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Anglesea Borefield Ecological Monitoring and Assessment Program 2017

Prepared for: Barwon Water

Document information

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Owner	Ecology Australia Pty Ltd
Project	17-074
Author	Louise Rodda, Katie Stevenson and Leila Brook
File	Anglesea Borefields MAP 2017 FINAL 29Jan2018.docx
Bioregion	Otway Plain
Distribution	Mark Dodgshun, Systems and Water Resource Engineer Barwon Water

Document History

Status	Changes	By	Date
Draft 1	First Draft	Katie Stevenson, Louise Rodda and Leila Brook	19/01/18
Final	Minor changes to draft	Katie Stevenson, Louise Rodda and Leila Brook	29/01/18

Cover photo: Anglesea Estuary, October 2017

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Acknowledgments

We gratefully acknowledge the assistance of:

- Mark Dodgshun Barwon Water
- Lachlan Davis Parks Victoria
- Emma Danby Parks Victoria

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Summary

Background

The revised Monitoring and Assessment Program (MAP) (Victorian Government 2014) is a requirement for the Anglesea Borefield Project (ABP) initiated under the Bulk Entitlement (BE) order 2009. The ABP was put in place to meet water demands of Geelong and surrounding areas when they exceed the capacity of regular water supplies.

This report provides the 2017 monitoring results of the terrestrial (vegetation and frogs) and aquatic components of the MAP which was designed to assess the impacts of water draw down on the environment and the programs long term sustainability.

Currently the Anglesea swamp and estuary are required to be monitored biennially under non water draw down periods and at present there are no plans to undertake water drawdown. The estuary was last monitored in 2015 and the swamp was monitored in 2016. Both the estuary and the swamp were monitored again in 2017 to align monitoring timing.

Terrestrial data were collected from permanent monitoring sites, six in the swamp plus an extra two frog monitoring sites, and four sites in the estuary. The data includes floristics and Ecological Vegetation Classes (EVCs), used to determine the hydroecology of the plants and EVCs expressed in functional groups. Other data collected included structural attributes and wetland boundaries.

Frog survey data collected included species richness, abundance and habitat attributes.

The aquatic monitoring included macroinvertebrate surveys at three sites (W3, SC1 and BCT1), and targeted Southern Pygmy Perch *Nannoperca australis* surveys at two sites (SC1 and BCT1). Opportunistic backpack electrofishing was also undertaken at one site (Breakfast Creek upstream of Breakfast Creek Road).

Results

Vegetation composition, functional groups and cover of bare ground continue to be largely unchanged in the swamp and estuary. Standing water was once again recorded at all sites in the Anglesea swamp and algal mats were present at some sites for the second successive year.

Lower frog numbers were recorded in the swamp and estuary in 2017 compared with 2016 and 2015 respectively. Three frog species (Common Froglet, Southern Brown Tree Frog and Southern Bullfrog) were recorded at one site (AS2) in the Anglesea swamp during the 2017 surveys, with no frogs recorded at other monitoring sites. One Southern Bullfrog was heard calling from one site (LAR4) in the Anglesea Estuary. Overall, frog numbers recorded during the current survey were lower, and records were obtained at fewer sites, compared with the previous surveys at both the Anglesea Swamp (in 2016) and the Anglesea Estuary (in 2015).

Rainfall is a key determinate of water levels in the swamp and sustained below average rainfall (2014-2017) is very likely associated with lower frog numbers. Populations may require a number of wet years to build up numbers. The Anglesea estuary is prone to naturally occurring acid events, and while the vegetation appears to be fairly resilient to low pH, frogs may be susceptible.

Under conditions of a drying climate, frog numbers could decline permanently as drier conditions in the swamp and associated acid events increase the vulnerability of frog populations.

The results from the macroinvertebrate surveys were consistent with previous years, showing fluctuation across various indices. The wetland site (W3) was depauperate compared with the other two sites assessed, which is likely influenced by a reduced hydroperiod and low pH.

Southern Pygmy Perch *Nannoperca australis* populations continue to persist at the Breakfast Creek tributary and Salt Creek sites. The detection of 65 fish at SC1 and 18 at BCT1 represent the fourth and third highest spring catch rates. SC1 appears to have experienced a population boom followed by bust and recovery over the same period. Recruitment success appears more regular at SC1 than BCT1.

Otways Cray *Geocharax gracilis* was detected at BCT1 and SC1 sites, and during a spot-check on Breakfast Creek. Otways Cray is listed as Endangered on the Victorian Advisory List of threatened invertebrates. This is the first time the species has been identified during the MAP, and was present in reasonable abundance. It was detected during macroinvertebrate surveys (dip netting), Southern Pygmy Perch surveys (bait trapping) and opportunistic electrofishing. This species warrants further consideration, and targeted surveys should be included in future monitoring programs.

1 Introduction

Ecology Australia was commissioned by Barwon Water to conduct the spring 2017 ecological Monitoring and Assessment Program (MAP) for the Anglesea Borefield Project (ABP). This included both the terrestrial (vegetation and frogs) and 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 has previously undertaken the aquatic ecology monitoring program (GHD 2010–2017). This year represents the first occasion where Ecology Australia has undertaken both the terrestrial and aquatic components of the MAP.

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.

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.

To align with the Anglesea Estuary monitoring, at the request of Barwon Water, biennial monitoring of the Anglesea Swamp was commenced in 2017.

The aquatic monitoring component of the revised MAP is required annually at three sites, and 2017 represented the third time the monitoring had been conducted since the 2014 review. Triennial monitoring of all 11 sites was last completed in 2015, and will next be required in 2018.

2 Methods

The terrestrial ecology (vegetation and frog) monitoring methods that are provided here follow the revised MAP requirements and remain unchanged since the last round of monitoring conducted in 2015 and 2016 (Ecology Australia 2015, 2016), but are reproduced in this report for ease of reference.

The aquatic monitoring has not previously been carried out by Ecology Australia, the methods provided here are based on the revised MAP requirements and approaches used by GHD (2010-2017).

Under the revised MAP (Victorian Government 2014) terrestrial ecological (vegetation and frog) and aquatic ecological monitoring was conducted as required at all sites in spring (Figure 1).

2.1 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 and 12.16;
- 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.

2.2 Vegetation

Field work was carried out in the last week of October 2017 and vegetation monitoring was conducted at the following sites in the Anglesea Swamp: AS1_2014, AS2, AS3, AS4, ASP7_2014 and, AGP2_2014 and the following sites in the Anglesea Estuary: LAR1, LAR2, LAR3, and LAR4.

2.2.1 Floristic composition

At each of the sites, plant species plant species and Ecological Vegetation Classes (EVCs) following the Department of Environment Land Water and Planning (DELWP) benchmarks (DELWP 2018a) were recorded in sequential $1m^2$ quadrats located along established 100m transects. The start and end of all transects are marked by steel pickets starting at zero metres. The quadrats are located on the left every second metre along the left hand side of the transect looking from start to end with the first quadrat placed at 1-2m, the second quadrat placed at 3-4m and so on to 99-100m.

There are a 50 quadrats along each transect in the swamp and 15 quadrats along LAR2, LAR3 and LAR4 transects and 7 quadrats along the transect at LAR1 in the estuary.

Field staff walk the right hand side of the transect to avoid trampling the quadrats on the left hand side.

Plant species were placed into respective Functional Groups (FGs) (see Table 1). The FGs and composition of EVCs were analysed to assess hydroecology (2.2.2) and structure (2.2.3).

2.2.2 Hydroecology

The FGs and EVCs were used to assess the degree of groundwater dependent vegetation across the swamp and estuary and the sensitivity of sites to groundwater drawdown.

Plant Functional Groups (Table 1) are based on the hydroecology (known or likely water requirements) of plant species, modified from Cassanova (2011), Doeg et.al. (2012) in Ecology Australia (2013b).

Functional Group data is presented in two forms in Figure 2, Figure 4, Figure 6, Figure 8, Figure 10 and Figure 12:

- Frequency and FG of the three most dominant species along the transect; and
- Frequency of each broad FG along the transect.

2.2.3 Structural attributes

Vegetation structure was documented through the recorded EVCs, dominant plant species and photo points. Photo points are located at 0m, 25m, 50m, and 75 m along each transect in the swamp and at the start of each transect in the estuary. Photos were taken looking toward the end of the transect.

2.2.4 Other attributes

Other transect attributes recorded were water depth (in the swamp only) and percentage cover of bare ground, rounded to the nearest 5%.

Water depth is a snap shot in time (one day of the year) and will vary considerably over time depending on rainfall. The presence of water is clearly a driver of wetland condition.

Water depth was not recorded in the estuary as water levels are managed and so remain fairly constant.

Bare ground provides space for recruitment. This can provide an indication of potential change at a site, for example – are the extant FGs recruiting, or are conditions favouring the recruitment of drier or wetter groups?

In 2016, large amounts of algal mat (consisting of filamentous algae) were observed in quadrats for the first time since the revised MAP monitoring commenced in 2014. The presence of an algal mat noted again in 2017 and was recorded in each quadrat.

2.2.5 Wetland boundaries

Wetland boundaries in the Anglesea Swamp were confirmed as far as practicable by mapping the interface between Swamp Scrub and Aquatic Sedgeland using aerials and ground-truthing. This mapping should detect significant boundary shifts in response to any longer term hydrological change.

2.2.6 Conservation status

Species of State and/or National status were determined by reference to DEPI's Advisory Lists (DEPI 2014) including listings under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act) and the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

2.2.7 Nomenclature and taxonomy

Plant taxonomy and the use of common names in this report follow The Victorian Biodiversity Atlas (VBA) (DELWP 2018b).

Where an asterisk (*) precedes a plant name it is used to signify non-indigenous taxa, those species which have been introduced to Victoria or Australia. A hash (#) is used to denote Victorian plants that are not indigenous to the region or local area.

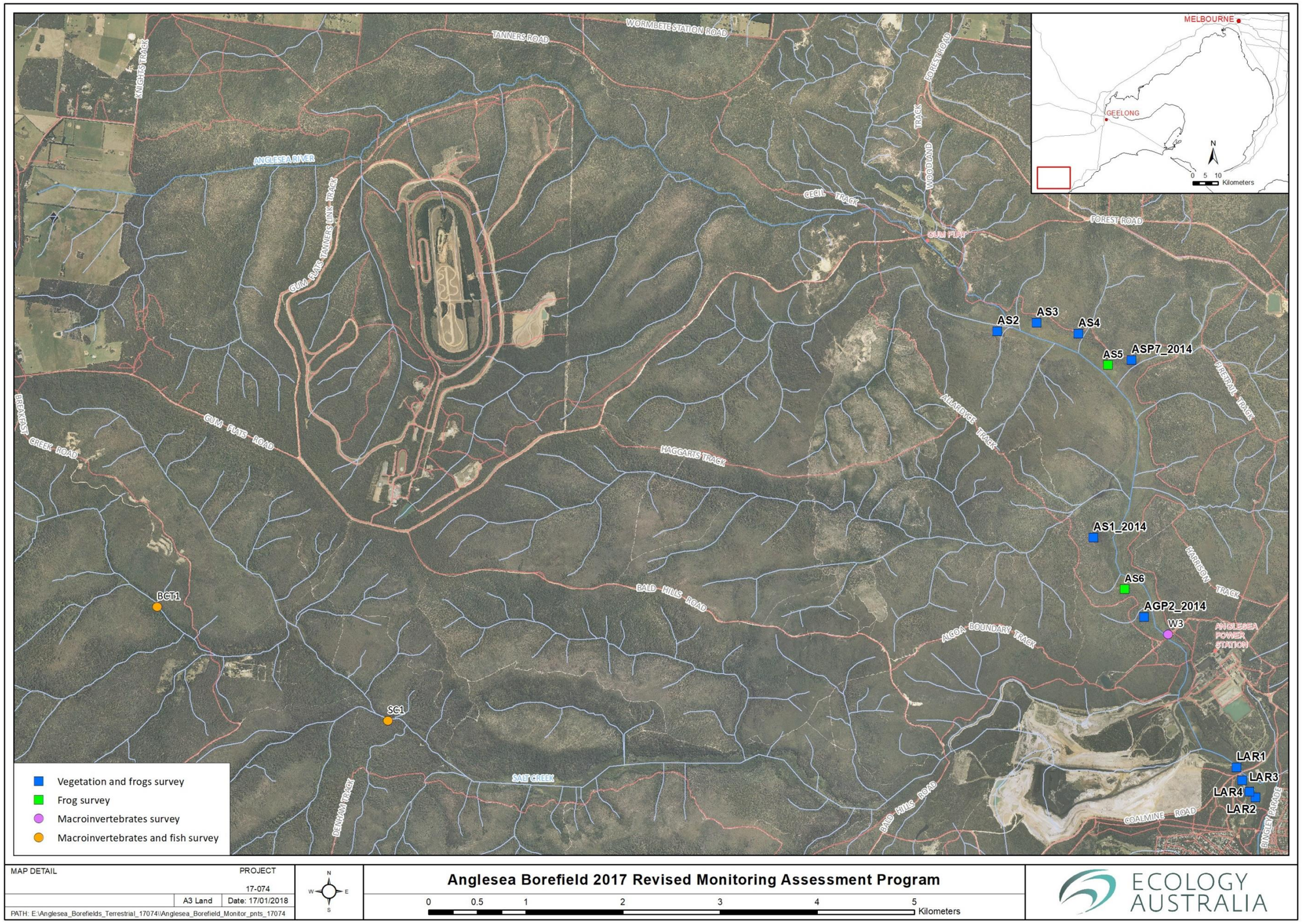


Figure 1 Anglesea Borefield revised ecological Monitoring and Assessment Program, 2017 survey sites

Table 1 Anglesea Borefield, revised ecological Monitoring and Assessment Program, Plant Functional Groups (modified from Cassanova (2011) and Doeg et.al. (2012)

Functional group code	Definition	Example species	Broad category
Tdr	*Terrestrial dry.* This species group does not require flooding and will persist in damper parts of the landscape because of localised high rainfall. Species in this group can invade or persist in riparian zones and the edges of wetlands, but are essentially terrestrial.	Messmate, Brown Stringybark, Prickly Moses, Silver Banksia	Dry
Tda	*Terrestrial damp*. These species germinate and establish on saturated or damp ground, but cannot tolerate flooding in the vegetative state. They require the soil profile to remain damp for at least several months.	Swamp Gum, Variable Sword-sedge, Manuka , Slender Bog-sedge	
ATl	*Amphibious fluctuation tolerator - low-growing.* This species group can germinate either on saturated soil or under water and grow submerged, as long as they are exposed to air by the time they start to flower and set seed. They require or tolerate shallow flooding for *c.* 3 months.	Austral Brookline, Swamp Club-sedge, Spotted Knotweed	Amphibious
ATe	*Amphibious fluctuation tolerator-emergent*. This species group consists of emergent monocots and dicots that survive in saturated soil or shallow water but require most of their photosynthetic parts to remain above the water (emergent). They tolerate fluctuations in the depth of water, as well as water presence. They need water or soil moisture to be present for *c.* 8-12 months of the year.	Tall Sedge, Red Fruit Saw-sedge, Pouched Coral-fern, Scrambling Coral-fern	
ATw	*Amphibious fluctuation tolerator- woody*. This species group consists of woody perennial species that may hold their fruits (and seeds) in the canopy and require water to be present in the root zone all year round, but will germinate in shallow water or on a drying substrate.	Woolly Tea-tree, Scented Paperbark	
ARp	*Amphibious fluctuation responder- plastic.* This species group occupies a similar zone to the ATI group, except that they have a morphological response to water level changes such as rapid shoot elongation or a change in leaf form. They can persist on damp and drying soil because of their morphological flexibility but can flower even if the site does not dry out. They occupy a slightly deeper/wet-for-longer site than the ATI group.	Creeping Cotula, Monkey Flower, River Buttercup	
Se	*Perennial-emergent.* This category refers to monocotyledonous species that require permanent water in the root zone, but remain emergent. They occur where water levels do not fluctuate or fluctuate with relatively little drawdown in the dry part of the year.	Cumbungi, Sea Rush, Southern Water-ribbons	Aquatic

2.3 Frogs

Frog surveys were undertaken twice, on 24 and 25 October 2017, and 13–15 November 2017, at the following twelve sites:

- AS1_2014, AS2, AS3, AS4, AS5, AS6, ASP7_2014 and AGP2_2014 in the Anglesea Swamp; and
- LAR1, LAR2, LAR3 and LAR4 in the Anglesea Estuary (Figure 1).

This includes the ten sites required by the MAP and two extra sites (AS5 and AS6), which are surveyed in the event that very low frog numbers are observed in the Anglesea Swamp.

2.3.1 Habitat assessment and water quality

Most habitat data was collected as part of vegetation assessments and monitoring. To supplement this information, the following variables were recorded in relation to frog habitat:

- Wetland permanence;
- Water quality parameters:
  - Temperature;
  - pH;
- Electrical Conductivity (EC);
- Dissolved Oxygen (DO);
- Turbidity; and
- A general habitat description, including levels of cover of fringing, emergent, submergent and floating vegetation where present.

Photos were also taken showing characteristic frog habitat.

2.3.2 Frog surveys

Two methods were used during surveys for frogs: aural surveys (diurnal and nocturnal) and nocturnal call playback surveys.

Diurnal and nocturnal aural surveys

Aural surveys were undertaken during the diurnal habitat assessments and at the beginning of each nocturnal survey for each site. They involved two zoologists listening for a period of approximately five minutes for the distinctive calls of male frogs. The species heard, and estimation of the number of frogs calling for each species, were recorded.

Nocturnal call playback

Following nocturnal aural surveys, call playback was used to elicit calling by male frogs that were not calling independently on site. This involved the broadcast of pre-recorded calls of each species via an MP3 player attached to a megaphone followed by a period of quiet listening. Frog calls broadcast during call playback, based on previous records included:

- Southern Brown Tree Frog *Litoria ewingii*;

- Southern Bullfrog *Limnodynastes dumerilii*;
- Spotted Marsh Frog *Limnodynastes tasmaniensis*;
- Striped Marsh Frog *Limnodynastes peronii*;
- Common Spadefoot Toad *Neobatrachus sudelli*; and
- Common Froglet *Crinia signifera*.

Call response data was used to estimate species richness and abundance within each site across the Anglesea Borefields and Estuary.

2.3.3 Conservation status

Species of State and/or National status were determined by reference to DELWP's Advisory Lists (DSE 2009, 2013) including listings under the Victorian FFG Act and the Federal EPBC Act.

2.3.4 Nomenclature and taxonomy

The scientific names, common names, and systematic orders of fauna species follow the Victorian Biodiversity Atlas (DELWP 2018b). In general, common names are used in the text.

2.4 Macroinvertebrate surveys

2.4.1 Macroinvertebrate sampling

Macroinvertebrate surveys were undertaken at three sites; W3, SC1 and BCT1 on 10–11 October 2017. Site BCT1 was relocated downstream as insufficient surface water was present at or within the vicinity of the coordinate provided. Based on photographs of BCT1 by GHD (2016), it was apparent that the site has previously been relocated to stream gauge SV3. 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.

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 jars using 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 U53 Horiba water quality meter.

2.4.2 Identification of macroinvertebrates

Macroinvertebrates were identified and enumerated using 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).

2.4.3 Analysis and interpretation of macroinvertebrate data

Macroinvertebrate data were analysed both as individual samples, and on a site basis using the combined data from three samples. The following indices were used to analyse macroinvertebrate data:

- Number of taxa – total number of taxa based on taxonomic resolution levels described in Section 2.4.2;
- Number of individuals – 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) (EPA 2004);
- SIGNAL score – average SIGNAL score for taxa collected in each sample, using the scores adopted by EPA (2003). Table 2 provides an interpretation of the scores, which provide an indication of water quality;
- 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 metric 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

2.5 Fish surveys

Surveys targeting Southern Pygmy Perch *Nannoperca australis* were undertaken at two sites; SC1 and BCT1 on 10-11 October 2017. As with the macroinvertebrate surveys, site BCT1 was relocated downstream due to insufficient surface water at the point where the surveys were originally intended to be conducted (see Section 2.4).

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 in the 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, however it is not specified in the reports of the surveys conducted 2012–2016 (GHD 2013–2017). The number of traps was increased with the aim to increase the chances of collecting 30 Southern Pygmy Perch per site.

The first 30 Southern Pygmy Perch were measured (total length) to the nearest millimetre, and weighed to the nearest 0.1 gram. Subsequent Southern Pygmy Perch were counted and recorded. Additional taxa of interest detected in bait traps or observed at each site were recorded.

Instream habitat assessment was undertaken at all sites surveyed. The habitat assessment consisted of a fish habitat datasheet based on those used by the Arthur Rylah Institute. 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 Celcius), conductivity (mS/cm)) were made with a calibrated Horiba U-53 water quality meter.

3 Results

The vegetation and frog monitoring were conducted at the same sites (with two additional sites for frogs) and findings for each site are presented below followed by site summaries in section 3.2.3. The aquatic ecology monitoring was carried out at sites in different locations to the terrestrial monitoring sites and as such the site summaries are presented separately in Section 3.3.

3.1 Flora

Site summaries are provided in Figures 2, 4, 6, 8, 10 and 12.

3.1.1 Floristic composition

Thirty five native plant species were recorded across all sites in the Anglesea Swamp (Appendix 1), and 19 native indigenous plant species, three weeds and one non indigenous Victorian plant species were recorded in the Anglesea Estuary (Appendix 2).

The number of plant species at any one site ranged from 7- 17 in the swamp and 8-14 in the estuary (Table 2, Appendix 1 and 2).

The vegetation in the swamp remains healthy. No weeds were recorded in the swamp and there was little sign of disturbance.

The estuary vegetation is also relatively healthy, weeds did not make up the dominant species in any of the transects (Appendix 2, Figures 2, 4, 6, 8, 10 and 12). The estuary has walking paths which provide access to the estuary and surrounds. Faint tracks were observed through the vegetation adjacent to the transects possibly created by anglers and people walking their dogs, but native vegetation was on the whole growing well with good cover.

Table 3 Anglesea Borefield revised ecological Monitoring and Assessment Program, number of native plant species across monitoring sites and Functional Groups, 2017.

Transect/Site	Total number of native plant species	Number of plant species in a dry Functional Group (Tdr, Tda)	Number of plant species in an Amphibious Functional Group (ATI, Ate, ATw)	Number of plant species in an Aquatic Functional Group (Se)
Anglesea Swamp				
AS2	16	11	2	3
AS3	11	3	7	1
AS4	17	7	9	1
ASP7_2014	17	4	9	4
AS1_2014	12	4	5	3
AGP2_2014	7	1	4	2
Anglesea Estuary				

Transect/Site	Total number of native plant species	Number of plant species in a dry Functional Group (Tdr, Tda)	Number of plant species in an Amphibious Functional Group (ATI, Ate, ATw)	Number of plant species in an Aquatic Functional Group (Se)
LAR1	8	3	2	3
LAR2	10	4	4	2
LAR3	14	7	4	3
LAR4	8	2	4	2

3.1.2 Hydroecology

Plants from six of the seven FGs (Tdr, Tda, ATI, Ate, ATw, and Se) were recorded across the monitoring sites in the Anglesea Swamp, ARp was the only group not represented (Appendix 1). In the Anglesea Estuary, six of the seven FGs were also represented (Tdr, Tda, ATI, Ate, ARp, and Se) with ATw the only group not recorded.

3.1.3 Structural attributes

In the swamp, three EVCs were recorded: Swamp Scrub, representing an open to closed shrubland to 4m, Aquatic Sedgeland, characterised by a variably dense sedgeland to 1.3m and Heathy Woodland which has a eucalypt canopy over a shrubby understory. Overall, the wetland vegetation continues to be dominated by plants in the Amphibious and Aquatic FGs (Figures 2 to 7).

Two EVCs were recorded in the estuary: Swampy Riparian Woodland comprised of a low open eucalypt canopy to 8m with an understory of scattered woody shrubs and small herbs, and Estuarine Wetland comprised of a dense cover of reeds and rushes to 1 m, with scattered tussock grasses and small herbs.

3.1.4 Other attributes

Water was present at all six sites in the swamp. The average water depth ranged from 5-21cm, which is similar to 2016 (Figures 2, 4, 6, 8, 10 and 12).

Bare ground was recorded at five of the six sites in the Anglesea Swamp, and average cover ranged from 0-3% which is comparable to 2016 (Figures 2, 4, 6, 8, 10 and 12). In the Anglesea Estuary, bare ground was recorded at 2 of the four sites and average bare ground cover ranged from 1-3%, compared with 2015 when no bare ground was recorded (Figures 2, 4, 6, 8, 10 and 12).

Algal mat was present at five sites in the swamp and the number of quadrats occupied ranged from 1 (ASP7_2014) to 41 (AS1_2014) which is similar to the results recorded in 2016. No algal mat was recorded at any of the estuary sites.

3.1.5 Wetland boundaries

There were no material changes to the wetland boundaries represented by the interface(s) of Aquatic Sedgeland and Swamp Scrub (Figures 24 and 25).

3.2 Frogs

Of the eight monitoring sites at Anglesea Swamp, six had open standing water at the time of the first round of frog surveys on 24 and 25 October 2017. These sites remained wet at the time of the second round of frog surveys on 13–15 November 2017, although the area of standing water had generally contracted. In contrast, the Anglesea Swamp was largely dry during the 2014 and 2015 surveys, and most sites had little or no surface water present by the second survey in 2016.

3.2.1 Frog species richness and abundance

Anglesea Swamp

Frogs were recorded during both surveys at the Anglesea Swamp. All records were obtained at one site, AS2, where three species were recorded. All records during the first survey at AS2 comprised calling males of two species, the Common Froglet *Crinia signifera* and the Southern Bullfrog *Limnodynastes dumerilii*, rather than observed frogs (Table 4). One frog was recorded at AS2 during the second survey, comprising one Southern Brown Tree Frog *Litoria ewingii* observed perching on rushes (Table 4, Plate 1).

Anglesea Estuary

One Southern Bullfrog was heard at LAR4 during the first survey (Table 4), and Common Froglets and Southern Bullfrogs were heard calling in the distance from LAR2. No frogs were recorded at the Anglesea Estuary monitoring sites during the second survey.

Table 4 Anglesea Borefield revised ecological Monitoring and Assessment Program, frog species and estimated abundances, 2017.

Site	Common Froglet		Southern Brown Tree Frog		Southern Bullfrog		Species Richness
	1	2	1	2	1	2	
Anglesea Swamp							
AS2	10–20	0	0	1	<5	0	3
AS3	0	0	0	0	0	0	0
AS4	0	0	0	0	0	0	0
AS5	0	0	0	0	0	0	0
ASP7_2014	0	0	0	0	0	0	0
AS1_2014	0	0	0	0	0	0	0
AS6	0	0	0	0	0	0	0
AGP2_2014	0	0	0	0	0	0	0
Anglesea Estuary							
LAR1	0	0	0	0	0	0	0
LAR2	0	0	0	0	0	0	0
LAR3	0	0	0	0	0	0	0

Site	Common Froglet		Southern Brown Tree Frog		Southern Bullfrog		Species Richness
	1	2	1	2	1	2	
LAR4	0	0	0	0	1	0	1

Plate 1 Southern Brown Tree Frog *Litoria ewingii* observed at AS2, Anglesea Swamp, 14 November 2017.

3.2.2 Habitat assessment and water quality

Anglesea Swamp

The Anglesea Swamp monitoring sites are largely dominated by dense fringing vegetation of Scented Paperbark (*Melaleuca squarrosa*) and Manuka (*Leptospermum scoparium*), surrounding emergent aquatic vegetation including sedges such as Zig-zag Bog-sedge (*Schoenus brevifolius*), Twig-sedges (*Baumea* species), Saw-sedges (*Ghania* species) and Water Ribbons (*Cycnogeton alcockiae*). At sites supporting standing water, submergent and floating vegetation, usually filamentous algae, is sometimes observed. Some sites also include small patches of bare ground, and low cover of woody debris.

All monitoring sites are considered ephemeral except for AS3 (semi-permanent) and AS4 (semi-permanent to permanent). Six sites had sufficient standing water to allow water quality measurements to be taken. Both AS4 and AS5 had no standing water in either survey and water quality could not be measured. Most sites had a quite low pH (2.75–3.92) and electric conductivity ranged from 21–2,320

µs/cm, with all but one measurement above 1,000 µs/cm. Dissolved oxygen levels varied from 3.54–7.82 mg/L and water temperatures were relatively warm, ranging from 13.9–18.8 °C. Turbidity could not be measured at some sites given low water levels. Where measurements were possible, turbidity was relatively low (0–10 NTU).

Anglesea Estuary

The Anglesea Estuary sites are dominated by fringing vegetation of grasses, sedges, rushes and herbs including Coast Tussock-grass, (*Poa poiformis* var. *poiformis),* Common Blown-grass (*Lachnagrosits filiformis)* (*Juncus kraussii* ssp*. australiensis*), Shiny Swamp-mat (*Selliera radicans*), Common Reed (*Phragmites australis*) and Narrow-leaf Cumbungi (*Typha domingensis*). There were scattered shrubs of Hop Goodenia (*Goodenia ovata*) and Manuka (*Leptospermum scoparium*) and stands of Swamp Gum (*Eucalyptus ovata* var. *ovata)* near the water's edge. Emergent vegetation, such as rushes, Common Reed, Cumbungi and Southern Water-ribbons, occurs relatively close to the banks; in deeper water, filamentous algae occurs as submergent vegetation.

All estuary monitoring sites are considered permanent, with stream widths ranging from 2–3 m to approximately 8 m. Water quality could be measured at all sites, and values were consistent between sites compared to measurements taken in the Anglesea Swamp. All sites had relatively low pH (3.82–3.89) and electric conductivity ranging from 2,710–3,250 µs/cm. Dissolved oxygen levels were relatively high (8.73–9.91 mg/L) and turbidity was consistently measured at 0 NTU. Water temperature varied from 17.7–18.6 °C

3.2.3 Flora and frog site summaries

These summaries include:

- transect photos at 25m intervals;
- the proportion of each EVC and each FG recorded at each site;
- the top three dominant plant species and their FG;
- other attributes including average bare ground cover, water depth algal mat;
- a habitat description;
- frog species occurrence and abundance;
- water quality data; and
- relevant comments.

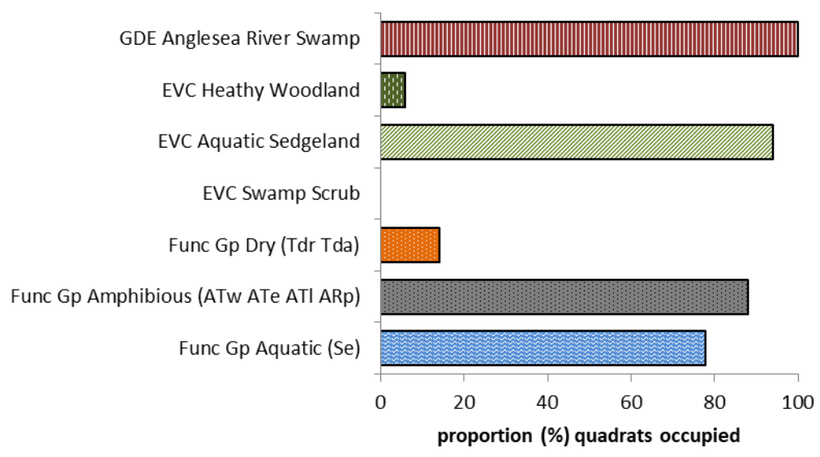
0– 25m

25– 50m

50-75m

75-100m

Proportion of EVCs and broad FGs, Site AS2



Key:

GDE: Groundwater Dependent Ecosystem

EVC: Ecological Vegetation Class

FG: Functional Group

Dominant Plant Species		Broad FG	Quadrats occupied (% frequency)
Schoenus brevifolius	Zig-zag Bog-sedge	Amphibious	88
Baumea tetragona	Square Twig-sedge	Aquatic	50
Cycnogeton alcockiae	Southern Water-ribbons	Aquatic	44

Other attributes		
Average % bare ground cover	1	(bare ground recorded in 3 quadrats)
Average water depth (cm)	14	Water recorded in 42 quadrats
Algal mat (quadrats occupied)	0	

Figure 2 Anglesea Borefield, revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site AS2, vegetation summary data, 2017

AS2: General habitat description	
Ecological Vegetation Class (EVC)	Aquatic Sedgeland
Wetland permanence	Ephemeral
Moderate cover of emergent vegetation (50–70%), mostly comprising Zig-zag Bog-sedge, Square Twig-sedge and some Southern Water-ribbons, interspersed among pools of shallow (<10cm) open water. Filamentous algae occurs as both submergent (10–20%) and floating (<5%) vegetation. Aquatic vegetation is surrounded by dense (70–100%) cover of fringing vegetation, comprising Scented Paperbark and Manuka, and woodland at further distance from the swamp.	

AS2: Frog abundance and richness			
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**
1	10–20	1–5	3

AS2: Water quality parameters					
pH	3.92	**Turbidity**	9 NTU	**Water temperature**	18.6 °C
EC	1060 µs/cm	**Salinity**	0.04%	**Dissolved Oxygen**	5.7 mg/L

Comments
Common Froglets and Southern Bullfrogs heard during the first survey, in both diurnal and nocturnal surveys. One Southern Brown Tree Frog observed perching on rushes during the second survey. Southern Bullfrogs (1–5) heard calling in the distance, to the northwest, during the second survey.

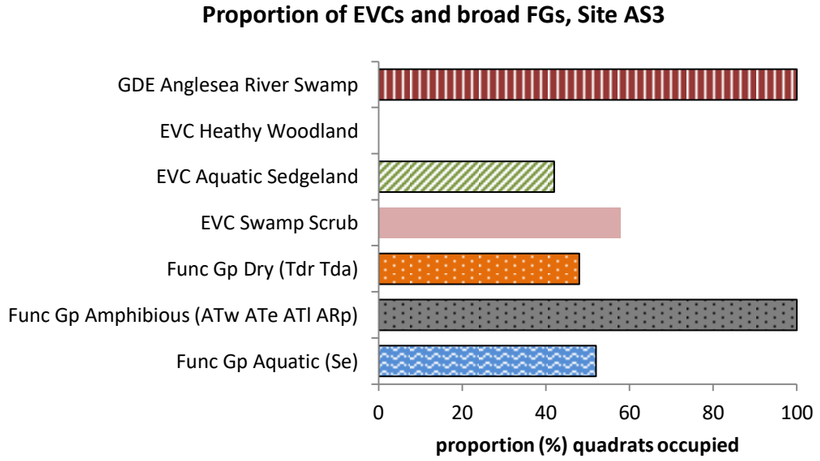
Figure 3 Anglesea Borefield Terrestrial revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site AS2, Frog summary data, 2017

0– 25m

25– 50m

50-75m

75-100m



Dominant Plant Species		Broad FG	Quadrats occupied (% frequency)
Schoenus brevifolius	Zig-zag Bog-sedge	Amphibious	88
Sprengalia incarnata	Pink Swamp-heath	Amphibious	66
Melaleuca squarrosa	Scented Paperbark	Amphibious	62

Other attributes		
Average % bare ground cover	0	(bare ground recorded in 0 quadrats)
Average water depth (cm)	5	Water recorded in 30 quadrats
Algal mat (quadrats occupied)	0	

Key:

GDE: Groundwater Dependent Ecosystem

EVC: Ecological Vegetation Class

FG: Functional Group

Figure 4 Anglesea Borefield, revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site AS3, vegetation summary data, 2017

AS3: General habitat description	
Ecological Vegetation Class (EVC)	Swamp Scrub
Wetland permanence	Semi-permanent
Wet swamp with shallow standing water (10–15 cm) and dense emergent cover (70–100%) of Zig-zag Bog-sedge surrounded by thick fringing vegetation (70–100%) dominated by Scented Paperbark, Pink Swamp-heath and Pouched Coral-fern. No floating or submergent vegetation was observed.	

AS3: Frog abundance and richness			
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**
0	0	0	0

AS3: Water quality parameters					
pH	3.62	**Turbidity**	0 NTU	**Water temperature**	13.9 °C
EC	1120 µs/cm	**Salinity**	0.03 %	**Dissolved Oxygen**	5.9 mg/L

Comments
Swamp contained standing water during both surveys. No frogs seen or heard calling at the site during surveys, but Southern Bullfrogs (1–5) and Southern Brown Tree Frogs (6–10) heard calling in the distance.

Figure 5 Anglesea Borefield revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site AS3, Frog summary data, 2017

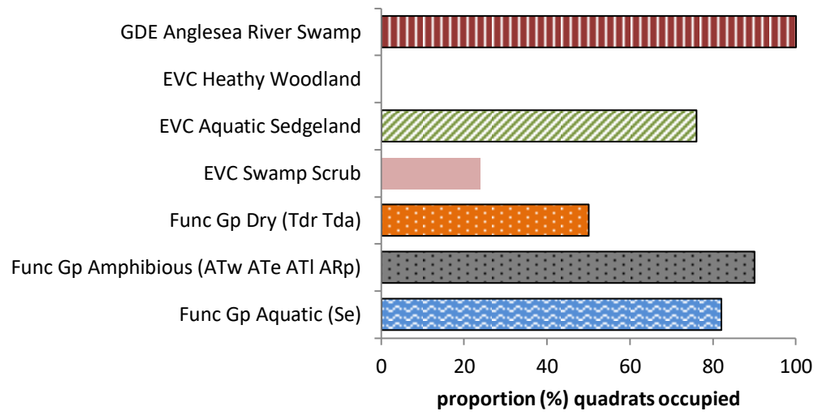
0– 25m

25– 50m

50-75m

75-100m

Proportion of EVCs and broad FGs, Site AS4



Key:

GDE: Groundwater Dependent Ecosystem

EVC: Ecological Vegetation Class

FG: Functional Group

Dominant Plant Species		Broad FG	Quadrats occupied (% frequency)
Cycnogeton alcockiae	Southern Water-ribbons	Aquatic	90
Baumea arthrophylla	Fine Twig-sedge	Aquatic	78
Schoenus brevifolius	Zig-zag Bog-sedge	Amphibious	54

Other attributes		
Average % bare ground cover	3	(bare ground recorded in 18 quadrats)
Average water depth (cm)	8	Water recorded in 37 quadrats
Algal mat (quadrats occupied)	2	

Figure 6 Anglesea Borefield, revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site AS4, vegetation summary data, 2017

AS4: General habitat description	
Ecological Vegetation Class (EVC)	Aquatic Sedgeland
Wetland permanence	Semi-permanent
Frog site did not support standing water and was dry underfoot during both surveys. High cover of fringing vegetation (90%) includes Pouched Coral-fern, Manuka and Scented Paperbark. Low levels (5–10%) of bare ground and small amounts (<5%) of logs and fallen timber occurring at the site.	

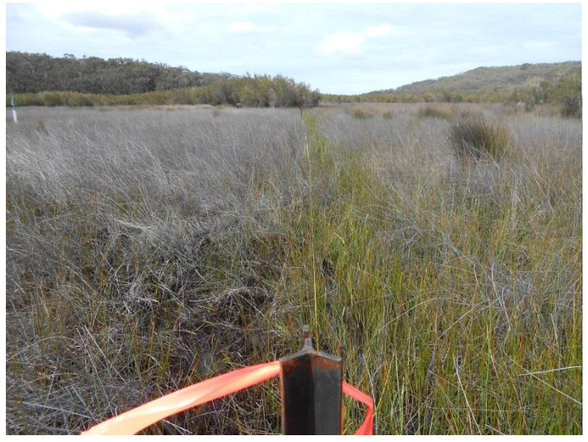
AS4: Frog abundance and richness			
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**
0	0	0	0

AS4: Water quality parameters					
pH	NA	**Turbidity**	NA	**Water temperature**	NA
EC	NA	**Salinity**	NA	**Dissolved Oxygen**	NA

Comments
No frogs seen or heard during site visits.

Figure 7 Anglesea Borefield revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site AS4, Frog summary data, 2017

0– 25m

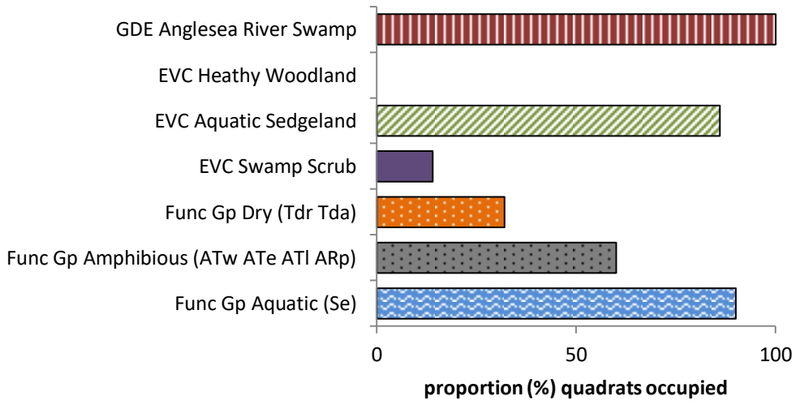


25– 50m

50-75m

75-100m

Proportion of EVCs and broad FGs, Site ASP7_2014



Dominant Plant Species	Broad FG	Quadrats occupied (% frequency)
Cycnogeton alcockiae	Southern Water-ribbons	Aquatic	88
Baumea arthrophylla	Fine Twig-sedge	Aquatic	76
Schoenus brevifolius	Zig-zag Bog-sedge	Amphibious	56

Other attributes		
Average % bare ground cover	<1	(bare ground recorded in 3 quadrats)
Average water depth (cm)	7	Water recorded in 40 quadrats
Algal mat (quadrats occupied)	1	

Key:

GDE: Groundwater Dependent Ecosystem

EVC: Ecological Vegetation Class

FG: Functional Group

Figure 8 Anglesea Borefield, revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site ASP7-2014, vegetation summary data, 2017

ASP7_2014: General habitat description	
Ecological Vegetation Class (EVC)	Aquatic Sedgeland
Wetland permanence	Ephemeral
Dense cover (90%) of emergent vegetation largely comprising dead and live Fine Twig-sedge and Zig-zag Bog-sedge with some Southern Water-ribbons. Small pools of open water, mostly shallow (c. 0.1 m) but with some pockets of deeper water. Dense fringing vegetation (90%) dominated by non-aquatic species such as Scented Paperbark.	

ASP7_2014: Frog abundance and richness			
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**
0	0	0	0

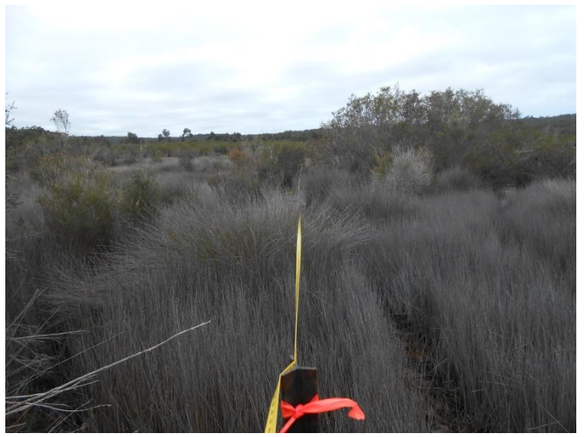
ASP7_2014: Water quality parameters					
pH	3.31	**Turbidity**	10 NTU	**Water temperature**	14.8 °C
EC	21 µs/cm	**Salinity**	0.06%	**Dissolved Oxygen**	3.54 mg/L

Comments
No frogs seen or heard during surveys.

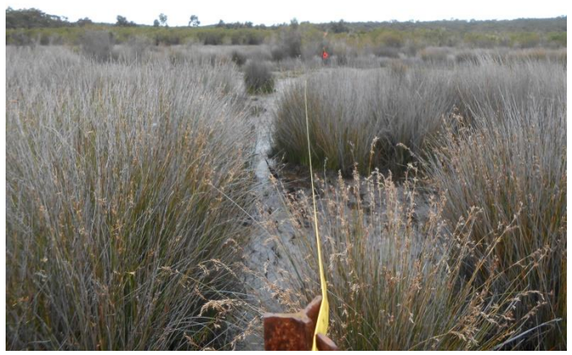
Figure 9 Anglesea Borefield revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site ASP7_2014, Frog summary data, 2017

0– 25m

25– 50m

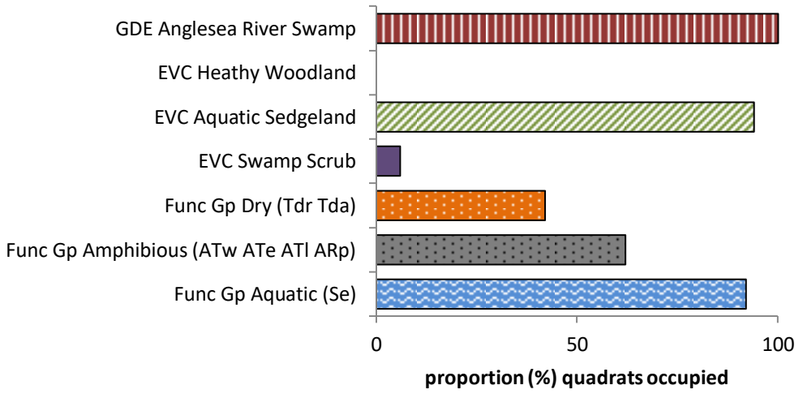


50-75m



75-100m

Proportion of EVCs and broad FGs, Site AS1_2014



Key:

GDE: Groundwater Dependent Ecosystem

EVC: Ecological Vegetation Class

FG: Functional Group

Dominant Plant Species		Broad FG	Quadrats occupied (% frequency)
Cycnogeton alcockiae	Southern Water-ribbons	Aquatic	90
Baumea arthrophylla	Fine Twig-sedge	Aquatic	54
Schoenus brevifolius	Zig-zag Bog-sedge	Amphibious	44

Other attributes		
Average % bare ground cover	1	(bare ground recorded in 4 quadrats)
Average water depth (cm)	14	Water recorded in 45 quadrats
Algal mat (quadrats occupied)	41	

Figure 10 Anglesea Borefield, revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site ASP7-2014, vegetation summary data, 2017

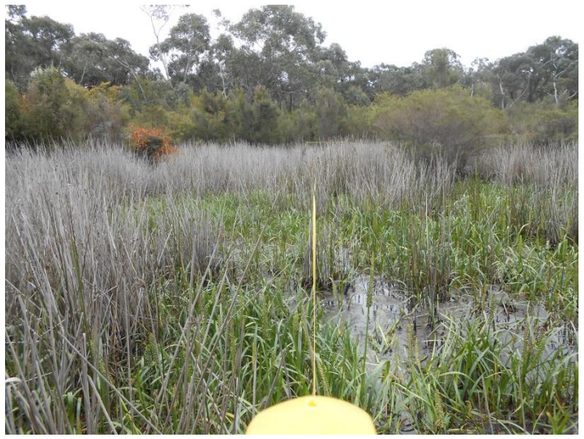
AS1_2014: General habitat description	
Ecological Vegetation Class (EVC)	Aquatic Sedgeland
Wetland permanence	Ephemeral
A shallow (10–15 cm), open swamp, interspersed with moderate cover (20–50%) of emergent vegetation, comprising Fine Twig-sedge, Zig-zag Bog-sedge, Southern Water-ribbons and occasional Scented Paperbark. The majority of open water supports high cover (70–100%) of floating filamentous algae. Filamentous algae also observed as submergent vegetation at low levels (20–50%). Dense cover of fringing vegetation (70–100%) surrounds the swamp, including Scented Paperbark and Prickly Tea-tree. Low levels (<5%) of bare ground and cover of woody debris also occur on the edges of the swamp.	

AS1_2014: Frog abundance and richness			
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**
0	0	0	0

AS1_2014: Water quality parameters					
pH	2.75	**Turbidity**	NA	**Water temperature**	18.8 °C
EC	2320 µs/cm	**Salinity**	0.11 %	**Dissolved Oxygen**	4.65 mg/L

Comments
No frogs seen or heard during the surveys.

Figure 11 Anglesea Borefield revised ecological Ecology Monitoring and Assessment Program, Anglesea Swamp, Site AS1_2014, Frog summary data, 2017



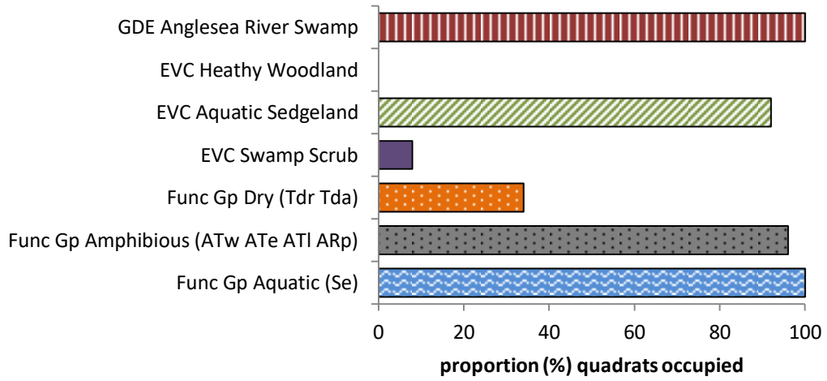
0– 25m

25– 50m

50-75m

75-100m

Proportion of EVCs and broad FGs, Site AGP2_2014



Dominant Plant Species	Broad FG	Quadrats occupied (% frequency)
Cycnogeton alcockiae	Fine Twig-sedge	Aquatic	92
Juncus procerus	Tall Rush	Amphibious	72
Melaleuca squarrosa	Scented Paperbark	Amphibious	50

Other attributes		
Average % bare ground cover	<1	(bare ground recorded in 2 quadrats)
Average water depth (cm)	22	Water present in 48 quadrats
Algal mat (quadrats occupied)	32	

Key:

GDE: Groundwater Dependent Ecosystem

EVC: Ecological Vegetation Class

FG: Functional Group

Figure 12 Anglesea Borefield, revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site AGP2_2014, vegetation summary data, 2017

AGP2_2014: General habitat description	
Ecological Vegetation Class (EVC)	Aquatic Sedgeland
Wetland permanence	Ephemeral
A deeper swamp (0.3 m) with high levels of emergent vegetation (70-100%) comprising thick tall cover of Tall Rush, Fine Twig-sedge, and interspersed with more open areas supporting dense patches of Southern Water-ribbons and moderate cover of floating algae (20–50%). High cover of fringing vegetation including dense stands of shrubs including Scented Paperbark. Low cover (<5%) of both logs and fallen timber, and artificial substrates (pipes) along the edges of the swamp.	

AGP2_2014: Frog abundance and richness			
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**
0	0	0	0

AGP2_2014: Water quality parameters					
pH	2.9	**Turbidity**	NA	**Water temperature**	16.5 °C
EC	1820 µs/cm	**Salinity**	0.08%	**Dissolved Oxygen**	7.82 mg/L

Comments
No frogs seen or heard on site during the surveys. Southern Bullfrogs heard calling in the distance during the second survey.

Figure 13 Anglesea Borefield revised ecological Ecology Monitoring and Assessment Program, Anglesea Swamp, Site AGP2_2014, Frog summary data, 2017

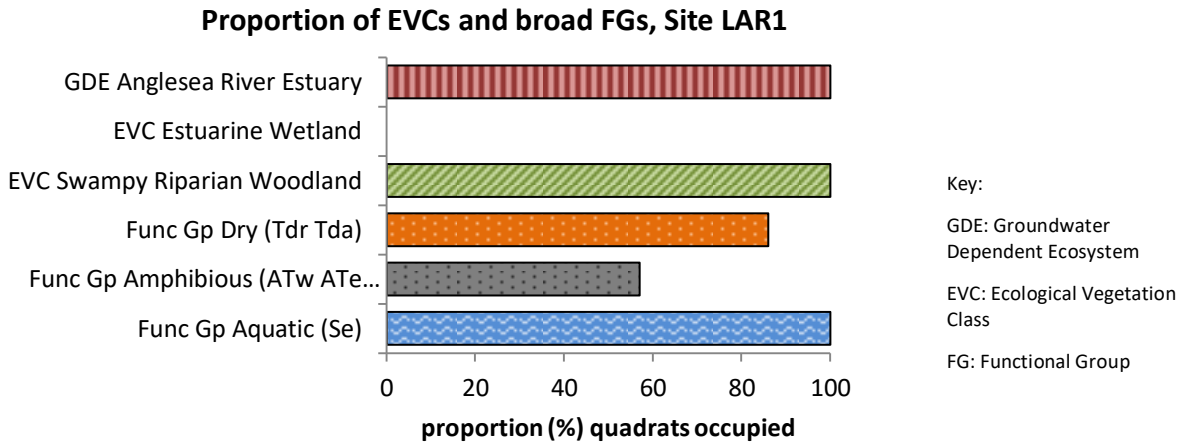
Supplementary frog monitoring sites

AS5: General habitat description					
Ecological Vegetation Class (EVC)	Aquatic Sedgeland				
Wetland permanence	Ephemeral				
Swamp not supporting surface water at the time of survey but soft underfoot. Open areas support moderate cover of emergent vegetation (30–50%) including dense mats of bog-sedge, twig-sedge and some Southern Water-ribbons. High cover of fringing vegetation (90%) including Scented Paperbark and Pouched Coral-fern. Small amounts (5%) of fallen timber also occurring at the site.					
AS5: Frog abundance and richness					
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**		
0	0	0	0		
AS5: Water quality parameters					
pH	NA	**Turbidity**	NA	**Water temperature**	NA
EC	NA	**Salinity**	NA	**Dissolved Oxygen**	NA
Comments					
No frogs seen or heard during the surveys.					

Figure 14 Anglesea Borefield revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site AS5, Frog summary data, 2017

AS6: General habitat description					
Ecological Vegetation Class (EVC)	Aquatic Sedgeland				
Wetland permanence	Ephemeral				
Open swamp with high cover (70–100%) of emergent vegetation, largely dominated by bog-sedge and twig-sedge, of which the majority are dormant/dead, interspersed with small stands of Scented Paperbark and Manuka. Small areas of shallow (10–15 cm) open water were observed at the time of the survey. The swamp is surrounded by dense (70–100%) non-aquatic fringing vegetation.					
AS6: Frog abundance and richness					
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**		
0	0	0	0		
AS6: Water quality parameters					
pH	2.82	**Turbidity**	0 NTU	**Water temperature**	16.4 °C
EC	1660 µs/cm	**Salinity**	0.07%	**Dissolved Oxygen**	NA
Comments					
No frogs seen or heard during the survey.					

Figure 15 Anglesea Borefield revised ecological Monitoring and Assessment Program, Anglesea Swamp, Site AS6, Frog summary data, 2017



Dominant Plant Species		Broad FG	Quadrats occupied (% frequency)
Cycnogeton alcockiae	Southern Water-ribbons	Aquatic	100
Leptospermum scoparium,	Manuka	Dry	71
Typha domingensis	Narrow-leaf Cumbungi	Aquatic	57
Goodenia ovata	Hop Goodenia	Dry	57

Other attributes	
Average % bare ground cover	0

Figure 16 Anglesea Borefield, revised ecological Monitoring and Assessment Program, Anglesea Estuary, Site LAR1, vegetation summary data, 2017

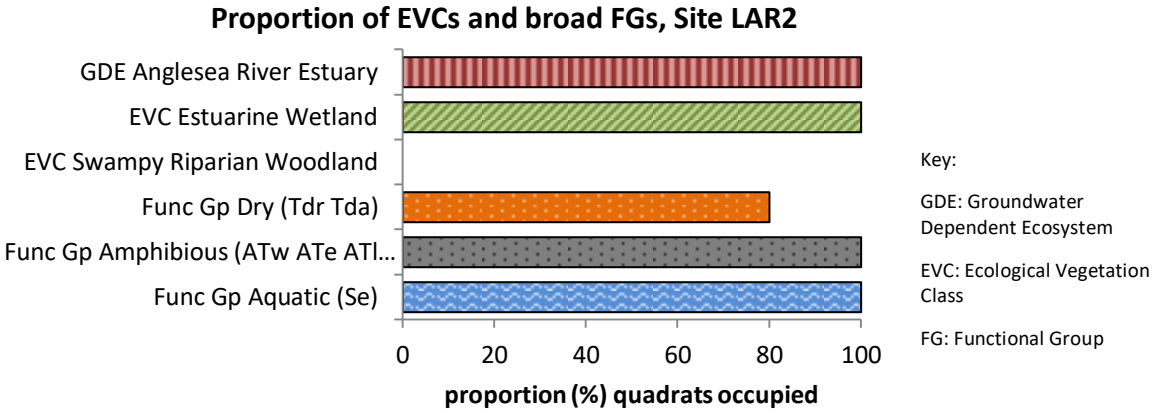
LAR1: General habitat description	
Ecological Vegetation Class (EVC)	Swampy Riparian Woodland
Wetland permanence	Permanent
Slow-flowing stream, 2–3 m in width. Dense (70–100%) fringing vegetation comprising Hop Goodenia, Scented Paperbark and Manuka. Low (10–20%) cover of emergent vegetation occurs within 1 m of the bank, including Common Reed, Narrow-leaf Cumbungi and Southern Water-ribbons. Small amounts of filamentous algae occurs as submergent vegetation (5–10%) covering rocks and concrete fragments, and floating vegetation (<5%).	

LAR1: Frog abundance and richness			
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**
0	0	0	0

LAR1: Water quality parameters					
pH	3.83	**Turbidity**	0 NTU	**Water temperature**	17.7 °C
EC	2710 µs/cm	**Salinity**	0.13%	**Dissolved Oxygen**	9.25 mg/L

Comments
No frogs seen or heard during the survey.

Figure 17 Anglesea Borefield revised ecological Monitoring and Assessment Program, Anglesea Estuary, Site LAR1, Frog summary data, 2017



Dominant Plant Species		Broad FG	Quadrats occupied (% frequency)
Juncus kraussii ssp.*australiensis*	Sea Rush	Aquatic	100
Selliera radicans	Shiny Swamp-mat	Amphibious	87
Phragmites australis	Common Reed	Amphibious	73
Lachnagrostis filiformis	Common Blown-grass	Dry	73

Other attributes	
Average % bare ground cover	0

Figure 18 Anglesea Borefield, revised ecological Monitoring and Assessment Program, Anglesea Estuary, Site LAR2, vegetation summary data, 2017

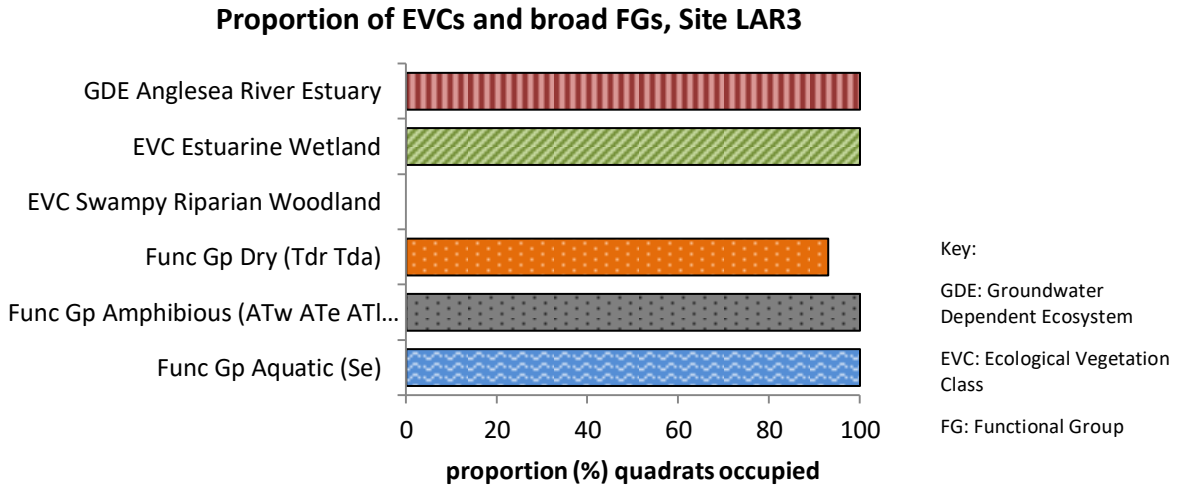
LAR2: General habitat description	
Ecological Vegetation Class (EVC)	Estuarine Wetland
Wetland permanence	Permanent
Slow-moving estuary stream, approximately 7 m wide, mostly comprising open water with moderate levels of filamentous algae occurring as submergent vegetation (50–70%). Low levels of emergent vegetation (<5%) occurs within 0.5 m of the bank comprising Common Reed, Sea Rush and Southern Water-ribbons. High levels (70–100%) of fringing vegetation occur on both banks. The west bank is fringed by a marsh of rushes, while the east bank supports planted vegetation followed by a boardwalk. Low levels (<5%) of bare ground and fallen timber occur at the site.	

LAR2: Frog abundance and richness			
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**
0	0	0	0

LAR2: Water quality parameters					
pH	3.82	**Turbidity**	NA	**Water temperature**	18.3 °C
EC	2950 µs/cm	**Salinity**	0.14%	**Dissolved Oxygen**	8.73 mg/L

Comments
No frogs seen or heard at the site. Approximately 10–20 Common Froglets and one Southern Bullfrog heard calling in the distance during the first survey.

Figure 19 Anglesea Borefield revised ecological Monitoring and Assessment Program, Anglesea Estuary, Site LAR2, Frog summary data, 2017



Dominant Plant Species		Broad FG	Quadrats occupied (% frequency)
Juncus kraussii ssp.*australiensis*	Sea Rush	Aquatic	100
Cycnogeton alcockiae	Southern Water-ribbons	Aquatic	100
Poa Poiformis var. poiforimis	Coast Tussock-grass	Dry	73

Other attributes	
Average % bare ground cover	0

Figure 20 Anglesea Borefield, revised ecological Monitoring and Assessment Program, Anglesea Estuary, Site LAR3, vegetation summary data, 2017

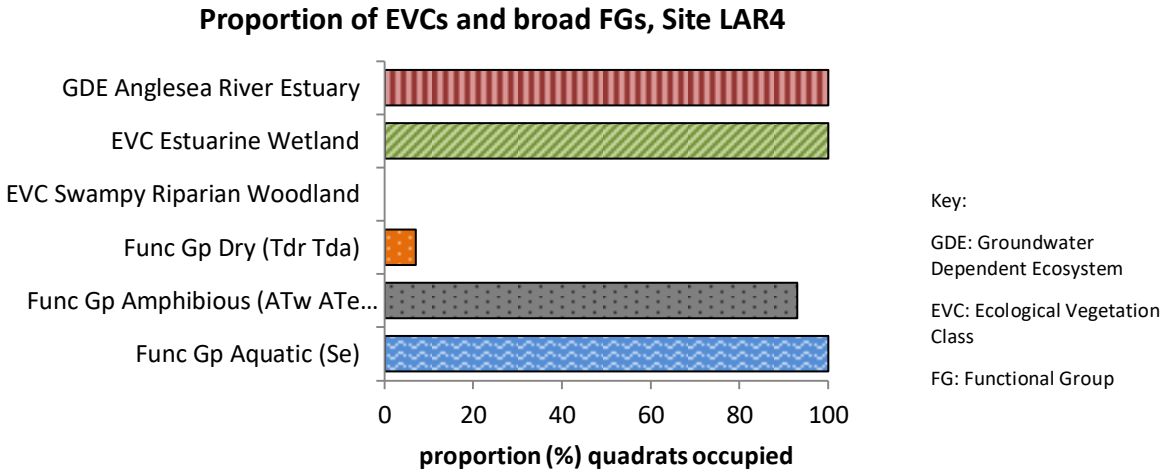
LAR3: General habitat description	
Ecological Vegetation Class (EVC)	Estuarine Wetland
Wetland permanence	Permanent
Slow-moving estuary stream, c. 6 m wide, with low (<5%) cover of Common Reed, rushes and Southern Water-ribbons as emergent vegetation near the banks. Moderate submergent cover (20–50%) of filamentous algae along the bottom of the stream. The site supports dense fringing vegetation (70–100%) comprising a marsh of Common Reeds to the east and Sea Rush and Shiny Swamp-mat to the west, with planted woodland vegetation at c. 4 m from the bank.	

LAR3: Frog abundance and richness			
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**
0	0	0	0

LAR3: Water quality parameters					
pH	3.88	**Turbidity**	0 NTU	**Water temperature**	18.4 °C
EC	3110 µs/cm	**Salinity**	0.15%	**Dissolved Oxygen**	9.91 mg/L

Comments
No frogs seen or heard during the surveys.

Figure 21 Anglesea Borefield revised ecological Monitoring and Assessment Program, Anglesea Estuary, Site LAR3, Frog summary data, 2017



Dominant Plant Species		Broad FG	Quadrats occupied (% frequency)
Juncus kraussii ssp.*australiensis*	Sea Rush	Aquatic	100
Cycnogeton alcockiae	Southern Water-ribbons	Aquatic	100
Selliera radicans	Shiny Swamp-mat	Amphibious	93

Other attributes	
Average % bare ground cover	0

Figure 22 Anglesea Borefield, revised ecological Monitoring and Assessment Program, Anglesea Estuary, Site LAR3, vegetation summary data, 2017

LAR4: General habitat description	
Ecological Vegetation Class (EVC)	Heathy Woodland
Wetland permanence	Permanent
Slow-moving 8-m wide estuary stream, comprising mostly open with minimal (5–10%) emergent vegetation dominated by Cumbungi and Southern Water-ribbons within 1 m of the bank. Submergent filamentous algae occurs at low levels (5–10%) within 2 m of the bank. The site is fringed by dense (70–100%) cover of Cumbungi and planted vegetation.	

LAR4: Frog abundance and richness			
Southern Brown Tree Frog	**Common Froglet**	**Southern Bullfrog**	**Species Richness**
0	0	1	1

LAR4: Water quality parameters					
pH	3.89	**Turbidity**	NA	**Water temperature**	18.6 °C
EC	3250 µs/cm	**Salinity**	0.16%	**Dissolved Oxygen**	9.09 mg/L

Comments
One Southern Bullfrog heard at the site during the first survey but no frogs heard or seen during the second survey.

Figure 23 Anglesea Borefield revised ecological Monitoring and Assessment Program, Anglesea Estuary, Site LAR4, Frog summary data, 2017

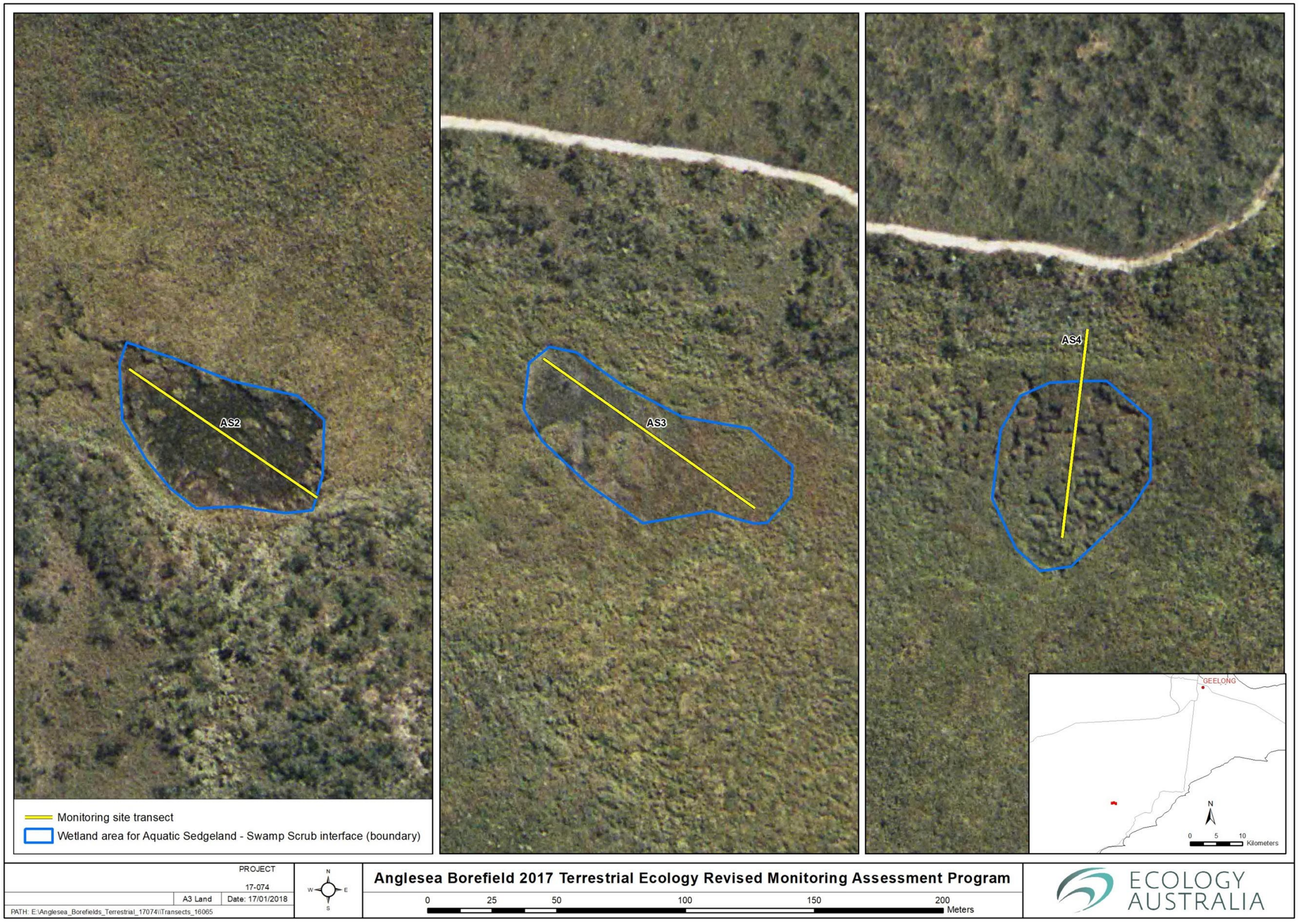


Figure 24 Anglesea Borefield revised ecological Monitoring Assessment Program, wetland boundaries, Anglesea Swamp, 2017

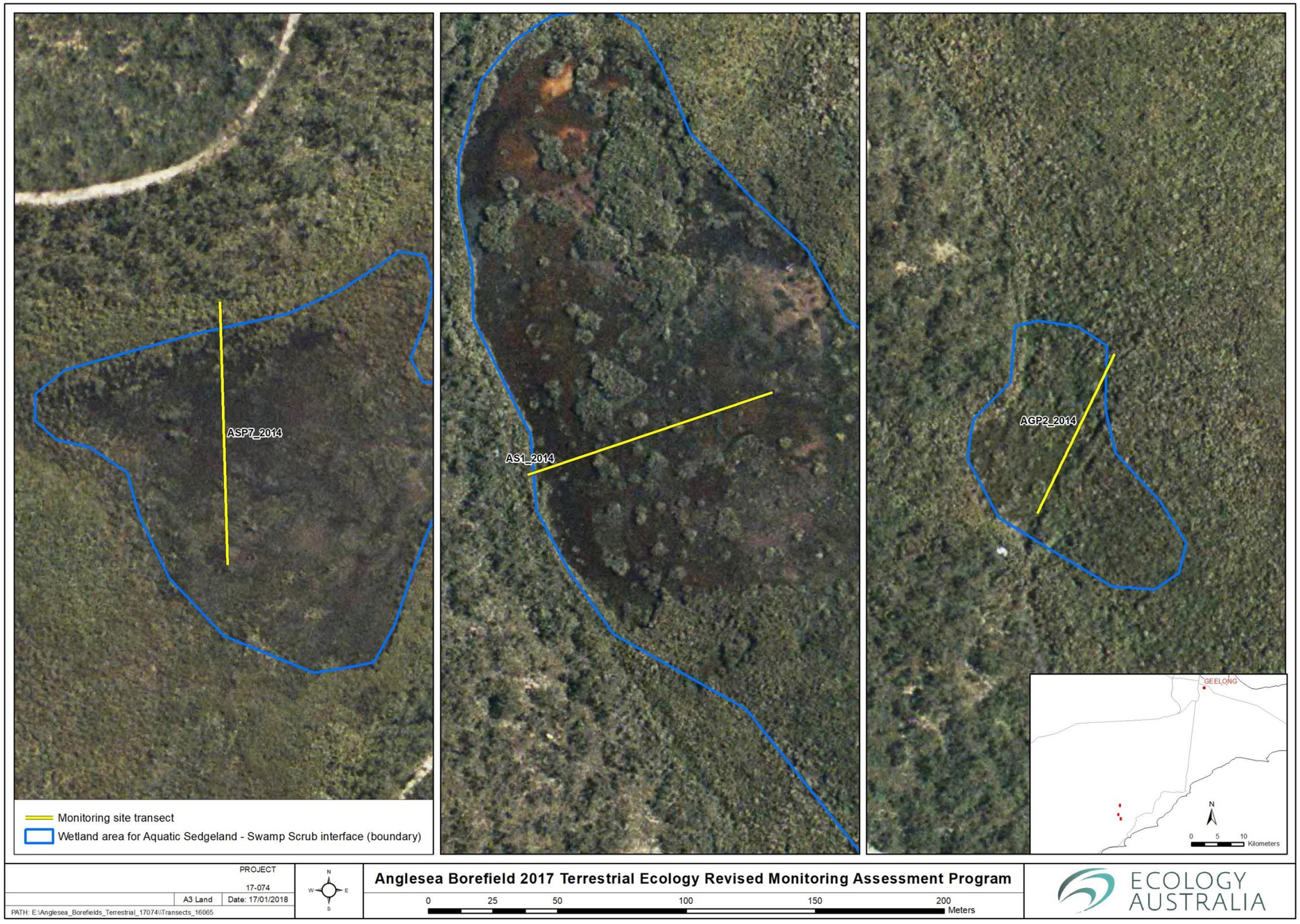


Figure 25 Anglesea Borefield revised ecological Monitoring Assessment Program, wetland boundaries, Anglesea Swamp, 2017

3.3 Aquatic monitoring

3.3.1 Macroinvertebrate results

The macroinvertebrate site results based on combined data from the three samples are provided in Table 5.

None of the nine samples collected contained sufficient macroinvertebrates to enable the sample to be picked in 30 minutes (each one had considerably less than 200 macroinvertebrates) and W3 was so depauperate that the combined data from three samples did not add up to 200 macroinvertebrates. Site W3 had the fewest taxa present, with only six detected across the three samples, and in one sample only two taxa were detected. This is substantially less than the SEPP objective (EPA 2004) of 23 taxa. Conversely, BCT1 and SC1 both attained SEPP objectives as combined samples.

None of the three sites attained SEPP objectives for EPA key families, and even the three sites combined were unable to attain the objectives, with W3 again performing considerably worse than BCT1 and SC1. All three sites attained SEPP objectives for SIGNAL scores when the three samples were combined, with SC1 attaining the highest score. No EPT or EPTO taxa were detected at W3, with BCT1 attaining the highest diversity for both EPT and EPTO.

Site W3 has not been surveyed since spring 2011 as it has regularly been dry at the time of survey, or an alternative wetland site has been surveyed. The results from spring 2017 are fairly consistent with those from 2011, however there were fewer taxa and fewer key families in 2017.

Site BCT1 has been regularly surveyed. The results from the past few years are fairly consistent, with some indices improving and others declining marginally. Between 2014 and 2017, the number of taxa, EPT and EPTO indices have improved, while key families and SIGNAL score have vacillated between higher and lower scores than in 2017.

Site SC1 has also been consistently surveyed. The overall number of taxa, number of EPA key families, and EPT taxa have increased substantially, and the SIGNAL score has also increased. The only metric where it has not improved is in the EPTO, as no Odonata were detected at SC1 in 2017.

The results of the individual macroinvertebrate samples will be further illustrated below by site (3.3.5)

Table 5 Macroinvertebrate survey indices: results by site (non-attainment of SEPP objectives indicated by shading)

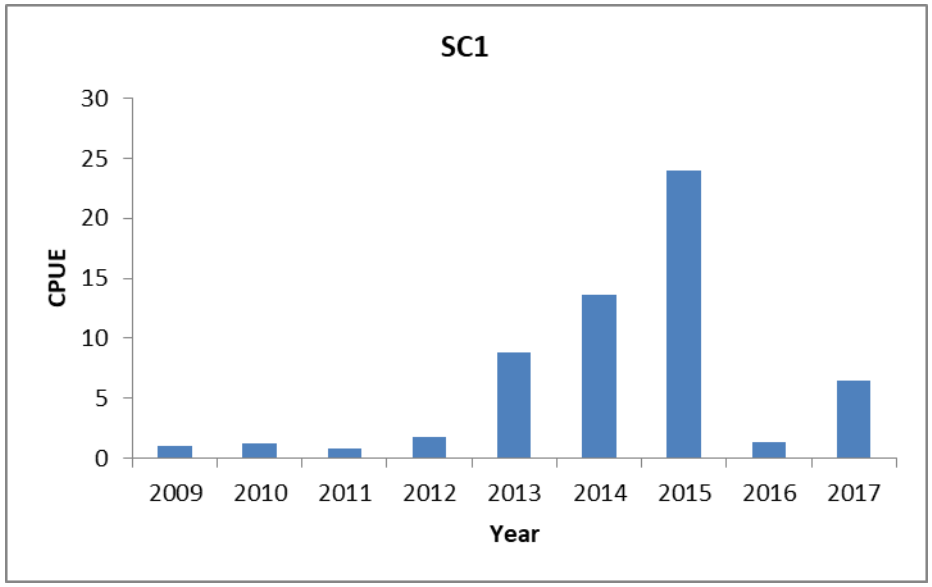
Indices	W3	BCT1	SC1	Total	SEPP objective
# taxa	6	24	24	32	23
# individuals	158	216	231	605	N/A
EPA key families	5	15	17	19	21
SIGNAL score	5.33	5.78	5.9	5.83	5.3
EPT	0	6	5	7	N/A
EPTO	0	8	5	10	N/A

3.3.2 Southern Pygmy Perch results

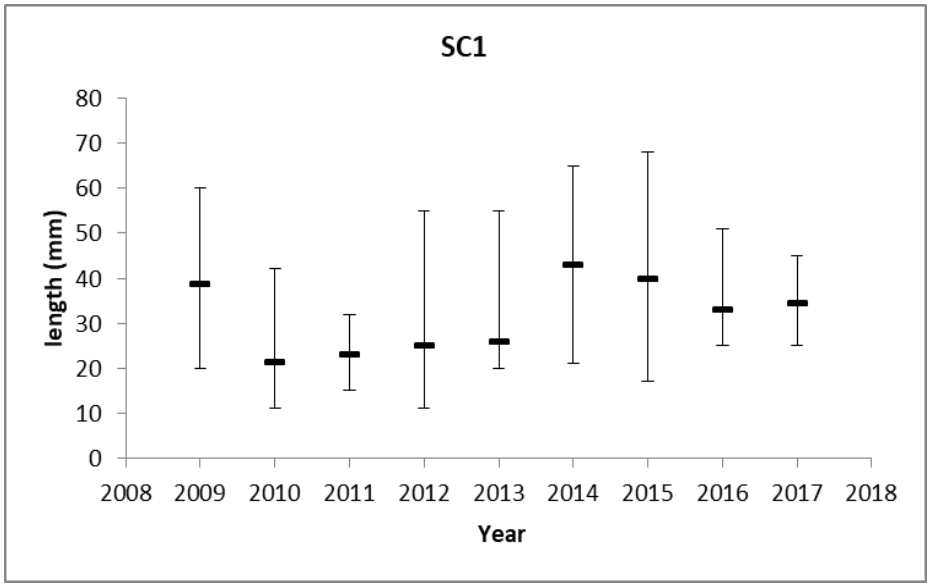
A total of 65 Southern Pygmy Perch were captured from Salt Creek (SC1), and 18 were captured from Breakfast Creek tributary (BCT1) (Figure 26 and Figure 27, Plate 2 and 3). These represent the fourth highest and third highest spring Catch Per Unit Effort (CPUE) respectively since 2010. CPUE was calculated based on the assumption that five bait traps were utilised each spring 2009–2016. 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). The use of CPUE to compare results is imperfect, as there may be an interaction effect whereby utilising additional traps in a small area may reduce the capture rate per trap. Higher total abundances have been noted from BCT1 in the most recent three years of survey, while the abundance in SC1 appears to have been highly variable over the past three years, with 2017 showing promising signs after a potential population crash in 2016. Recruitment appears to have occurred annually at SC1, while it may have been opportunistic at BCT1 based on the length distributions of captured individuals.

Plate 2 Male Southern Pygmy Perch from BCT1

Plate 3 Male and female Southern Pygmy Perch from SC1

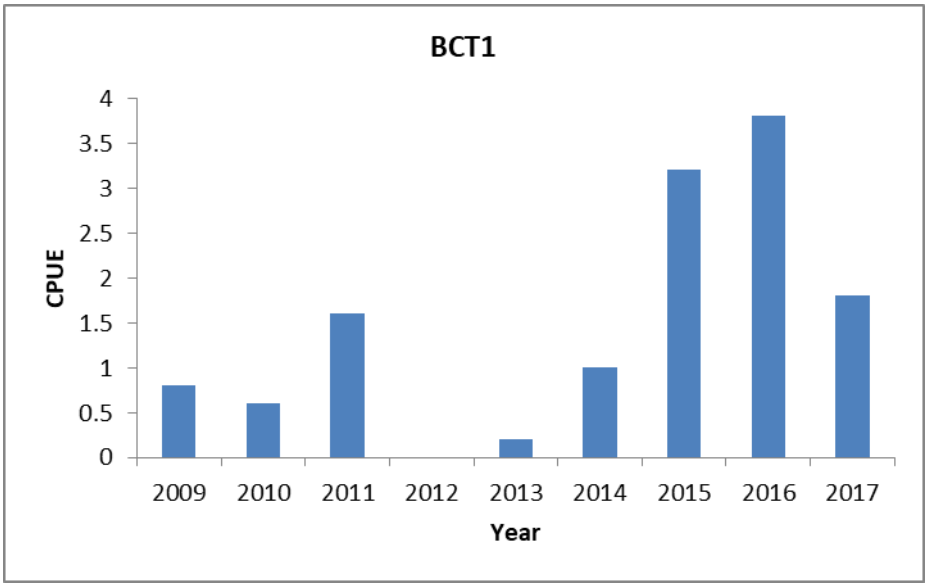


a) fish catch per unit effort at SC1.

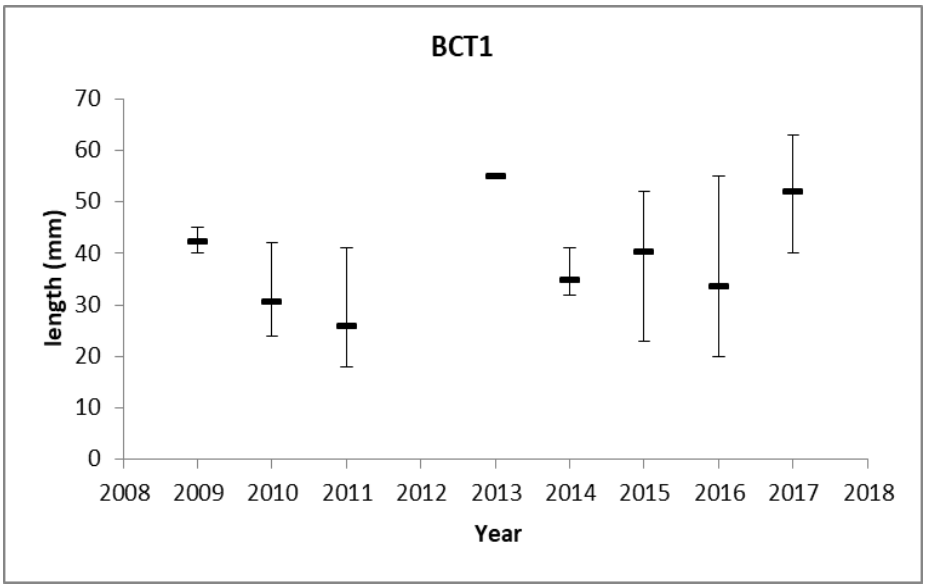


b) mean, minimum and maximum total length of measured Southern Pygmy Perch. n= CPUE x5 from Figure 27a), with the exception of 2017 where n=CPUEx10

Figure 26 Southern Pygmy Perch capture rates and length summary 2009-2017 at SC1



a) fish capture per unit effort at BCT1



b) mean, minimum and maximum total length of measured Southern Pygmy Perch. n= CPUE x5 from Figure 27a), with the exception of 2017 where n=CPUEx10

Figure 27 Southern Pygmy Perch capture rates and length summary 2009-2017 at BCT1

3.3.3 Water quality

Water quality results, whilst not attaining SEPP objectives for dissolved oxygen and pH, are fairly consistent with previous years (

Table 6).

Table 6 Water quality results (shading represents non-compliance with SEPP objectives)

	Temperature (°C)	Conductivity (µs/cm)	Dissolved oxygen		pH
			mg/L	%Sat	
SEPP objective		<500		85-110	6.4-7.7
W3	10.97	312	4.52	40	2.77
BCT1	8.67	250	7.01	70	5.39
SC1	11.53	314	3.75	38	4.99

3.3.4 Non-target fauna and additional survey effort

An electrofishing spot check consisting of 243 seconds of power on time was undertaken on Breakfast Creek at the Breakfast Creek Road crossing, using a Smith Root LR24 backpack electrofisher. This was undertaken opportunistically in an effort to provide further information on the distributional extent of Southern Pygmy Perch and Otways Cray *Geocharax gracilis.*

Otways Cray was detected at two of the three surveys locations (BCT1 and SC1), and was also confirmed to occur at the Breakfast Creek Road crossing (Table 7, Plate 4, Plate 5). The crays were detected during the fish survey (bait traps), during the macroinvertebrate survey (dip nets), and by electrofishing. Otways Cray is listed as Endangered on the Victorian Advisory List of threatened invertebrates. There are no local records on the Victorian Biodiversity Atlas (DELWP 2017), however there is a published record from Salt Creek ~2007 (Schultz et al. 2007).

Table 7 Non-target fauna recorded during aquatic surveys

Non-target fauna	SC1	BCT1	Breakfast Creek at Breakfast Creek Road
Otways Cray	8 (dip net)	15 (dip net) 6 (bait trap)	5 (electrofishing)
Eastern Smooth Frog	Present (calling)		<5 (calling)
Eastern Smooth Frog (tadpole)	1 (dip net)		1 (electrofishing)

Plate 4 Otways Cray – Breakfast Creek

Plate 5 Otways Cray – BCT1

3.3.5 Aquatic monitoring results by site

Wetland 3 (W3)

At the time of survey, W3 was very shallow, contracted, and dominated by dense Scented Paperbark and Tea-tree. 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 was present in high abundance, and 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 area adjacent to the roadside (i.e. downstream of the road culvert). W3 had very limited standing water; had there been any less the site would have been ruled out.

The macroinvertebrate results for the wetland site were poor for all indices other than SIGNAL (Table 8).

Table 8 Macroinvertebrate sample results at W3, displayed individually and combined for the site, showing SEPP objectives (shading indicates non-attainment of SEPP objectives)

	W3-1	W3-2	W3-3	W3	SEPP objective
# taxa	6	2	5	6	23
# individuals	58	30	70	158	-
Key families	5	1	4	5	21
SIGNAL	5.33	5.00	5.20	5.33	5.30
EPT	0	0	0	0	-
EPTO	0	0	0	0	-

Salt Creek (SC1)

Plate 6 Salt Creek at SC1, showing bait trap set for fish survey

Of the three sites, Salt Creek at SC1 had the largest area of surface water available for sampling, and appeared permanent, with depths exceeding 1.5 m. The substrate was silt/clay, and the flow velocity was dominated by lentic (still) habitats with approximately 10% 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), 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* sp, *Carex* sp and *Isolepis* sp.

The macroinvertebrate results for the Salt Creek site as a combined sample (i.e. combined data from three sampled) attained SEPP objectives for number of taxa, but did not as individual samples (

Table 9). Similarly to the other two sites, abundance and key families representation was poor. One of the three samples was particularly poor, with no EPT or EPTO taxa, and only 21 individuals collected. The SIGNAL scores indicated that the site suffers from mild pollution, but attained SEPP objectives.

Table 9 Macroinvertebrate sample results at SC1, displayed individually and combined for the site, showing SEPP objectives

	SC1-1	SC1-2	SC1-3	SC1	SEPP objective
# taxa	13	17	11	24	23
# individuals	94	116	21	158	-
Key families	10	14	8	17	21
SIGNAL	5.7	5.71	5.5	5.9	5.30
EPT	2	4	0	5	-
EPTO	2	4	0	5	-

Detected numbers of Southern Pygmy Perch and CPUE were higher in 2017 than 2016, but remain substantially lower than 2015. The length-frequency histogram suggests there are multiple age classes present at SC1, and that recruitment successfully occurred in the past 12 months. Southern Pygmy Perch reach maturity at approximately 30 mm (Robinson 2012), and five of the 18 fish detected were below this threshold (Figure 28).

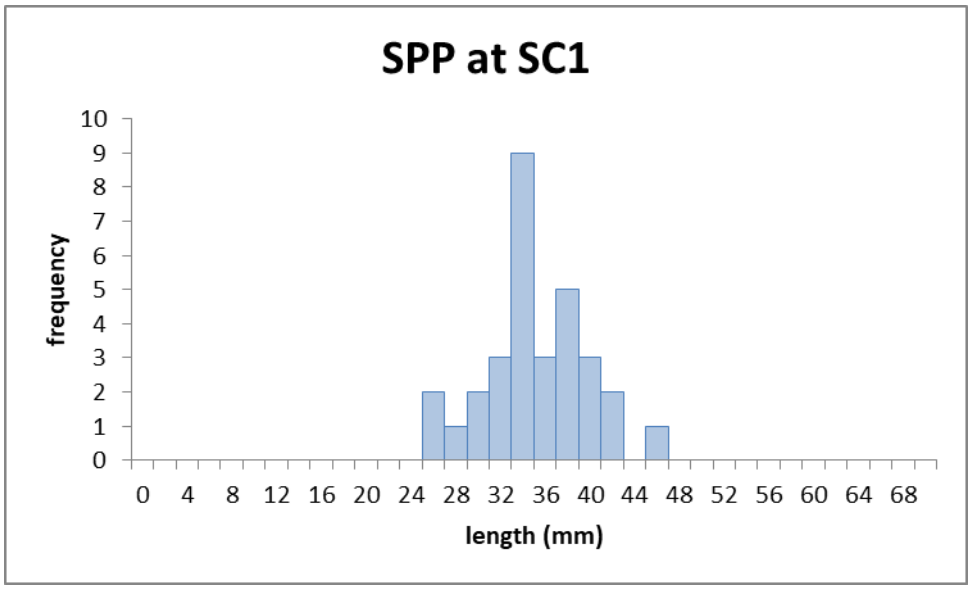


Figure 28 Length-frequency histogram of Southern Pygmy Perch at SC1. N=18

Breakfast Creek tributary (BCT1) at SV3

Plate 7 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 75 cm, maximum depth of 45 cm and an average depth of 15 cm. The substrate was silt/clay, and the flow velocity was dominated by lentic (still) habitats with less than 15% glide and 1% run 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) (75%), overhanging terrestrial vegetation (50%), branches (10%), logs (<5%), aquatic vegetation (<1%), and overhanging bank (<1%). The dominant aquatic vegetation types were *Juncus* sp, *Carex* sp and *Blechnum* sp.

As with SC1, the macroinvertebrate results for the Breakfast Creek tributary site as a combined sample attained SEPP objectives for number of taxa, but did not as individual samples (

Table 10). Similarly to the other two sites, abundance was poor, and there was poor representation by key families. The results across the three samples were relatively consistent. The SIGNAL scores indicated that the site ranges between mild pollution and clean water, but attained SEPP objectives.

Table 10 Macroinvertebrate sample results at BCT1, displayed individually and combined for the site, showing SEPP objectives (shading indicates non-compliance with SEPP objectives)

	BCT1-1	BCT1-2	BCT1-3	BCT1	SEPP objective
# taxa	17	13	12	24	23
# individuals	82	33	101	231	-
Key families	12	9	10	15	21
SIGNAL	5.93	5.88	6.10	5.78	5.30
EPT	5	4	4	6	-
EPTO	5	6	5	8	-

Detected numbers of Southern Pygmy Perch were similar over the most recent three surveys, however CPUE was much lower in 2017. The length-frequency histogram suggests that recruitment failure may have occurred in the past 12 months, while length distributions from 2016 (GHD 2017) were indicative of successful recent recruitment at that time. Southern Pygmy Perch reach maturity at approximately 30 mm (Robinson 2012), and none of the fish detected in 2017 were below this threshold (Figure 29).

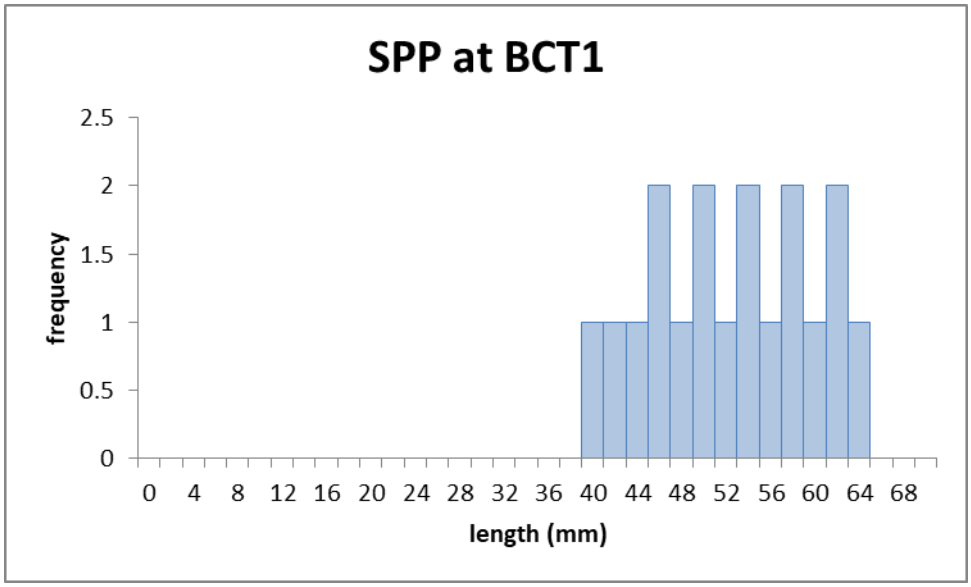


Figure 29 Length-frequency histogram of Southern Pygmy Perch at BCT1. n=31

4 Discussion

Vegetation

The terrestrial ecology monitoring of the Anglesea Swamp and Anglesea Estuary as in previous years, focused on plant functional groups and frogs and their distribution in the Anglesea Swamp and Estuary. The aquatic ecology component focussed on macroinvertebrate communities and Southern Pygmy Perch populations.

Mean annual rainfall was lower in 2017 (609mm) than in 2016 (714mm) and lower than the average mean annual rainfall (627mm) but still considerably greater more than in 2014 and 2015 (498 and 488mm respectively) based on data from the weather station at Aireys Inlet (BOM 2018). The greater rainfall may account for increased standing water being recorded at all six vegetation monitoring sites in 2016 and 2017 compared to prior years when very little standing water was recorded. Average water depth at the swamp monitoring sites ranged from 5–22 cm in both 2016 and 2017. The Anglesea Estuary is managed so water levels remain fairly constant, and water levels appeared similar to 2016.

The data suggests that EVCs remain unchanged from previous years in the Anglesea Estuary and Anglesea Swamp (Ecology Australia 2015 and 2016). There was little change observed in the plant FGs with amphibious and aquatic FGs continuing to be the dominant groups in the estuary in 2015 and 2017, and in the Swamp in 2016 and 2017 (Ecology Australia 2015 and 2016). Plant species numbers remained fairly consistent across all transects (Appendix 1).

It was noted for a second year that filamentous algal mats were present at some sites in the Anglesea Swamp. Algal mats were first recorded in 2016 and may be associated with reduced flows.

The Anglesea Estuary is prone to naturally occurring acid events under certain climatic conditions. The vegetation appears to be fairly resilient and persists through these events which can have more noticeable impacts on other biota such as fish.

Frogs

Despite the presence of surface water at six frog sites in the Anglesea Swamp during the surveys, frogs were recorded at fewer sites, and in generally lower abundances in 2017 compared with 2016. While frogs were heard calling from areas surrounding three sites, they were only recorded at one monitoring site (AS2), compared with records from four sites in 2016. Three frog species were recorded at AS2 (Common Froglet, Southern Brown Tree Frog and Southern Bullfrog), but numbers of Bullfrogs were much lower in the current survey (1–5) compared with numbers heard in 2016 (>20). More frogs were heard calling in the first survey in October compared with the second survey in November, when standing water levels were lower.

One Southern Bullfrog was recorded at a site (LAR4) in the Anglesea Estuary, compared with c. 10 Common Froglets and a Southern Bullfrog heard across three sites in 2015. A chorus of Common Froglets (10–20) were heard in the distance towards Anglesea township, but were not detected at the monitoring sites.

Consistent with previous reports (Ecology Australia 2014, 2015 and 2016) the results continue to suggest that water levels in the swamp are largely rainfall dependent and therefore variable. The vegetation remains resilient and appears to be adapted to this natural rainfall variability. Frog numbers were down

as they are dependent on adequate standing water for breeding and would require extended rainfall to build up more substantial numbers. They may also be sensitive to acid events in the estuary.

Depending on future responses of water regimes in the Anglesea Swamp to climate predictions not only may water levels in the Anglesea Swamp change but acid events affecting the estuary may alter. Eventually changes in plant FGs may be expected. Should conditions become drier and more acidic then it would be expected that frog numbers could decline, or certainly not increase above the levels observed.

Aquatic Ecology

Macroinvertebrate surveys provide an overview of the health of aquatic systems. The macroinvertebrate survey results were relatively consistent with previous years, with sites demonstrating slight improvements under some indices, and minor reductions in others. Site SC1 showed the most marked improvements compared with recent years, while W3 showed the most notable decline. W3 had a considerably lower pH level than the other two sites, which is likely to have an impact upon the biota present as a pH of 2.7 is likely to be inhospitable for many taxa. While low, this is a naturally acidic system and low pH is characteristic of the wetland sites. In addition, having rarely contained sufficient water for survey (it was last surveyed in 2011) the short hydroperiod of this wetland is likely to greatly influence the macroinvertebrate community composition and abundance. It should be noted that comparisons between these results and SEPP objectives (EPA 2004) are provided for consistency with previous reports however should be interpreted with caution. The SEPP objectives are based on the standard RBA methods. These surveys undertaken for this project were triplicate edge, single season samples from predominantly lentic habitats; standard RBA sampling entails edge and riffle samples collected in both autumn and spring from predominantly lotic habitats and never from wetlands. 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).

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). If further surveys were to yield similar results, then the populations present in Salt Creek and Breakfast Creek tributary may be an important source population for recolonisation lower in the catchment. During the 2017 spring surveys for Southern Pygmy Perch, the species was detected at both survey sites. Southern Pygmy Perch have been detected at both sites in every spring survey since 2010, with the exception of 2012 at BCT1. The population appears to have had successful recruitment in the past 12 months at SC1, where the abundance appears to have improved since 2016; whereas recruitment was not evident at BCT1 in 2017, despite abundance appearing stable. 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.

The most notable result from the aquatic ecological monitoring was the detection of the endangered Otways Cray. This species has been recorded twice in this region, in 2007 and 2017. 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 this period. Consideration should be given to the inclusion of this species in the monitoring program in future years.

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Appendix 1 Anglesea Borefield, terrestrial ecology, Monitoring and Assessment Program, Anglesea Swamp, native plant species and Functional Groups

Key:

k = poorly known species classified under 'Advisory List of Rare or Threatened' (VROT) plants in Victoria' (DEPI 2014)

Status	Scientific name	Common name	Functional group	AS2	AS3	AS4	ASP7_2014	AS1_2014	AGP2_2014
	Banksia marginata	Silver Banksia	Tdr	✓		✓			
	Baumea arthrophylla	Fine Twig-sedge	Se			✓	✓	✓	✓
	Baumea juncea	Bare Twig-sedge	ATe				✓	✓	
	Baumea tetragona	Square Twig-sedge	Se	✓	✓	✓	✓		
	Cassytha glabella	Slender Dodder-laurel	Tdr		✓	✓	✓	✓	
	Cassytha pubescens	Downy Dodder-laurel	Tdr	✓					
k	*Chorizandra australis*	Southern Bristle-sedge	Se	✓			✓		
	Comesperma ericinum	Heath Milkwort	Tdr			✓			
	Cryptostylis subulata	*Large Tongue-orchid*	Se	✓					
	Cycnogeton alcockiae	Southern Water-ribbons	Se	✓		✓	✓	✓	✓
	Dillwynia cinerascens	Grey Parrot-pea	Tdr	✓					
	Drosera binata	Forked Sundew	Tda		✓	✓			
	Eleocharis sphacelata	Tall Spike-sedge	Se					✓	
	Empodisma minus	Spreading Rope-rush	ATe		✓	✓	✓	✓	✓
	Epacris obtusifolia	Blunt leaf-Heath	ATw		✓	✓	✓		
	Eucalyptus willisii	Shining Peppermint	Tdr	✓					
	Ghania radula	Thatch Saw-sedge	Tdr	✓					
	Ghania sieberiana	Red-fruit Saw-sedge	ATe			✓	✓		✓
	Gleicheinia dicarpa	Pouched Coral-fern	ATe		✓	✓	✓	✓	
	Isolepis inundata	Swamp Club-sedge	ATl					✓	
	Juncus procerus	Tall Rush	ATe						✓
	Lepidosperma longitudinale	Pithy Sword-sedge	ATe			✓	✓		
	Leptospermum continentale	Prickly Tea-tree	Tdr			✓	✓	✓	
	Leptospermum lanigerum	Woolly Tea-tree	ATw			✓	✓		
	Leptospermum scoparium	Manuka	Tda	✓	✓	✓	✓	✓	✓
	Melaleuca squarrosa	Scented Paperbark	ATw	✓	✓	✓	✓	✓	✓
	Opercularia varia	Variable Stinkweed	Tdr	✓					
	Platylobium obtusangulum	Common Flat-pea	Tdr	✓					
	Pteridium esculentum	Bracken	Tdr	✓					
	Pultenea gunnii	Golden Bush-pea	Tdr			✓			
	Pultenea spp.	Bush-pea	Tdr			✓			
	Rhytidosporum procumbens	White Marianth	Tdr	✓					
	Schoenus brevifolius	Zig-zag Bog-sedge	ATe	✓	✓	✓	✓	✓	
	Sprengalia incarnata	Pink Swamp-heath	ATw		✓	✓			
	Xyris operculata	Tall Yellow-eye	ATe		✓		✓		

Appendix 2 Anglesea Borefield, terrestrial ecology, Monitoring and Assessment Program, Anglesea Estuary, native plant species and Functional Groups

Key:

= Victorian species not indigenous to the region, location or local area
*= Species not native to Victoria

Status	Scientific name	Common name	Functional group	LAR1	AS2	AS3	AS4
#	*Acacia longifolia subsp. sophorae*	*Coast Wattle*	*NA*	✓			
*	*Aster subulatus*	*Aster-weed*	*NA*		✓		
	Cassytha melantha	*Coarse Dodder-laurel*	*Tdr*				✓
	Cycnogeton alcockiae	*Southern Water-ribbons*	*Se*	✓	✓	✓	✓
	Eucalyptus ovata. var. ovata	*Swamp Gum*	*Tda*	✓		✓	
	Ficinia nodosa	*Knobby Club-sedge*	*Tdr*			✓	
	Frankenia pauciflora var. gunnii	*Southern Sea-heath*	*Tdr*				✓
	Gahnia sieberiana	*Red-fruit Saw-sedge*	*Ate*	✓			
	Goodenia ovata	*Hop Goodenia*	*Tdr*	✓	✓	✓	✓
*	*Holcus lanatus*	*Yorkshire Fog*	*NA*			✓	
	Isolepis inundata	*Swamp Club-sedge*	*ATi*				✓
	Juncus kraussii ssp. australiensis	*Sea Rush*	*Se*	✓	✓	✓	✓
	Lachnagrostis filiformis	*Common Blown-grass*	*Tdr*		✓		
	Leptinella longipes	*Coast Cotula*	*ARp*		✓	✓	✓
	Leptosperumum scoparium	*Manuka*	*Tda*	✓	✓	✓	
	Lobelia anceps	*Angled Lobelia*	*ATe*		✓	✓	✓
	Phragmites australis	*Common Reed*	*ARp*	✓	✓	✓	✓
*	*Plantago coronopus*	*Buck's-horn Plantain*	*NA*		✓		
	Poa poiformis var. poiformis	*Coast Tussock-grass*	*Tdr*		✓	✓	✓
	Scenecio glomeratus	*Annual Fireweed*	*Tdr*			✓	
	Schoenus apogon	*Common Bog-sedge*	*Tda*			✓	
	Selliera radicans	*Shiny Swamp-mat*	*ARp*		✓	✓	✓
	Typha domingensis	*Narrow-leaf Cumbungi*	*Se*	✓		✓	✓

Appendix 3 Macroinvertebrate survey results

Class/Order	Family/Subfamily	Genus	BCT1-1	BCT1-2	BCT1-3	SC1-1	SC1-2	SC1-3	W3-1	W3-2	W3-3	Grand Total
Acarina			2	4	7		4	3				20
Amphipoda	Paramelitidae				1		1					2
Amphipoda				2								2
Anaspidacea	Koonungidae					12	5					17
Coleoptera	Chrysomeliidae (L)		1									1
Coleoptera	Dytiscidae (A)		1			10	8	1	3		3	26
Coleoptera	Hydrochidae (A)					2	2					4
Coleoptera	Hydrophilidae (A)		1		1		1	1	2		1	7
Coleoptera	Scirtidae (L)					2			32	18	43	95
Decapoda	Parastacidae	*Geocharax gracilis*	6	3	6		2	6				23
Diptera	Ceratopogoninae		1					1				2
Diptera	Chironomidae						1					1
Diptera	Chironominae		4	1	10	8	9	4	4		6	46
Diptera	Culicidae								16	12	17	45
Diptera	Orthocladiinae			2	1	18	4					25
Diptera	Psychodidae		1					1				2
Diptera	Simuliidae		1		13	10	34	1				59
Diptera	Tanypodinae					1	2		1			4
Ephemeroptera	Caenidae	*Tasmanocoenis*					2					2
Ephemeroptera	Leptophlebiidae	*Thraulophlebia*	1	1		12	10					24
Ephemeroptera	Leptophlebiidae	*Ulmerophlebia*			1							1
Ephemeroptera	Leptophlebiidae						4					4
Hemiptera	Veliidae		1	1		12	13	1				28
Isopoda	Janiridae	*Heterias*	1					1				2
Lepidoptera	Crambidae					1						1
Mecoptera	Nannochoristidae	*Nannochorista*	1					1				2
Odonata	Argiolestidae	*Austroargiolestes*		1								1
Odonata	Telephlebiidae	*Austroaeschna*		1	2							3
Odonata	Telephlebiidae/Brachytronidae		3	1								4
Oligochaeta				1		3	2					6
Plecoptera	Gripopterygidae	*Illiesoperla*	1	1	3	1						6
Plecoptera	Gripopterygidae		49		47	2	1					99
Trichoptera	Ecnomidae	*Dateronomina*	1		1							2
Trichoptera	Hydrobiosidae	*Taschorema* complex					1					1
Trichoptera	Leptoceridae	*Triplectides*	6	14	8		10					38
		Grand Total	**82**	**33**	**101**	**94**	**116**	**21**	**58**	**30**	**70**	**605**