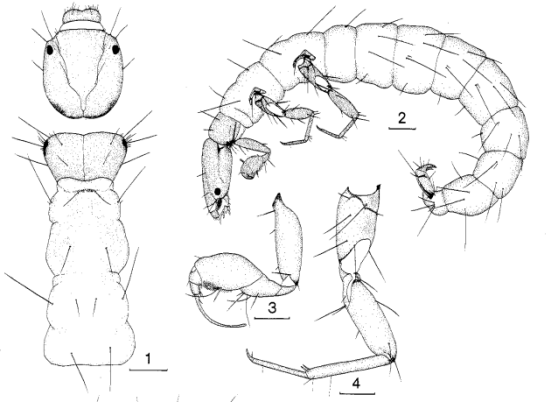

Figure 1 Apsilochorema urdalum. (from Dean & Bunn 1989)

Phylum: Arthropoda Class: Insecta Order: Trichoptera
Family: Hydrobiosidae Subfamily:
Scientific name: *Apsilochorema urdalum* (Neboiss, 1962)
Common name: Caddisfly
Australian National code: QT010303

CURRENT CONSERVATION STATUS:

Apsilochorema urdalum is currently not listed under any State or Commonwealth legislation.

Apsilochorema urdalum is not listed on the 2018 IUCN Red List of Threatened Species.

BIOLOGICAL OVERVIEW:

Apsilochorema urdalum is only known from the south-west of Western Australia, where it has only been recorded from 12 locations. Very little is known about the life history or biology of this species but the species appears to be restricted to rapidly flowing small forest streams. Reduced water flow, fire and bauxite mining may be a threat to this species. This species was identified as a candidate priority species for Western Australia.

DESCRIPTION:

Apsilochorema urdalum is a small caddisfly and has wings with a blackish pubescence. Anterior wing length: 6.5-8.0 mm. Adults live close to water. See Neboiss (1982) for a full description.

The larvae are free-living trichopterans and are actively predaceous. The front leg has well developed claws and there is dorsal sclerotization on the first thoracic segment. For a full larval description see Dean & Bunn (1989).

DISTRIBUTION:

Endemic to south-western Australia

Some locations within the Conservation area: Greater Hawke National Park, Shannon N, Lane Poole Reserve

Type Material: Beedelup Falls, Western Australia, 13.xi.1958

AREA OF EXTENT (EOO): 22,327.73 km^2
AREA OF OCCUPANCY (AOO): 48 km^2
Number of locations: 12

HABITAT:

It inhabits small forest streams, rivers and pools. Larvae are found in rapid streams. *Apsilochorema urdalum* appears to occur in high rainfall areas in streams with high flow areas e.g. falls and rapids.

POPULATION:

Most of the records are pre-1984. Earlier records (pre-1980) were mainly from locations near falls and rapids (Waterfall Gully, Harvey Falls, Deep River, Carey Brook, Beedalup Brook, Ellen Brook Falls near Margaret River, Canterbury River). Two forest stream locations monitored by DBCA are close to these locations; Harvey River (near Hoffman's Mill) had records in 2005, 2007, 2010; Carey Brook had records in 2010 and 2011. Another monitored site Big Brook (in Lane Poole Reserve) had records from 2005 and 2007. Rainfall in the south-west Western Australia was high in 2005, but 2007 and 2010 were low rainfall years. It is possible that this rare species was collected from these locations in 2007 and 2010 as many other streams were dry and the species was seeking locations with flowing water.

THREATS, LIMITING FACTORS AND MANAGEMENT ISSUES:

Apsilochorema urdalum appears to be restricted to high rainfall areas in streams with high flow areas e.g. falls and rapids. Bauxite mining and reduced water flow are threats to this species. The area near Big Brook has extensive bauxite mining and this location is now within the bauxite mining area. A large haul-pack road was constructed just upriver from this location in 2011 and the location was also burnt by a wildfire in 2015. No records have occurred at this site since 2007 and the population at this location may be lost due to combination of reduced flow, mining activities and fire.

SOURCE MATERIALS

Dean J.C. & Bunn S.E. (1989) Larval descriptions of the Hydrobiosidae, Philopotamidae, Hydropsychidae and some Ecnomidae (Trichoptera) from south-western Australia, with notes on biology. *Australian Journal of Marine and Freshwater Research,* **40,** 631-643.

Neboiss A. (1962) The Australian Hydrobiosidae (Trichoptera: Rhyacophilidae). *Pacific Insects,* **4,** 521-582.

Neboiss A. (1982) The Caddis-Flies (Trichoptera) of South -Western Australia. *Australian Journal of Zoology,* **30,** 271-325.

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Batrachomatus nannup (Watts 1987)

Figure 1 Batrachomatus nannup
Line = 4mm (from Hendrich and Balke 2016)

Phylum: Arthropoda Class: Insecta Order: Coleoptera
Family: Dytiscidae Subfamily: Hydroporinae
Scientific name: *Batrachomatus nannup* (Watts 1987)
Common name: Diving beetle
Australian National code: QC092502

CURRENT CONSERVATION STATUS:

Batrachomatus nannup is currently not listed under any State or Commonwealth legislation in Australia

Batrachomatus nannup is not listed on the 2018 IUCN Red List of Threatened Species.

BIOLOGICAL OVERVIEW.

Batrachomatus nannup is only known from the south-west of Australia, where is has only been recorded from a 30km section of the Blackwood River (EOO< 5,000km^2, AOO <500km^2). The population seems to be stable and it is often found in abundance in the cool deep pools of the main channel of the river. A reduction in the depth and number of river pools will affect the distribution of this diving beetle. Little is known on the biology of this species and it is unknown how tolerant it is changes in salinity and temperature. This species was identified as a candidate priority species for Western Australia.

DESCRIPTION:

Batrachomatus is a shiny black oval diving beetle with reddish legs. Length 9.0 - 9.6 mm. See Hendrich & Balke (2013) for full species description and Alarie, Watts & Nilsson (2012) for description of larvae.

Batrachomatus nannup is the only species from this Genus found in southern Western Australia. It differs from most specimens of *Batrachomatus wilsoni* and *Batrachomatus larson*i sp. n. in the lack of any reddish humeral angles to elytra, the more flattened and narrowly formed body, and in having the reticulation on the elytra weak without punctuation, instead of moderately strong and punctuate. All three species can be easily separated by the shape of their median lobes and their distribution.

DISTRIBUTION:

Endemic to south-western Australia. Restricted to a 30km section of the Blackwood River between Sue's Bridge and Bridgetown.

Some locations are within the Blackwood River Conservation Reserve.

Type location: Bridgetown, WA.

AREA OF EXTENT (EOO): 866 km^2
AREA OF OCCUPANCY (AOO: 0.02 degree grid): 28 km^2
Number of records used for calculation: 21
Number of locations: 6
NB: Additional records indicated in CENRM (2004) but these fall within the EOO indicated.

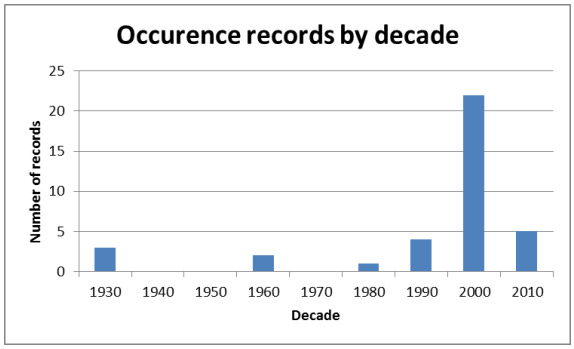
HABITAT:

In late spring the adults of *Batrachomatus nannup* are found either in larger (6–10 m²) and deeper (40–80 cm depth) sandy pools in the flood zone of the river or among floating roots, rotten twigs and logs in shallow water of protected embayments of the slow flowing river . In summer and in dryer periods the adults seem to be restricted to only the deepest parts of the almost standing river, under larger logs, stones and rotten debris. When disturbed the beetles are observed swimming around and coming to the surface.

POPULATION:

The population of *Batrachomatus nannup* seems to be stable and it is common in the section of the Blackwood River where it is found (mainly between Nannup and Bridgetown). It is generally restricted to the main channel of the Blackwood River and is not often found in the tributaries.

Records are spread between the 1930s and 2016. Most records have been recorded since 2000 which is due to survey effort and monitoring being carried out the Blackwood River since 2004.



THREATS, LIMITING FACTORS AND MANAGEMENT ISSUES

Batrachomatus nannup is generally only located in the main river channel, so this species may have some dependency on water flow or river depth. A reduction in the depth and number of river pools will affect the distribution of this diving beetle. Threats may include sedimentation (in-filling of pools), climate change (reduced runoff, river flow and water levels), and increased salinity. This species only occurs in the mid-reaches of the Blackwood river and may be limited by salinity tolerances, but this is unknown.

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Hendrich L. & Balke M. (2013) Revision of Australian Matini diving beetles based on morphological and molecular data (Coleoptera, Dytiscidae, Matinae), with description of a new species. *ZooKeys,* **293**.

Diplectrona sp. AV9

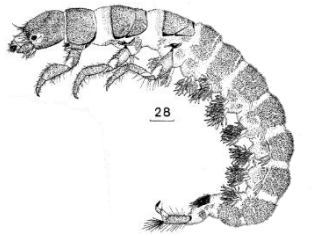

Figure 1 Diplectrona sp. AV9. (from Dean and Bunn 1989)

Phylum: Arthropoda Class: Insecta Order: Trichoptera
Family: Hydropsychidae Subfamily:
Scientific name: *Diplectrona sp. AV9*
Common name: Caddisfly
Australian National code: QT0606A1

CURRENT CONSERVATION STATUS:

Diplectrona sp. AV9 is currently not listed under any State or Commonwealth legislation.

Diplectrona sp. AV9 is not listed on the 2018 IUCN Red List of Threatened Species.

BIOLOGICAL OVERVIEW.

Diplectrona sp. AV9 is a larval form of a caddisfly (Trichoptera) which is only found in south-west of Western Australia. No records of Diplectroninae adults have been described in Western Australia. This species appears to be restricted to small to medium fast flowing forest streams in the Donnelly River Catchment and has only been recorded from two locations. A known threat to this species is increased loads of suspended sediment. It has not been recorded from neighbouring catchments (Warren River and Blackwood River) which may due to higher salinity in these catchments, but this is unknown. Further taxonomic work is required for this species as it is possible *Diplectrona sp. AV9* does not belong to the family Diplectrona. Adults need to be associated with the larvae so the species can be formally described. This species was identified as a candidate priority species for Western Australia.

DESCRIPTION:

Diplectrona sp. AV9 is a larval form of a caddisfly (Trichoptera) in the hydropsychid subfamily Diplectroninae. No records of Diplectroninae adults have been described in Western Australia. For a description of the larvae see Dean (1999). The larvae appear to be predaceous and construct retreats and silk capture nets on and between stones or wood in medium to fast currents.

Wells and Neboiss (2018) have recently revised the Australian Diplectroninae. They noted that Dean (1999b) listed a single larval *Diplectrona* from south-western Western Australia. However, commented that among the very large collection of adult Trichoptera in Museum Victoria, no diplectronines have been identified from very far west of the Great Dividing Range of eastern Australia.

Further taxonomic work is required for this species. Adults need to be associated with the larvae so the species can be formally described. It may be possible the south-west species does not belong to the family Diplectrona as several earlier described species of Diplectrona are now recognised as new genera (see Wells & Neboiss, 2018). Despite the unresolved taxomony, this species is rare, highly restricted and seems to be a unique diplectronine species occurring in Western Australia.

DISTRIBUTION:

Endemic to south-western Australia. Appears to be restricted to Donnelly River catchment.

AREA OF EXTENT (EOO): insufficient locations
AREA OF OCCUPANCY (AOO): 8 km^2
Number of records used for calculation: 8
Number of locations: 2

Type location: *Diplectrona sp. AV9* larvae described by Dean and Bunn (1989) was provided by Ivor Growns collected from Carey Brook.

Location within the Conservation area: Greater Hawke National Park

HABITAT:

Diplectrona sp. AV9 occurs between stones and wood in small medium to fast flowing forest streams.

POPULATION:

Populations of *Diplectrona sp. AV9* seem to be restricted to the Donnelly river catchment. *Diplectrona sp. AV9* was first recorded by Growns and Davis (1994b; 1994a) from Carey Brook during 1988 and 1989 (no co-ordinates are given in the publications). More recent records are from two locations currently monitored by DBCA; Record Brook has records between 2006 and 2009 but has not been recorded in recent years; Carey Brook has consistent records between 2008 and 2013 but the species was not recorded in 2016. There have been no records from a monitoring site in Barlee Brook (Donnelly river catchment) or from close-by Treen Brook or Lefroy Brook within the Warren river catchment. Wells & Neboiss (2018) noted for most species of Australian diplectronine they reviewed, few specimens are available in collections and few species have been collected in large numbers at any time, which suggests that they are rare

THREATS, LIMITING FACTORS AND MANAGEMENT ISSUES

Caddis-flies depend on an aquatic environment in good condition. Activities that alter water qualities such as temperature, turbidity, increased sedimentation, water flow, pH, dissolved oxygen and conductivity will adversely affect this species, particularly larval stages. Growns and Davis (1994a) recorded that *Diplectrona* was not present after the commencement of logging or during periods of high loads of suspended inorganic solids in Carey Brook. This invertebrate is a net-spinning filter feeder, so it is likely that the increase in suspended solids may have affected its abundance through inorganic suspended sediments clogging its gills or the nets used for feeding. Reduced water flow from water allocations or reduced rainfall will also impact on the feeding habitats of this species and reduce dissolved oxygen levels within the water column. The Record Brook location may be under threat in the future if this area is used for public water supply. Salinity may also be a threat to this species and could be why it has not been recorded from the nearby Warren River and Blackwood River catchments.

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Watts C.H.S. & Leys R. (2008) Review of the epigean species of Paroster SHARP, 1882, with descriptions of three new species, and phylogeny based on DNA sequence data of two mitochondrial genes (Coleoptera: Dytiscidae: Hydroporinae) *Koleopterologische Rundschau,* **78,** 9-36.

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Hesperocordulia berthoudi (Tillyard 1911) Orange Streamcruiser

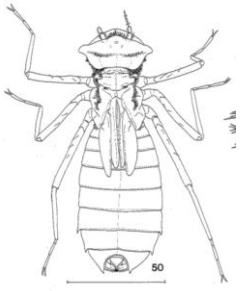


Figure 1 Hesperocordulia berthoudi.
(Photo from dragonflypix, larva from Theischinger & Watson 1984. Line = 10.0mm)

Phylum: Arthropoda Class: Insecta Order: Odonata
Family: Austrocorduliidae Subfamily: Gomphomacromiinar
Scientific name: *Hesperocordulia berthoudi* (Tillyard 1911)
Common name: Orange streamcruiser
Australian National code: QO290101

CURRENT CONSERVATION STATUS:

Hesperocordulia berthoudi is currently not listed under any State or Commonwealth legislation.

Hesperocordulia berthoudi is not listed on the 2018 IUCN Red List of Threatened Species.

Hesperocordulia berthoudi was suggested as a priority species by Moore (1997), as Vulnerable by Hawking (1999; Hawking & Theischinger, 2004) and classified as Near Threatened by Sutcliffe (2003).

BIOLOGICAL OVERVIEW.

Hesperocordulia berthoudi is a dragonfly only known from the south-west of Western Australia. It appears to be restricted to habitats with high flows (near riffles and waterfalls) and permanent water in high rainfall areas. It is rarely collected and has a restricted distribution (EOO<20,000km^2, AOO<500km^2). It has been recorded from 13 locations. Bauxite mining occurs in the area of several locations and may be a threat to this species, but this is unknown. Reduced flow from declining rainfall and dams may also be a threat to this species. Bush *et al.* (2014a) predicts that under a high emissions scenario this species will have no suitable habitat left by 2055. This species was identified as a candidate priority species for Western Australia.

DESCRIPTION:

Hesperocordulia is a monotypic genus with only one species. *Hesperocordulia berthoudi*, is a dragonfly endemic to the south-western Australia. It is known as the orange streamcruiser and is a medium-sized, orange, red and black dragonfly with clear wings and very long legs. Wings in mature females are orange brown. Abdomen with orange and black banding. Total length 54mm, hind wing 30.5mm (SeeTillyard, 1911for full description). Adults have a fast erratic flight or patrols near water. Adults settle near water.

The larvae have a short hairy head with eyes strongly protruding laterally and segment 10 directed clearly dorsally. Total length of larvae: 24-26 mm. See Theischinger & Watson (1984) for a full species description.

DISTRIBUTION:

Endemic to South-western Australia and appears to be restricted to permanent streams and rivers.

AREA OF EXTENT (EOO):18,492 km^2
AREA OF OCCUPANCY (AOO): 76 km^2
Number of records used for calculation: 35
Number of locations: 13
Type location: Waroona, WA.

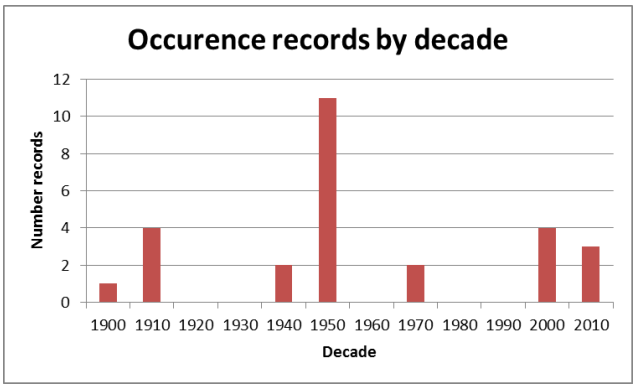
Some locations are within the Conservation areas: Serpentine NP, Mt Frankland NP, St John Brook Conservation Park, Drinking water source protections zones

HABITAT:

It inhabits streams, rivers and pools in high rainfall areas. Found under stones and litter in permanent rapid streams (Watson, 1962).

POPULATION:

Hesperocordulia berthoudi is rarely collected. A large number of records are from 1956-1958, collected by J.A.L Waston from sites in the Perth Hills.



THREATS, LIMITING FACTORS AND MANAGEMENT ISSUES

Hesperocordulia berthoudi appears to be a rare species and not encountered as often as other dragonfly species. It is restricted to habitats with high flows (near riffles and waterfalls) and permanent water in the high rainfall regions of the south-west. Reduced flow from declining rainfall and dams maybe a threat to this species. Several locations where this species was found in the 1950s are below dams on the Canning River, Serpentine River and Churchman Brook. Modelling of sensitivity to climate change in Bush *et al.* (2014a) predicts that under a high emissions scenario this species will have no suitable habitat left by 2055, so that presumably even under a medium emissions scenario climate change is likely to be threat to this species. Habitat destruction could be a threat for species for locations near Waroona and Pinjarra due to urban expansion or Bauxite mining.

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Kaninga gwabbalitcha (Dean, 2000)

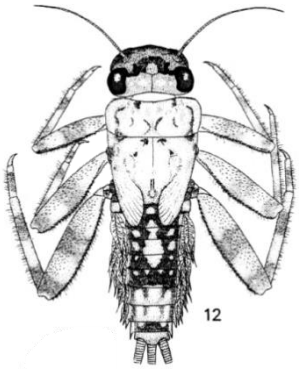

Figure 1 Kaninga gwabbalitcha. (from Dean, 2000a)

Phylum: Arthropoda Class: Insecta Order: Ephemeroptera
Family: Leptophlebiidae Subfamily:
Scientific name: *Kaninga gwabbalitcha* (Dean, 2000)
Common name: Mayfly
Australian National code: QE0608A4

CURRENT CONSERVATION STATUS:

Kaninga gwabbalitcha is currently not listed under any State or Commonwealth legislation.

Kaninga gwabbalitcha is not listed on the 2018 IUCN Red List of Threatened Species.

BIOLOGICAL OVERVIEW.

Kaninga gwabbalitcha is a mayfly only known from south-western Australia where it appears to be highly restricted (EOO<5,000km^2, AOO<500km^2). It has only been recorded from 4 locations. One of these locations has a historical record (1994) but this species has not been recorded again at this location despite the location being surveyed since 2005. Very little is known about the life history or biology of this species but reduced flow and fire may be a threat, as there have no records at one location since a wildfire in 2004. This species was identified as a candidate priority species for Western Australia.

DESCRIPTION:

Kaninga gwabbalitcha is a mayfly endemic to south-west Western Australia. It is the only species within the genus *Kaninga*. The genus was previously designated as 'Genus Q' (Dean & Suter, 1996; Dean, 1999a).

Adults are patterned with the pronotum mainly yellow with dark brown on the side margins. The abdomen is patterned, contrasting between pale yellow (sometimes with a reddish tinge) and dark brown. Legs are brown without banding. Length of the male body is 9-10 mm and forewing 10.2 mm, females are slightly larger. See Dean (2000a) for full description.

Larvae are robust with generally a medium brown to yellow colour. Legs are pale yellow with brown banding. The abdomen has contrasting brown and yellow pattern, with segments 7 and 8 paler. Gills are present on abdominal segments 1-7. See Dean (2000a) for full description.

DISTRIBUTION:

South-western Australia; appears restricted to small- medium sizes forest streams**.**

Location within the Conservation area: Greater Hawke National Park

Type location: Carey Brook, Western Australia

AREA OF EXTENT (EOO): 146 km^2
AREA OF OCCUPANCY (AOO): 16 km^2
Number of records used for calculation: 7
Number of locations: 4

Note: ALA has 3 records (Halotype, 2 paratype). These records have incorrect co-ordinates as they are located in Northern Territory, but type location is Carey Brook, Western Australia (see Dean 2000).

HABITAT:

Small to medium sized forest streams.

POPULATION:

Kaninga gwabbalitcha seems to be rare and is normally collected in low numbers (<5 animals). Dean (2000a) had a record from Fish Creek (MRHI site) from 1994. This site has been monitored by DBCA since 2005 and there have been no records of *Kaninga gwabbalitcha.* A wildfire did occur at his site in 2004. The Carey Brook location has had several records between 1978 and 2011, but this species was not recorded during sampling in 2013 and 2016.

THREATS, LIMITING FACTORS AND MANAGEMENT ISSUES

Very little is known about the life history or biology of *Kaninga gwabbalitcha*, but reduced flow and fire may be a threat, as there have no records at one location since it was burnt by a wildfire.

SOURCE MATERIALS

Dean J.C. (1999) *Preliminary keys for the identification of Australian mayfly nymphs of the family Leptophelebiidae. Identification Guide No. 20,* Cooperative Research Centre for Freshwater Ecology, Albury.

Dean J.C. (2000) Descriptions of new Leptophlebiidae (Insecta: Ephemeroptera) from Australia. II. *Kaninga*, a new monotypic genus from south-western Australia. *Records of the Western Australian Museum,* **20,** 87 - 94.

Dean J.C. & Suter P. (1996) Mayfly nymphs of Australia. A guide to genera. Murray-Darling Freshwater Research Centre, ,Albury, New South Wales. Identification guide No. 7.

Paramphisopus palustris (Glauert 1924)

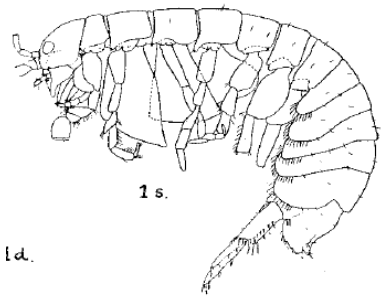

Figure 1 Paramphisopus palustris (from Nicholls 1924*)*

Phylum: Arthropoda Class: Malacostraca Order: Isopoda
Family: Amphisopodidae
Scientific name: *Paramphisopus palustris* (Glauert 1924)
Common name: Isopoda
Australian National code: OR010101

CURRENT CONSERVATION STATUS:

Paramphisopus palustris is currently not listed under any State or Commonwealth legislation. Some locations are within conservation estate.

Paramphisopus palustris is not listed on the 2018 IUCN Red List of Threatened Species.

BIOLOGICAL OVERVIEW.

Paramphisopus palustris is an isopod which is only found in the south-west of Western Australia and is restricted to groundwater-fed wetlands of the Swan Coastal Plain. Its EOO is < 5,000km2. Historically it was found in abundance in many wetlands on the Swan Coastal Plain, although it has been estimated that 80% of the Swan Coastal Plain wetlands have been lost or degraded (Environmental Protection Authority, 2007) and it is uncertain if populations of *P. palustris* have declined since the 1990s, when the Swan Coastal Plain wetlands were surveyed by Balla and Davis (1993). Threats to this species include altered hydrology, habitat loss and degradation. Gouws & Stewart (2007) recorded this species from 23 locations, but they also provide evidence that phylogenetically there are three clades occurring on the Swan Coastal Plain and that the species is not as widely distributed as previously thought. Evidence now exists to suggest the taxon includes several genetic forms different at the species level. Resolving some of taxonomical issues around *Paramphisopus palustris* will determine how restricted this species is, but will inevitably result in the area of extent being smaller than previous thought. This species was identified as a candidate priority species for Western Australia.

DESCRIPTION:

Paramphisopus palustris is a crustacean in the class Isopoda. Its body is rather slender and laterally compressed. The eyes are large and prominent. The colour can vary with the surroundings but a majority are a dark olive brown. Its length when extended is about 15mm. In the male, the first gnathopod is expanded and is about twice as long as wide. In the female this limb is more slightly built, distinctly shorter, and without any expansion. See Nicholls (1943) for a full description.

P. palustris is a detrital feeder and an examination of gut contents revealed diatoms, organic debris, and bits of green filamentous algae (Hembree & George, 1978). It does not possess resistant eggs, so to survive periods of dryness it burrows into deep fissures in the lake bed to moisture.

The family Amphisopodidae are phylogenetically distinct and are an important component of the relictual and Gondwanan fauna (Wilson & Johnson, 1999). *Paramphisopus palustris* was

originally placed within the genus *Phreatoicus* (Glauert, 1924; Nicholls, 1924). Subsequent taxonomic treatments (Nicholls, 1926; Sheppard, 1927) included the species in *Amphisopus* and *Phreatomerus*, before Nicholls (1943) established the genus *Paramphisopus* for its reception. Currently there is some unresolved taxomony around*, P. palustris, P. palustris var fairbridgei* and *P. montanus.* Gouws & Stewart (2007) have found phylogenetically there are three well-supported larger clades occurring (1) north of the Swan River, (2) south of the Swan River, and (3) in an area further south. They showed evidence of seven lineages regarded as Evolutionarily Significant Units and possibly several subspecies, all which will be local endemics to the Swan coastal Plain.

DISTRIBUTION:

A south west Australian endemic species found in groundwater-fed wetlands of the Swan Coastal Plain around Perth, Western Australia

Type location: Dog Swamp/Smith's Lake, Perth, Western Australia

AREA OF EXTENT (EOO): 3,762 km^2
AREA OF OCCUPANCY (AOO: 0.02 degree grid): 44 km^2
Number of records used for calculation: 35
Number of locations: 9?

Note: There are more records for this species in published literature. Several records need clarification e.g. ALA record Bulter's swamp Claremont NSW, should be Claremont Lake (formerly Bulter's Swamp, Claremont WA). There are also several records without co-ordinates; Mongers Lake, Guilford, Pinjarra, Wattle Grove (Welshpool).

HABITAT:

Found in groundwater-fed wetlands of the Swan Coastal Plain. Some of these wetlands dry out during the summer and during this dry phase *Paramphisopus palustris* buries into the deep fissures in the lakebed to survive in the damper areas.

POPULATION:

Early collections revealed *Paramphisopus palustris* to be present in many of the coastal swamps and lakes near Perth (Nicholls, 1943). This species is often found in abundance when water levels are high. Hembree & George (1978) found the abundance declined quickly when water levels began to recede in summer and it was not collected again until the following water level rise. Hembree and George (1978) surveyed the northern Swan Coastal Plain wetlands but only recorded one population in Lake Jandabup. *Paramphisopus palustris* was recorded in 27 Swan Coastal Plain wetlands in the 1990's (Balla & Davis, 1993; Davis *et al.*, 1993) and Gouws & Stewart (2007) recorded this species from 23 locations. It has been estimated that more than 80% of wetlands on the Swan Coastal Plain have been lost or degraded (Environmental Protection Authority, 2007) so it is uncertain how many populations have declined since 1998.

THREATS, LIMITING FACTORS AND MANAGEMENT ISSUES

Altered hydrology, habitat loss and degradation are threats to this species. With a reduction in rainfall and groundwater levels in the Swan Coastal Plain (SCP) region, groundwater is becoming disassociated from surface water, often resulting in changes in salinity or lakes drying out. In addition to this, the Swan Coastal Plain has underlying acid sulphate soils and several wetlands are experiencing acidification events. There has been a decline in populations of *Paramphisopus palustris* at several locations due to these threats e.g. Lake Jandabup (Sommer & Horwitz, 2009; Sommer & Horwitz, 2001) and Lake Mealup (Pennifold, 2017), but the number of locations with declining or lost populations is unknown.

SOURCE MATERIALS

Balla S. & Davis J. (1993) Wetlands of the Swan Coastal Plain. Volume 5: managing Perth's wetlands to conserve the aquatic fauna. Water Authority of Western Australia, Environmental Protection Authority,Perth.

Davis J.A., Rosich R.S., Bradley J.S., Growns J.E., Schmidt L.G. & Cheal F. (1993) Wetland classification on the basis of water quality and invertebrate community data. Water Authority of Western Australia,Perth. Vol. 6.

Environmental Protection Authority. (2007) State of Environment Report Western Australia. Government of Western Australia, http://www.epa.wa.gov.au/state-environment-report-2007

Gouws G. & Stewart B. (2007) From genetic structure to wetland conservation: a freshwater isopod Paramphisopus palustris (Phreatoicidea: Amphisopidae) from the Swan Coastal Plain, Western Australia. *Hydrobiologia,* **589,** 249-263.

Hembree D. & George R.W. (1978) The Aquatic Invertebrate Fauna of the Northern Swan Coastal Plain. Western Australian Museum,

Nicholls G.E. (1943) The Phreatoicoidea. Part I. The Amphisopidae. *Papers and Proceedings of the Royal Society of Tasmania***,** 1 - 71.

Pennifold M.G. (2017) Lake Mealup Invertebrate sampling November 2016. Summary presented to Lake Mealup Technical Advisory Group.

Sommer B. & Horwitz P. (2001) Water quality and macroinvertebrate response to acidification following intensified droughts in a Western Australian wetland. *Marine and Freshwater Research,* **52,** 1015-1021.

Sommer B. & Horwitz P. (2009) Macroinvertebrate cycles of decline and recovery in Swan Coastal Plain (Western Australia) wetlands affected by drought-induced acidification. *Hydrobiologia,* **624,** 191-203.

Wilson G.D.F. & Johnson R.T. (1999) Ancient endemism among freshwater isopods (Crustacea, Phreatoicidea). In: *The Other 99%. The Conservation and Biodiversity of Invertebrates.* (Eds W. Ponder & D. Lunney), pp. 264 - 268.

Paroster pallescens (Sharp 1882)

Figure 1 Paroster pallescens.
Line = 1mm (from Watts & Leys 2008)

Phylum: Arthropoda Class: Insecta Order: Coleoptera
Family: Dytiscidae Subfamily: Hydroporinae
Scientific name: *Paroster pallescens* (Sharp 1882)
Common name: Diving Beetle
Australian National code: QC091406

CURRENT CONSERVATION STATUS:

Paroster pallescens is currently not listed under any State or Commonwealth legislation.

Paroster pallescens is not listed on the 2018 IUCN Red List of Threatened Species.

BIOLOGICAL OVERVIEW.

Paroster pallescens is a diving beetle only known from the south-west of Australia, restricted to the coastal areas between Pinjarra and Geraldton. This species is well adapted to living and breeding in temporary waters and often occurs in considerable numbers for a relatively short time. There are very few records for this species and it has been recorded from only 6 locations. It's EOO <20,000km^2 and AOO <500km^2. Most locations are threatened by land clearing. This species was identified as a candidate priority species for Western Australia.

DESCRIPTION:

Paroster pallescens is a medium sized diving beetle endemic to south-western Australia. It is dark reddish-brown to black with a dark/light dorsal colour pattern with lighter areas towards the front of the head and extreme side margins of the pronotum and elytra. The eyes are moderately large; and the antenna is relatively short and stout. The body is oval shaped and deep-bodied with a length 2.5–3.1 mm. See Watts and Leys (2008) for a full species description.

Paroster pallescens, like most *Paroster* species, appear to have specialized in exploiting seasonally flooded habitats and are well adapted to living in temporary waters (Hendrich & Balke, 2016). They are often the first water beetles to appear after these seasonal pools form. In many places, particularly shallow gutters and pools, they are the dominant species and occur in considerable numbers for a relatively short time in spring and are usually gone well before the water has dried up. Breeding also occurs in these places but frequently adults are abundant yet no larvae are present. It would seem that breeding is highly synchronized and growth rapid, not unexpected in these short-term habitats where larval food can be plentiful and competition from other species is slight (Hendrich & Fery, 2008).

VARIATION: The colour varies somewhat in general lightness or darkness. The strength of the dorsal reticulation and punctation is variable with some specimens, particularly females, strongly reticulate giving a mat surface.

The degree of sexual dimorphism in microreticulation of the elytra varies considerably between populations, for example there is little difference between the sexes in specimens from the Swan Valley, whereas specimens from near Pinjarra south of Perth the females have strong microreticulate.

DIFFERENTIAL DIAGNOSIS: The species can be confused with both *Paroster couragei* and *P. niger* but most specimens are larger and differently coloured, and can be distinguished by the characters given under those species (Watts & Leys, 2008). Resembles a small *P. sharpi*, *P. baylyi* or *P. michaelseni* but considerably smaller and the males have unmodified fore claws in contrast to the males of those species.

DISTRIBUTION:

Endemic to south-western Australia restricted to the coastal areas from Pinjarra to Geraldton.

AREA OF EXTENT (EOO): 12,078 km^2
AREA OF OCCUPANCY (AOO): 24 km^2
Number of records used for calculation: 10
Number of locations: 6
Type location: “W.Australia”

One location is within the Conservation area: Ellen Brook NR.

HABITAT:

Paroster pallescens occurs in shallow, seasonally flooded areas on the coastal sand plain near Perth, often together with *P. couragei* and *P. niger*. In some localities it can be extremely abundant for a short period in spring. Like all *Paroster* species which are reasonably well known, it disappears well before its habitat dries up in summer.

POPULATION:

Paroster pallescens can appear in high numbers in seasonally flooded habitats. In many places, particularly shallow gutters and pools, they are the dominant species and occur in considerable numbers for a relatively short time in spring and are usually gone well before the water has dried up. Breeding also occurs in these places but frequently adults are abundant yet no larvae are present. It would seem that breeding is highly synchronized and growth rapid. This species was identified as a candidate priority species for Western Australia.

THREATS, LIMITING FACTORS AND MANAGEMENT ISSUES

Paroster pallescens seems to be restricted to the coastal sand plain between Pinjarra and Geraldton. There are very few records for this species and it has been recorded from less than 10 locations. One location is within Ellen Brook Nature Reserve, but all other locations are threatened by habitat loss due to urbanisation and land clearing.

SOURCE MATERIALS

Hendrich L. & Balke M. (2016) A new epigean Paroster Sharp, 1882 from coastal New South Wales, Australia. Spixiana, 39, 213-218.

Hendrich L. & Fery H. (2008) Paroster baylyi sp. n., P. ursulae sp. n. (Col. Dytiscidae, Hydroporinae) and the water beetle diversity of pan-gnammas on isolated granite outcrops in the Mallee of south-western Australia. Zootaxa, 1704, 27-41.

Watts C.H.S. & Leys R. (2008) Review of the epigean species of Paroster SHARP, 1882, with descriptions of three new species, and phylogeny based on DNA sequence data of two mitochondrial genes (Coleoptera: Dytiscidae: Hydroporinae) Koleopterologische Rundschau, 78, 9-36.

Plectrotarsus minor (Mosely 1953)

Figure 1 Plectrotarsus minor.
(Australian National Insect Collection)

Phylum: Arthropoda Class: Insecta Order: Trichoptera
Family: Plectrotarsidae Subfamily:
Scientific name: *Plectrotarsus minor* (Mosely 1953)
Common name: Caddisfly
Australian National code: QT110302

CURRENT CONSERVATION STATUS:

Plectrotarsus minor is currently not listed under any State or Commonwealth legislation.

Plectrotarsus minor is not listed on the 2018 IUCN Red List of Threatened Species.

Sutcliffe (2003) suggested that *Plectrotarsus minor* was highly restricted and classified it as Endangered.

BIOLOGICAL OVERVIEW:

Plectrotarsus minor is a small to medium caddisfly only know from the south-west of Western Australia. This species is very rare with only 3 records, each over 50 years apart. Very little is known about the life history or biology of *Plectrotarsus minor*. The adults are terrestrial and live close to water, while the larvae are aquatic. Further records are needed on this species to determine its distribution and conservation status. This species was identified as a candidate priority species for Western Australia.

DESCRIPTION:

Plectrotarsus minor is a little moth-like caddisfly. It has wings densely covered with a long pubescence. Total length 8-12 mm, anterior wing 6-7 mm. For description see Neboiss (1982).

The larvae are shredding detritivores and construct cases from pieces of plant material (Neboiss, 1986). For a larval description see Dean (2000b).

There are only 5 species within the Plectrotarsidae Family. Adults of this family are found flying during daytime in bright sunshine in a moth-like manner around flowering tea-tree (Leptospermum) and other shrubs (Neboiss, 1986).

DISTRIBUTION:

Endemic to south-western Australia restricted to the south-coast region.

One location within the Conservation area: Muir NR

Type Location: Albany 1866

AREA OF EXTENT (EOO): insufficient locations with co-ordinates
AREA OF OCCUPANCY (AOO): 4 km^2
Number of locations: 3

Additional locations without co-ordinates: Nornalup 1958 and type location Albany (See Neboiss, 1982)

HABITAT:

Unknown. One location is a shallow peat flat covered in very dense Melaleuca. This site is maintained by an over-flow from Poorginup Swamp.

THREATS, LIMITING FACTORS AND MANAGEMENT ISSUES:

This species is highly restricted and very rare. Only 3 location records have been found and these were from Albany1866, Nornalup 1958 and Swamp on Mygelup Rd nr Lake Poorginup 2014. All these locations are on the south coast and *Plectrotarsus minor* may be restricted to this area. Stewart (2009) and Cook et al (2008) have not published any records for Plectrotarsidae in their study on the south coast region waterways.

SOURCE MATERIALS

Cook B., Janicke G. & Maughan J. (2008) Ecological values of waterways in the South Coast Region, Western Australia. Centre of Excellence in Natural Resource Management University of Western Australia. Report No CENRM079,.

Dean J.C. (2000) *Preliminary keys for the identification of Australian caddisfly larvae of the Families Antipodoeciidae, Atriplectididae, Limnephilidae and Plectrotarsidae. Identification guide no. 31.,* Cooperative Research Centre for Freshwater Ecology, Albury.

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Sutcliffe K. (2003) *The conservation status of aquatic insects in south-western Australia.*PhD, Murdoch University, Perth, Western Australia.