Anglesea Borefield MAP - Aquatic Ecological Monitoring 2018

Prepared for: Barwon Water

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Cover photo: Otway bush yabby *Geocharax gracilis captured at site BC2*

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- Scott Nicholson — Parks Victoria
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- Tom Scarborough — Barwon Water

Ethics and Permits

All surveys were undertaken under the following ethics and research permits granted to Ecology Australia:

- Wildlife and Small Institutions Animal Ethics Committee (WSIAEC) projects 11.16;
- Fisheries Research Permit 1142;
- *Wildlife Act 1975*, *Flora and Fauna Guarantee Act 1988*, and *National Parks Act 1975* Research Permit 10007806; and
- Scientific Procedures Fieldwork Licence 20097.

Summary

Ecology Australia was commissioned by Barwon Water to conduct the spring 2018 ecological Monitoring and Assessment Program (MAP) for the Anglesea Borefield Project (ABP). This consisted of the aquatic ecological (fish and macroinvertebrates) components of the revised MAP (Victorian Government 2014).

The aquatic monitoring component of the revised MAP is required annually at three sites, and triennially at 11 sites. Triennial monitoring of all 11 sites was last completed in 2015, and hence was conducted again in 2018. Monitoring consists of modified RBA sampling for macroinvertebrates at all sites, and targeted sampling for a genetically distinct population of Southern Pygmy Perch *Nannoperca australis* using bait traps.

All macroinvertebrate samples exhibited low abundance and diversity, which is consistent with previous years. No samples met the SEPP objectives for number of taxa, key families, or number of EPT taxa. Some samples and/or overall sites met the objectives for SIGNAL scores. Limited availability of surface water including poor connectivity, and poor water quality are likely to be contributing factors in the poor macroinvertebrate indices results.

A total of 56 Southern pygmy perch were captured from Salt Creek (SC1), and none were captured from Breakfast Creek tributary (BCT1). The abundance of Southern pygmy perch in SC1 appears to have been highly variable over the 11 years of monitoring, but catch per unit effort appears to have stabilised after a potential population reduction in 2016. Recruitment appears to have occurred annually at SC1. Recruitment has not been detected at BCT1 since spring 2016. The populations in Salt Creek and Breakfast Creek tributary may be important source populations for recolonisation lower in the catchment.

Otway bush yabby *Geocharax gracilis* was detected at six of the eleven surveys locations, including repeat detections at the two study sites where they were detected in 2017 (Ecology Australia 2018), and four new sites. A total of 126 individuals were detected. Otway bush yabby is listed as Endangered on the Victorian Advisory List of threatened invertebrates (DSE 2009).

Due to the limited presence of surface water, it may be beneficial to reduce the number of macroinvertebrate samples per site from three down to two, to avoid oversampling sites that consist of small refuge pools; oversampling likely results in poorer results per sample.

Given the recent failure to detect Southern pygmy perch at BCT1, it would be beneficial to reassess the catchment for additional populations. As a genetically distinct population in an isolated catchment, it is of concern that the species may have retracted to a single remnant population as this would indicate a high level of vulnerability for this genetic lineage.

Consideration should be given to formalised inclusion of Otway bush yabby in the monitoring program in future years, including investigations into the extent of the population throughout the study area.

1 Introduction

Ecology Australia was commissioned by Barwon Water to conduct the spring 2018 ecological Monitoring and Assessment Program (MAP) for the Anglesea Borefield Project (ABP). This consisted of the aquatic ecological (fish and macroinvertebrates) components of the revised MAP (Victorian Government 2014).

The ABP was established to access and supply ground water to Geelong and surrounding areas in periods of drought when demands placed on regular water supply sources exceed capacity.

The MAP is a requirement of the ABP under the Bulk Entitlement (BE) (Anglesea Groundwater) Order 2009, established under the Water Act 1989. It was developed and implemented in 2009 (Victorian Government 2009) to assess the impacts of water draw down on the environment and the long term sustainability of the program. Potential risks to ecological values include acid generation, reduced water table (aquifer levels) and altered surface water regime.

Ecology Australia has developed and conducted the terrestrial monitoring components to date, the details of which are provided in annual reports (Ecology Australia 2009–2013a). GHD undertook the initial aquatic ecology monitoring program (GHD 2010–2017). This is the second year that Ecology Australia has undertaken the aquatic ecology monitoring components of the program.

As required under the BE (Victorian Government 2009), a review of the MAP was carried out in 2013 and knowledge gaps were addressed (GHD 2013b, Ecology Australia 2013b). The outcome was a revised focus with terrestrial monitoring targeting specific areas identified as currently at risk, which include the Anglesea Swamp and the Anglesea Estuary. The survey protocol for aquatic monitoring under the revised MAP (Victorian Government 2014) requires:

- Annual spring monitoring of macroinvertebrates at three sites:
  - Breakfast Creek tributary (BCT1);
  - Salt Creek (SC1); and
  - Lower Anglesea River wetland (Wetland 3).
- Annual spring sampling of Southern pygmy perch *Nannoperca australis* at two sites:
  - Breakfast Creek tributary (BCT1); and
  - Salt Creek (SC1).
- Triennial spring sampling of macroinvertebrates at all 11 aquatic monitoring sites.

Triennial monitoring of all 11 sites was last completed in 2015, and hence was conducted again in 2018.

The terrestrial ecology component of the revised MAP included baseline monitoring of the Anglesea Swamp for three consecutive years (2014–2016) which is now complete (Ecology Australia 2014, 2015 & 2016). From 2017 onwards, the current MAP requires the swamp to be monitored biennially in the absence of ground water pumping, and annually during water draw down.

The estuary was last monitored in 2015 (Ecology Australia) and in the continued absence of ground water pumping, was monitored again in 2017 (Ecology Australia 2018).

To align with the Anglesea Estuary monitoring, at the request of Barwon Water, biennial monitoring of the Anglesea Swamp commenced in 2017. As a result, no terrestrial monitoring was required in 2018.

2 Study Area

The study area encompasses the Anglesea Swamp, located within Anglesea Heath Park, Otway Forest Park and Great Otway National Park. Eleven sites were investigated for the 2018 monitoring program and are listed in Table 1 and depicted in Figure 1.

Table 1 List of sites investigated in 2018 including location and sampling regime

Site name	Site ID	Easting	Northing	Sampling required
Upper Anglesea River 1	UAR1	242968	5752428	Macroinvertebrate sampling
Upper Anglesea River 2	UAR2	246596	5753550	Macroinvertebrate sampling
Breakfast Creek 1	BC1	240936	5746555	Macroinvertebrate sampling
Breakfast Creek 2	BC2	243188	5747870	Macroinvertebrate sampling
Breakfast Creek 3	BC3	243466	5747638	Macroinvertebrate sampling
Breakfast Creek Tributary 1	BCT1*	242894	5748151	Macroinvertebrate and fish sampling
Breakfast Creek Tributary 2	BCT2	242917	5748114	Macroinvertebrate sampling
Salt Creek (above swamplands)	SC1	245272	5746978	Macroinvertebrate and fish sampling
Anglesea Wetland 1	Wetland 1	252545	5748828	Macroinvertebrate sampling
Anglesea Wetland 2	Wetland 2	253277	5747834	Macroinvertebrate sampling
Anglesea Wetland 3	Wetland 3	253304	5747866	Macroinvertebrate sampling

GDA94 Map Zone 55H

*moved to SV3 for consistency with previous years (refer to section 3.1)

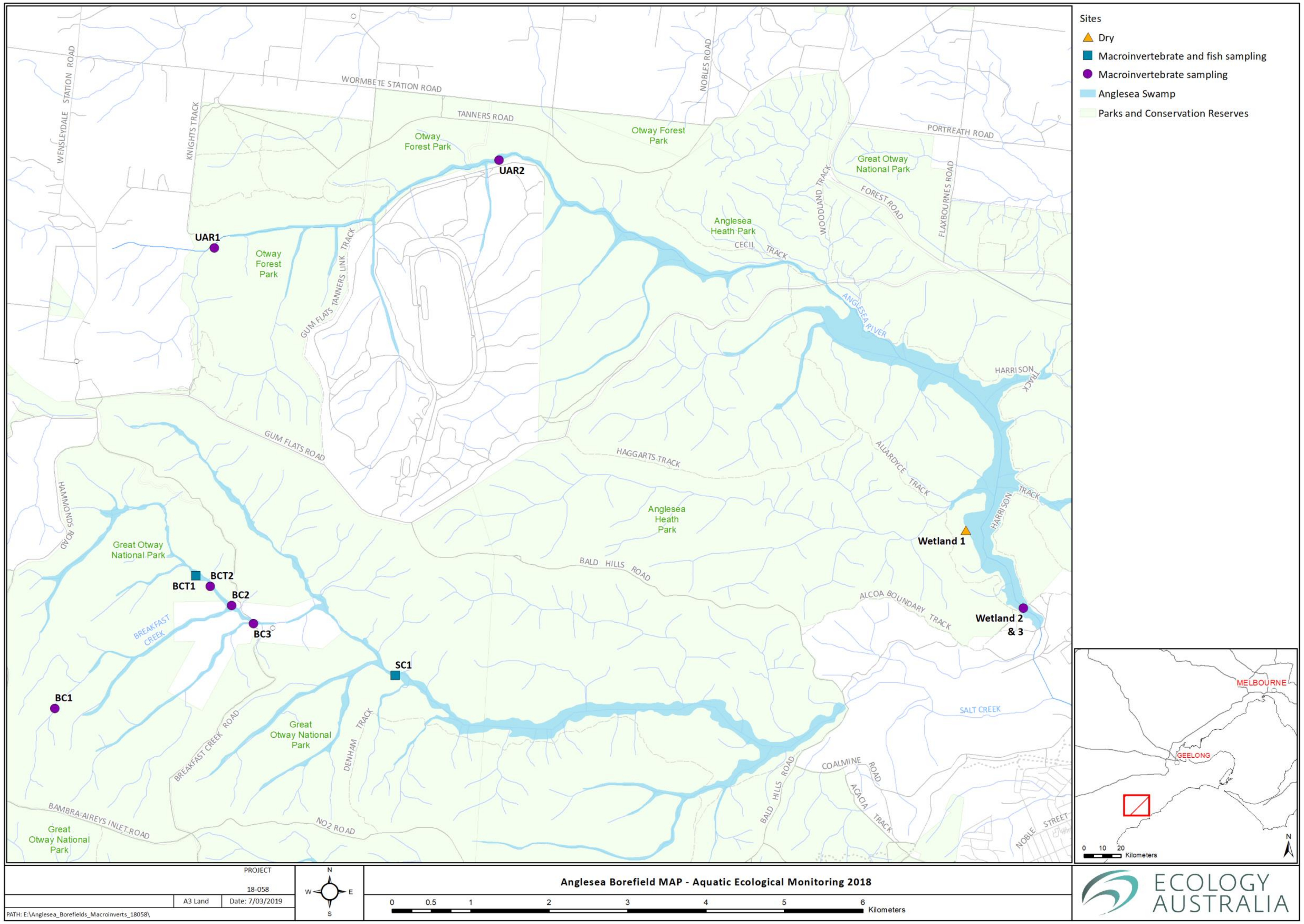


Figure 1 The locations of the eleven sites investigated in 2018

3 Methods

The aquatic sampling methods used are based on the revised MAP requirements and approaches used by GHD (2010–2017), with minor modifications as per the methods carried out by Ecology Australia in spring 2017 (Ecology Australia 2018).

Under the revised MAP (Victorian Government 2014) terrestrial ecological (vegetation and frog) monitoring was not undertaken in 2018 and spring aquatic ecological monitoring was conducted as required at all suitable sites (Figure 1).

3.1 Macroinvertebrate surveys

Macroinvertebrate surveys were undertaken at nine sites on 16–19 October 2018. Site BCT1 was again relocated downstream due to insufficient surface water being present at or within the vicinity of the location coordinates provided in 2017. Based on photographs of BCT1 by GHD (2016), it was apparent that the site has previously been relocated to stream gauge SV3 (Ecology Australia 2018). Following consultation with Mark Dodgshun of Barwon Water, the survey was again undertaken at SV3, however for consistency it will be referred to as BCT1. Wetland 1 could not be sampled as there was insufficient surface water available to collect three samples. Wetland 2 and Wetland 3 were combined into a single site, as they act as a single waterbody due to connectivity between the two sites, and as there was insufficient water in either one to collect three samples, but sufficient water once the two sites were combined.

As per the methods outlined by GHD (2016), triplicate edge samples were collected at each site following the methods outlined in the Victorian Rapid Bioassessment (RBA) Methodology for Rivers and Streams (EPA 2003). A 0.25 mm mesh net with a 30 cm x 30 cm opening was used to collect each sample. Edge ('sweep') samples were collected from water bodies with little to no flow. The sampling objective was to subsample all types of habitats present, which can include overhanging vegetation, coarse woody debris, backwaters, bare edges, leaf packs and macrophytes. Each sample consisted of 10 m of habitat, which was not necessarily contiguous. The water and habitat was agitated to dislodge macroinvertebrates and suspend them within the water column. Additional invertebrates which were observed but not collected (e.g. fast moving) were noted on the sample label.

Samples were live-sorted ('picked') following the standard RBA procedures and preserved in 70% ethanol. In summary, the procedures entail:

- Picking for 30 minutes from a white tray, aiming to collect 200 animals from as many different taxa as possible;
- If less than 200 animals are collected within 30 minutes then picking continues for an additional 10 minutes;
- If 200 animals are collected within 40 minutes and no new taxa are detected, then picking ceases; otherwise picking continues for an additional 10 minutes. This continues until a maximum of 60 minutes of picking has been completed; and
- Avoidance of favouring large and abundant taxa over smaller, more cryptic taxa, by picking a maximum of approximately 30 of each taxa, with the exception of animals which may superficially appear to be the same but typically require microscopic examination to identify the additional taxa (e.g. Chironomid subfamilies).

At each site, RBA field sampling and habitat assessment sheets were completed, including in situ water quality measurements using a calibrated U-52 Horiba water quality meter.

3.1.1 Macroinvertebrate identification

Macroinvertebrates were identified and enumerated with a stereo microscope using keys outlined in MDFRC (2013), which provides an update on those outlined in Hawking (2000). The majority of taxa were identified to family level with the following exceptions as per the RBA protocols (EPA 2003):

- Chironomidae are identified to sub-family;
- Oligochaeta and Acarina are not identified below these taxonomic levels;
- Adult and larval beetles are listed separately; and
- Taxa excluded from the recommended indices were discarded.

Additionally, specimens of the orders Ephemeroptera, Plecoptera, Trichoptera and Odonata were identified to genus level, as per GHD (2015–2017).

3.2 Macroinvertebrate data analyses

Macroinvertebrate data were analysed both as individual samples, and on a site basis using the combined data from three samples. Where available, the results were compared against indices in State Environment Protection Policy – Waters of Victoria (SEPP-WoV) (2003). SEPP-WoV objectives are based on combined edge and riffle samples, so these are provided as a guideline only as the current sampling regime consists of triplicate edge samples. The SEPP has been updated since the last year of monitoring and is now SEPP-W (Victorian Government Gazette 2018). SEPP-WoV indices have been used for consistency with previous reports (GHD 2010-2017, Ecology Australia 2018), in addition to SEPP-W objectives to be in line with current indices.

The following indices were used to analyse macroinvertebrate data:

- Number of taxa — total number of taxa based on taxonomic resolution levels described in Section 3.1.1;
- Abundance — total number of individuals collected excluding those that were discarded (e.g. Collembolla, Staphlinidae beetles);
- Number of EPA key families — based on the number of taxa that have been identified as typical of waterways in this region (segment B3: Forests B) (Victorian Government Gazette 2003);
- SIGNAL score — average SIGNAL score for taxa collected in each sample, using the scores adopted by EPA (2003) and based on methods of Chessman (1995). Table 2 provides the corresponding water quality categories;
- Number of EPT taxa — number of taxa from the orders of Ephemeroptera, Plecoptera and Trichoptera (EPT), which are considered more sensitive to pollution and disturbance and hence are considered an indicator of ecosystem health;
- Number of EPTO taxa — number of taxa from the orders of Ephemeroptera, Plecoptera, Trichoptera and Odonata (EPTO). This index is used for waterways in 'Mediterranean climate' regions, and aids in interpreting the health of lentic (still water) systems, where the numbers

of Plecoptera are diminished while Odonata, which are also relatively sensitive to pollutants and disturbance, are more abundant and diverse (Pinto et al. 2004)

Table 2 SIGNAL score classifications

SIGNAL score	Water quality
>7	Excellent
6-7	Clean water
5-6	Mild pollution
4-5	Moderate pollution
<4	Severe pollution

3.3 Fish surveys

Surveys targeting Southern pygmy perch *Nannoperca australis* were undertaken at two sites; SC1 and BCT1 on 17–19 October 2018. As with the macroinvertebrate surveys, site BCT1 was relocated downstream due to insufficient surface water (see 3.1).

Ten bait traps (mesh size of 2 mm and funnel entrances of 4 cm) with 4 inch yellow glow sticks were set in the afternoon and retrieved the following morning at both sites. This is a modification of the methods used by GHD (2015–2017), where it is believed that five bait traps were set each year during surveys conducted from 2012–2016 (GHD 2013–2017). The number of traps was increased to increase the likelihood of collecting 30 Southern pygmy perch per site.

The first 30 Southern pygmy perch were required to be measured (total length) to the nearest millimetre, and weighed to the nearest 0.1 gram. Subsequent Southern pygmy perch were also measured to increase the accuracy of population structure estimates. Additional taxa of interest detected in bait traps or observed at each site were recorded, with a particular focus on threatened crayfish Otway bush yabby *Geocharax gracilis*.

Instream habitat assessment was undertaken at all sites surveyed. The habitat assessment included notes on existing sources of disturbance, notes and estimates of biological and physical attributes (e.g. wetted instream cover, riparian shading, aquatic vegetation, substrate composition, flow and depth) and in situ water quality measurement. An outline of some of these habitat descriptors is provided below:

- The percentage cover of various forms of instream habitat (based on the proportion of the wetted area that they covered at the time of assessment).
- The shading estimate as per the EPA Rapid Bioassessment method (EPA 2003). This is an estimate based on a plan view as it would appear with the sun directly overhead (i.e. midday).
- The flow status estimate is as per the USEPA fieldsheets that are incorporated into the latest iteration of the Victorian EPA Rapid Bioassessment fieldsheets (Version: September 2012). This is an estimate based on the proportion of the channel filled and/or substrate exposed.
- The disturbance rating estimate is based on identification of a number of disturbance sources including levels of bank erosion, riparian vegetation clearance, parallel or adjacent roads, bridges/culverts/fords, rubbish, drain input, water extraction points, stock access,

sedimentation, invasive exotic vegetation, barriers to fish passage, channelization and hydrological alterations; together with a severity rating (i.e. high, medium, low) applied to the disturbance sources that were identified at a given site.

Water quality measurements (dissolved oxygen (mg/L), pH, temperature (degrees Celsius), conductivity (mS/cm)) were made with a calibrated Horiba U-52 water quality meter.

4 Results

4.1 Macroinvertebrates

The macroinvertebrate site results based on combined data from each site sampled are provided in Table 3, for comparison against previous results (GHD 2010-2017, Ecology Australia 2018).

None of the samples collected contained sufficient macroinvertebrates to enable the sample to be picked in 30 minutes (each one had considerably less than 200 macroinvertebrates) and two sites were so depauperate that the combined data from three samples did not add up to 200 macroinvertebrates. Site W2/3 had the fewest taxa present, with only nine taxa detected across the three samples, and in one sample only four taxa were detected. This is substantially less than the State Environmental Protection Policy (SEPP) – Waters of Victoria (WoV) objective (Vic. Gov. 2003) of 24 taxa. No samples attained SEPP objectives for number of taxa, and even as combined samples by site there were no sites that achieved this objective.

None of the sites attained SEPP–WoV objectives for EPA key families, and even the three sites combined were unable to attain the objectives, with W2/3 again performing considerably worse than all other sampled sites. As combined sites, the highest number of taxa detected was 19, which occurred at two of the sites sampled.

Three sites attained SEPP–WoV objectives for SIGNAL scores when the three samples were combined, with BC1 attaining the highest score. BCT1 attained the highest diversity for both EPT and EPTO, but still failed to meet the SEPP–WoV objectives.

Table 3 Site macroinvertebrate indices results (non-attainment of SEPP objectives indicated by shading)

Indices	W2/3	SC1	BCT1	BCT2	BC1	BC2	BC3	UAR1	UAR2	SEPP objective*
# taxa	9	18	19	17	17	16	14	14	19	24
Abundance	209	120	143	206	400	276	281	433	242	N/A
EPA key families	6	13	12	13	12	12	11	9	11	26*
SIGNAL score	5.44	5.53	5.22	5.63	6.0	5.85	5.83	5.73	5.38	5.8
EPT	1	2	5	3	2	3	3	1	1	9
EPTO	1	2	7	3	4	3	3	2	2	N/A

4.2 Southern pygmy perch results

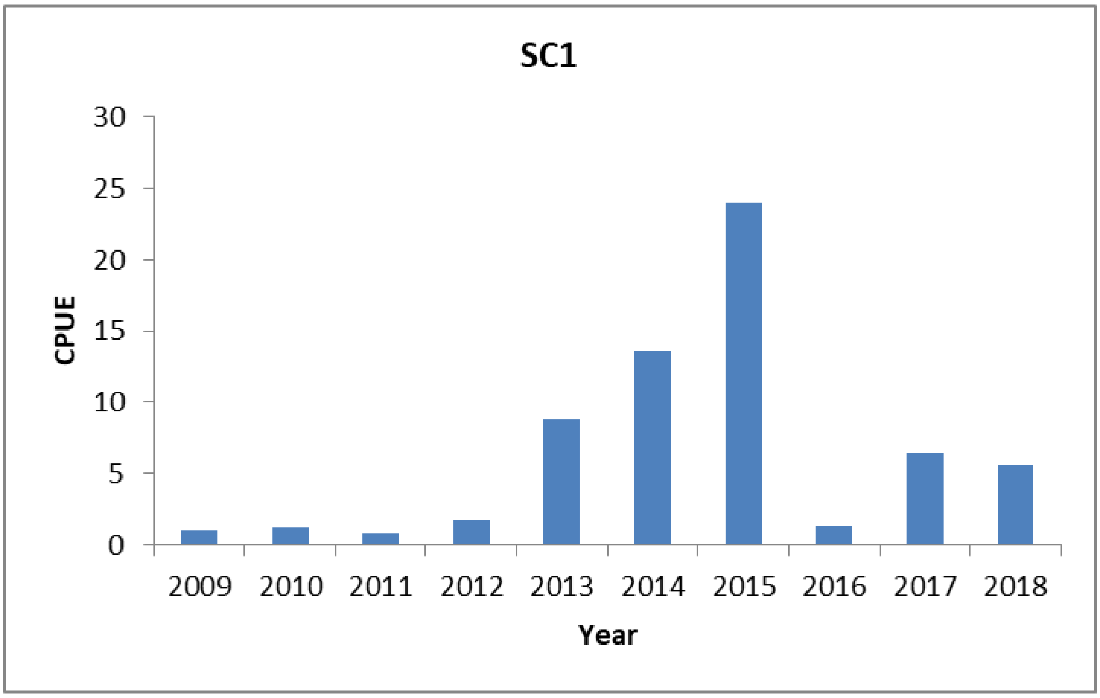
A total of 56 Southern pygmy perch were captured from Salt Creek (SC1), and none were captured from Breakfast Creek tributary (BCT1) (Figure 2 and Figure 3, Plate 1 and 2). These represent the fifth highest and equal lowest spring Catch Per Unit Effort (CPUE) since 2009, respectively. CPUE was calculated using number of traps deployed, based on the assumption that five bait traps were utilised each spring from 2009–2016, and ten traps were utilised in 2017 and 2018. It is unclear how many of the fish were detected via electrofishing versus bait traps in 2009 and 2010, or how many bait traps were used between 2012 and 2016 as it is not specified in the methods (GHD 2010–2017). While CPUE is typically measured by units of time, this was not feasible due to the lack of data from previous years.

Higher total abundances had been noted from BCT1 in the three preceding years of survey, followed by a reduction to zero fish detected in 2018. Recruitment was last detected in spring 2016 (GHD 2017), which means there have been two successive spring sampling events where recruitment was not detected. However, recruitment for this and most Victorian freshwater fish species is more reliably detected by sampling fish in autumn, rather than spring. Although no fish were detected during this round of monitoring, it should be noted that none were detected in spring 2012, and the population was redetected the following autumn.

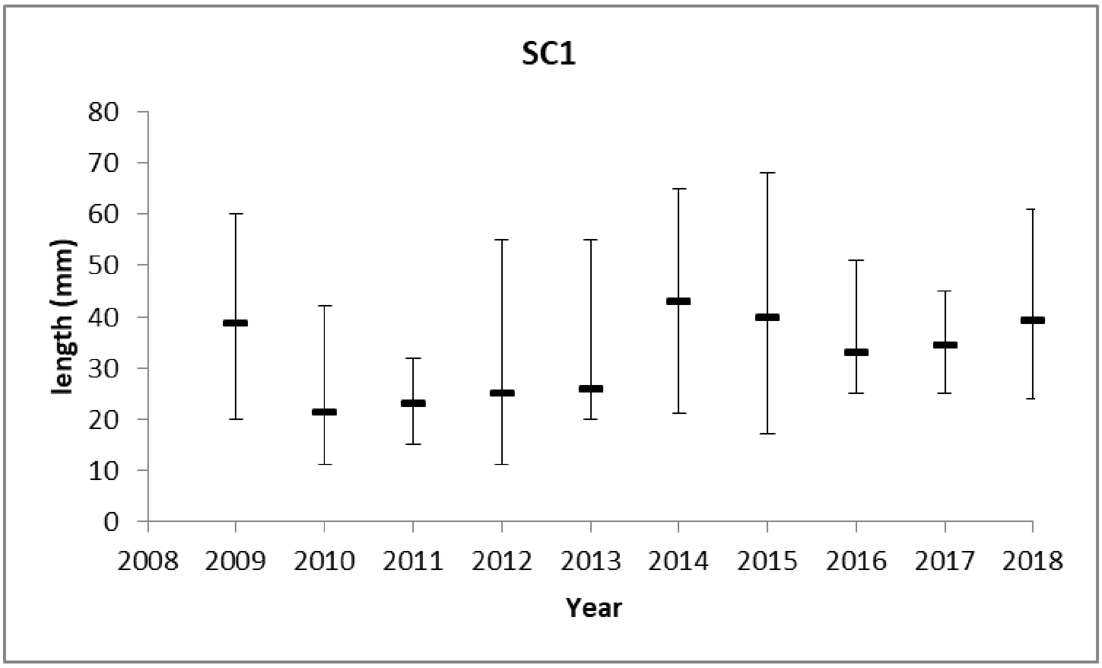
The abundance of Southern pygmy perch in SC1 appears to have been highly variable over the 11 years of monitoring, but numbers appear to have stabilised after an apparent reduction in 2016. Recruitment appears to have occurred annually at SC1.

A single Short-finned eel *Anguilla australis* (approximately 500 mm) was observed while setting bait traps at BCT1.

Plate 1 Male, female and juvenile Southern pygmy perch from SC1

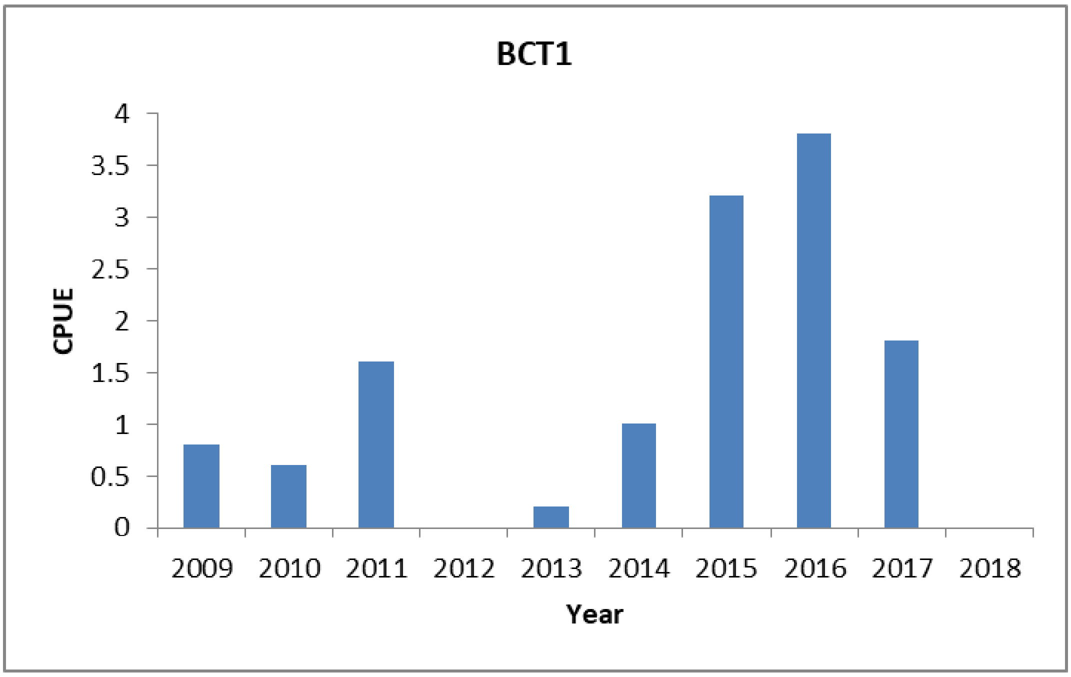


a) fish catch per unit effort at SC1.

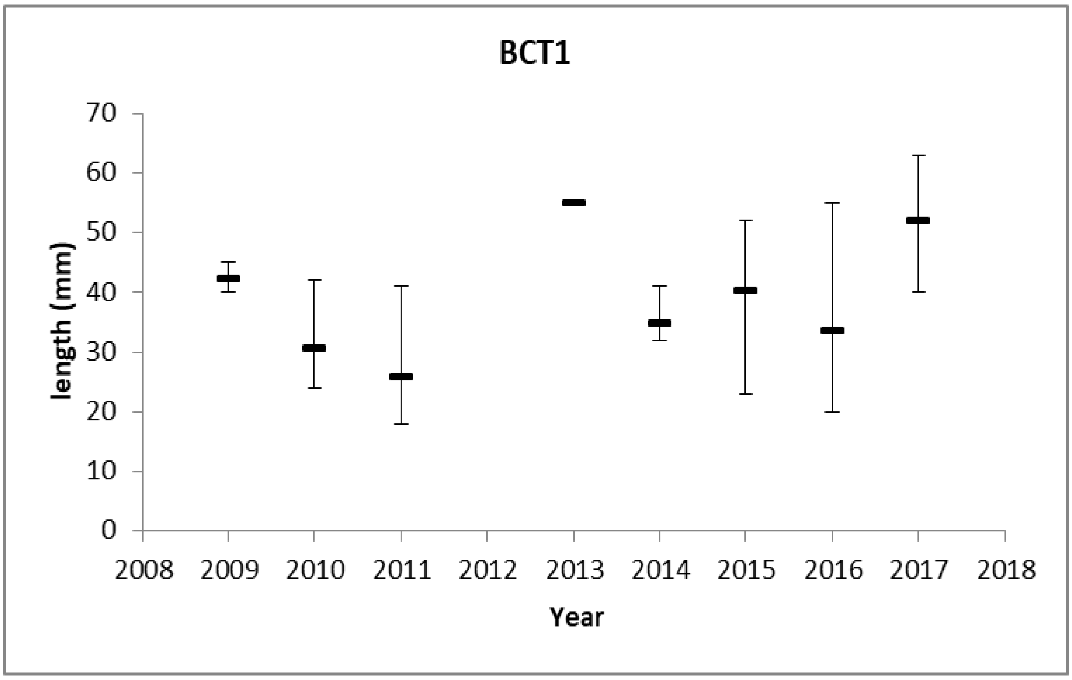


b) mean (black bars), together with minimum and maximum lengths (TL) of Southern pygmy perch. n= CPUE x5 from Figure 27a), with the exception of 2017 and 2018 where n=CPUEx10

Figure 2 Southern pygmy perch spring CPUE a), and length (TL) b) summary 2009–2018 at SC1



a) fish capture per unit effort at BCT1



b) mean (black bars), together with minimum and maximum lengths (TL) of Southern pygmy perch. n= CPUE x5 from Figure 27a), with the exception of 2017 and 2018 where n=CPUEx10

Figure 3 Southern pygmy perch spring CPUE a), and length (TL) b) summary 2009–2018 at BCT1

4.3 Water quality

Water quality results, whilst not consistently indicating attainment of SEPP objectives for conductivity, dissolved oxygen and pH, were fairly consistent with results from previous years (GHD 2010–17, Ecology Australia 2018) (Table 4). It should be noted that to accurately assess against SEPP-WoV indices, a minimum of 11 data points are required from a single year, hence single snap-shot measurements provide a poor indication of compliance.

Table 4 In situ water quality results (shading represents potential non-compliance with SEPP objectives, pink for measurements that indicate failure against both SEPP-WoV and SEPP-W, orange for measurements that indicate failure against one)

	Temperature (°C)	Conductivity (µs/cm)	Dissolved oxygen		pH
			mg/L	%Sat	
SEPP-WoV objective		<500 (75th percentile)		>90 (25th percentile)	6.4-7.7 (25th-75th percentile)
SEPP-W objective		<200 (75th percentile)		>85 (25th percentile	6.5-7.5 (25th -75th percentile)
UAR1					
UAR2	18.2	844	8.1	86	6.62
BC1	16.82	1930	6.72	71.9	7.12
BC2	12.67	339	5.12	51	5.16
BC3	14.10	368	2.8	28.2	3.15
BCT1	13.22	291	5.84	57.6	5.45
BCT2	14.0	292	6.9	69	4.94
SC1	13.48	321	6.33	62.8	5.23
W1*					
W2&3	13.54	4960	3.57	35.9	2.61

*W1 had insufficient surface water to take water quality readings

4.4 Otway bush yabby

Otway bush yabby *Geocharax gracilis* is a small freshwater crayfish listed as Endangered on the Victorian Advisory List of threatened invertebrates (DSE 2009). The species Otway bush yabby was detected at six of the eleven surveys locations, including repeat detections at the two study sites where they were detected in 2017 (Ecology Australia 2018), and four new sites. Otway bush yabby were detected during the fish survey (bait traps), during the macroinvertebrate survey (dip nets), and during additional, targeted dip netting (Table 5). A total of 126 individuals were detected. There are no local records of this species on the Victorian Biodiversity Atlas (DELWP 2017), however there is a published record from Salt Creek c.2007 (Schultz et al. 2007). Upon discovery in 2017 it was requested by Mark Dodgshun of Barwon Water that this species be monitored concurrently with the effort that was being employed for fish and macroinvertebrates (Ecology Australia 2018).

Table 5 Records of Otway bush yabby (spring 2018)

Site	Macroinvertebrate sampling	Bait trapping	Additional dip netting
UAR1	14*		
UAR2	5*		
BC1	0		
BC2	6*		
BC3	0		
BCT1	30	5	28
BCT2	27*		
SC1	4	1	6
W1			
W2&3	0		

*new record

Plate 2 Otway bush yabby, mature and juvenile specimens – Breakfast Creek tributary (BCT1)

Plate 3 Otway bush yabby – BC2

4.5 Aquatic monitoring results by site

Wetland 1

At the time of survey, Wetland 1 had very limited surface water and was deemed unsuitable for survey. Water depth was a maximum of 5 cm, which precluded taking water quality readings. The substrate was predominantly clay/silt, with *Juncus* spp., Paperbark and Tea-tree throughout the site (Plate 4).

Plate 4 Wetland 1 showing insufficient surface water for sampling

Wetland 2 and 3

At the time of survey, Wetlands 2 and 3 were very shallow, contracted, and dominated by dense Paperbark and Tea-tree. These two wetlands are connected and hence do not constitute independent sites. Additionally, at the time of survey there was insufficient surface water present in either wetland to collect three samples, so after discussions with Mark Dodgshun, Wetlands 2 and 3 were converted to a single site.

The substrate was predominantly clay/silt, with a gravel track running adjacent to the site and presenting a potential point source of pollutants and sediment. Filamentous algae, macrophytes and coarse particulate organic matter were present in moderate abundance. The majority of the site exhibited no obvious flow, with the exception of a small channel crossing under the track. Despite combining the two wetlands, this site had very limited standing water; had there been any less the site would have been ruled out. At the time of sampling, the water quality readings indicated that it was far from meeting SEPP objectives for pH, conductivity and dissolved oxygen.

The macroinvertebrate results for the wetland site were poor for all indices (Table 6). Site W2/3 has regularly been dry at the time of survey, or an alternative wetland site has been surveyed. Macroinvertebrate sampling results from Wetland 2/3 were broadly similar with the most recent survey in 2017 (Ecology Australia 2018); with minor improvements were observed across all indices despite massive increases in electrical conductivity.

Table 6 Macroinvertebrate sample results at W2/3, displayed individually and combined for the site, showing SEPP objectives (shading indicates potential non-attainment of SEPP objectives)

	W2/3-1	W2/3-2	W2/3-3	SEPP-W objective	W2/3	SEPP-WoV objective
# taxa	4	6	6	17	9	24
Abundance	111	41	57	-	209	-
Key families	2	5	3	-	6	26
SIGNAL	5.5	5.0	5.7	-	5.44	5.8
SIGNAL2	2.8	3.2	2.7	4.2		
EPT	0	1	0	6	1	9
EPTO	0	1	0	-	1	-

Salt Creek (SC1)

Plate 5 Salt Creek at SC1

Salt Creek at SC1 had one of the largest areas of surface water available for sampling, and appeared permanent. The substrate was silt/clay, and the flow velocity was dominated by lentic (still) habitats with small sections of glide. The main instream cover available for fish and macroinvertebrates, in decreasing order of prevalence, consisted of coarse particulate organic matter (e.g. leaves and other organic debris), loose silt lying on the surface, overhanging terrestrial vegetation, aquatic vegetation, branches, overhanging bank and logs. There was some evidence of deer damage (pugging) around the site. The dominant aquatic vegetation types were *Juncus* spp., *Carex* spp. and *Isolepis* spp.

The macroinvertebrate results for Salt Creek failed to attain SEPP objectives for all indices with the exception of the SIGNAL and SIGNAL2 score for one of the three samples (Table 7). No EPT or EPTO taxa were detected in two of the three samples. SC1 has been surveyed annually, and was last surveyed in 2017 (Ecology Australia 2018). The pH and dissolved oxygen levels both showed improvements, while the macroinvertebrate results showed declines against all measurements. However, the macroinvertebrate results are largely better or similar to the results from 2014–2016 (GHD 2015–2017), with the exception of a lower SIGNAL score.

Table 7 Macroinvertebrate sample results at SC1, displayed individually and combined for the site, showing SEPP objectives

	SC1-1	SC1-2	SC1-3	SEPP-W objective	SC1	SEPP-WoV objective
# taxa	10	12	13	17	18	24
Abundance	47	20	50	-	117	-
Key families	7	9	8	-	13	26
SIGNAL	5.5	5.8	4.9	-	5.5	5.8
SIGNAL2	3.5	4.3	3.3	4.2		
EPT	0	2*	0	6	2*	9
EPTO	0	2*	0	-	2*	-

*additional taxa present at genus level

Southern pygmy perch total abundance and CPUE were slightly lower than the previous year, and remain substantially lower than 2015. The length-frequency histogram shows there are multiple age classes present at SC1, and that successful recruitment has occurred in the past 12 months. Southern pygmy perch reach maturity at approximately 30–33 mm (Knight 2008), and 12–13 of the 56 fish detected were below this threshold (Figure 4).

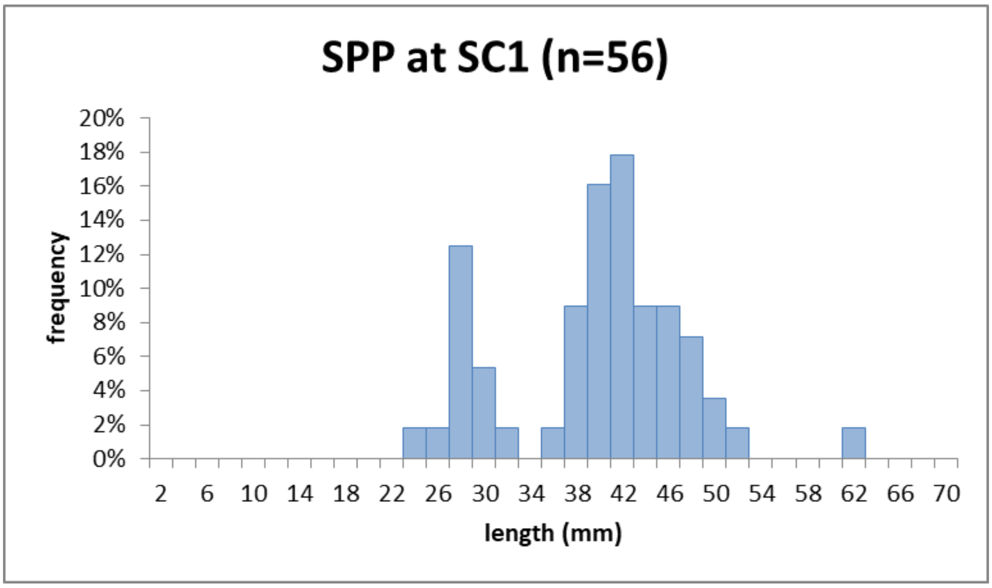


Figure 4 Length-frequency histogram of Southern pygmy perch at SC1.

Breakfast Creek tributary 1 (BCT1) at SV3

Plate 6 Breakfast Creek tributary (BCT1) at SV3, showing stream gauge

Breakfast Creek tributary at SV3 (relocated BCT1) consisted of a narrow, shallow stream, with a maximum width of 1 m. The substrate was silt/clay, and the flow velocity was dominated by lentic (still) habitats with less than 15% glide within the surveyed reach. The main instream cover available for fish and macroinvertebrates, in decreasing order of prevalence, consisted of coarse particulate organic matter (e.g. leaves and other organic debris), loose silt lying on the surface, overhanging terrestrial vegetation, woody debris, aquatic vegetation, overhanging bank and moss. The dominant aquatic vegetation type was *Blechnum* sp. The water level was slightly lower than in 2017, based on the site photographs, and stream gauge SV3 (235274A) data provided by Tom Scarborough of Barwon Water. During the sampling period in 2017, the water level ranged from 0.125–0.144 m and discharge ranged from 0.02–0.08 ML/day, whereas in 2018 the water level was 0.1–0.112 m and discharge was <0.003 ML/day.

Similarly to SC1, the macroinvertebrate results for the Breakfast Creek tributary site 1 failed to attain SEPP objectives for every index with the exception of SIGNAL score, of which two of the individual samples met the required score, and SIGNAL2 where all samples met the required score (Table 8). Whilst failing to meet the objectives, BCT1 results were superior to other sites for number of taxa, number of EPT taxa, and number of EPTO taxa. BCT1 showed slight declines against measured indicators for macroinvertebrates compared with 2017 results (Ecology Australia 2018), despite no major changes in water quality levels. Site BCT1 has been sampled annually. The results from the past few years are fairly consistent, with some indices improving and others declining marginally. Compared with 2014–2016 (GHD 2015–16), the number of taxa, EPT and EPTO indices have improved, while key families are similar and the SIGNAL score has dropped.

Table 8 Macroinvertebrate individual sample and combined sample results at BCT1 and the SEPP objectives (shading indicates non-compliance with objectives)

	BCT1-1	BCT1-2	BCT1-3	SEPP-W objective	BCT1	SEPP-WoV objective
# taxa	10	15	8	17	19	24
Abundance	45	63	35	-	143	-
Key families	7	11	7	-	12	26
SIGNAL	6.2	5.6	6.4	-	5.6	5.8
SIGNAL2	5.6	4.3	5.3	4.2		
EPT	2	4	3	6	5	9
EPTO	4	5	3	-	7	-

No Southern pygmy perch were detected during this round of monitoring. The length-frequency histogram from 2017 suggests that recruitment failure may have occurred, however detection of recruitment has been inconsistent at this site throughout the 11 years of monitoring. Southern pygmy perch reach maturity at approximately 30–33 mm TL (Knight 2008), and none of the fish detected in 2017 were below this threshold. However, recruitment is more reliably detected by autumn rather than spring sampling. Additionally, growth rates of fish can be highly variable between sites depending on factors such as temperature and resource availability, so length alone can be a very coarse measurement of recruitment. Two additional bait traps were deployed downstream of the stream gauge, however these also failed to detect any fish. It should be noted that a single Short-finned eel (approximately 500 mm TL) was observed within the site whilst setting the bait traps. This species is omnivorous and is likely to prey upon both Southern pygmy perch and Otways bush yabby.

Breakfast Creek tributary 2 (BCT2)

Plate 7 Breakfast Creek tributary 2 (BCT2)

Breakfast Creek tributary at BCT2 was sampled as two small pools. The pH and dissolved oxygen levels were both low. The substrate was silt/clay, and the site was solely made up of lentic (still) habitat. The main instream cover available for macroinvertebrates, in decreasing order of prevalence, consisted of coarse particulate organic matter (e.g. leaves and other organic debris), trailing bank vegetation, loose silt lying on the surface, aquatic vegetation and overhanging bank. The dominant aquatic vegetation types were *Carex* spp. and ferns trailing in the water.

The macroinvertebrate results for Breakfast Creek tributary 2 were similar to those for BCT1 and SC1; failing to meet any SEPP objectives with the exceptions of a single sample which achieved the objective for SIGNAL score, and SIGNAL2 where all samples met the objective (Table 9). No prior surveys have been conducted at BCT2 due to insufficient surface water. The site performed similarly to other sites surveyed this year, despite being consistently too dry to sample in the past.

Table 9 Macroinvertebrate individual sample and combined sample results at BCT2 and the SEPP objectives (shading indicates non-compliance with objectives)

	BCT2-1	BCT2-2	BCT2-3	SEPP-W objective	BCT2	SEPP objective
# taxa	13	13	12	17	17	24
Abundance	69	67	63	-	206	-
Key families	11	11	10	-	13	26
SIGNAL	5.7	5.8	5.6	-	5.6	5.8
SIGNAL2	4.6	4.2	4.2	4.2		
EPT	3	3	3	6	3	9
EPTO	3	3	3	-	3	-

Breakfast Creek 1 (BC1)

Plate 8 Breakfast Creek at BC1

Breakfast Creek at BC1 had contracted to isolated pools at the time of sampling, and consisted of three pools each approximately 8 m long. The flow velocity was dominated by lentic (still) habitats with small sections of glide. The substrate covered all size classes from clay/silt through to bedrock, with bedrock and boulder being the dominant classes present (each approximately 25%). The main instream cover categories present for macroinvertebrates, in decreasing order of prevalence were loose silt lying on substrate, coarse particulate organic matter, undercut banks, trailing bank vegetation and moss. The only aquatic vegetation noted was *Carex* spp. Small patches of exotic groundcover were noted in a largely intact riparian zone. The conductivity at this site was elevated, at 1.93 mS/cm, and much higher compared with the other two sites sampled on Breakfast Creek.

The macroinvertebrate results for Breakfast Creek at BC1 did not attain SEPP objectives for number of taxa, key families or number of EPT taxa (Table 10). The SIGNAL scores largely indicated that the water quality of the site was classified as clean water, and that it attained SEPP-WoV objectives for this index. One of the three samples attained the SEPP-W objective for SIGNAL2. BC1 in 2018 recorded much higher electrical conductivity levels but showed improvements in dissolved oxygen and pH levels compared with spring 2010 (GHD 2011). The macroinvertebrate results show slight improvements.

Table 10 Macroinvertebrate individual sample and combined sample results at BC1 and the SEPP objectives (shading indicates non-compliance with objectives)

	BC1-1	BC1-2	BC1-3	SEPP-W objective	BC1	SEPP objective
# taxa	9	11	10	17	17	24
Abundance	141	138	121	-	400	-
Key families	6	7	7	-	12	26
SIGNAL	7	5.8	6.2	-	6.0	5.8
SIGNAL2	3.9	4.8	4	4.2		
EPT	2*	2	2*	6	2*	9
EPTO	2*	4	2*	-	4*	-

*additional taxa present at genus level

Breakfast Creek 2 (BC2)

Plate 9 Breakfast Creek at BC2

Breakfast Creek at BC2 was deeply incised and shallow, and the pH and dissolved oxygen levels were low. The substrate was predominantly silt/clay with small proportions of bedrock and boulder. The flow velocity was zero throughout the sampled reach. The main instream cover available for aquatic fauna, in decreasing order of prevalence, consisted of coarse particulate organic matter (e.g. leaves and other organic debris), loose silt lying on the surface, overhanging terrestrial vegetation, overhanging bank and logs. No aquatic vegetation was noted, however ferns trailed into the water.

The macroinvertebrate results for Breakfast Creek at BC2 did not attain SEPP objectives for number of taxa, number of key families, or number of EPT taxa as individual or combined samples (Table 11). The SIGNAL scores indicated that the site suffers from mild pollution, but attained SEPP objectives for this index. All three samples attained SEPP-W objectives for SIGNAL2. BC2 water quality and macroinvertebrate results appear broadly in agreement between 2013 (GHD 2014) and 2018.

Table 11 Macroinvertebrate sample results at BC2, displayed individually and combined for the site, showing SEPP objectives

	BC2-1	BC2-2	BC2-3	SEPP-W objective	BC2	SEPP objective
# taxa	14	13	12	17	16	24
Abundance	69	91	115	-	276	-
Key families	10	10	11	-	12	26
SIGNAL	5.9	6.3	6.4	-	5.85	5.8
SIGNAL2	4.2	4.3	4.4	4.2		
EPT	3*	3	3	6	3*	9
EPTO	3*	3	3	-	3*	-

*additional taxa present at genus level

Breakfast Creek 3 (BC3)

Plate 10 Breakfast Creek at BC3

Breakfast Creek at BC3 had the largest area of surface water available for sampling but dissolved oxygen and pH levels were low. The substrate was dominated by sand, with some pebbles, gravel and clay/silt, and consisted entirely of lentic (still) habitats. The main instream cover available for macroinvertebrates, in decreasing order of prevalence, consisted of coarse particulate organic matter (e.g. leaves and other organic debris), loose silt lying on the surface, overhanging terrestrial vegetation, aquatic vegetation, overhanging bank, roots and logs. The dominant aquatic vegetation type was *Carex* spp.

The macroinvertebrate results for Breakfast Creek at BC3 did not attain SEPP objectives for number of taxa, number of key families, or number of EPT taxa (Table 12). Similarly to the other two Breakfast Creek sites, BC3 attained SEPP-WoV objectives for SIGNAL. Only one of the three samples attained SEPP-W objectives for SIGNAL2. Water quality at BC3 has declined since the last readings taken in 2013 (GHD 2014), particularly pH but also dissolved oxygen and turbidity, which may account for the reductions in EPT and EPTO taxa recorded in the current round of monitoring.

Table 12 Macroinvertebrate sample results at BC3, displayed individually and combined for the site, showing SEPP objectives

	BC3-1	BC3-2	BC3-3	SEPP-W objective	BC3	SEPP objective
# taxa	11	10	9	17	14	24
Abundance	93	92	95	-	281	-
Key families	8	8	8	-	11	26
SIGNAL	7	6.1	6.1	-	5.83	5.8
SIGNAL2	4.5	4.1	4	4.2		
EPT	3	2	2	6	3	9
EPTO	3	2	2	-	3	-

Upper Anglesea River 1 (UAR1)

Plate 11 Upper Anglesea River at UAR1

The sampled reach of Anglesea River at UAR1 was made up of three isolated pools. The substrate was predominantly silt/clay, with some gravel and sand present. There was no flow within the sampled reach. The main instream cover available for aquatic fauna, in decreasing order of prevalence, consisted of aquatic vegetation, coarse particulate organic matter (e.g. leaves and other organic debris), loose silt lying on the surface, trailing bank vegetation, overhanging bank and logs. The dominant aquatic vegetation types were *Triglochin/Cycnogeton* spp., unknown grass-like submerged vegetation, *Juncus* spp., *Carex* spp. and *Myriophyllum* spp. Several trail bike tracks in the vicinity, including upstream of the sampled reach, were resulting in erosion and likely increased sedimentation.

The macroinvertebrate results for Upper Anglesea River at UAR1 failed to attain SEPP objectives for number of taxa, key families, SIGNAL2 and EPT taxa (Table 13). The SIGNAL scores indicated that the site suffers from mild pollution, and two of the three samples attained SEPP-WoV objectives for this index. The macroinvertebrate results from UAR1 are broadly similar with those achieved in spring 2013 (GHD 2014).

Table 13 Macroinvertebrate sample results at UAR1, displayed individually and combined for the site, showing SEPP objectives

	UAR1-1	UAR1-2	UAR1-3	SEPP-W objective	UAR1	SEPP objective
# taxa	14	11	10	17	14	24
Abundance	169	130	133	-	433	-
Key families	9	6	6	-	9	26
SIGNAL	5.7	6.0	5.9	-	5.73	5.8
SIGNAL2	3.3	3	3	4.2		
EPT	1	1	1	6	1	9
EPTO	2	2	2	-	2	-

Upper Anglesea River 2 (UAR2)

Plate 12 Upper Anglesea River 2 (UAR2)

Upper Anglesea River at UAR2 consisted of a 30 m pool, with a maximum width of 7 m. No flow was present within the sampled reach and the conductivity was quite high (0.844 mS/cm). The substrate was predominantly silt/clay, with small amounts of sand. The main instream habitats providing habitat for macroinvertebrates were loose silt lying on the surface, coarse particulate organic matter, macrophytes, snags and moss. The dominant aquatic vegetation types were submerged, feather-like vegetation, *Cycnogeton/Triglochin* spp. and *Carex* spp.

Similarly to UAR1, the macroinvertebrate results for Upper Anglesea River at UAR2 also failed to attain SEPP objectives for number of taxa, key families, SIGNAL2 and EPT taxa (Table 14). The SIGNAL scores indicated that the site suffers from mild pollution, but two of the three samples attained the SEPP objective. UAR2 water quality readings showed some improvements compared with the previous sampling in 2013 (GHD 2014), with dissolved oxygen and pH levels both improving to indicate compliance with SEPP objectives. Despite these improvements, there were marked reductions in overall abundance and number of EPTO taxa.

Table 14 Macroinvertebrate sample results at UAR2, displayed individually and combined for the site, showing SEPP objectives

	UAR2-1	UAR2-2	UAR2-3	SEPP-W objective	UAR2	SEPP objective
# taxa	13	13	17	17	19	24
Abundance	96	79	77	-	252	-
Key families	8	8	10	-	11	26
SIGNAL	5.8	6.2	5.6	-	5.38	5.8
SIGNAL2	3.2	3.5	3.5	4.2		
EPT	0	1	1	6	1	9
EPTO	1	2	2	-	2	-

5 Discussion

Macroinvertebrate surveys are regularly employed to provide an overview of the condition or 'health' of aquatic systems due to the relatively rapid nature of the assessment. The macroinvertebrate survey results were relatively consistent with previous years, with sites demonstrating slight improvements for some indices, and minor reductions in others.

The last time the full complement of sites were due to be sampled in spring was in 2015. At this time, BC1, BC2, BC3, BCT2, UAR1 and UAR2 were dry (GHD 2016). For the current round of monitoring, site W1 was dry, and W2 and W3 were combined due to lack of site fidelity and insufficient water for either to be sampled individually.

The use of multiple indices to analyse the status of the macroinvertebrate communities enhances the capacity to assess the state of the communities, and hence the state of the aquatic systems, by mitigating for limitations in individual indices (Tiller and Metzeling 2002). However, it should be noted that comparisons between these results and SEPP-WoV objectives (Vic. Gov. 2003) are provided for consistency with previous reports and should be interpreted with caution. The SEPP objectives are based on the standard RBA methods. Sampling undertaken for this project consisted of triplicate edge, single season samples from predominantly lentic habitats; while standard RBA sampling entails edge and riffle samples collected in both spring and autumn from predominantly lotic habitats and never from wetlands. As a result, it is probably more appropriate to track the progress of each site against baseline data, rather than make only semi-valid comparisons against the objectives.

Simplifying macroinvertebrate tolerance to a single score per family (SIGNAL) allows for more rapid assessment, but comes at a cost. Macroinvertebrate tolerance varies both within families, and in relation to different pollutants, physicochemical parameters and habitat variability (EPA 2004).

The low abundance and diversity of macroinvertebrates detected, and poor performance against SEPP objectives could be attributed to a few different factors. Due to the limited surface water present at all sites, all, or nearly all available surface water was sampled at every suitable site. This is likely to impact upon the results, as this reduces the degree of selectiveness that can be employed in sampling all microhabitats present; and it is possible that some sites may not have been wetted for a sufficient period for colonisation/re-colonisation by the full complement of potential species. Additionally, the reduction in connectivity between sites influences colonisation, and is further influenced by the motility of each taxa. The impacts of acid sulphate soils and/or acid events can result in low pH levels, most notably in Wetland 2/3. The lack of surface water as a result of evapotranspiration is likely to further reduce the suitability for macroinvertebrates and other aquatic life, as physicochemical parameters (such as salinity and temperature) become more extreme; as demonstrated by the high electrical conductivity noted at sites BC1 and particularly W2/3.

Although the water quality readings cannot reliably be compared against SEPP-WoV objectives as they do not meet the requirements of 11 readings per site over the course of 12 months, they can indicate likelihood of compliance. Of the eight sites where in situ water quality assessments were taken, only one was indicative of meeting the SEPP-WoV objectives for dissolved oxygen levels, and only two for pH and five for conductivity. Of the three sites that appeared likely to fail to meet the SEPP objectives for conductivity, one measured nearly ten times higher than the 75th percentile to meet the objective. W2/3 again exhibited a considerably lower pH level than other sites that were sampled, which is likely to have an impact upon the biota present as a pH of 2.61 is likely to be inhospitable for the vast majority of taxa. While low, low pH is characteristic of the wetland sites (Ecology Australia, unpublished data). In addition, having rarely contained sufficient water for survey (prior to 2017 it was last surveyed in 2011) the short hydroperiod of this wetland is likely to greatly influence the macroinvertebrate community composition and abundance.

The Southern pygmy perch population in the Anglesea catchment was identified as genetically distinct from surrounding catchments, and at the time of genetic assessment, the historically abundant populations from the Anglesea River and surrounding wetlands were not detected (Cesar 2012). Based on work conducted on this species by Hammer (2008) and the overall life history of the species, this is unsurprising. Hammer (2008) identified the species as demonstrating limited localised movement, inhabiting multiple isolated drainages, and exhibiting broad genetic sub-structure throughout its range. Further to the limited dispersal capability of the species are the compounding impacts of short life-span and numerous threatening processes (including introduced species, habitat degradation and destruction, and climate change), which results in higher likelihood of localised extirpation (Todd et al. 2017, Wedderburn, Hammer and Bice 2012).

If further surveys of Southern pygmy perch in the broader catchment area were to be undertaken and yield similar results to that found previously (Cesar 2012), then the populations present in Salt Creek and Breakfast Creek tributary may be important source populations for recolonisation lower in the catchment. During the 2017 spring surveys for Southern pygmy perch, the species was detected at both survey sites, however in spring 2018 no Southern pygmy perch were detected in BCT1. Southern pygmy perch have been detected at both sites in every spring survey since 2010, with the exception of 2012 and 2018 at BCT1. The population at BCT1 has previously persisted despite three successive spring sampling events whereby no recruits were detected (2012–14) (GHD 2013–2015). Appearance and reappearance at BCT1 may indicate that the site does not encompass the local Breakfast Creek source population. In Salt Creek, the population appears to have had successful recruitment in the past 12 months at SC1, and the abundance appears to have stabilised after a drop in 2016. While the review of the MAP (GHD 2013b) suggested the BCT1 population was more stable, more recent surveys have detected more individuals and more consistent evidence of recruitment at SC1.

Based on the length-frequency histogram of Southern pygmy perch at SC1, young of year Southern pygmy perch and/or 1+ Southern pygmy perch for the current year of monitoring are likely to be ≤32 mm. As a species that breeds predominantly in spring, and based on the spring timing of sampling, these fish are likely to be closer to or just over 1+. This size range is largely in agreement with Knight (2008), whereby males reach maturity at 30 mm and females at 33 mm.

The detection of a Short-finned eel at BCT1 suggests that further work may be warranted to determine the fish fauna within the catchment, as the exclusive use of bait traps is a poor sampling method for most fish species and no other fish species have been detected over the duration of the monitoring program.

The most notable result from the aquatic ecological monitoring in 2017 and 2018 was the detection of the endangered Otway bush yabby. This species has previously been recorded in this region in 2007 (Schultz 2007), however 2017 was the first time it was recorded as part of this monitoring program. Based on the abundance and size ranges encountered, it is likely that this species has maintained a population in the Breakfast Creek and Salt Creek catchments throughout the monitoring period. The species was detected at an additional four sites in 2018, including from the upper Anglesea River.

Recommendations

- Due to the limited presence of surface water, it may be beneficial to reduce the number of macroinvertebrate samples per site from three down to two, to avoid oversampling which likely results in poorer results per sample. As the new SEPP-W indices for macroinvertebrates are based on single samples, the importance of collecting quality samples is enhanced.
- Given the recent failure to detect Southern pygmy perch at BCT1, it would be beneficial to reassess the catchment for additional populations. This has not been done since 2012, and would ideally focus on historic records from Anglesea River and associated wetlands and Breakfast Creek in addition to known refuge pools throughout Salt Creek and Anglesea River (as identified in GHD 2010), and an investigation into refuge pools in the Breakfast Creek catchment. As a genetically distinct population in an isolated catchment, it is of concern that the species may have retracted to a single remnant population. This results in a high level of vulnerability for this genetic lineage.
- Consideration should be given to the inclusion of Otway bush yabby in the monitoring program in future years, including investigations into the extent of the population throughout the study area.

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Appendix 1 Results of macroinvertebrate sampling

Taxa	BC1-E1	BC1-E2	BC1-E3	BC2-E1	BC2-E2	BC2-E3	BC3-E1	BC3-E2	BC3-E3	BCT1-E1	BCT1-E2	BCT1-E3	BCT2-E1	BCT2-E2	BCT2-E3	SC1-E1	SC1-E2	SC1-E3	UAR1-E1	UAR1-E2	UAR1-E3	UAR2-E1	UAR2-E2	UAR2-E3	W2/3-E1	W2/3-E2	W2/3-E3	Grand Total
Acarina	1	1			1	1	2			3	2	1		1		3	1	2	1			1	1	2				**24**
Ceinidae																			47	36	53	1	2	1				**140**
Ceratopogonidae											1																	**1**
Chironominae	1	32	1	18	26	18	2	6	20	3	13	4	4	1	1	3	1	7	1	1	1			1				**165**
Dixidae			1																									**1**
Dytiscidae A	5	15	4	6	14	17	9	12	8				2			3	2	6	9	14	6	15	11	11	3	1	5	**178**
Ecnomidae - Ecnomina											3																	**3**
Geocharax gracilis				2	2	2				12	11	7	8	8	11	4			5	4	5	5	5	5				**96**
Gripopterygidae - Dinotoperla										5	3	3	4	4	3													**22**
Dytiscidae L	3		1	3	5	6	15	12	12									1	2			3	5	6				**74**
Hydrophilidae A	2		1										3		1	1	1					4	3	1			1	**18**
Leptoceridae - Leptorussa	84	32	48	1		3	4	1	1								1		5	6	5		1	2		1		**195**
Leptoceridae - Triplectides				1	2					11	17	17	9	2	12		1											**72**
Leptoceridae - Triplectides/Triplectidina	32		9																									**41**
Leptophlebiidae - Nousia		38	37	4	13	14	14	26	21		1		8	5	18		1											**200**
Leptophlebiidae - Ulmerophlebia	7																											**7**
Notonectidae																										1		**1**
Oligochaeta		1		9	1	5		4	3	1	1		4	1	1			5				2		1				**39**
Orthocladiinae				2	1	7	8		2	2	1	1	5	5	3	3	3	1	1									**45**
Leptoceridae	1																											**1**
Polycentropodidae - Neureclipsis				1	3	1	1					1																**7**
Scirtidae L		1		1	3	3	1	2	3				2	2	1			1	15	7	7	28	21	8	30	5	16	**157**
Simuliidae																	1											**1**
Leptophlebiidae	1																											**1**
Tanypodinae			1	5		2		2	1		4		8	9				2				2	2	1				**39**
Tipulidae								1																				**1**
Veliidae														2	1	20	4	14	1					4		1		**47**
Argiolestidae - Austroargiolestes		1								1	2																	**4**
Culicidae	3	13	17	14	18	36	32	25	24		2		11	26	8			1	44	40	32	13	8	15	60	27	23	**492**
Curculionidae A																									18		11	**29**
Gordiidae														1														**1**
Hydraenidae A	1		1				1									1		1	1	1		1					1	**9**
Hydrochidae A				1	1		4	1								6	3	1	23	7	11	9	11	8				**86**
Janiridae					1						1				3									2				**7**
Koonungidae																		3	3	11	4							**21**
Lestidae - Austrolestes																			11	3	9	3	2	1				**29**
Nannochoristidae										2																		**2**
Paramelitidae												1	1			3	1	5					1					**12**
Phreatoicidae																						9	6	7				**22**
Podonominae																								1				**1**
Pyralidae				1																								**1**
Sphaeriidae		3																										**3**
Talitridae											1																	**1**
Telephlebiidae - Austroaeschna		1								3																		**4**
Grand Total	**141**	**138**	**121**	**69**	**91**	**115**	**93**	**92**	**95**	**43**	**63**	**35**	**69**	**67**	**63**	**47**	**20**	**50**	**169**	**130**	**133**	**96**	**79**	**77**	**111**	**36**	**57**	**2300**