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Anglesea Borefield Monitoring and Assessment Program 2024



Prepared for: Barwon Water

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Summary

Introduction

In 2024, Ecology Australia was commissioned by Barwon Water to undertake the Monitoring and Assessment Program for aquatic and terrestrial ecological monitoring of the Anglesea Borefield. Barwon Water is permitted to extract groundwater from the Anglesea Borefield under the Bulk Entitlement (Anglesea Groundwater) 2009 to supplement the water supply to Geelong and surrounding areas when required. Under the Bulk Entitlement, it was necessary to establish a comprehensive Monitoring and Assessment Program, which has since been reviewed by independent experts and approved by the Minister for Water.

The purpose of the Monitoring and Assessment Program is twofold:

1. To monitor for any changes in the environmental values and health of the groundwater dependent ecosystem.
2. To continue to gather the data required to build our understanding of the long-term sustainability of the groundwater resources into the future.

The Monitoring and Assessment Program is continually reviewed and updated as part of the Bulk Entitlement review process. Barwon Water did not extract water from the borefield in 2024, and it is currently in standby mode with the pumps removed.

Methods

Vegetation monitoring was undertaken along six permanent transects in the Anglesea River Swamp and four permanent transects in the Anglesea Estuary. The data collected included:

- plant species lists
- Ecological Vegetation Class (EVC)
- Plant Functional Group
- bare ground cover
- water depth (in the swamp only).

Frog survey data was collected at eight sites in the Anglesea River Swamp and four sites in the Anglesea Estuary and included:

- frog species richness
- frog abundance
- water quality
- habitat attributes.

Aquatic ecological monitoring consisted of the one-in-three-year spring macroinvertebrate surveys undertaken at 11 sites, as well as targeted surveys for southern pygmy perch and Otway bush yabby at two sites. Fish and macroinvertebrate monitoring components included:

- macroinvertebrate indices

- fish and crayfish species richness
- fish and crayfish abundance
- biometrics (fish and crayfish)
- water quality
- habitat attributes.

Findings

Vegetation

The Anglesea River Swamp and Anglesea Estuary sites continue to be dominated by indigenous flora species. There was, however, an increase in the number of exotic species present compared to the 2022 survey (increasing from two species to nine). Of the native species, those belonging to the aquatic or amphibious functional groups dominated all Anglesea River Swamp sites in each of the last five monitoring years (compared with terrestrial species). In contrast, while the abundance of native terrestrial species was greatest at three of four sites in the Anglesea Estuary in 2024, the combined abundance of both the aquatic and amphibious native species was still greater across each site and year. This suggests that both the Anglesea River Swamp and Estuary continue to be dominated by native amphibious and aquatic species. Across sites within the Anglesea River Swamp or Estuary, most functional groups were maintained at constant levels, only fluctuating at some sites or showing emerging trends at the individual site level.

The Anglesea River Swamp sites in 2024 were dominated by the wetland EVCs Aquatic Sedgeland and/or Swamp Scrub (consistent with previous findings). In 2024, the wetland EVC Aquatic Herbland was recorded at AS1_2014 for the first time. It has likely been present in conjunction with other EVCs in previous years but perhaps not been considered dominant or occurring in a discrete enough patch for separation from other commonly co-occurring EVCs (such as Aquatic Sedgeland). In line with previous assessments, Estuarine Wetland and/or Swampy Riparian Wetland (both wetland EVCs) dominated the Anglesea Estuary sites.

Assessment of change in wetland boundaries over time for the Anglesea River Swamp sites revealed no clear trends or significant changes between 2019 and 2024 (i.e. no evidence of contraction or expansion).

Frogs

In 2024, southern brown tree frog and southern bullfrog at the Anglesea River Swamp and southern brown tree frog at the Anglesea Estuary were detected in record high abundances. Frog species richness has remained low and abundance has varied considerably over time, appearing to only loosely be linked to rainfall conditions in the period preceding the surveys. Climatic variability and annual variation in rainfall may result in frogs dispersing and contracting to more suitable areas; it appears frogs may be moving considerable distances in response to changes in water availability and away from areas that may only be suitable following conditions of high rainfall. During favourable conditions, frogs may also populate locations where they have often been absent for extended periods.

Macroinvertebrates

Only 9 of the 11 triennial macroinvertebrate survey sites were able to be sampled in 2024, as it was a dry year. The other 2 sites were also dry with no standing water present. Most sites were reduced in inundated areas when compared to the previous triennial survey in 2021. Since the last triennial survey, SIGNAL2 scores have shown a decline at all creek sites. In contrast, the number of macroinvertebrate families present, including five-year high scores for annual sites (SC1 and BCT1), has improved among creek sites. This result indicates that pollution tolerant species have become more prevalent, and that other aspects of habitat suitability such as hydrological regime may have improved, resulting in additional taxa colonising the sites. EPT and EPTO scores appear to have declined at many sites in 2024 but have remained low across all sites over time.

The 2024 and 2021 triennial survey results are similar, although different indices were used in each survey. Victorian lakes macroinvertebrate index (VLAKES) scores have improved yearly since their introduction in 2022, and the number of families present in the wetland sites remains low.

Southern pygmy perch and Otway bush yabby

Southern pygmy perch was recorded in both the Breakfast Creek tributary and Salt Creek sites. This is the second year that this species was detected within the Breakfast Creek tributary site after a five-year non-detection period. Only a small number of fish were detected at Breakfast Creek. The Salt Creek population continues to be stable with several cohorts of fish detected.

Otway bush yabby was detected at four of the nine sites surveyed, including the annual sites where they have been detected continuously since 2019. A mix of sizes including new recruits were detected at both annual sampling sites, indicating recent and ongoing breeding success and survival of juveniles into the population. In contrast, the population at BC3, a triennial site, was dominated by adults, suggesting that breeding success may be infrequent at that site. The Otway bush yabby was not detected within the Upper Anglesea River, despite being detected at both sites in 2021. Loss of refuge populations and eventual extirpation of the species from Upper Anglesea River may occur if dry conditions persist.

1 Introduction

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1.1 Scope of work

1.1.1 Aquatic ecology

Aquatic ecological monitoring component included the annual and triennial spring monitoring of macroinvertebrates (11 sites total) (Figure 1):

- Breakfast Creek (BC1–3)
- Breakfast Creek tributary (BCT1–2)
- Salt Creek (SC1)
- Lower Anglesea River wetland (W1–3)
- Upper Anglesea River (UAR1–2).

It should be noted that the annual sites are BCT1, SC1 and a combined W2/3 site, with the later split during the triennial survey to form two sites, W2 and W3.

Spring targeted sampling of southern pygmy perch *Nannoperca australis* and the endangered Otway bush yabby *Geocharax tasmanicus* was included at two sites:

- Breakfast Creek tributary 1 (BCT1)
- Salt Creek (SC1).

1.1.2 Terrestrial ecology

The Terrestrial Ecological monitoring component included spring monitoring of vegetation along established transects at six sites and frog monitoring at eight sites located within in the Anglesea River Swamp (Figure 1):

- AS1_2014 (vegetation and frog monitoring)
- AS2 (vegetation and frog monitoring)
- AS3 (vegetation and frog monitoring)
- AS4 (vegetation and frog monitoring)
- AS5 (frog monitoring only)
- AS6 (frog monitoring only)
- ASP7_2014 (vegetation and frog monitoring)
- AGP2_2014 (vegetation and frog monitoring).

For the Anglesea Estuary, spring monitoring of vegetation and frogs was undertaken at established transects at four sites:

- LAR1
- LAR2
- LAR3
- LAR4.

This report presents the monitoring methods and results, along with a discussion including a comparison of the 2024 data with a subsection of the data collected since the MAP review and update in 2014 (the five most recent years are presented within this report for visual clarity and succinctness, due to the large amount of temporal data now associated with the project).

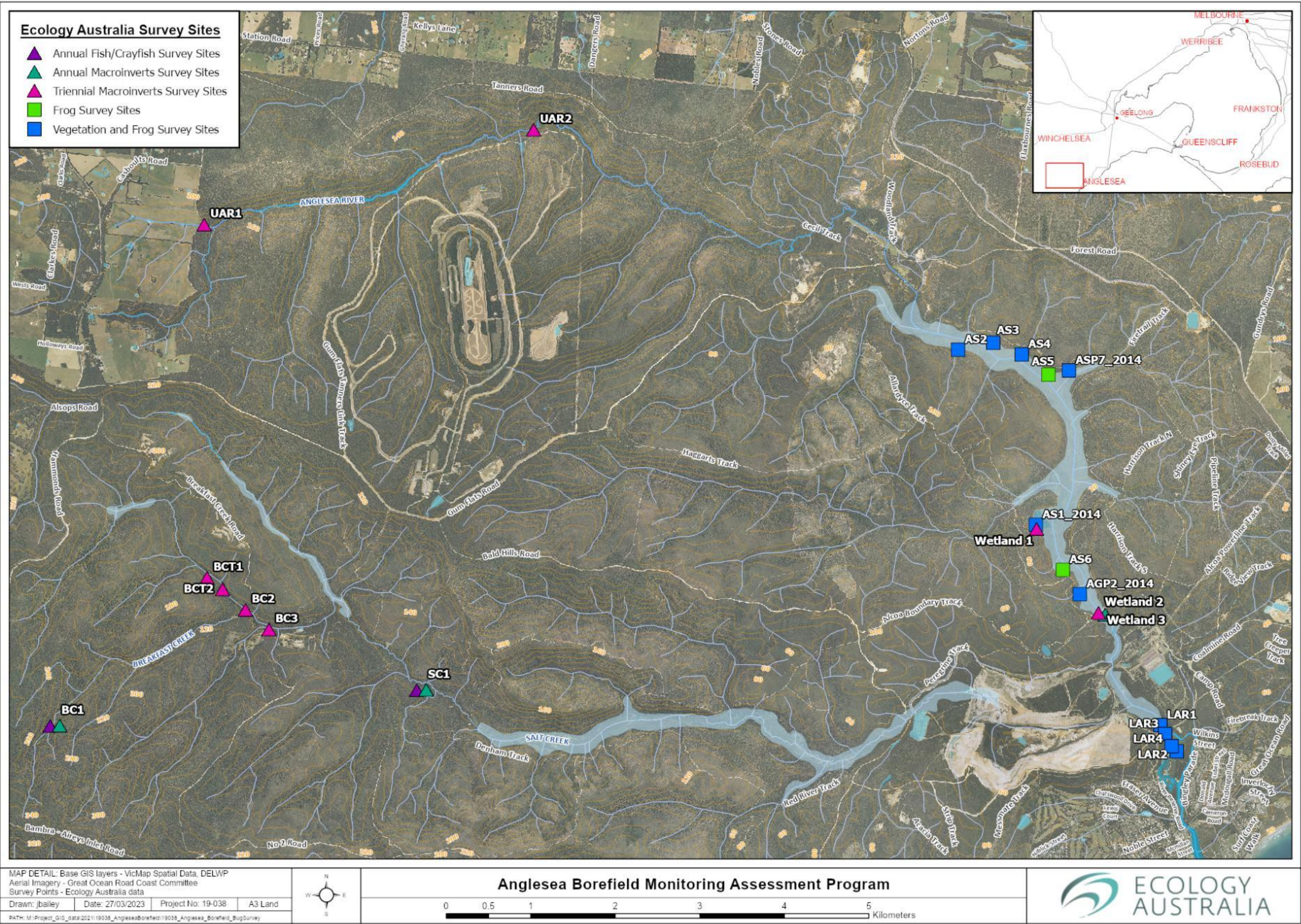


Figure 1 Anglesea Borefield ecological Monitoring and Assessment Program survey sites.

2 Methods

2.1 Aquatic ecology

2.1.1 Water quality and habitat

At each site sampled, Victorian Rapid Bioassessment (RBA) field sampling and habitat assessment sheets (EPA 2021) were completed. In situ water quality measurements were collected using a calibrated Horiba U-52 water quality meter. Parameters measured included temperature, pH, conductivity, dissolved oxygen and turbidity.

2.1.2 Macroinvertebrate surveys

Macroinvertebrate surveys were undertaken at 9 of the 11 macroinvertebrate surveying sites between 19–22 November 2024. During the sampling period, sites UAR1 and W1 were found to be dry and were therefore unable to be sampled. As per the established methods (GHD 2016), triplicate edge ('sweep') samples were collected at each site where sufficient surface water was present, following the methods outlined in the RBA Methodology for Rivers and Streams (EPA 2021). A 250 µm mesh net with a 30 cm x 30 cm opening was used to collect each sample. The sampling objective of the RBA method is to subsample all types of macrohabitats present with a 10 m cumulative (not necessarily contiguous) sweep sample.

Samples were live-sorted ('picked') following the standard RBA procedures (EPA 2021) and preserved in ~70% ethanol. The key components and steps of the RBA live picking procedure are:

- 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 additional 10-minute increments to a maximum total of 60 minutes
- for each taxa, a maximum of 30 individuals is picked, except for groups that require microscopic examination to identify the taxonomic resolution of family (e.g. Amphipoda) or taxa requiring identification to a lower taxonomic resolution than family (e.g. Chironomidae to sub-family, or Odonata, Ephemeroptera, Plecoptera and Trichoptera to genus).

Additionally, all fish and crayfish captured in the sweep nets were recorded, measured and weighed (as per section 2.1.5) then released.

2.1.3 Macroinvertebrate identification

Macroinvertebrates were identified and enumerated with a stereo microscope using the online interactive guide known as the 'Bug Guide' (La Trobe University Centre for Freshwater Ecosystems 2025), a consolidated online resource comprised of dozens of taxonomic guides produced by annual taxonomic workshops over the 1994–2013 period. The majority of taxa were identified to family level, with the following exceptions as per the RBA protocols (EPA 2021):

- Chironomidae were identified to sub-family.
- Oligochaeta and Acarina were not identified below these taxonomic levels.
- Adult and larval beetles were differentiated.
- Terrestrial, semi-terrestrial and microcrustacean taxa were excluded.
- Specimens of the orders Ephemeroptera, Plecoptera, Trichoptera and Odonata were identified to genus level, as per GHD (2016).

2.1.4 Macroinvertebrate data analysis

Macroinvertebrate data were analysed at sample scale (three individual samples per site) for the following indices, some of which are detailed in the RBA manual (EPA 2021):

- Number of macroinvertebrate families — total number of taxa based on taxonomic resolution levels described in section 2.1.3. The number of families present in a waterbody is a biodiversity metric that can be used as a coarse indicator of environmental conditions.
- SIGNAL2— for creek and river sites, the average SIGNAL2 score for taxa collected in each sample, based on methods of Chessman (2003). SIGNAL2 is a biotic index based on the presence of macroinvertebrate taxa and is used to assess pollution in Australian rivers and streams. Taxa are assigned a water pollution sensitivity grade from 1–10. A grade of 1 indicates taxa that are very tolerant to pollution, and 10 indicates high sensitivity to pollution. The score for a waterbody is calculated by the average grade of the taxa present, with lower scores indicating poorer water quality.
- VLAKES – for wetland sites, the average VLAKES score for taxa collected in each sample, based on methods of EPA (2010). VLAKES is a scoring system similar to SIGNAL2, with the grades adjusted for Victorian Lakes (including wetlands). Taxa are assigned a sensitivity grade from 1–10. A grade of 1 indicates taxa that are tolerant to pollution, and 10 indicates taxa with high sensitivity to pollution. The score for a waterbody is calculated by the average grade of the taxa present, with lower scores generally indicating poorer water quality.
- EPT — number of genera from the orders of Ephemeroptera, Plecoptera and Trichoptera (EPT). These taxa are typically considered more sensitive to disturbance, hence lower EPT scores are considered indicative of disturbance. This index would normally be calculated at the taxonomic resolution of family rather than genus, however genus has been used for the MAP. Application of a family-based EPT index is not well suited to wetlands and slow or intermittently flowing lowland streams because most stonefly and many mayfly and caddisfly taxa are naturally absent or uncommon in such habitats.
- EPTO — number of genera from the orders of Ephemeroptera, Plecoptera, Trichoptera and Odonata (EPTO). This is a further modified version of the EPT index used to assist in interpreting the health of lentic 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).

Short-term temporal index trends were plotted over a five-year period to visualise change in the indices over time. Approximate trends were plotted using the average indices value per site (i.e. calculated as the average of all sample index values at a given site). Site W2/W3, where sampling site

and effort has varied over time (see: Halliday and Walker 2024), was combined prior to analysis to ensure consistency with previous survey efforts and data analysis approaches.

2.1.5 Fish and crayfish surveys

Surveys targeting southern pygmy perch and Otway bush yabby were undertaken at sites BCT1 and SC1 on 19 and 20 November 2024. Ten bait traps (stretched mesh size of 2 mm and funnel entrances of 40 mm diameter) with yellow glow sticks placed inside to serve as an attractant were set in the afternoon and retrieved the following morning at both sites. This is consistent with the monitoring approach used by Ecology Australia from 2017–2023. Additionally, fish and Otway bush yabby were incidentally collected during RBA sweep netting.

All captured southern pygmy perch and Otway bush yabby were recorded per replicate and gear type (i.e. bait trap or RBA sweep sample). The first 50 individuals of each species at each site were measured for total length (southern pygmy perch) or occipital carapace length (Otway bush yabby) to the nearest mm and weighed to the nearest 0.1 g, while any remaining individuals were counted. The length of immaturity (≤ 30 mm) has been used to define young-of-year fish, as southern pygmy perch are considered to mature in their first year (Robinson 2012). A length of ≤ 10 mm for Otway bush yabby has been used to indicate young-of-year and juvenile animals, as the exact length of maturity is not known for this species. All southern pygmy perch and Otway bush yabby were returned to point of capture.

2.2 Terrestrial ecology

2.2.1 Vegetation

Vegetation monitoring was undertaken at the 10 sites required by the MAP between 7–10 October 2024 within the Anglesea River Swamp and Anglesea Estuary at the following sites:

- Anglesea River Swamp: AS1_2014, AS2, AS3, AS4, ASP7_2014 and AGP2_2014
- Anglesea Estuary: LAR1, LAR2, LAR3 and LAR4

Note that vegetation monitoring is not undertaken at Anglesea River Swamp sites AS5 and AS6 (additional sites for frog monitoring only).

Data collection

One established transect was surveyed at each site. Transect lengths varied, with all Anglesea River Swamp transects 100 m in length, while the Anglesea Estuary transects for LAR2, LAR3 and LAR4 were 30 m in length, and LAR1 was 14 m in length. Anglesea River Swamp transects were arranged to run through the swamp, while the Anglesea Estuary transects were either aligned parallel to the waterway, or ran through the waterway.

Along each transect, 1 m² quadrats were placed at every second metre along the left-hand side of the transect looking from start to end, with the first quadrat placed at 1–2 m, the second placed at 3–4 m through to the end of the transect. In total, 50 quadrats were established along each transect in the Anglesea River Swamp, 15 quadrats along LAR2, LAR3 and LAR4 transects, and 7 quadrats along LAR1 in the Anglesea Estuary sites. Field staff walked on the right-hand side of the transect to avoid trampling the vegetation within quadrats.

The presence/absence of flora species within quadrats was recorded and used to calculate a frequency score for each species. Every species that was alive and rooted in or overhanging each quadrat was recorded. Additionally within each quadrat, the single most dominant EVC present was recorded (using the reference benchmarks for the Otway Plain bioregion [DSE 2004]). The EVC occupying the majority of the quadrat area (where two or more EVCs were present) was considered the most dominant. Where the Otway Plain EVC benchmarks lacked the appropriate community description, EVC descriptions from the *Benchmarks for wetland Ecological Vegetation Classes in Victoria* (DELWP 2022) were utilised, as these describe a broader array of wetland EVC types. Water depth was recorded at sites in the swamp (as estuary sites mainly run parallel to the waterbody). The percentage cover rounded to the nearest 5% of bare ground was also recorded (decreases in bare ground would potentially represent change due to recruitment). The presence of algal mats was recorded at sites in both the Anglesea Estuary and Anglesea River Swamp. Algal mats were defined as thick layers of filamentous algae which form on top of the water in scattered locations. Photo points were taken at each site and located at 0 m, 25 m, 50 m, and 75 m along each transect in the Anglesea River Swamp sites and the start of each transect in the Anglesea Estuary sites. Photos were taken facing the end of each transect.

Data analysis

Note – to improve visual clarity, figures displaying historical data were limited to the most recent five vegetation monitoring years, despite monitoring data going back as far as 2014 under the current MAP. Increased data QA/QC processes this year led to the rectification of some historic vegetation monitoring data.

Species richness

Species richness is an indicator of the total diversity of species across sites. Descriptive statistics for species richness were presented in a bar chart and tabulated form for each site across the most recent five vegetation monitoring years. The tabulated species richness information also included richness for each of the three broad plant functional groups at each site.

Plant functional groups

Plant species recorded in surveys across the Anglesea River Swamp and Anglesea Estuary were classified into functional groups (Table 1). Functional groups were based on the hydroecology (known or likely water requirements) of plant species using a methodology modified from Casanova (2011) and Doeg et al. (2012), as detailed in McMahon et al. (2013). Where species were identified only to genus or family level, an adapted functional group was assigned as either T (Terrestrial) or A (Amphibious).

Plant functional groups (Table 1) were used to assess the changes in amphibious or aquatic species across all sites at the Anglesea River Swamp and Anglesea Estuary. For each site, the percentage of quadrats that contained species from each of the three broad functional groups (amphibious, aquatic and terrestrial) was calculated for each of the last five vegetation monitoring years. In addition, the percentage of quadrats that contained species from each of the three broad functional groups was calculated for each EVC within each site. This provides an indication of the hydroecology of EVCs at each site. The percentage of quadrats containing each species was also calculated for each site and year individually, with this species frequency data plotted to show change in species composition over time. To investigate the hydroecology of EVCs present, the percentage occurrence of each functional group across EVCs was also calculated.

Considerable ambiguity in the taxonomy exists when distinguishing between manuka *Leptospermum scorparium* (Tda – Terrestrial Damp) and the prickly tea-tree *Leptospermum continentale* (Tdr – Terrestrial Dry). Therefore, records of both species were grouped together in this year’s analysis as tea-tree *Leptospermum spp.* and assigned the summary functional group of T (Terrestrial). The genus *Cycnogeton* (water-ribbons) is taxonomically unresolved, which has led to variation in the number of species recorded in previous monitoring years, with plants referred to as either *Cycnogeton procerum*, *Cycnogeton alcockiae* or both. Until the taxonomy of this species is finalised, all *Cycnogeton* records will be referred to as *Cycnogeton procerum* sp. aff.

Structural attributes

For both the Anglesea River Swamp and Anglesea Estuary, the percentage of quadrats where each EVC was recorded across each site and year was calculated. EVC structural attributes used in the descriptions for each EVC were taken from the relevant EVC benchmark (DSE 2004; DELWP 2022).

Algal mats

The percentage occurrence of algal mats across quadrats was calculated for each site and year across the last five monitoring years.

Wetland boundary mapping

Wetland boundaries for the Anglesea River Swamp sites were confirmed as far as practicable by mapping the interface between Swamp Scrub and Aquatic Sedgeland using Google Earth Pro and ESRI aerial imagery dating back to 2019 (to provide an indication of boundary changes over time). Mapping of this interface was done through visually assessing changes in vegetation in aerial imagery. Aerial imagery was only publicly available through these sources for select years (2019, 2021, 2023 and 2024) and was of varying resolution quality. While visual assessments of aerial imagery at this resolution cannot detect any fine-scale changes in wetland boundaries, this mapping will assist in detecting significant boundary shifts in response to longer-term hydrological changes.

Table 1 Plant Functional Groups (modified from Casanova 2011; Doeg et al. 2012).

Functional group	Definition	Example species
Dry		
Tdr	<i>Terrestrial dry</i> . 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
Tda	<i>Terrestrial damp</i> . 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 each year.	Swamp Gum, Variable Sword-sedge, Manuka, Slender Bog-sedge
Amphibious		
Atl	<i>Amphibious fluctuation tolerator - low-growing</i> . 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 approximately 3 months of the year.	Austral Brookline, Swamp Club-sedge, Spotted Knotweed
Ate	<i>Amphibious fluctuation tolerator - emergent</i> . 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 8–12 months of the year.	Tall Sedge, Red Fruit Saw-sedge, Pouched Coral-fern, Scrambling Coral-fern
Atw	<i>Amphibious fluctuation tolerator- woody</i> . 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	<i>Amphibious fluctuation responder - plastic</i> . This species group occupies a similar zone to the Atl 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 and can flower even if the site does not dry out. They occupy a slightly deeper/wet-for-longer site than the Atl group.	Creeping Cotula, Monkey Flower, River Buttercup
Aquatic		
Se	<i>Perennial-emergent</i> . 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 a relatively little drawdown in the dry part of the year.	Cumbungi, Sea Rush, Southern Water-Ribbons

2.2.2 Frogs

A team of 2 zoologists undertook 2 repeat surveys for frogs across all 12 sites on 28–29 October and 2–3 November 2024. The survey was undertaken at 10 sites (6 in the Anglesea River Swamp and 4 in the Anglesea Estuary) as required by the MAP, as well as 2 additional sites (sites AS5 and AS6). The 2 additional sites are surveyed if frog activity at the Anglesea River Swamp is deemed to be low (e.g. low abundance or diversity of frogs at the main Anglesea River Swamp sites), as was the case for the 2024 survey season. The current method represents a return to the standard survey approach and does not consider data from other sources (e.g. local community groups).

Habitat assessment and water quality

To supplement the habitat data collected as part of vegetation monitoring, the following frog habitat variables were recorded:

- an estimate of wetland permanence (i.e. 'semi-permanent' or 'permanent')
- water quality parameters using a calibrated Horiba U52 multiprobe:
 - Temperature (°C)
 - pH
 - Electrical Conductivity (EC) (mS/cm)
 - Dissolved Oxygen (DO) (mg/L)
 - Turbidity (NTU)
- a general habitat description, including cover estimates of fringing, emergent, submergent and floating vegetation.

Attempts were made to collect measurements for all water quality parameters within 20 m of the defined site centroid during both frog surveys, however sometimes water levels were too low to achieve this. Photos were taken showing representative frog habitats at each survey site at the time of survey.

2.2.3 Frog surveys

Weather conditions

As in previous years, all surveys were conducted during suitable weather for frog activity (i.e. temperatures > 15°C). Temperature (°C) and relative humidity (%) was measured at each site with a handheld Kestral weather station. Cloud cover was measured using the eights (otkas) scale, where the sky is divided into eight equal parts. A cloudless sky has 0 otkas, while a completely overcast sky has 8 otkas. Moon phase is calculated on the scale 0–4, with no moon being 0, a moon phase of 2 being 50% moon, and a full moon being 4. The proportion of wind being based on a scale 0–3, with 0 = calm, 1 = light wind, and 3 = strong wind (values greater than this are likely to be unsafe for fieldwork). The intensity of rainfall recorded during a survey was 0–3. No rain during a survey = 0, light rainfall = 1, moderate rainfall = 2, heavy rainfall = 3. Rainfall from the 24 hours prior to a survey, in addition to annual rainfall in the period preceding surveys, was obtained from the BOM weather station located at Aireys Inlet.

Zoologists used both diurnal and nocturnal visual and auditory surveys to detect frogs at each of the survey sites during suitable weather for frog activity (i.e. temperatures > 15°C). Nocturnal surveys

included call playback and spotlighting, with weather conditions at the time of the survey recorded using a Kestrel weather meter. In spring 2024, each frog survey was completed

Visual surveys

Visual and aural surveys were undertaken at each site during the diurnal habitat assessment and at the beginning of each nocturnal survey. For the aural surveys, two zoologists listened for the distinctive calls of male frogs at each site for a fixed period of 15 minutes. The species heard and an estimation of the number of frogs calling for each species was recorded. For visual surveys, zoologists searched for frogs for no less than 15 minutes at each site by scanning suitable areas of vegetation, the water's surface, and along the edge of the water body. Nocturnal surveys were conducted using head-torches and/or hand-held spotlights to look for the distinctive eye-shine of frogs.

Nocturnal call playback

Call playback was used following the nocturnal aural survey to encourage calling behaviour in male frogs that were not calling independently. This approach relies on the broadcast of pre-recorded calls of each species through a bluetooth speaker at a volume of 75–80 dB, followed by a period of quiet listening. The frog calls selected and played during each call playback was based on records of frog species in the greater Anglesea area. The following species calls were used during each call playback:

- southern brown tree frog *Litoria ewingii*
- southern bullfrog *Limnodynastes dumerilii*
- spotted marsh frog *Limnodynastes tasmaniensis*
- striped marsh frog *Limnodynastes peronii*
- common spadefoot toad *Neobatrachus sudellae*
- Victorian smooth froglet *Geocrinia victoriana*
- common froglet *Crinia signifera*.

Call response data were used to determine frog species richness and estimate abundance within each site across the Anglesea catchment and estuary.

3 Results

3.1 Anglesea River Swamp catchment

3.1.1 Aquatic ecology

Aquatic habitat and water quality

Lower Anglesea River wetland site W1 was dry and unable to be sampled (Figure 2a). Wetland site W2 was contracted to a similar extent to 2023, but with sufficient inundated area to enable triplicate sweep samples to be taken. Very slow flowing water connected wetland 2 to wetland 3 through the culvert (Figure 2b). Wetland 3 consisted of a single larger pool (~5 m diameter) immediately downstream of the culvert, with very slow flowing water extending downstream for ~20 m before loss of surface water (Figure 2c). In wetland 2, the algae cover was very high (nearly 100% coverage), with common water-ribbon *Cyanogeton procerum* sp. aff emerging through the algae bed and scattered throughout the remnants of the pool. Wetland 3 appeared devoid of algae and macrophytes, although there was a substantial load of organic matter in the form of leaves and flowers from the surrounding tree canopy, primarily composed of tea-tree and paperbark. The substrate in all wetlands was predominantly clay/silt.

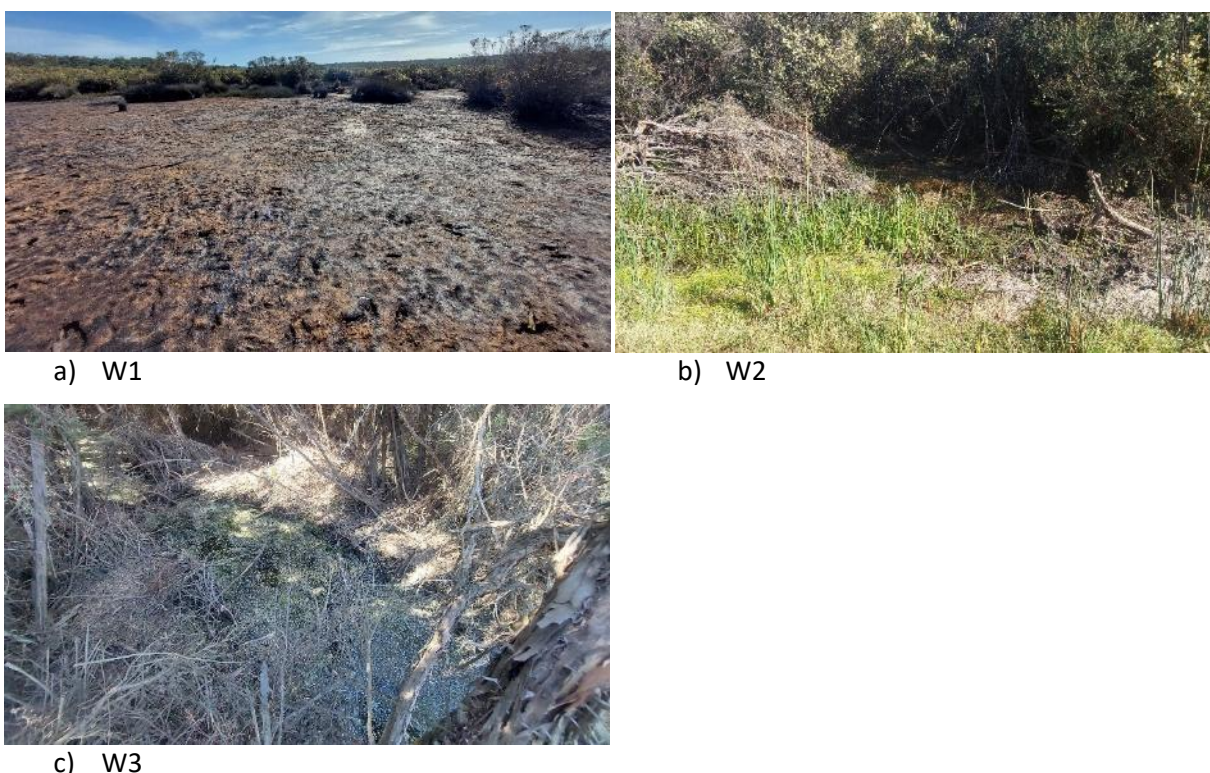


Figure 2 Lower Anglesea River wetlands sites W1–3 (22 November 2024).

No flowing water was observed at either of the upper Anglesea River sites (UAR1 or UAR2) in 2024. Site UAR1 was dry and unable to be sampled, while UAR2 had contracted to a series of deep, disconnected pools (Figure 3a). All sampling was conducted within two of these pools that were considered to offer the best available and representative habitat. Neither of the pools were sampled during the previous triennial survey in 2021 due to excessive pool depth, steep banks and the abundance of more suitable and safer habitat to sample immediately downstream.

Aquatic habitat differed between the two pools sampled, with one pool dominated by common water-ribbon and the other by woody debris including a recently fallen tree (Figure 3b). Filamentous algae and coarse particulate organic matter (especially leaf litter) were also prevalent in both pools.

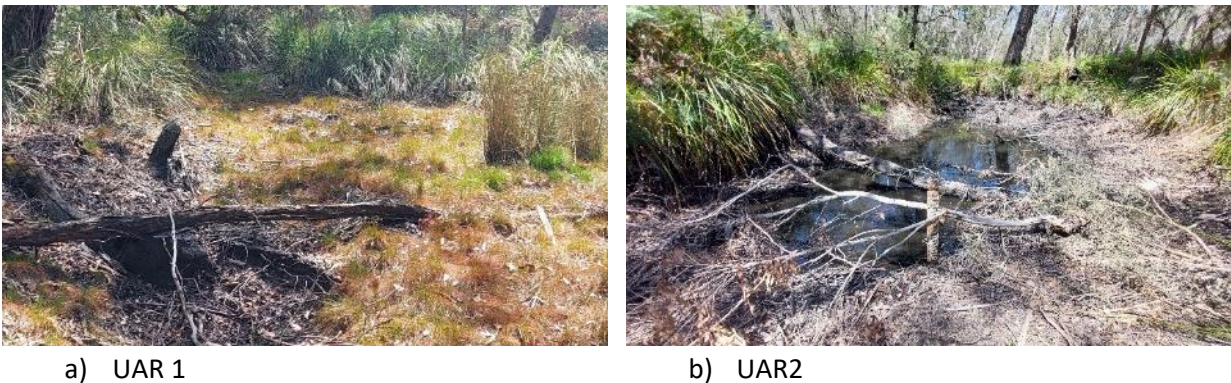


Figure 3 Upper Anglesea River in 2024 at the upstream dry site UAR1 (a) and downstream site UAR2 (b) which had contracted to a series of deep, disconnected pools (20–21 November 2024).

Water quality results are presented in Table 2 and were broadly consistent with the results from the last five years (e.g. Halliday and Walker 2024). It should be noted that water quality results are known to be highly variable within short temporal periods, particularly dissolved oxygen and temperature. Of note, pH was very low within Wetland 2/3 and conductivity was nearly double that recorded in the previous year (2.8 ms/cm in 2023; Halliday and Walker 2024).

Table 2 Anglesea River catchment water quality results for 2024 (measurements made morning–midday).

Site	Temperature (oC)	pH	Conductivity (ms/cm)	Dissolved oxygen		Turbidity (NTU)
				(mg/L)	(%)	
UAR2	15.4	6.2	0.1	1.7	17.5	23.5
W2/W3	14.7	2.2	4.9	#	#	4.6

Not available due to water quality metre failure

Aquatic fauna

Macroinvertebrates

Macroinvertebrate results are presented in Table 3 and Figure 4. Aside from one sample, the VLAKES scores for wetland sites were higher in W2 than W3. The highest number of families in a sample (5) was recorded in W3. SIGNAL2 scores for UAR2 were generally low (≤ 3) but families were relatively high for the Anglesea River catchment, with two samples containing ≥ 15 families.

Table 3 Macroinvertebrate indices scores from all Anglesea River catchment wetland and river sites for 2024 (E1, E2 and E3 = Edge sample 1–3). NA = indices not applicable for this site.

Index	W2 (wetland)			W3 (wetland)			UAR2 (river)		
	E1	E2	E3	E1	E2	E3	E1	E2	E3
VLAKES	6	6.5	6	4.8	5.5	6	NA	NA	NA
SIGNAL2	NA	NA	NA	NA	NA	NA	2.9	2.7	3
# Families	3	3	4	5	3	3	11	16	15
EPT	0	0	0	0	0	0	0	0	0
EPTO	0	0	0	0	0	0	2	2	2

The combined site W2/3 (see section 2.1.4) has shown a year-by-year increase in VLAKES score since the introduction of this index in 2022 (Figure 4). The W2/3 number of families, EPT and EPTO have all remained low over the last five years. The UAR2 site has shown an increase in both number of families and EPTO (due to an increase in odonates) since it was last sampled in 2021, while SIGNAL2 score decreased slightly, and EPT has remained at 0.

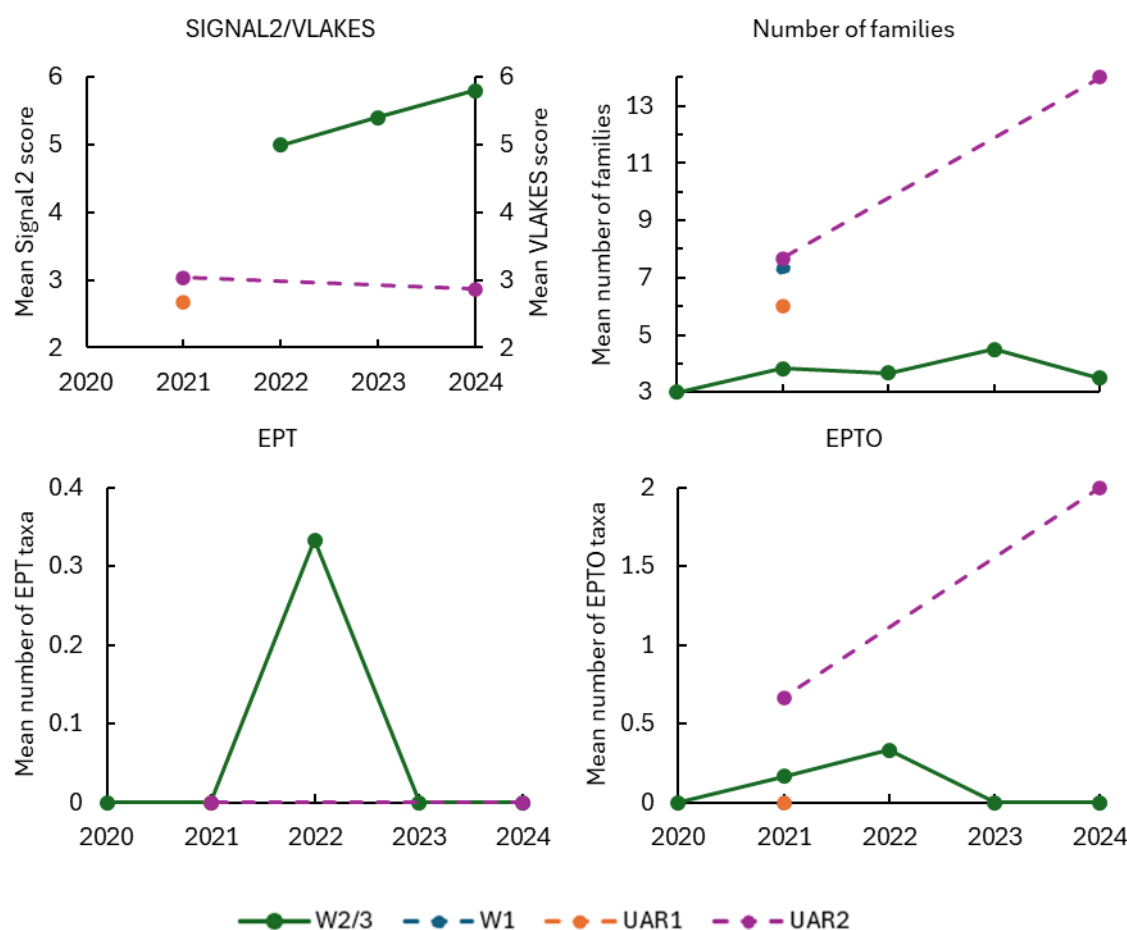


Figure 4 Mean macroinvertebrate indices scores for the Anglesea River catchment sites over the 2020–2024 period. The annual survey site W2/3, which has been combined for the purpose of analysis (see section 2.1.4), is shown with a solid connecting line. Triennial sites are shown with a dashed line where applicable, noting both W1 and UAR1 were unable to be sampled in 2024 due to dry conditions.

3.1.2 Vegetation

Floristic composition

During the 2024 surveys, a total of 29 vascular indigenous plant species and 1 exotic species were recorded across the Anglesea River Swamp (96.67% indigenous, 3.33% exotic) (Appendix 1), which is unchanged from the 2022 surveys. When looking at individual sites, total native species richness varied, ranging from 8 to 15, while minor increases of either 1 or 2 species were recorded at 3 sites between 2022 and 2024 (Figure 5).

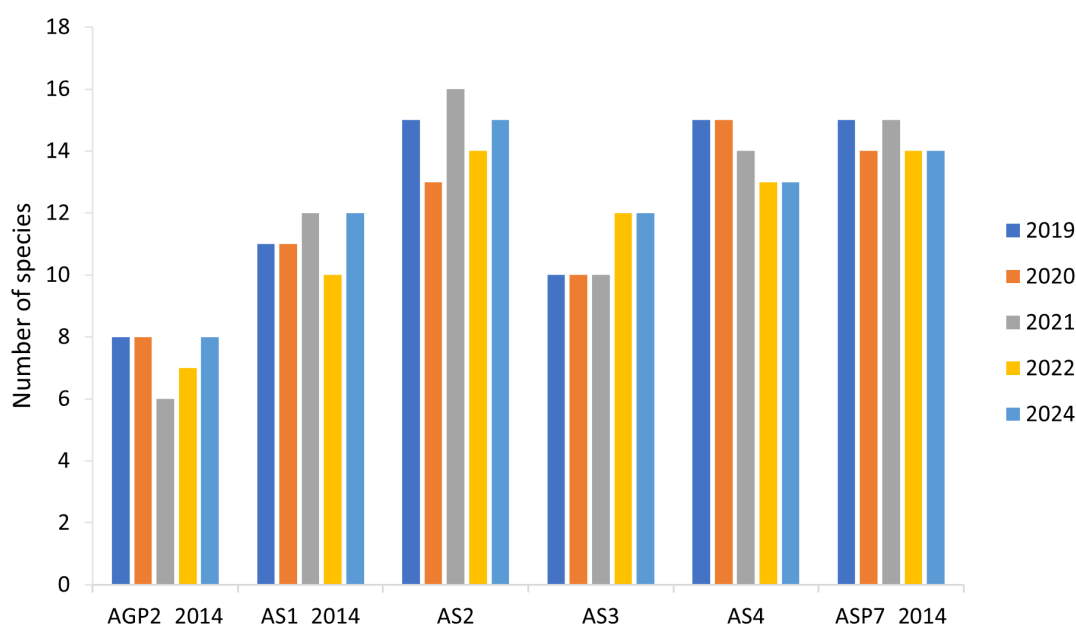


Figure 5 Native species richness at each survey site in the Anglesea River Swamp (AGP2_2014, AS1_2014, AS2, AS3, AS4, ASP7_2014) over the last five monitoring years.

Mean native species richness across all vegetation sites within the Anglesea River Swamp has remained stable across the last five monitoring years, ranging from 11.67 to 12.33 (Figure 6).

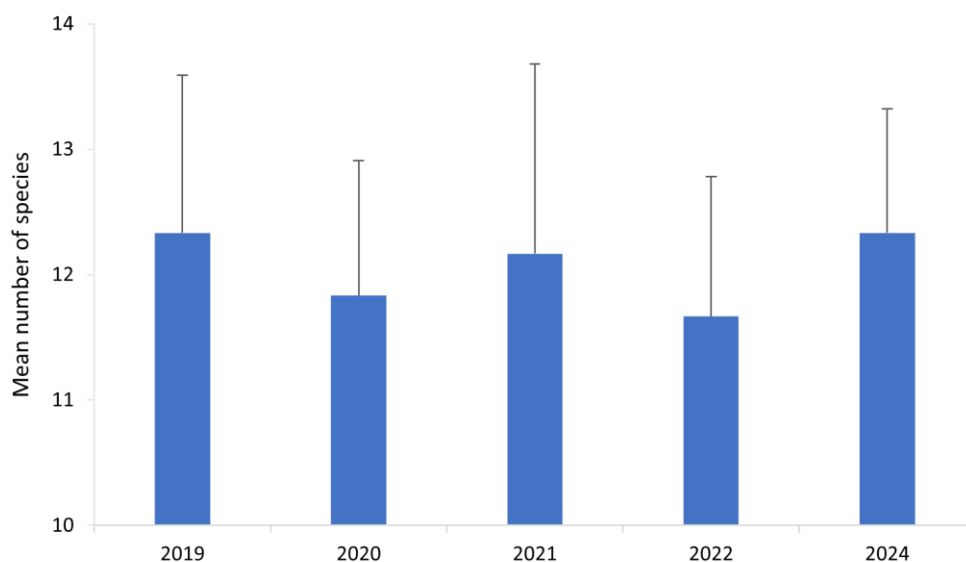


Figure 6 Mean native species richness ($\pm$ SE) across all Anglesea River Swamp sites (AS2, AS3, AS4, ASP7_2014, AS1_2014 and AGP2_2014) over the last five monitoring years.

Hydroecology of species and EVCs

The amphibious functional group had the greatest native species diversity at most sites, with 5–10 species present at each site (Table 4). The aquatic functional group had lower levels of diversity, with 1–

3 species present at each site. At most sites, the terrestrial functional group had 1–2 native species recorded, though site AS2 had a higher diversity of terrestrial species (7).

While the aquatic functional group had markedly lower levels of species diversity (Table 4) than the amphibious, it has been equally or more abundant than the amphibious functional group in all of the last five years at ASP7, and in three of the last five years at AGP2 (Figure 7 and Figure 8). The higher abundance of the aquatic functional group at these sites has been largely driven by a high abundance of common water ribbons and fine twig sedge at ASP7, and common water ribbons at AGP2. Meanwhile, the terrestrial functional group was the least abundant across all sites in each of the last five monitoring years.

Table 4 Number of native plant species and associated functional groups recorded across Anglesea Borefield ecological Monitoring and Assessment Program swamp sites.

Transect/Site	Total number of native plant species	Number of species in a terrestrial functional group	Number of species in an amphibious functional group	Number of species in an aquatic functional group
AS2	15	7	5	3
AS3	12	2	9	1
AS4	13	2	9	2
ASP7_2014	14	2	10	2
AS1_2014	12	2	8	2
AGP2_2014	8	1	5	2

At the site level, while there has been some inter-annual variability, the relative abundances of each functional group have remained relatively stable across the last five monitoring years (Figure 7 and Figure 8). Similarly, examination of individual species abundance trends (Figure 7 and Figure 8) demonstrates that most species have either demonstrated a stable abundance at each site over the past five monitoring years, or have exhibited some minor fluctuations (e.g. tall rush and scented paperbark at AGP2), but often without a consistent increasing or declining trend.

With the exception of the Heathy Woodland at site AS2 (the only non-wetland EVC recorded), most EVCs were dominated by native species from either the amphibious or aquatic functional groups (Figure 9). However, the functional group composition of EVCs varied between sites. For example, while Aquatic Sedgeland was dominated by amphibious species at site AS2, relatively higher proportions of terrestrial or aquatic species were seen within this EVC at AGP2, AS1, AS4 and ASP7. Similarly, while Swamp Scrub at most sites included a considerable aquatic species component, Swamp Scrub at site AS1 contained no aquatic species (comprising instead entirely amphibious and terrestrial species).

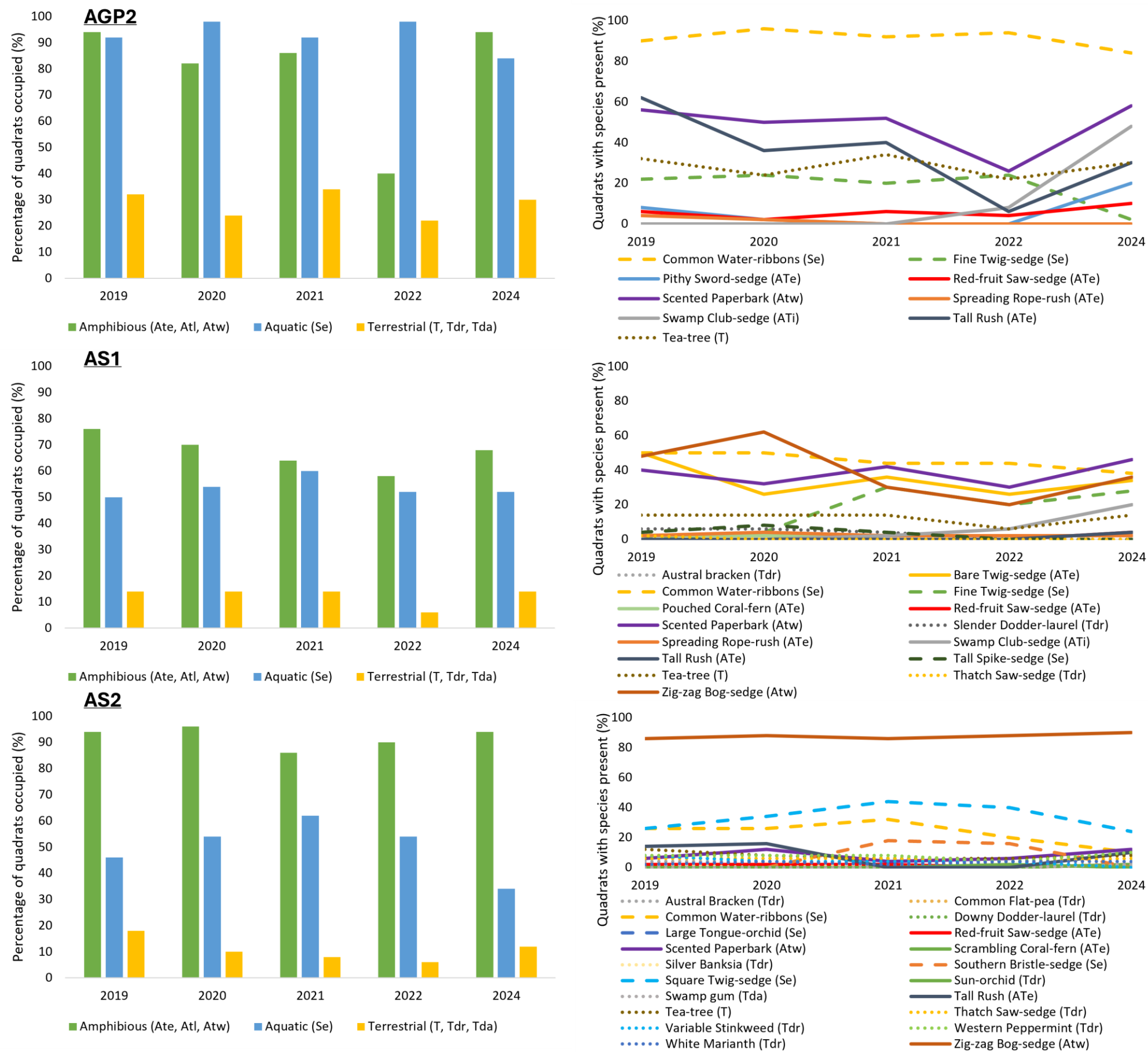


Figure 7 Percentage of quadrats occupied by broad functional groups and percentage of quadrats occupied by each species across the last five monitoring years (sites AGP2, AS1 and AS2). Aquatic species are shown using dashed lines, amphibious using solid lines, and terrestrial using dotted lines. Anglesea River Swamp sites were not monitored in 2023 as these are only monitored every two years when the borefield is on standby.

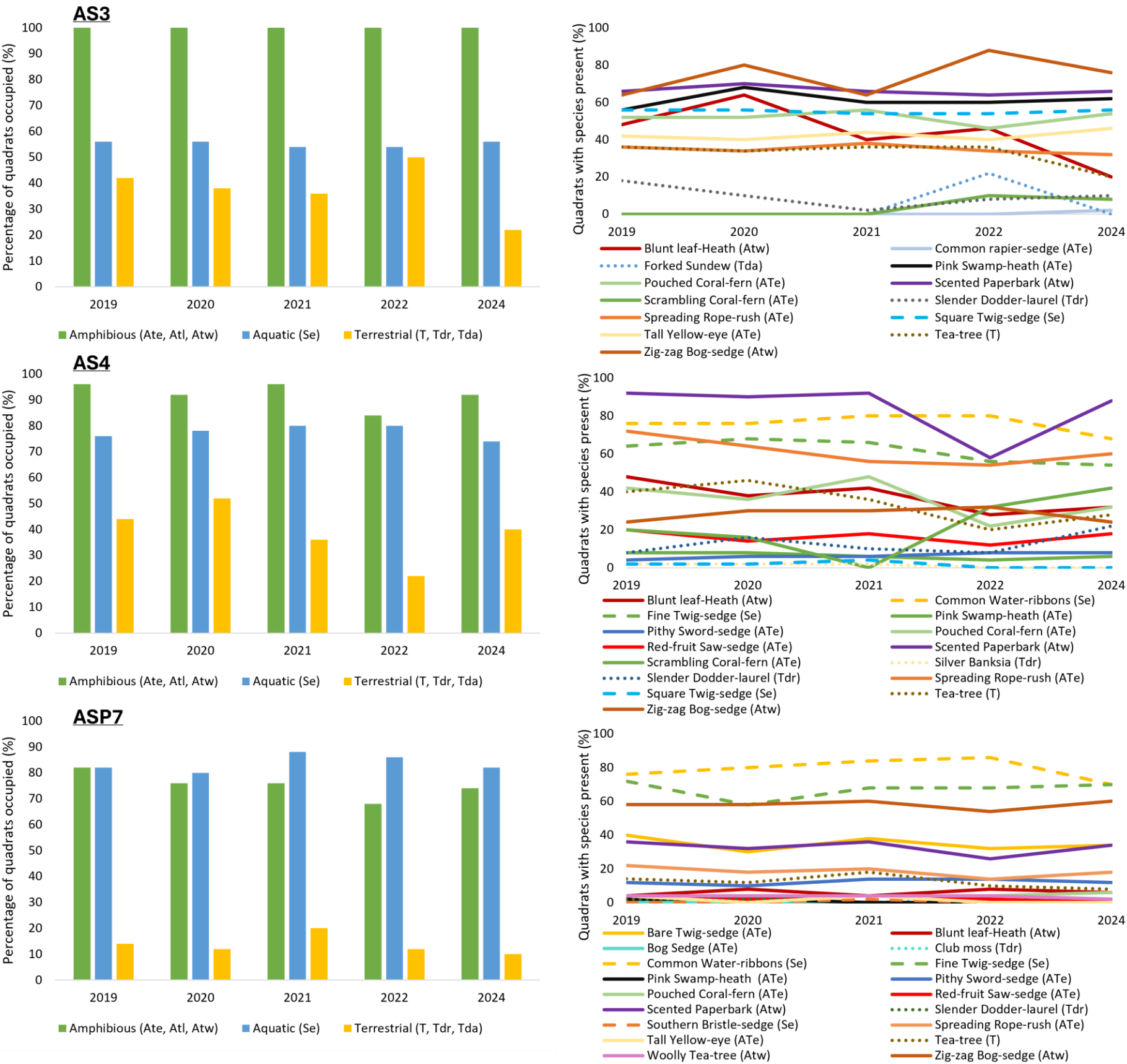


Figure 8 Percentage of quadrats occupied by broad functional groups and percentage of quadrats occupied by each species across the last five monitoring years (sites AS3, AS4 and ASP7). Aquatic species are shown using dashed lines, amphibious using solid lines, and terrestrial using dotted lines. Anglesea River Swamp sites were not monitored in 2023 as these are only monitored every two years when the borefield is on standby.

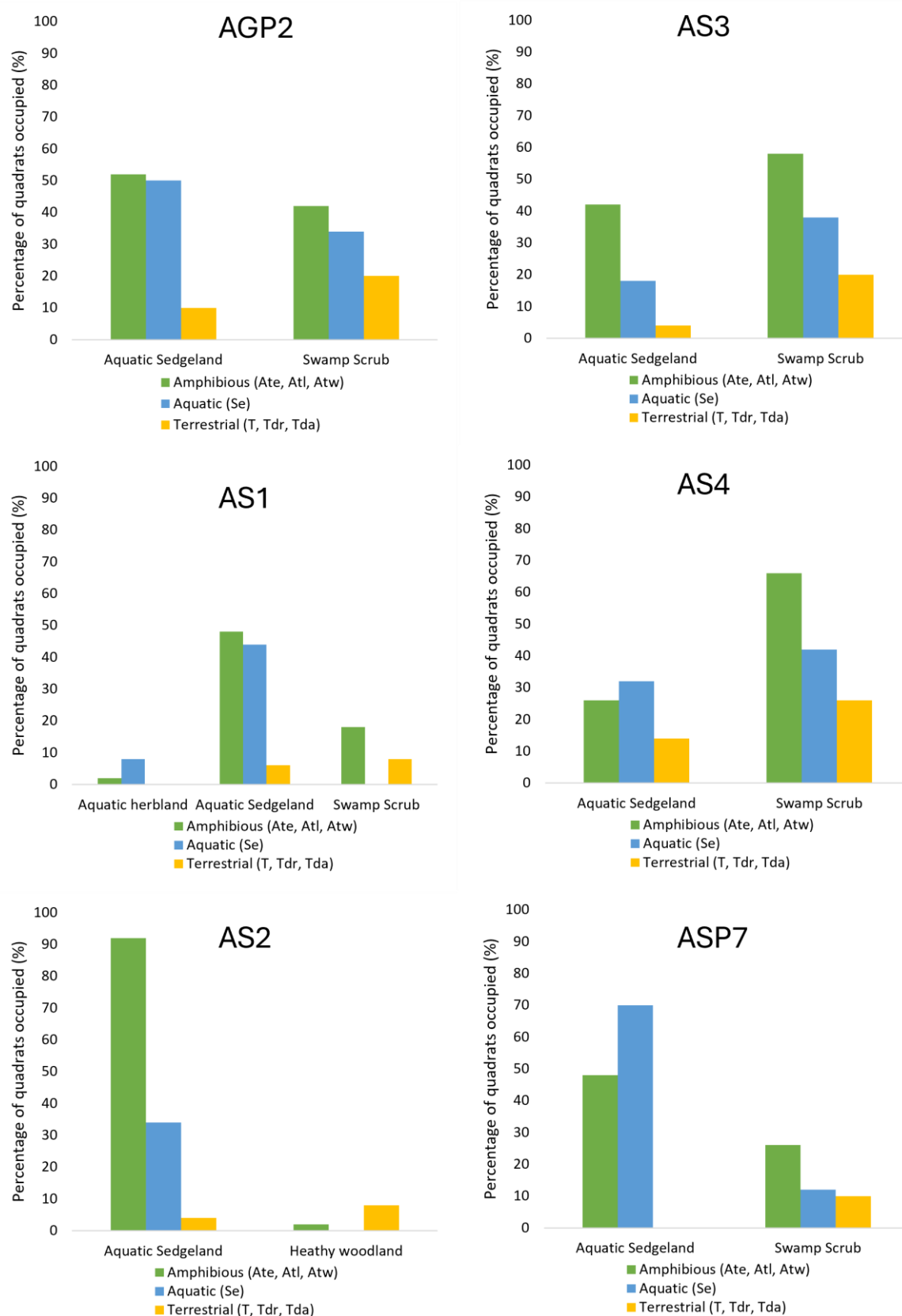


Figure 9 Percentage of quadrats where each functional group occurred in 2024, grouped by EVC.

Structural attributes

Vegetation structure (EVCs)

Within the Anglesea River Swamp sites, four EVCs have been recorded: Aquatic Herbland, Aquatic Sedgeland, Swamp Scrub and Heathy Woodland (Figure 10). Aquatic Herbland was deemed present as a dominant EVC for the first time in 2024, based on the dominance of *Cycnogeton procerum* sp. aff. throughout discrete areas of site AS1_2014 (in line with benchmark descriptions provided in [DELWP 2022]). The four EVCs are:

- Aquatic Herbland, dominated by submergent to low-growing emergent herbaceous species (within the study area principally *Cycnogeton procerum* sp. aff.), typically does not support trees or shrubs.
- Aquatic Sedgeland, typically abundant across all swamp sites, is a wetland EVC characterised by species-poor and variably dense sedgeland to 1.3 m tall.
- Swamp Scrub, which tends to be less dominant than aquatic sedgeland across sites, is a closed scrubland to 8 m tall. Emergent trees may sometimes be present, but this EVC is typically characterised by dense thickets of *Leptospermum* spp. (tea-trees) or *Melaleuca squarrosa* (scented paperbark).
- Heathy Woodland, a eucalypt-dominated woodland growing to approximately 10 m tall. It lacks a secondary tree layer and instead supports a diverse array of narrow-leaved shrubs or bracken.

Photo point monitoring for each site is available in Appendix 7 to Appendix 9. These photos provide visual representation of the vegetation structure at each site.

Patterns in dominant EVC categories appear to vary by site. At sites AS2 and AS3, the percentage of quadrats with EVCs that are considered dominant has remained relatively steady (Figure 10). At sites AGP2 and AS4 dominant EVC percentages have been more variable between years, however these shifts have not shown a consistent pattern. The only sites that appear to be showing signs of directional change in dominant EVC percentage cover are sites ASP7 and AS4, which have increased in Swamp Scrub abundance and decreased in Aquatic Sedgeland abundance since 2021. Abundance of Swamp Scrub and Aquatic Sedgeland have previously showed large fluctuations at AS4 (i.e. between 2019 and 2020). Thus, trends at this site should be monitored to see whether fluctuations continue beyond 2021.

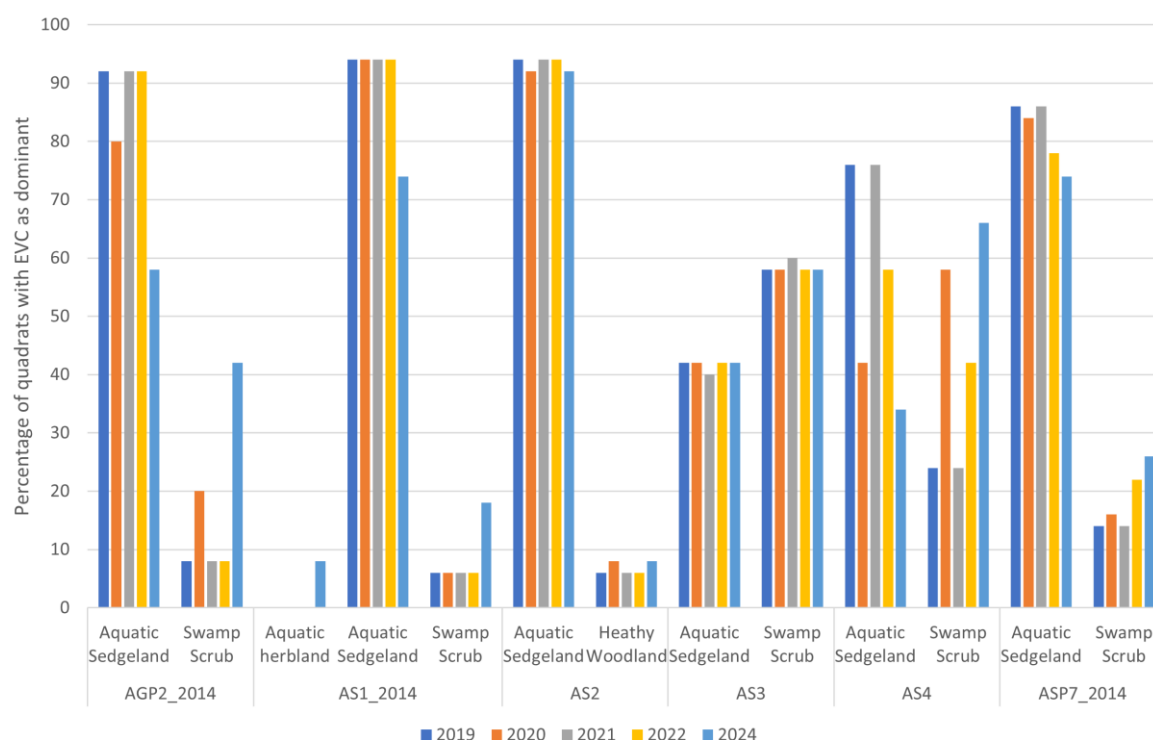


Figure 10 Percentage of quadrats within which each dominant EVC across Anglesea River Swamp sites was recorded. Swamp sites were not monitored in 2018 or 2023 as these are only monitored every two years when the borefield is on standby.

Water depth

Water was present at five of the six Anglesea River Swamp sites in 2024, with quadrat depths recorded from 0–20 cm across sites. This is the first time that water has been absent from a site in the Anglesea River Swamp during the five-year monitoring period. Quadrat depths were also shallower than the previous monitoring period (2022) which had higher maximums, ranging from 0–46 cm.

Other structural attributes

Bare ground was present at two of the six Anglesea River Swamp sites in 2024, with quadrat covers ranging from 0–55%. This contrasts with 2022 where bare ground was present at four sites but cover only ranged from 0–3%. Bare ground has fluctuated widely across the Anglesea River Swamp sites in other years, with greater variability likely resulting from changes in the presence or absence of inundation (with bare ground only being recorded in the absence of inundation).

Algal mats

In 2024, algal mats were only present at AS1_2014 and AGP2_2014 (Figure 11). In contrast, in the 2022 survey algal mats were present at all sites except AS3. At AS1_2014, the percentage of quadrats where algal mats were present also declined from 74% in 2022 to 34% in 2024. This continues a generally declining trend at the AS1_2014 since 2019 (where they were present in 88% of quadrats). Algal mat presence at AGP2_2014 also declined from 58% in 2022 to 4% in 2024. In all previous years the

percentage frequency at this site fluctuated between 60%–80%. No algal mats have been recorded at AS3 in any years.

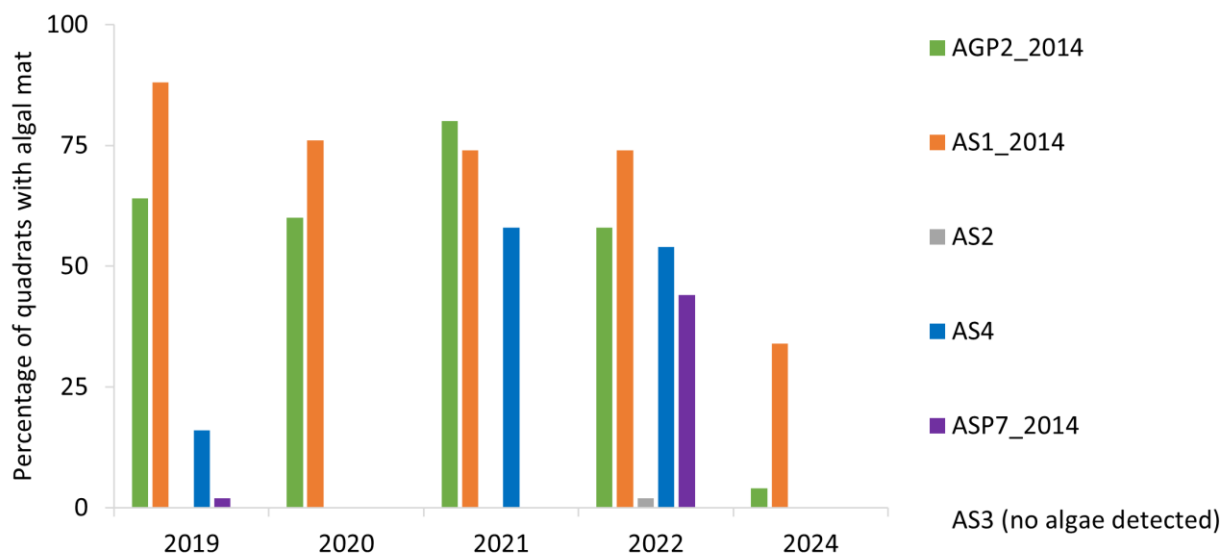


Figure 11 Algal mat records at all sites in the Anglesea River Swamp over the last five monitoring periods. No monitoring was undertaken in the Anglesea River Swamp in 2023 as vegetation is only monitored every two years when the borefield is on standby.

Wetland boundaries

Change in wetland boundaries over time was assessed by mapping the interface between the Swamp Scrub and Aquatic Sedgeland at each site. No patterns of change to the wetland boundaries for the six sites were noticeable for the period between 2019 and 2024 (Figure 12 to Figure 17). While some variability can be seen between years, there is likely to be some variation attributable either to resolution of the aerial imagery for particular years and differences in observer interpretation/mapping error, particularly given that the boundary between these two EVCs is not always a clear delineation, and will generally include somewhat of a natural ecotone or matrix.



Figure 12 Wetland boundary change over time (since 2019) for site AGP2 based upon interface between Swamp Scrub and Aquatic Sedgeland (as mapped from aerial imagery for noted years).



Figure 13 Wetland boundary change over time (since 2019) for site AS1 based upon interface between Swamp Scrub and Aquatic Sedgeland (as mapped from aerial imagery for noted years).



Figure 14 Wetland boundary change over time (since 2019) for site AS2 based upon interface between Swamp Scrub and Aquatic Sedgeland (as mapped from aerial imagery for noted years).



Figure 15 Wetland boundary change over time (since 2019) for site AS3 based upon interface between Swamp Scrub and Aquatic Sedgeland (as mapped from aerial imagery for noted years).



Figure 16 Wetland boundary change over time (since 2019) for site AS4 based upon interface between Swamp Scrub and Aquatic Sedgeland (as mapped from aerial imagery for noted years).

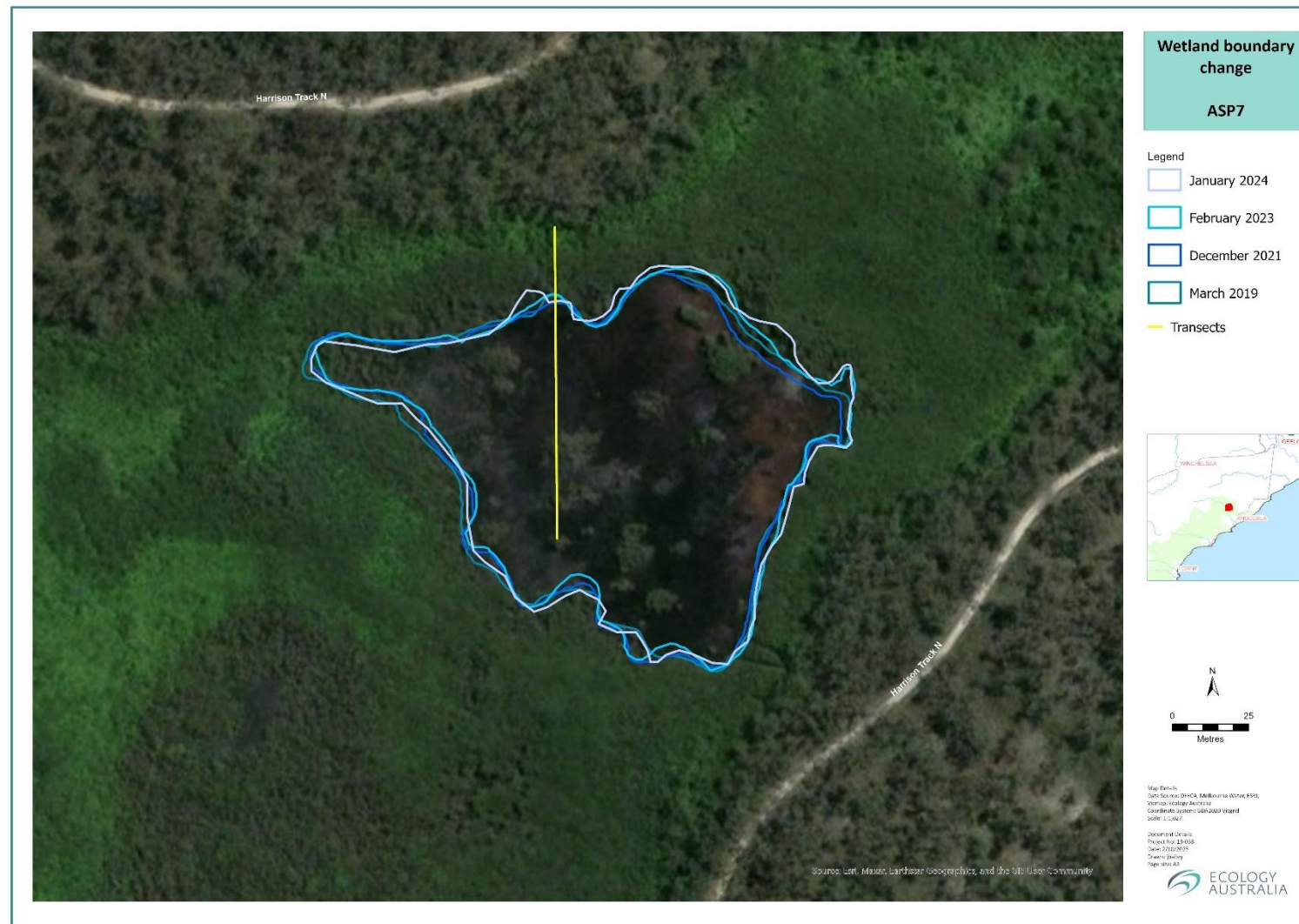


Figure 17 Wetland boundary change over time (since 2019) for site ASP7 based upon interface between Swamp Scrub and Aquatic Sedgeland (as mapped from aerial imagery for noted years).

3.1.3 Frogs

Frog survey conditions

Surface water was evident at all eight sites within the Anglesea River Swamp over the survey period. The average water depth at the time of the first survey (28–29 October 2024) being approximately 0.17 m. The average water depth among all study sites within the Anglesea River Swamp decreased to approximately 0.1 m by the second survey (2–3 November 2024). The weather conditions recorded during the two nocturnal frog surveys were relatively similar (Table 5). The total annual rainfall was relatively stable across the period 2019–2024 (Figure 18).

Table 5 Water depth and weather conditions during spring nocturnal frog surveys, 2024.

Variable	Survey 1	Survey 2
Temperature (°C)	7.3–18.2	7.8–17.4
Humidity (%)	63–99	68–91
Cloud cover (0–8)	0–8	0–4
Moon light (0–4)	0	3
Wind speed (0–3)	1	0
Rainfall during survey (0–3)	0	0
Rain in past 24 hours (mm)	0	0
Depth (m)	0.17	0.1

Frog species richness and abundance

At the completion of the two surveys, half the sites had a frog species richness index of three (AS2, AS3, AS5, and AGP2), with two species detected at AS1 and one species each at AS6 and ASP7. There were no frogs detected calling within 100 m at AS4. The inclusion of frogs calling from distances of greater than 100 m from each of the Anglesea River Swamp sites had little effect (i.e. shifts of more than one species) on species richness overall with the exception of AS4, which increased from zero to three species (Table 6). This was typically for those species with louder and / or higher pitch calls (e.g. southern brown tree frog, southern bullfrog), with a maximum of three species detected calling within or beyond 100 m at any one site. In general, frog diversity and abundance detected in surveys at the Anglesea River Swamp sites in 2024 closely matched that of the 2022 surveys (Halliday et al. 2023).

Table 6 Frog species and estimated abundances detected within 100 m during two nocturnal surveys at the Anglesea River Swamp sites in 2024. The number of frogs heard calling at distances greater than 100 m from the survey sites is listed in parentheses. The total species richness within 100 m and beyond 100 m (in parentheses) is also provided.

Site	Southern Brown Tree Frog		Common Froglet		Southern Bullfrog (Pobblebonk)		Species richness
	Night 1	Night 2	Night 1	Night 2	Night 1	Night 2	
AS1_2014	0 (3)	0 (3)	6 (0)	2 (0)	6 (9)	4 (4)	2 (2)
AS2	4 (3)	5 (2)	4 (0)	3 (0)	5 (12)	3 (6)	3 (2)
AS3	5 (5)	0 (0)	3 (0)	2 (0)	4 (8)	2 (2)	3 (2)
AS4	0 (6)	0 (3)	0 (5)	0 (5)	0 (7)	0 (3)	0 (3)
AS5	2 (5)	2 (2)	3 (0)	4 (0)	4 (8)	0 (0)	3 (2)
AS6	0 (0)	0 (0)	6 (0)	5 (0)	0 (3)	0 (2)	1 (1)
AGP2_2014	4 (2)	1 (0)	4 (0)	4 (0)	3 (0)	1 (2)	3 (2)
ASP7_2014	0 (4)	0 (1)	5 (0)	3 (0)	0 (8)	0 (3)	1 (2)

Frog species richness has remained very low (2–3) over the last five years and there is considerable variation in abundance between years, as estimated by the number of individual frogs detected calling at Anglesea River swamp sites (based on mean data across all sites) during nocturnal and diurnal surveys (Figure 18). Frog abundance has increased considerably from very low levels in 2019 and 2020 to reach record high levels in 2022 for one species (common froglet) and in 2024 for two species (southern bullfrog and southern brown tree frog).

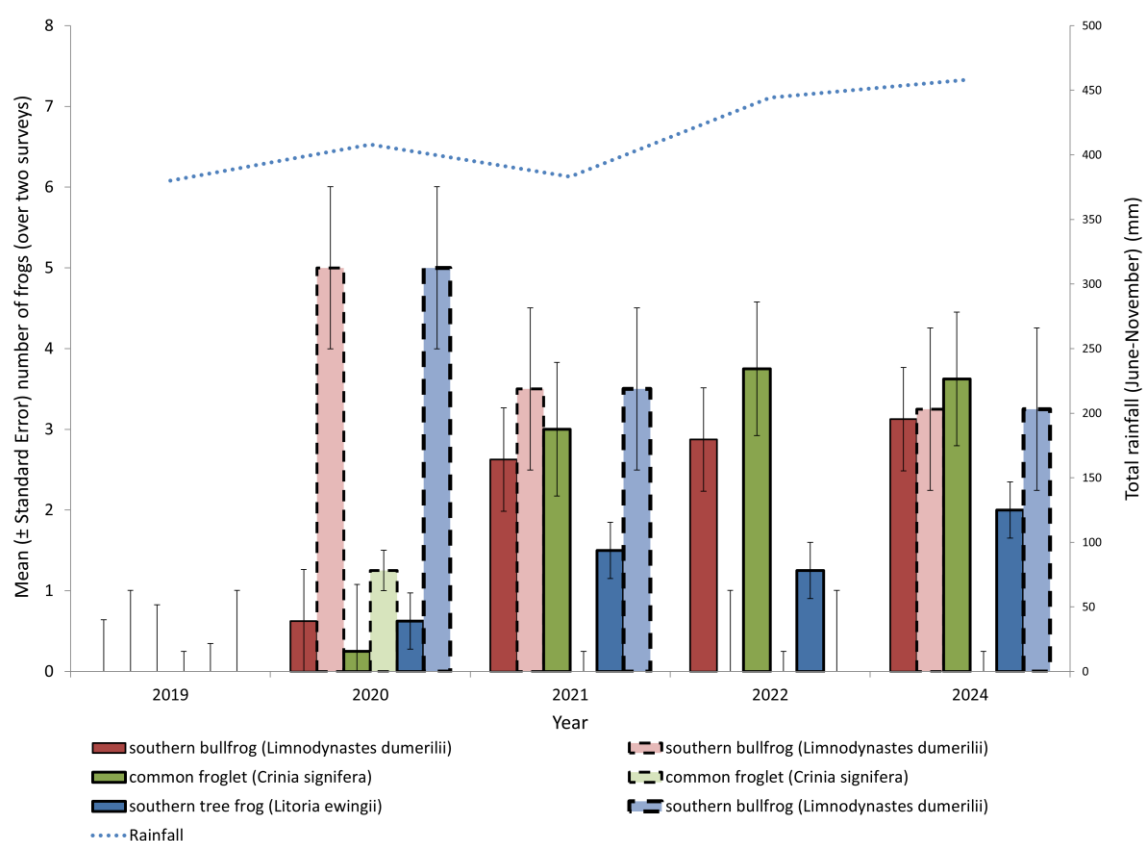


Figure 18 The mean number of frogs detected calling during surveys (nocturnal and diurnal) within 100 m of each survey site for 2019 to 2024. Anglesea swamp and estuary sites are indicated with solid and dashed black outlines, respectively. Total annual rainfall for Aireys Inlet is indicated by the dotted blue line.

Frog habitat assessment and water quality

Most of the Anglesea River Swamp monitoring sites are bordered by a dense shrub cover of scented paperbark *Melaleuca squarrosa* and prickly teatree *Leptospermum continentale*. In the Anglesea River Swamp proper, this gives way to clearings of emergent aquatic vegetation, such as zig-zag bog-sedge *Schoenus brevifolius*, square twig-sedge *Machaerina tetragona* and at distances greater than 100 m fine twig-sedge *M. arthropphylla*. Many areas also consist of swards of sedges, both live and dead, that occasionally form thick mats across the site, with fringing vegetation consisting of shorter pink swamp-heath *Sprengelia incarnata* or pouched coral-fern *Gleichenia dicarpa*. At sites with standing water, common water-ribbons *Cycnogeton procerum* spp. aff. and filamentous algae are often present as submergent and floating vegetation. Some sites also include small patches of bare ground and low cover of woody debris, especially where the emergent vegetation (e.g., zig-zag bog-sedge) meets the fringing vegetation.

All Anglesea River Swamp monitoring sites are considered semi-permanent to permanent in their hydrological regime except for AS3 (semi-permanent) and AS4 (permanent). Low water levels at some sites prevented water quality measures resulting in an N/A for the values at some sites (Table 7). During the 2024 surveys, all sites had sufficient standing water to allow for most water quality parameters to be

measured in both surveys (Table 7). In general, all sites were acidic and electrical conductivity (EC) was moderate.

Water temperatures varied from 13.1–21.8°C (Table 7). Turbidity was variable across sites and generally low with most values < 10 NTU (Table 7). Dissolved oxygen (DO) levels varied between 1.55–9.17 mg/L (Table 7), which is not unusual given that measurements were taken at various times of the day, with DO levels lower in the second survey (Table 7).

Table 7 Water quality measures for the two surveys conducted within sites at the Anglesea River swamp.

Variable	Time		Temperature (°C)		pH		Electrical conductivity (mS/cm)		Salinity (g/L TDS)		Turbidity (NTU)		Dissolved oxygen (mg/L DO)		Depth (m)	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Survey																
AS2	21:16	21:32	19.8	21.8	5.05	8.31	3.4	0.02	0.17	3.93	0	0	9.17	7.23	0.2	0.15
AS1_2014	16:17	15:18	15.5	20.7	4.12	5.69	1.28	1.68	0.05	0.08	42	6.7	9.08	3.68	0.2	0.2
AS6	15:45	15:53	13.1	15	3.86	4.66	1.38	1.36	0.06	0.06	15	66	7.83	NA	0.2	0.1
AGP2_2014	14:54	16:34	15.3	13.8	3.6	4.82	2.2	2.41	0.1	0.12	8	9	6.93	NA	0.15	0.08
AS3	22:23	10:32	13.3	NA	3.84	NA	2.58	NA	0.12	NA	0	NA	1.55	NA	0	0.05
AS4	22:57	10:57	18.8	NA	5.14	NA	3.25	NA	0.17	NA	7	NA	4.65	NA	0.1	0.05
AS5	23:33	11:21	17.7	19.7	5.38	5.35	3.27	3.41	0.16	0.17	2	0	6.02	2.56	0.3	0.25
ASP7_2014	00:21	11:49	17.8	NA	3.41	NA	2.56	NA	0.12	NA	1	NA	4.26	NA	0.2	0.05

3.2 Salt Creek catchment

3.2.1 Aquatic habitat and water quality

The Salt Creek site is characterized by a large and deep permanent pool, situated within a small and shallow channel (Figure 19). This location has had water present at each site visit since at least 2017 and may be regarded as a permanent drought refuge. The substrate is composed of silt/clay. No flow was observed from the pool entrance or exit; however, the pool appeared to be maintaining depth and ~1.5 m was recorded on the gauge at the time of survey. Inundated habitat types (e.g. woody debris, leaf litter, overhanging vegetation) and coverage appeared similar to that observed in 2023. There was a substantial amount of loose silt present. Aquatic macrophytes continue to be absent from the site.



Figure 19 Salt Creek at site SC1 (20 November 2024).

All three Breakfast Creek sites were a series of disconnected pools. BC1, the most upstream site, consisted of small pools (~1–3 m long) among a bedrock dominated creek bed with large volumes of leaves and other organic debris (Figure 20a). BC2 consisted of a single large standing pool (~50 m long) (Figure 20b). BC3, the most downstream site, was a series of moderately sized standing pools (~5–10 m long) (Figure 20c). Water was not visibly flowing over the V-notch weir at site BC3 nor downstream of the Breakfast Creek Road bridge. In contrast to BC1 (bedrock dominated), the streambed at BC2 and BC3 was primarily comprised of silt/clay, with some sand, pebbles and gravel. Breakfast Creek tributary sites BCT1 and BCT2 were narrow and shallow with very slowly flowing water (Figure 20d). Physical habitat cover available for fish and macroinvertebrates at all sites in decreasing order of prevalence included coarse particulate organic matter (leaves and other organic debris), undercut banks, overhanging terrestrial vegetation, woody debris, filamentous algae, and roots.

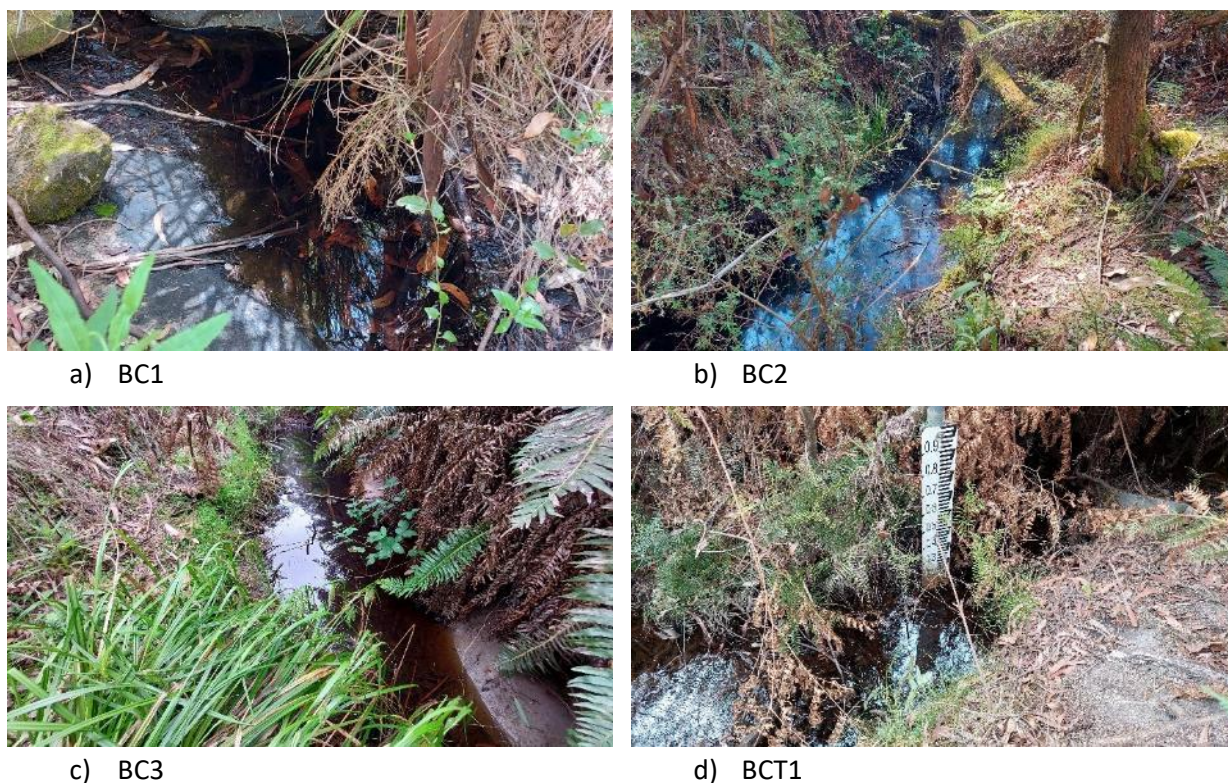


Figure 20 A selection of photos from Breakfast Creek and tributary in 2024. Photos a), b) and c) show example pools from each of the Breakfast Creek sites. Photo d) shows tributary at one of the wider and deeper points, with the BCT1 V-notch weir in the top right of the photo (19–21 November 2024).

Water quality results are presented in Table 8 and were broadly consistent with the results from the last five years (e.g. Halliday and Walker 2024). It should be noted that water quality parameters such as temperature and dissolved oxygen vary diurnally.

Table 8 Salt Creek catchment in situ water quality measurements for 2024 (measurements made morning–midday).

Site	Temperature °C	pH	Conductivity ms/cm	Dissolved oxygen		Turbidity NTU
				mg/L	%	
BC1	13.0	6.3	0.8	2.6	25.4	14
BC2	18.2	5.8	0.3	2.1	22.1	35
BC3	13.3	7.6	0.3	2.0	19.5	35
BCT1	11.7	6.7	0.2	5.1	47.9	136
BCT2	12.1	7.3	0.3	6.0	57.8	14
SC1	14.9	6.5	0.3	2.0	2.4	63

3.2.2 Aquatic fauna

Macroinvertebrates

Macroinvertebrates results are presented in Table 9. The Salt Creek catchment sites remained at the low end of the typical SIGNAL2 score range for this project (typically ~4–6; see Halliday and Walker 2024). SIGNAL scores were lowest for all samples at BC2 (< 4). The number of families detected ranged between 7–17, with the lowest number of families recorded at BC2. The number of EPT and EPTO taxa ranged between 0–3 per sample (Table 9).

Table 9 Macroinvertebrate indices scores from all Salt Creek catchment sites for 2024 (E1, E2 and E3 = Edge sample 1–3).

Index	BC1			BC2			BC3			BCT1			BCT2			SC1		
	E1	E2	E3	E1	E2	E3	E1	E2	E3	E1	E2	E3	E1	E2	E3	E1	E2	E3
SIGNAL2	4.6	4.4	4.4	3.1	2.6	3.3	3.7	4.1	4.2	4.6	4.9	4.6	4.7	4.9	4.1	3.7	4	3.7
# Fam.	14	13	17	8	8	7	11	15	17	9	11	14	15	13	8	13	13	11
EPT	2	2	2	1	0	1	1	2	3	2	1	3	1	1	0	0	0	0
EPTO	2	2	3	1	0	1	2	3	3	2	1	3	2	1	0	0	0	0

The SIGNAL2 scores for Salt Creek catchment sites have shown a general decline over the last five years (Figure 21). The number of families detected at Salt Creek catchment sites, however, has shown a general increase over the last five years, with all sites other than BC2 (small decline) recording an increase in the number of families detected since the previous monitoring event. The number of EPT and EPTO taxa has remained low (< 4); whether this number increased, declined, or remained stable varied by site. One site, SC1, recorded a score of zero for EPT and EPTO in 2024, the first time a zero score for these indices has been recorded over the last five years.

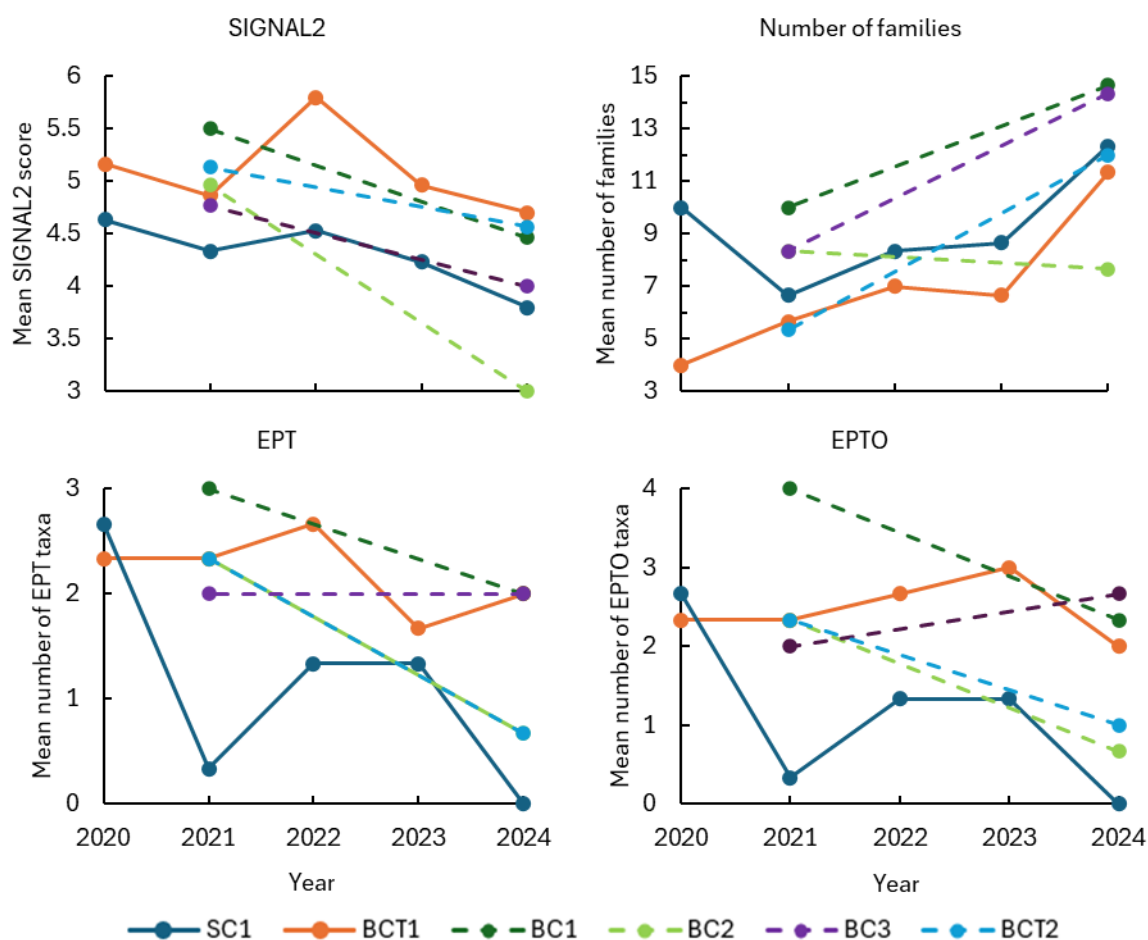


Figure 21 Macroinvertebrate results for all Salt Creek catchment sites and indices over the 2020–2024 period. The annual survey sites SC1 and BCT1 are shown with a solid connecting line. Triennial sites BC1–3 and BCT2 are shown with a dashed line.

Fish and crayfish

A total of 77 southern pygmy perch were captured in 2024, 75 from Salt Creek (62 in bait traps and 13 during the dip netting), and 2 from the Breakfast Creek tributary (both from bait traps) (see photos in Appendix 6). For the second year in a row southern pygmy perch have been found at the Breakfast Creek tributary site following a five-year period of non-detection (2018–2022) (Figure 22). The Catch Per Unit Effort (CPUE) (i.e. total number of fish caught/total number of traps set) for southern pygmy perch at the Salt Creek site (SC1) has marginally increased each year since a low of < 3.0 in 2021, but remains below the 2020 peak of ~7.

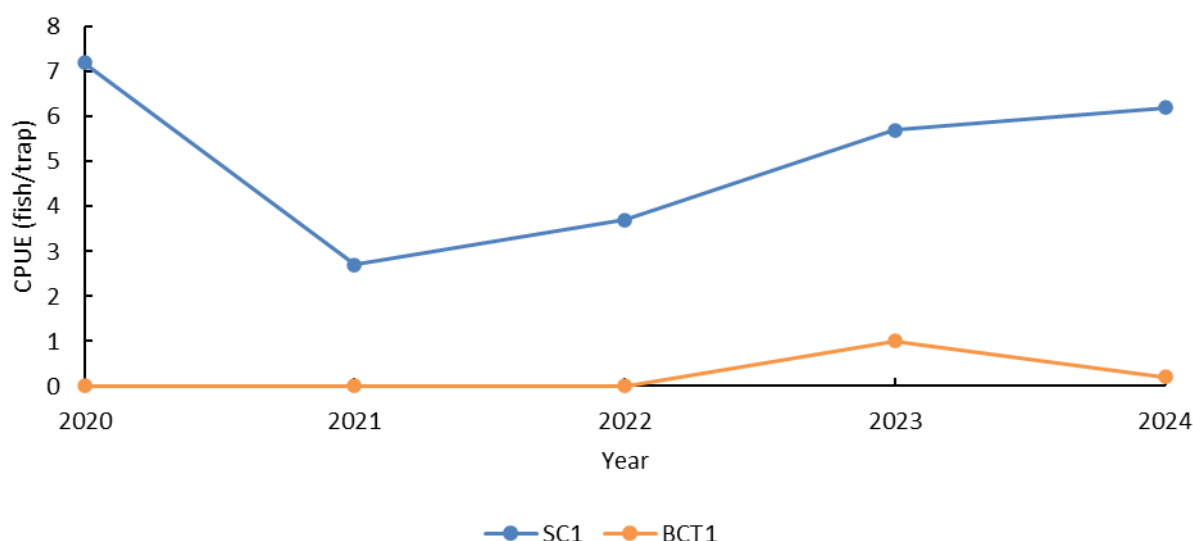


Figure 22 The annual Salt Creek catchment sites SC1 and BCT1 southern pygmy perch Catch Per Unit Effort (CPUE; (number of fish caught/number of traps set) summaries 2020–2024.

The size range of the southern pygmy perch collected from the Salt Creek site SC1 was broad (21–82 mm TL), with the varying values along the length frequency distribution plot (Figure 22) suggesting annual recruitment success, with a subsequent population structure comprised of multiple age cohorts from young-of-year juveniles (age 0+ years), through to sub-adults and adults.

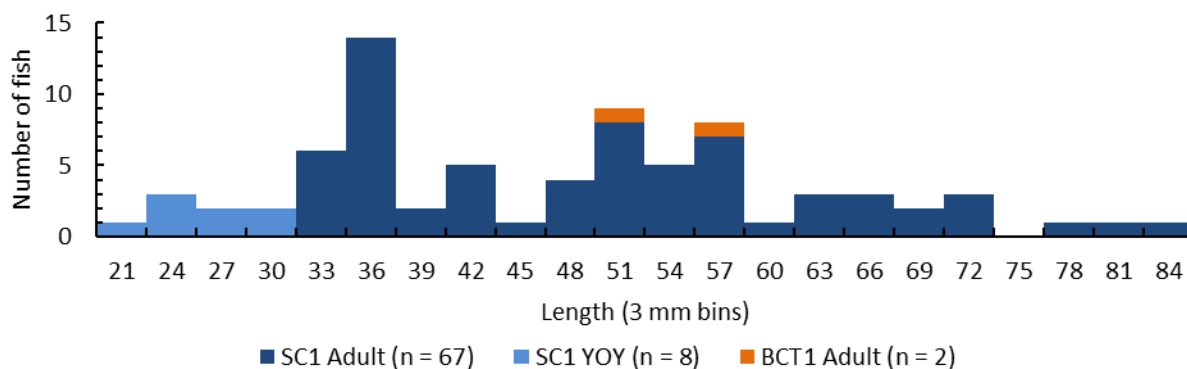


Figure 23 Length-frequency histogram for the 2024 southern pygmy perch captured at the Salt Creek catchment sites SC1 and BCT1, including the size considered likely to be representative of the YOY cohort, i.e. immature (≤ 30 mm) (Robinson 2012).

A total of 110 Otway bush yabbies were captured in 2024, 16 from BC3, 49 from BCT1, 31 from BCT2, and 14 from SC1 (Figure 24; see photos in Appendix 6). These crayfish were captured by targeted bait trapping (BCT1 = 13, SC1 = 3) and sweep netting (BC3 = 16, BCT1 = 36, BCT2 = 31, SC1 = 11). For the sites surveyed annually (SC1 and BCT1), the abundance of Otway bush yabby in the Breakfast Creek tributary site BCT1 was lower in 2024 compared with 2023 but within the typical range recorded since 2020 (Figure 24). Site SC1 has shown a small increase of Otway bush yabby year-on-year for the last four years, with 2024 representing the highest abundance result since the high recorded in 2020, which was significantly higher than all other years (Figure 24).

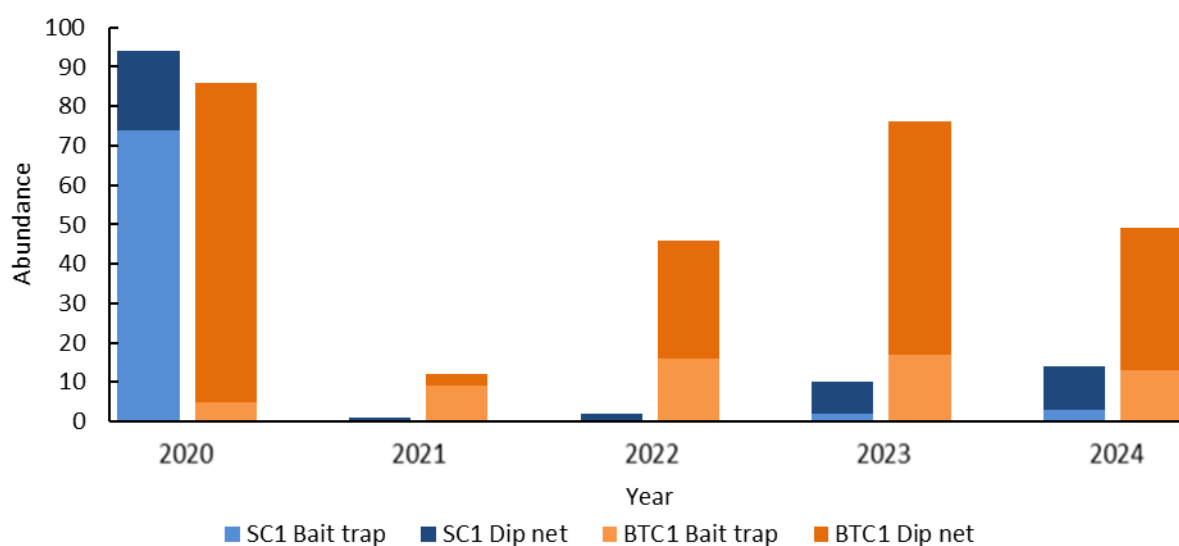


Figure 24 Otway bush yabby abundances from 2020–2024, including data from bait trapping and dip netting catch for the Salt Creek catchment sites SC1 and BCT1. Note: dip netting is fundamentally a presence/absence sampling method.

Crayfish of sizes considered likely to be representative of young-of-year and juveniles (i.e. ≤ 10 mm Occipital Carapace Length; OCL) were detected at all sites, suggesting recent recruitment success (Figure 25). A wide range of crayfish sizes (juveniles through to adults) were recorded from most sites and is likely indicative of annual recruitment success. The large proportion of young-of-year and juveniles at sites BCT1 and BCT2 indicate strong recruitment success in recent years. In contrast, larger adults dominated at site BC3, suggesting an aging population lacking in recent or regular recruitment success.

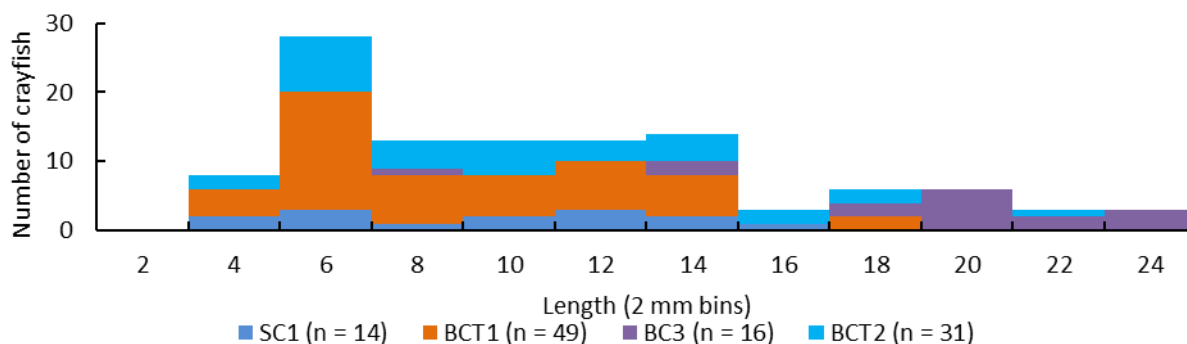


Figure 25 Length-frequency histogram for the 2024 Otway bush yabbies captured at the Salt Creek catchment sites SC1, BCT1, BC3 and BCT2. Note that an OCL of ≤ 10 mm is considered indicative of YOY or juveniles.

3.3 Anglesea Estuary

3.3.1 Vegetation

Floristic composition

In the Anglesea Estuary, 18 indigenous plant species (62.1%), 9 exotic species (31%) and 2 native Victorian species not indigenous to the study area (6.9%) were recorded in 2024 (Appendix 2). Total species richness in the Anglesea Estuary sites increased by 8 species, from 21 species in 2022, to 29 species in 2024. This was primarily driven by an increase in the number of exotic species present (increasing from 2 to 9), while the number of indigenous species remained relatively stable, only increasing by 1 (from 17 to 18). Across the Anglesea Estuary native species richness increased by between 1–6 species at 3 sites but declined by 2 species at site LAR1 (Figure 26). Total native species richness varied across sites, ranging from 7–16 (an increase in both the minimum and maximum native species richness compared with 2022 results).

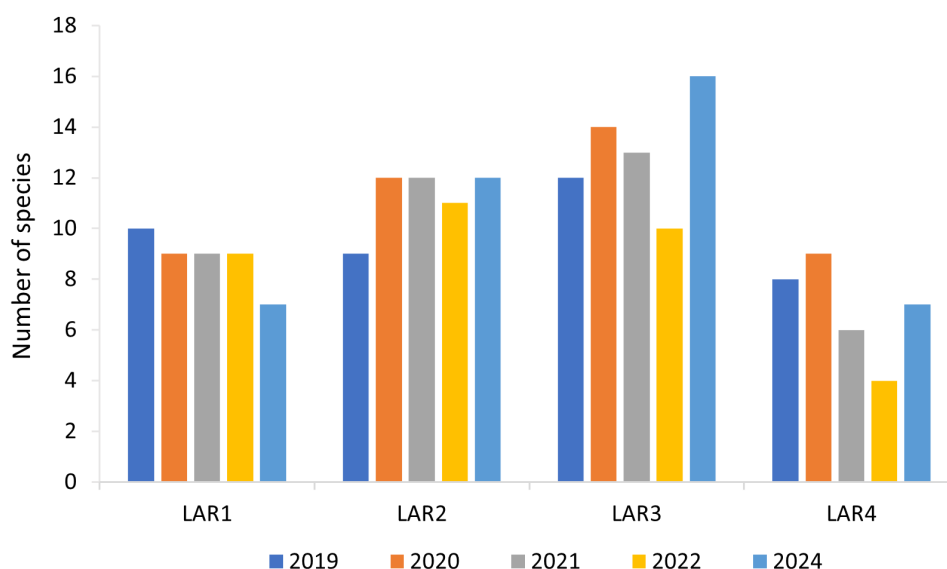


Figure 26 Native species richness at each survey site in the Anglesea Estuary (LAR1, LAR2, LAR3 and LAR4) over the last five monitoring years.

Mean native species richness has fluctuated across all estuary sites over the past five monitoring years, ranging from 8.5 to 11 (a range of 2.5) (Figure 27). However, no distinct trends have been observed.

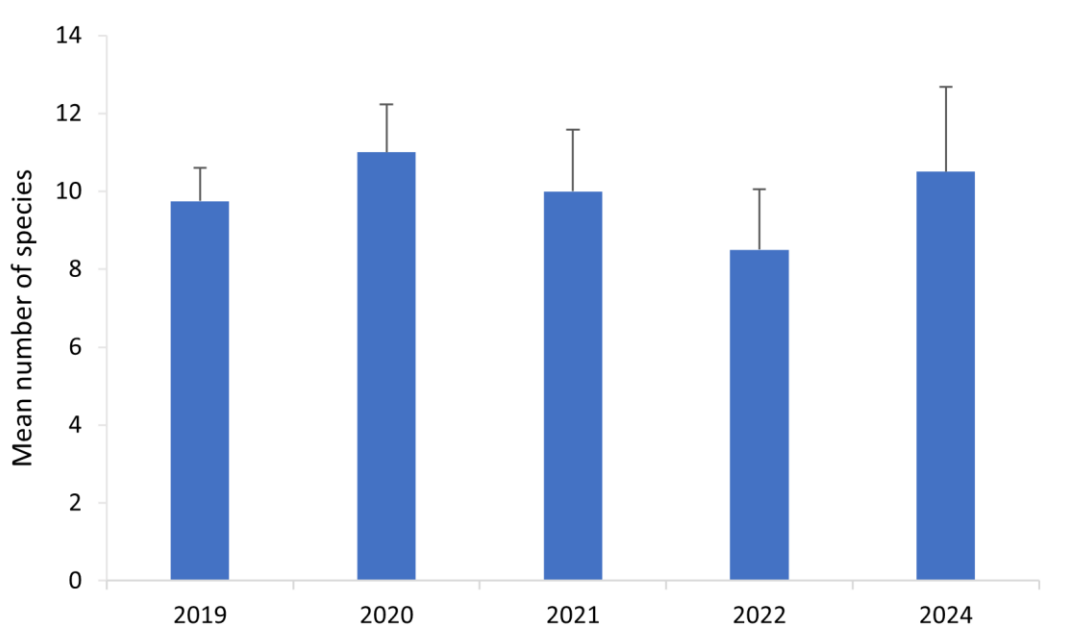


Figure 27 Mean native species richness ($\pm$ SE) across all Anglesea Estuary sites (LAR1, LAR2, LAR3 and LAR4) over the last five monitoring years.

Hydroecology of species and EVCs

In 2024, the greatest diversity of native species at each site within the Anglesea Estuary came from the terrestrial functional group (between four and ten species at each site) (Table 10). All sites in 2024 had two species present from the aquatic functional group, while sites had one or three species present from the amphibious functional group.

Table 10 Number of native plant species and associated functional groups recorded across Anglesea Borefield ecological Monitoring and Assessment Program estuary sites.

Transect/Site	Total number of native plant species	Number of species in a terrestrial functional group	Number of species in an amphibious functional group	Number of species in an aquatic functional group
LAR1	7	4	1	2
LAR2	12	7	3	2
LAR3	15	10	3	2
LAR4	7	4	1	2

Figure 28 shows bar and line plots depicting the percentage of quadrats occupied by broad functional groups and the percentage of quadrats occupied by each species across the last five monitoring years. At LAR1 the terrestrial functional group has been dominant or co-dominant in three of the past five surveys, and there appears to have been a progressive decline in the abundance of the aquatic functional group over the past three years (from 100% percent frequency in 2019 and 2020 to 57.1% in

2024). The amphibious functional group experienced a marked decline in abundance in 2022 (from 71.4% in 2021 to 28.6% in 2022) but has since increased slightly to 42.9% in 2024 (not yet returning to 2021 levels). Aquatic and amphibious species that have declined in abundance over this period are common water-ribbons, shiny swamp-mat *Goodenia radicans*, angled lobelia *Lobelia anceps*, sea rush *Juncus kraussii* subsp. *australiensis*, swamp club-sedge *Isolepis inundata*, and common reed *Phragmites australis*. At LAR1 swamp gum *Eucalyptus ovata* (terrestrial) has increased in abundance since 2017. While its abundance showed a marked decline in 2022, it has otherwise been maintained at 100% abundance since 2020.

At LAR2 the terrestrial functional group has increased in cover since 2019 but has never been the dominant functional group. Meanwhile, amphibious abundance has remained steady at 100% at LAR2, but the aquatic functional group also experienced a decline in abundance at LAR2 between 2021 and 2022, with a slight increase observed in 2024 (though not yet returning to levels seen in 2020).

At LAR3, amphibious and aquatic functional group abundance has fluctuated slightly over the past five years with relatively high levels of both functional groups present in 2024.

At LAR4, 2024 was the first time that the terrestrial functional group was dominant, the aquatic functional group has also been maintained at a high level of abundance in 2024, while the amphibious functional group has fluctuated, and is currently at a relatively low level compared with the previous four years. Terrestrial species that have fluctuated in abundance over time at LAR4 include coast tussock-grass *Poa poiformis* var. *poiformis*, hop goodenia *Goodenia ovata*, and tea-tree *Leptospermum* spp.

Functional group composition trends for the two EVCs recorded within Anglesea Estuary in 2024 varied between sites (Figure 29).

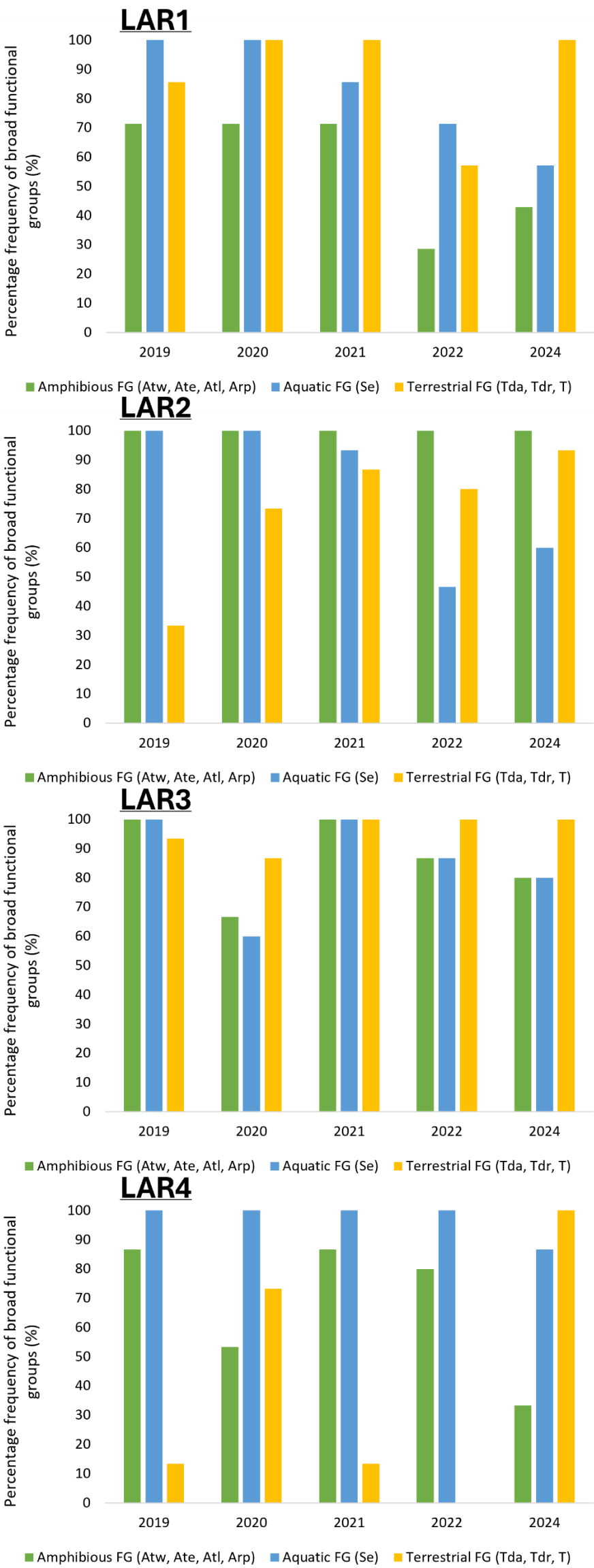
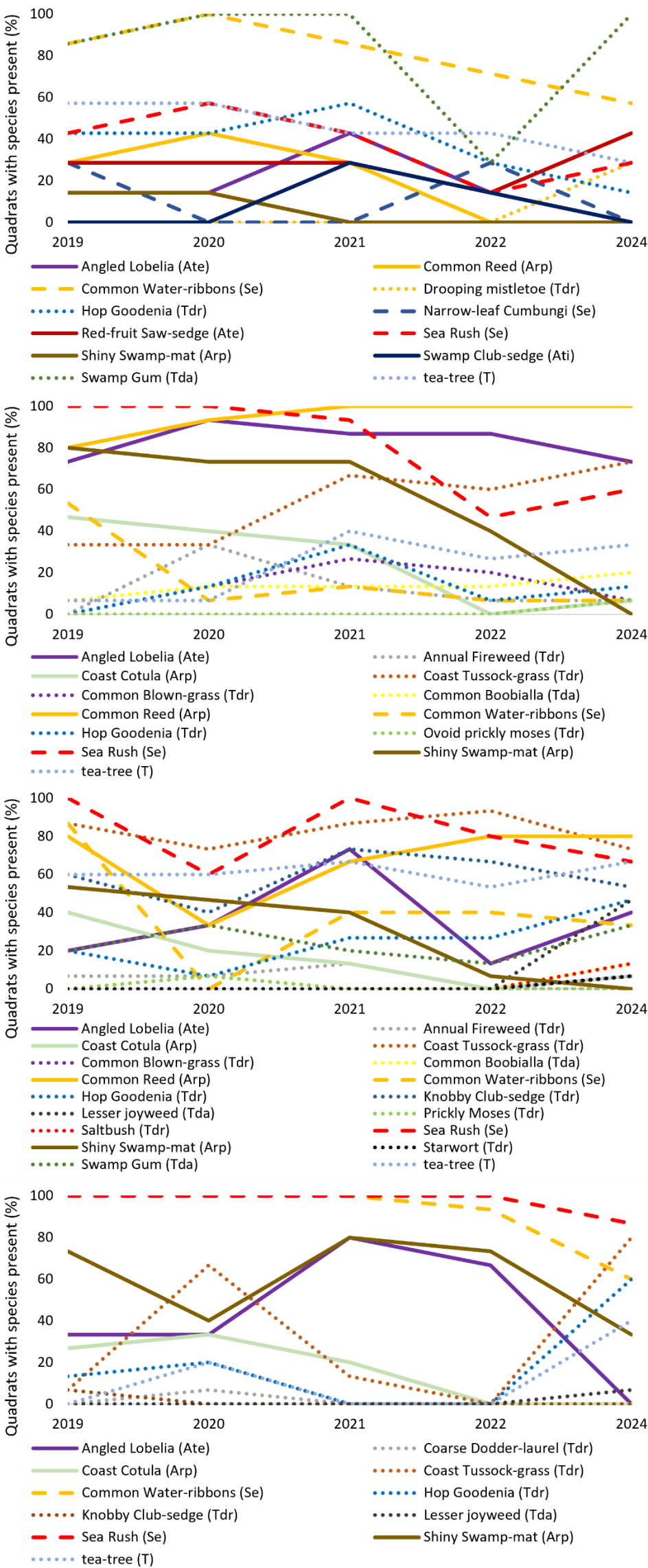


Figure 28 Bar plots show the percentage of quadrats occupied by broad functional groups. Line plots show the percentage of quadrats occupied by each species across the last five monitoring years (Sites LAR1, LAR2, LAR3 and LAR4). Aquatic species are shown using dashed lines, amphibious using solid lines, and terrestrial using dotted lines.

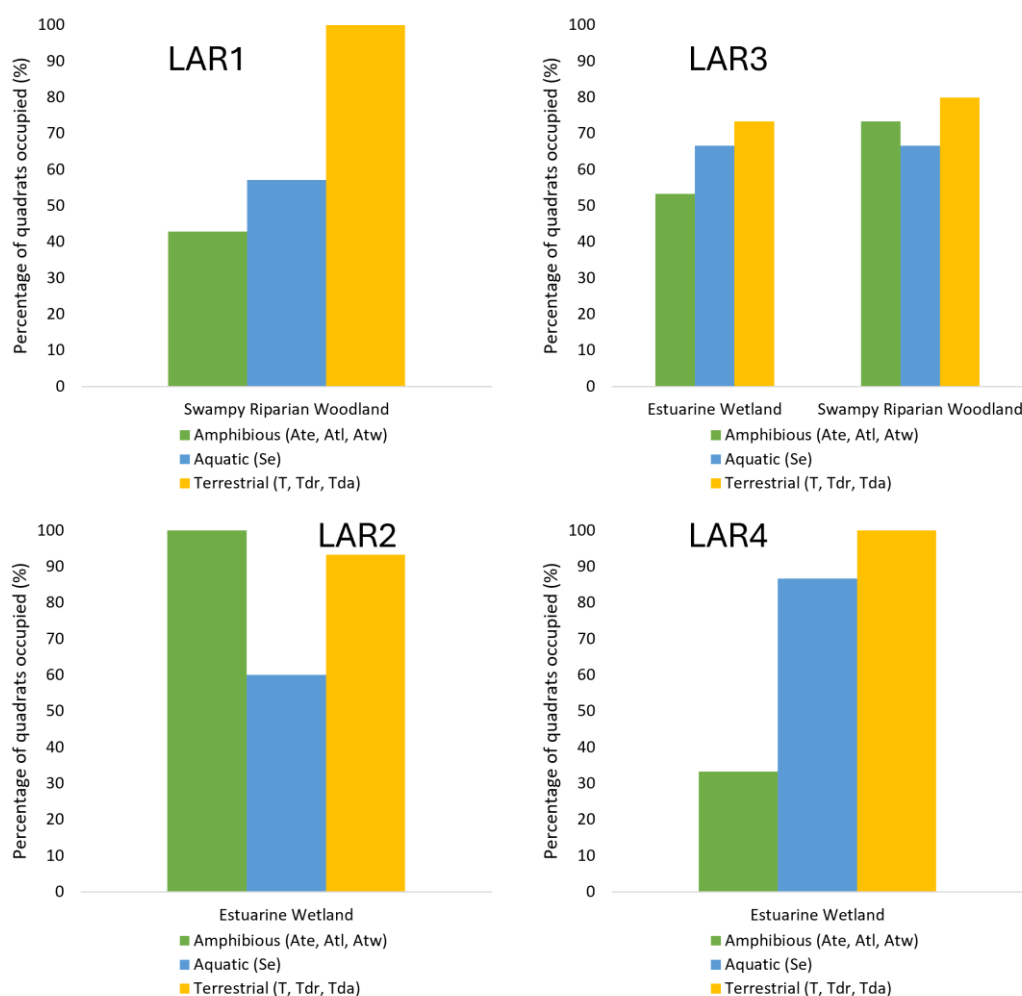


Figure 29 Percentage of quadrats where each functional group occurred in 2024, grouped by EVC.

Structural attributes

Structural attributes (EVCs)

Within the Anglesea Estuary Sites, only two dominant EVCs have been recorded across all years (Estuarine Wetland and Swampy Riparian Woodland, Figure 30). Estuarine Wetlands within the study area comprise a dense cover of reeds and rushes to 1 m tall, with scattered tussock grasses and herbs present. Swampy Riparian Woodland is a wetland EVC which typically grows to 15 m tall, with the midstorey and understorey typically dominated by large to medium shrub species, growing in association with large tussock grasses and sedges. Photopoint monitoring for each site is available in Appendix 7–Appendix 9. These photos provide visual representation of the vegetation structure at each site.

Over the past five monitoring years, the proportion of each EVC has remained steady at all sites except LAR3 (Figure 30). At LAR3, the site has historically been dominated by Estuarine Wetland, though over the last two monitoring years there has been an increased cover of Swampy Riparian Woodland

recorded. LAR1 is dominated by Swampy Riparian Woodland, while LAR2 and LAR4 are dominated by Estuarine Wetland.

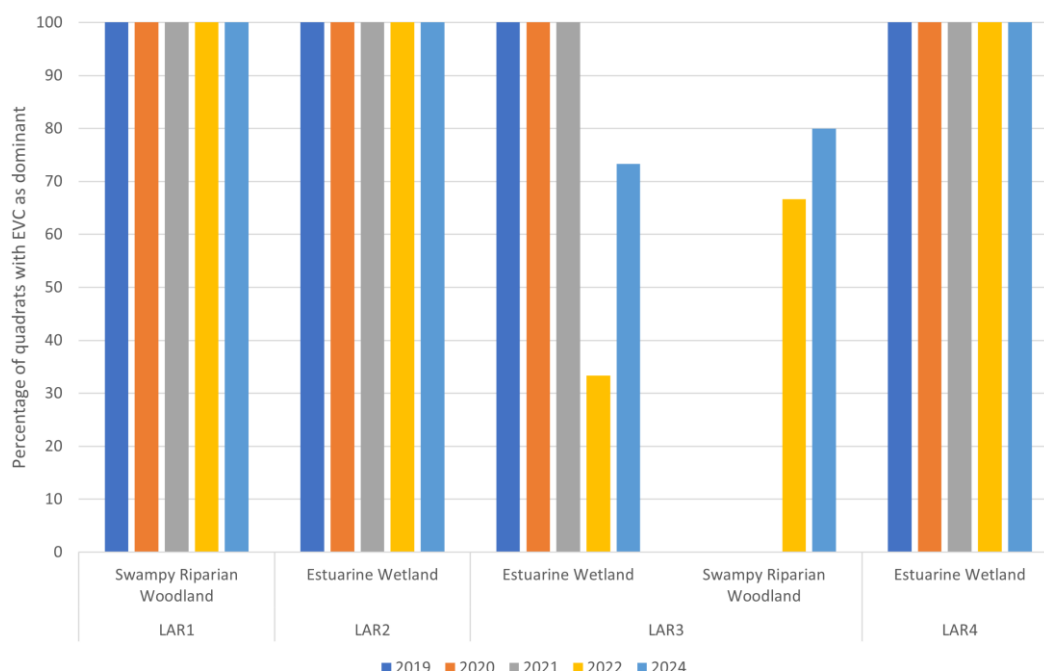


Figure 30 Percentage of quadrats with each dominant EVC across all sites within the Anglesea Estuary over the past five monitoring years. Estuary sites were not monitored in 2023 as these are only monitored every two years when the borefield is on standby.

Other structural attributes

In the Anglesea Estuary, bare ground was recorded at three of the four sites, with quadrat cover ranging from 0–25%. In 2019 no bare ground was recorded at any sites within the Anglesea Estuary, while across other years it has fluctuated between sites and quadrats (mainly ranging from 0–25% in all other years, but with a maximum of up to 80% at LAR1 in 2022).

Algal mats

No algal mats were recorded across any Anglesea Estuary sites in 2024, with the last algal mat records at LAR1 in 2020. LAR1 is the only site in the Anglesea Estuary where algal mats have been recorded, where they were first recorded in 2017.

3.3.2 Frogs

Frog survey conditions

The four sites within the Anglesea Estuary all had substantial areas of inundated habitat over the survey period. The average water depth among all Anglesea Estuary sites was slightly higher (0.05 m) at the time of the first survey (28–29 October 2024) compared to the second survey (2–3 November 2024). The weather conditions (including preceding rainfall) recorded during the two nocturnal frog surveys were relatively similar (Table 5).

Frog species richness and abundance

Frog species richness has remained very low (2–3) over the last 5 years and there is considerable variation in the abundance between years, as estimated by the number of individual frogs detected calling within 100 m of the Anglesea Estuary study sites (data from all sites pooled) during aural surveys (Figure 18). Frog abundance was higher in 2024 than in 2023, with the abundance of southern tree frog being the highest and southern bullfrog being the second highest recorded over the 2019–2024 period.

All frog detections at Anglesea Estuary sites were from calling individuals, with no individuals observed visually during nocturnal or diurnal surveys. Frogs were detected calling within 100 m of each site, with southern brown tree frog and southern bullfrog detected at all sites (Table 11). Frogs were also recorded at distances greater than 100 m at each site (Table 11). While southern brown tree frog and southern bullfrog were detected calling at all Anglesea Estuary site across both surveys, common froglet was only detected calling at distances greater than 100 m, and only at LAR1 and LAR2. All Anglesea Estuary sites had a species richness of two, with the inclusion of frogs calling at distances greater than 100 m resulting in an increased in species richness (from two to three) at sites LAR1 and LAR2 (Table 11).

Table 11 Frog species and estimated abundances detected within 100 m during two nocturnal surveys at the Anglesea Estuary sites in 2024. The number of frogs heard calling at distances greater than 100 m from the survey sites is listed in parentheses. The total species richness within 100 m and beyond 100 m (in parentheses) is also provided.

Site	Southern Brown Tree Frog		Common Froglet		Southern Bullfrog (Pobblebonk)		Species richness
	1	2	1	2	1	2	
LAR1	5 (6)	3 (4)	0 (2)	0 (0)	4 (7)	2 (0)	2 (3)
LAR2	3 (3)	2 (3)	0 (0)	0 (2)	2 (1)	2 (1)	2 (3)
LAR3	4 (2)	2 (0)	0 (0)	0 (0)	4 (5)	4 (0)	2 (2)
LAR4	4 (7)	2 (3)	0 (0)	0 (0)	3 (3)	2 (0)	2 (2)

Frog habitat assessment and water quality

The Anglesea Estuary consists of relatively deep slow-moving water. The cover of aquatic vegetation is generally low, except for filamentous algae and a low cover of floating and submergent vegetation. Common reed *Phragmites australis* is an emergent species that provides sparse edge vegetation at most sites. Fringing vegetation provides greater levels of cover to frogs at these sites and is dominated by sedges, rushes, grasses, and herbs including cast tussock-grass, *Poa poiformis* var. *poiformis*, common

blown-grass *Lachnagrostis filiformis*, sea rush *Juncus kraussii* subsp. *australiensis*, and shiny swamp-mat. The site LAR1 also supports narrow-leaf cumbungi *Typha domingensis* and southern water-ribbons, scattered hop goodenia *Goodenia ovata* and manuka *Leptospermum scoparium* with stands of swamp gum *Eucalyptus ovata* var. *ovata* located near the water's edge.

All Anglesea Estuary monitoring sites are considered permanent, with stream widths ranging from 2–3 m (LAR1) to approximately 12 m wide (LAR3 and LAR4), and quite deep (Table 12). Water quality measurements were generally consistent between sites within surveys. All sites had low pH, water temperatures above 15°C for all surveys (Table 12). Electrical conductivity was within the range expected (5–14 mg/L) for an estuary environment (Table 12), with low turbidity. Turbidity was low (1–5 NTU) and dissolved oxygen was low to moderate during the second survey (Table 12).

Table 12 Water quality measures for the two surveys conducted within sites at the Anglesea Estuary.

Site	Time		Temperature (°C)		pH		Electrical conductivity (mS/cm)		Salinity (g/L TDS)		Turbidity (NTU)		Dissolved oxygen (mg/L DO)		Depth (m)	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Survey	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
LAR1	10:40	9:15	15.2	18.4	5.36	4.11	4.04	4.04	0.2	0.2	3	1	5.76	5.56	0.2	0.9
LAR2	11:28	10:01	21.2	22.8	3.68	3.78	10.9	9.8	0.59	0.55	4	5	10.89	7.26	2.5	2
LAR3	10:59	9:32	18.6	21.9	4.53	3.61	5.96	9.2	0.34	0.51	3	4	7.36	NA	2.5	2
LAR4	11:11	9:47	20.8	22.4	3.83	3.73	10.4	8.39	0.58	0.46	4	4	10.63	6.53	2.5	2.5

4 Discussion

The objectives of the MAP are twofold:

1. To monitor for any changes in the environmental values and health of the groundwater dependent ecosystem.
2. To continue to gather the data required to build our understanding of the long-term sustainability of the groundwater resources into the future.

The following discussion sections summarise and discuss the findings of the current round of monitoring under the MAP and should be considered in relation to the above objectives.

4.1 Vegetation

4.1.1 Anglesea River Swamp

Within the Anglesea River Swamp, indigenous species continued to dominate across all sites in 2024, and a diverse array of native species functional groups were also maintained from 2022 levels (seven functional groups), with the overarching amphibious and submerged functional groups still dominating strongly (compared with the terrestrial functional groups). The terrestrial functional group has been the least abundant over the last five monitoring years at each site, also showing no increasing trend over this period at any site. This suggests that there is no encroachment of dryland species within the Anglesea River Swamp.

When examining change in the percentage of quadrats containing each species, there were no consistent increasing or declining trajectories across years. There were also no consistent trajectories of species within or between sites. This aligns with the generally stable functional group abundances which were also noted when analysing broad functional group abundance across time.

As in previous years, the Anglesea River Swamp sites were generally dominated by the wetland EVCs Aquatic Sedgeland and/or Swamp Scrub. The proportion of each EVC present has remained relatively steady across sites AS2 and AS3. However, sites AGP2 and AS4 have had a more variable proportion of EVCs recorded each year, including shifts in proportions of Aquatic Sedgeland and Swamp Scrub present between years. Perennial vegetation types such as Aquatic Sedgeland and Swamp Scrub would generally not be expected to exhibit significant shifts in their abundances between individual years. This variability may instead reflect these EVCs growing in a close matrix with one another, leading to variability in EVCs which are intersected between years during monitoring.

At sites AS4 and ASP7 there appears to be an emerging directional change towards increasing abundance of Swamp Scrub and decreasing abundance of Aquatic Sedgeland since 2021 (three concurrent monitoring periods). However, at AS4, this trend was also preceded by large fluctuations in the abundance of each of these EVCs in the preceding two monitoring periods, which was contrary to this emerging directional change. Long-term trends in the occurrence of each EVC should continue to be monitored and analysed for continuing and emerging trends, as this can signal hydrological regime change (Frood and Papas 2016).

The wetland EVC Aquatic Herbland was recorded as a dominant EVC at AS1_2014 for the first time in 2024. However, it has likely been present in conjunction with other EVCs in previous years but has not been considered dominant or occurring in a discrete enough patch for separation from other commonly co-occurring EVCs (such as Aquatic Sedgeland). The only non-wetland EVC recorded continued to be Heathy Woodland, which has been recorded at a relatively stable frequency, but only from site AS2 and only at one end of the 100 m transect.

When examining the hydroecology of each EVC at each site, all EVCs except the Heathy Woodland (the only terrestrial EVC) were found to be dominated by native species from either the amphibious or aquatic functional groups, which is typical for wetland EVCs under natural conditions.

Assessment of change in wetland boundaries over time revealed no clear trends or significant changes between 2019 and 2024. This suggests that the wetlands are not currently contracting or expanding.

4.1.2 Anglesea Estuary

Indigenous species still dominated within the Anglesea Estuary in 2024, despite a notable increase in the number of exotic species recorded since 2022 (now comprising 31% of the total species richness).

Within the Anglesea Estuary the combined abundance of species from the aquatic and amphibious functional groups was still greater than the terrestrial species abundance across all years since 2019, indicating a continuous dominance of wetland species across Anglesea Estuary sites.

Functional group composition across the Anglesea Estuary does not appear to be showing a consistent increase or decrease in any of the functional groups across all sites, with abundances either being maintained, fluctuating, or emerging trends being confined to the site-scale.

Despite stable patterns in functional groups, trends in individual species occurrence appear more variable between the Anglesea Estuary sites, with clear patterns less easy to discern at an estuary-wide scale. Nonetheless, some trends can be seen over this period including a decline in abundance of shiny swamp-mat *Goodenia radicans* (amphibious) at all sites over the past five years (with this species only recorded at LAR4 in 2024). Angled lobelia (amphibious) was also not detected at LAR1 and LAR4 in 2024 following a decline since 2022; it was, however, still present at LAR2 and LAR3. While there were no estuary-wide patterns for species there were declines across all dominant amphibious and aquatic species (sea rush *Juncus Kraussii* subsp. *australiensis* [aquatic], *Cynnogeton procerum* sp. aff [aquatic], and shiny swamp-mat *Goodenia radicans* [amphibious]) at site LAR4 in 2024. These appear to have been compensated for by an increase in the abundance of terrestrial species in the same year, including knobby club sedge *Ficinia nodosa*, hop goodenia *Goodenia ovata*, and tea tree *Leptospermum* spp.

Swamp gum *Eucalyptus ovata* (terrestrial) has increased in abundance at LAR1 since 2017, with this species now maintaining presence at 100% of quadrats except for a brief decline in 2022. Given that this species is a long-lived, slow-growing species and not expected to rapidly change in abundance, the sudden decline in abundance in 2022 may potentially relate to observers not recording all overhanging material occurring above quadrats in that year. The steady increase in abundance since 2017 relates to growth of existing mature specimens at the site, as opposed to recruitment of new individuals.

While trends in vegetation functional groups and species cover vary across sites in Anglesea Estuary there has been a declining pattern in abundance for some amphibious and aquatic species (particularly

smaller, low-growing herbaceous species) in recent years. This includes the decline in shiny swamp-mat across all sites and angled lobelia across LAR1 and LAR4, as discussed in preceding paragraphs. Conversely, some larger structurally dominant species which favour more stable hydrological conditions or drier conditions (e.g. swamp gum, coast tussock-grass and hop goodenia) may be increasing in dominance at some sites. This includes an increase in swamp gum at LAR1, coast tussock grass at LAR2 and LAR4, and hop goodenia at LAR3 and LAR4. The spread of these species may be further negatively impacting some low-growing herbaceous species through increased competition for resources such as space, light and moisture.

The Anglesea Estuary sites were dominated by either Estuarine Wetland or Swampy Riparian Wetland (both wetland EVCs), or a combination of both. While EVCs recorded for sites LAR1, LAR2 and LAR4 have remained unchanged since the inception of this monitoring (comprising either entirely Swampy Riparian Woodland [LAR1] or Estuarine Wetland [LAR2 and LAR3]), LAR3 has recorded a shift over the previous two monitoring periods. Previously this site was dominated entirely by Estuarine Wetland, but in 2022 and 2024 Swampy Riparian Woodland was recorded as the dominant EVC in 66.67% and 80% of quadrats, respectively. This suggests a potential shift towards or encroachment of Swampy Riparian Woodland at this site.

4.2 Frogs

The 2024 frog monitoring surveys show some notable shifts in the abundance of species detected relative to the previous survey year (2022) (Halliday et al. 2023). Most notably, the abundance of southern brown tree frog at the Anglesea River Swamp sites increased to the highest recorded in the current MAP.

As was the case in 2022, frogs were detected within 100 m of all Anglesea River Swamp sites except AS4, with species diversity similar between 2022 and 2024, except for AS1 where two species were detected instead of three in 2022 (Halliday et al. 2023). Species richness has remained low throughout the MAP, and a maximum of three frog species were detected at any one site within the Anglesea River Swamp and two species at Anglesea Estuary sites.

The persistence of frog populations is reliant on suitable aquatic habitat for successful breeding, including adequate water depth and quality (McDiarmid and Altig 2000). Water quality metrics, such as salinity and acidity can have a significant impact on amphibian development (Chinathamby et al. 2006; Barth and Wilson 2010). Despite low pH (high acidity) measurements at both the Anglesea River Swamp and Anglesea Estuary (had pH values < 5.36), frogs were detected at both sites. Water levels and water quality parameters were adequate for frog reproduction at all Anglesea Estuary sites. As in previous years (e.g. Halliday et al. 2023), there was substantial variation between sites in frog abundance and species richness.

Despite water availability, there is considerable variability in the timing of breeding of the three frog species commonly found at both the Anglesea River Swamp and Anglesea Estuary. However, the period required for larvae to achieve metamorphosis is more variable between these species. Southern bullfrog tadpoles metamorphose from December to April, achieving metamorphosis in 3–6 months (Anstis 2008). In contrast, common froglet tadpoles can metamorphose in 4–6 weeks, making this species less likely to be affected by water level changes and the potential drying-out of water bodies (Lane and Mahoney 2002; Hazell et al. 2003; Anstis 2008). It has been suggested that to maintain all three frog

species at a site, free-standing water needs to be available within approximately 50 m of a site for over six months (Chinathamby et al. 2006; Anstis 2008) to ensure the difference in species reproductive seasonality overlap. As such, the increase in frog abundance in 2024 (and presumed increases in overall frog population size) at the Anglesea River Swamp, suggests water availability and water quality was at least periodically adequate for successful breeding and recruitment of all three frog species to occur over the 2022–2024 period. Similarly, the record abundance of frogs detected calling at the Anglesea Estuary in 2024 (highest since 2020) suggests that the availability and quality of free-standing water over the preceding period has been adequate for additional breeding and recruitment somewhere nearby (the Anglesea River at the estuary itself is presumed mostly unsuitable breeding habitat), which is due to the presence of various predatory fish species (Gillespie 2002), with subsequent dispersal to the monitoring sites. While large Australian frog species (e.g. growling grass frog) are known to disperse across large distances (e.g. up to 430 m), the three species occurring within the Anglesea sites likely disperse across considerably shorter distances under suitable conditions. Nonetheless, the ability for frogs to disperse across small-moderate (e.g. up to 100 m) distances is likely an important adaptive strategy both in response to climate variability and change (Wassens et al. 2013), and to enable some frog species to occupy sites where reproduction was not possible, such as sites where pH levels indicate available water to be too acidic for amphibian reproduction (e.g. ASP7).

4.3 Aquatic ecology

4.3.1 Macroinvertebrates

Since the last triennial survey, SIGNAL2 scores have shown a decline at all creek sites. This suggests that the macroinvertebrate community is shifting over time, with taxa sensitive to pollution becoming less common. Declines in this index are often considered to indicate a deterioration in water quality. In contrast, there has been a general improvement among creek sites in terms of the number of macroinvertebrate families present. Compared with the previous triennial survey, six of the seven creek sites surveyed showed increases while the remaining site showed only a small decline. An increase in family richness (a coarse measure of diversity) is generally indicative of an improvement in waterway condition such as habitat suitability and/or a favourable antecedent hydrological regime. In lowland habitats with intermittent flow regimes, most taxa with potential to occur or recolonise are adapted to a wide range of water quality conditions. When taxa richness is very low, as is consistently the case for MAP survey sites, recolonisation of additional taxa, the majority of which are likely to be tolerant species, will reduce the earlier weighting that any pollution sensitive taxa were having on the SIGNAL2 score. This is one possible explanation for the contrasting result between the two indices. While it is possible that the lower SIGNAL2 score is an indication of an actual deterioration in water quality, it should be remembered that monitoring is occurring infrequently (once every three years for most sites), these are simple and coarse indices, and due to the way SIGNAL2 is calculated (an average of the sensitivity grade assigned to each taxa present) this index is likely to be unreliable when taxa richness is low. Further examination of the long-term dataset is recommended to put this result into meaningful context by ascertaining if this scenario (i.e. a decline in SIGNAL2 coinciding with an increase in Number of Families) has occurred previously over the MAP.

The wetland sites surveyed annually have shown a marginal but consistent increase over the 2022–2024 period (i.e. since the VLAKES index was first used). This indicates an increase in the proportion of pollution sensitive taxa and may indicate an improvement in water quality conditions. However, as the

number of families present in the wetland sites has remained low (mean = 3.5 taxa/sample in 2024), the detection of a small number of sensitive taxa can have a large influence on the VLAKES score.

The EPT and EPTO scores taxa was notably low across all sites, with none detected in Salt Creek nor the lower Anglesea wetlands. EPT and EPTO scores for the lower Anglesea wetlands have been consistently low over the last five years and the longer-term dataset, suggesting there is little value in continuing to calculate these indices for wetland sites. As outlined in section 2.1.4, this isn't surprising given most stonefly and many mayfly and caddisfly taxa are naturally absent or uncommon in wetland habitats. The continuing acidic conditions within the lower Anglesea wetlands (pH = 2.2) further diminishes the potential for EPTO species to occur. Low pH has a demonstrated negative effect on diversity and presence of sensitive taxa (Courtney and Clements 1998; Tripole et al. 2008). Annual variation in the creek scores for these indices has been mixed, but more sites showed a decline than an increase in 2024. Although it is possible that these declines may indicate unfavourable conditions/disturbance at these sites, the scores are too low to be particularly meaningful (i.e. a $\pm$ change of one additional taxa has a large influence), despite the modifications that have been made to both indices (i.e. using genus level instead of family level) to increase their efficacy for the MAP.

Macroinvertebrate abundance and diversity are influenced by a wide range of factors including not only water quality, disturbance, habitat suitability, but the hydrological conditions at the time of sampling and during the preceding period. The area of inundated habitat at the time of sampling has varied considerably between surveys over the 2020–2024 period. Macroinvertebrate communities are known to shift as waterbodies change phases, i.e. from wet in 2021 (all habitats were inundated, creeks were flowing and wetlands were full) to dry in 2024 (not all habitats inundated, two sites dry and all other sites having reduced inundation with most a series of disconnected pools) (e.g. Porst et al. 2012). The preceding conditions and particularly larger change of state, from wet to dry, are likely to have a substantial influence on the change detected between surveys.

4.3.2 Southern pygmy perch

Southern pygmy perch were detected at the Breakfast Creek tributary site in 2023 for the first time since 2017 and were found to persist there in 2024. Maintenance of the southern pygmy perch population in these systems is important, with the Anglesea lineage of southern pygmy perch species being unique (Cesar 2012), and other lineages of this species (Murray–Darling Basin) having already been declared as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*. Following the apparent local loss and recolonisation of this species at BCT1 through time, effort should be made to determine the source population and consider monitoring at this location in addition to, or instead of, BCT1 to enable the status and viability of this population to be more reliably monitored.

The Salt Creek site appears to be a permanent refuge pool and has maintained a continuous southern pygmy perch population since at least 2009. This population is likely to be an important source population in the local landscape (potentially even for BCT1), likely providing emigrants for dispersal and recolonisation of other areas of the Salt Creek catchment under the correct environmental conditions e.g. high flows/flooding (Tonkin et al. 2008). A broad size range of fish, including young-of-year fish, older juveniles, sub-adults, and large adult fish, was detected in 2024 suggesting the site offers suitable habitat required to support the annual breeding and recruitment success required of a well-structured population. Effort should be made to protect this refuge pool, as it currently appears (i.e. in the absence

of broad scale surveys to locate other refuge pools and populations) to be a key location for the survival of this species in the Salt Creek catchment.

4.3.3 Otway bush yabby

Otway bush yabby was detected at four of the nine sites sampled in 2024, including the two annual monitoring sites (SC1 and BCT1) where they have been targeted and detected annually since 2019. These two sites appear to support relatively stable populations, including new recruits and a wide range of juveniles and adults in 2024. However, the species was not detected at some sites where it had been found to occur in 2021 (Halliday et al. 2022): Upper Anglesea River site (UAR2 – not detected) and the upstream site (UAR1 – dry in 2024). Considering the low number of sites sampled and the fact that targeted surveying only occurred at two sites (detections elsewhere come from RBA samples), it is unknown whether this result is representative of the Upper Anglesea River more broadly. Natural wet-dry cycles do occur in this area, and Otway bush yabby is considered to be resilient to drying conditions due to moderate burrowing capabilities (DELWP 2021). The species is threatened by habitat loss and declining water quality (DELWP 2021), both of which have the potential to occur in the Upper Anglesea River, and may result in some local losses to this species. It is likely that refuge pools are important for survival and persistence of this species, however the species' tolerances and survival abilities during drying events and the extent to which they are able to subsequently recolonise remains poorly understood.

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Appendix 1 Anglesea Borefield, terrestrial ecology, Monitoring and Assessment Program, Anglesea River Swamp, plant species and Functional Groups, spring 2024.

Symbol	Key:
P	Protected flora species under the FFG Act
vu	Vulnerable under the FFG Act
*	Species exotic within Victoria

Status	Scientific name	Common name	Functional group	AGP2_2014	AS1_2014	AS2	AS3	AS4	ASP7_2014
	<i>Banksia marginata</i>	Silver banksia	Tdr			✓			
	<i>Cassytha glabella</i>	Slender dodder-laurel	Tdr				✓	✓	✓
P	<i>Cryptostylis subulata</i>	Large tongue-orchid	Se			✓			
	<i>Cycnogeton procerum</i> sp. aff.	Common water-ribbons	Se	✓	✓	✓		✓	✓
	<i>Empodisma minus</i>	Spreading rope-rush	Ate		✓		✓	✓	✓
P	<i>Epacris obtusifolia</i>	Blunt-leaf heath	Atw				✓	✓	✓
vu	<i>Eucalyptus falciformis</i>	Western peppermint	Tdr			✓			
	<i>Eucalyptus ovata</i> subsp. <i>ovata</i>	Swamp gum	Tda			✓			
	<i>Gahnia radula</i>	Thatch saw-sedge	Tdr			✓			
	<i>Gahnia sieberiana</i>	Red-fruit saw-sedge	Ate	✓	✓	✓		✓	
P	<i>Gleichenia dicarpa</i>	Pouched coral-fern	Ate		✓		✓	✓	✓
P	<i>Gleichenia microphylla</i>	Scrambling coral-fern	Ate			✓	✓	✓	
*	<i>Hypochaeris radicata</i>	Flatweed	NA	✓		✓			
	<i>Isolepis inundata</i>	Swamp club-sedge	Ati	✓	✓				
	<i>Juncus procerus</i>	Tall rush	Ate	✓	✓	✓			
	<i>Lepidosperma filiforme</i>	Common Rapier-sedge	Ate				✓		
	<i>Lepidosperma longitudinale</i>	Pithy sword-sedge	Ate	✓				✓	✓
	<i>Leptospermum lanigerum</i>	Woolly tea-tree	Atw						✓
	<i>Leptospermum</i> spp.	Tea-tree	T	✓	✓	✓	✓	✓	✓

Status	Scientific name	Common name	Functional group	AGP2_2014	AS1_2014	AS2	AS3	AS4	ASP7_2014
	<i>Machaerina arthropphylla</i>	Fine twig-sedge	Se	✓	✓			✓	✓
	<i>Machaerina juncea</i>	Bare twig-sedge	Ate		✓				✓
	<i>Machaerina tetragona</i>	Square twig-sedge	Se			✓	✓		
P	<i>Melaleuca squarrosa</i>	Scented paperbark	Atw	✓	✓	✓	✓	✓	✓
	<i>Platylobium obtusangulum</i>	Common flat-pea	Tdr			✓			
	<i>Pteridium esculentum</i> subsp. <i>esculentum</i>	Austral bracken	Tdr		✓				
	<i>Rhytidosporum procumbens</i>	White marianth	Tdr			✓			
	<i>Schoenus brevifolius</i>	Zig-zag bog-sedge	Atw		✓	✓	✓	✓	✓
	<i>Schoenus</i> spp.	Bog sedge	Ate						✓
P	<i>Sprengelia incarnata</i>	Pink swamp-heath	Ate				✓	✓	✓
	<i>Xyris operculata</i>	Tall yellow-eye	Ate				✓		
Number of species per site				9	12	16	12	13	14
Total number of species				30					

Appendix 2 Anglesea Borefield, terrestrial ecology, Monitoring and Assessment Program, Anglesea Estuary, plant species and Functional Groups, spring 2024.

Symbol	Key:
C	Species listed as Regionally Controlled under the CaLP Act
*	Species exotic within Victoria
#	Species native to Victoria but often growing outside of their natural range

Status	Scientific name	Common name	Functional group	LAR1	LAR2	LAR3	LAR4
#	<i>Acacia longifolia</i> subsp. <i>sophorae</i>	Coast Wattle	NA	✓	✓		
	<i>Acacia verticillata</i> subsp. <i>ovoidea</i>	Ovoid Prickly Moses	Tdr		✓		
	<i>Alternanthera denticulata</i> s.s.	Lesser Joyweed	Tda			✓	✓
	<i>Amyema pendula</i> subsp. <i>pendula</i>	Drooping Mistletoe	Tdr	✓			
*	<i>Anthoxanthum odoratum</i>	Sweet Vernal-grass	NA			✓	
*	<i>Atriplex</i> spp.	Saltbush	Tdr			✓	
* C	<i>Chrysanthemoides monilifera</i>	Boneseed	NA	✓			
	<i>Cycnogeton procerum</i> sp. aff.	Common water-ribbons	Se	✓	✓	✓	✓
*	<i>Erigeron sumatrensis</i>	Tall Fleabane	NA			✓	
	<i>Eucalyptus ovata</i> subsp. <i>ovata</i>	Swamp Gum	Tda	✓		✓	
	<i>Ficinia nodosa</i>	Knobby Club-sedge	Tdr			✓	
	<i>Gahnia sieberiana</i>	Red-fruit Saw-sedge	Ate	✓			
*	<i>Gladiolus</i> spp.	Gladiolus	NA			✓	
	<i>Goodenia ovata</i>	Hop Goodenia	Tdr	✓	✓	✓	✓
	<i>Goodenia radicans</i>	Shiny Swamp-mat	Arp				✓
*	<i>Holcus lanatus</i>	Yorkshire Fog	NA				
	<i>Juncus kraussii</i> subsp. <i>australiensis</i>	Sea Rush	Se	✓	✓	✓	✓
	<i>Lachnagrostis filiformis</i>	Common Blown-grass	Tdr		✓	✓	
	<i>Leptinella longipes</i>	Coast Cotula	Arp		✓	✓	

Status	Scientific name	Common name	Functional group	LAR1	LAR2	LAR3	LAR4
	<i>Leptospermum</i> spp.	Tea Tree	T	✓	✓	✓	✓
	<i>Lobelia anceps</i>	Angled Lobelia	Ate		✓	✓	
#	<i>Myoporum insulare</i>	Common Boobialla	Tda		✓	✓	
	<i>Phragmites australis</i>	Common Reed	Arp		✓	✓	
	<i>Poa poiformis</i> var. <i>poiformis</i>	Coast Tussock-grass	Tdr		✓	✓	✓
	<i>Senecio glomeratus</i> subsp. <i>glomeratus</i>	Annual Fireweed	Tdr		✓		
*	<i>Sonchus oleraceus</i>	Common Sow-thistle	NA			✓	
	<i>Stellaria</i> spp.	Starwort	Tdr			✓	
*	<i>Vulpia bromoides</i>	Squirrel-tail Fescue	NA			✓	
*	<i>Vulpia</i> spp.	Fescue	NA		✓		
Number of species per site				9	14	20	7
Total number of species				29			

Appendix 3 A selection of photos taken under the microscope during the macroinvertebrate ID.



Leptoceridae Lectrides sp.



Leptoceridae Lectrides sp. (pale morph)*



Polycentropodidae Plectrocnemia sp.



Leptoceridae Leptorussa sp.



Megapodagrionidae Austroargiolestes sp.



Chiltoniidae sp.



Scirtidae sp.



Dytiscidae sp. (adult)

*Pale morphological characteristics similar to those described by Wickson et al. (2014), which may be the first time these characteristics have been detected outside of the Grampians National Park.

Appendix 4 Results by sample, including genus/species identifications where identified, for all macroinvertebrate sites sampled in Breakfast Creek (BC1–BC3) and tributary (BCT1–BCT2) in 2024 (E1 = Edge sample 1, E2 = Edge sample 2 and E3 = Edge sample 3, T = Total per site).

Order, Family or Sub-family	Genus/species	BC1				BC2				BC3				BCT1				BCT2			
		E1	E2	E3	T	E1	E2	E3	T	E1	E2	E3	T	E1	E2	E3	T	E1	E2	E3	T
<i>Acarina</i>	sp.	5		1	6	1			1	2	7	16	25		2	3	5	12	6	5	23
<i>Calocidae</i>	<i>Caloca</i>											1	1								
<i>Ceratopogoninae</i>	sp.															1	1				
<i>Chironomidae*</i>	sp.						4	3	7						1		1				
<i>Chironominae</i>	sp.	32	23	65	120	142	142	52	336	9	8	5	22	2	1	3	6	2	4		6
<i>Chrysomelidae</i>	sp.											1	1								
<i>Culicidae</i>	sp.	4	1	13	18	10	14	31	55	52	30	75	157					11	5	1	17
<i>Diptera*</i>	sp.													1			1				
<i>Dixidae</i>	sp.	3	1	2	6																
<i>Dytiscidae</i>	sp.	41	15	68	124	13	11	24	48	55	55	55	165		3		3	9	7	3	19
<i>Gastropoda*</i>	sp.	1		1	2																
<i>Hydrochidae</i>	sp.	4	2	1	7					1	3	1	5					1			1
<i>Hydrophilidae</i>	sp.		1		1	1	2	3	6			1	1						1		1
<i>Janiridae</i>	sp.									18	1	1	20								
<i>Leptoceridae</i>	<i>Lectrides</i>											1	1	1		1	2				
	<i>Leptorussa</i>	122	30	123	275	6			6												
	<i>Triplectides</i>			1	1			2	2		5		5		1	3	4				
<i>Leptophlebiidae</i>	<i>Nousia</i>	2	9		11					10	6	21	37								
<i>Megapodagrionidae</i>	<i>Austroargiolestes</i>			2	2					2	1		3					1			1
<i>Nannochoristidae</i>	sp.		1		1									1	3	3	7	1	5		6
<i>Nanophyidae</i>	sp.															1	1				
<i>Odonata (Epirocta)*</i>	sp.															1	1				

Order, Family or Sub-family	Genus/species	BC1				BC2				BC3				BCT1				BCT2			
		E1	E2	E3	T	E1	E2	E3	T	E1	E2	E3	T	E1	E2	E3	T	E1	E2	E3	T
<i>Odonata (Zygoptera)*</i>	sp.			1	1											4	4	2			2
<i>Oligochaeta</i>	sp.			1	1	1			1	5		1	6	1			1				
<i>Orthocladinae</i>	sp.		1	1	2						3	2	5	1		5	6	3	4	1	8
<i>Paramelitidae</i>	sp.	1			1		2		2		1		1								
<i>Parastacidae</i>	<i>Geocharax tasmanicus</i>									6	5	5	16	12	12	12	36	10	10	11	31
<i>Planorbidae</i>	sp.						1		1												
<i>Podonominae</i>	sp.														1		1				
<i>Polycentropodidae</i>	<i>Plectrocnemia</i>													1	0	2	3	1	4		5
<i>Scirtidae</i>	sp.	66	72	7	145			9	9						1		1	1			1
<i>Sphaeriidae</i>	sp.	3	1	1	5																
<i>Stratiomyidae</i>	sp.		1		1																
<i>Tanyderidae</i>	sp.																		6		6
<i>Tanypodinae</i>	sp.			1	1		2		2		2	2	4		1	4	5	4	4	2	10
<i>Telephlebiidae</i>	<i>Austroaeschna</i>	1		5	6					4	1	1	6					2	1	1	4
<i>Veliidae</i>	sp.	4			4	2			2		13	15	28	3	2	1	6	12	1	22	35
Total		289	158	294	741	176	178	124	478	164	141	204	509	23	28	44	95	72	58	46	176

*Damaged or immature specimens unable to be taken to a lower taxonomic resolution.

Appendix 5 Results by sample, including genus/species identifications where identified, for all macroinvertebrate sites sampled in Salt Creek (SC1), Upper Anglesea River (UAR2) and Lower Anglesea River Wetlands (W2–W3) in 2024 (E1 = Edge sample 1, E2 = Edge sample 2 and E3 = Edge sample 3, T = Total per site).

Order, Family or Sub-family	Genus/species	SC1				UAR2				W2				W3			
		E1	E2	E3	T	E1	E2	E3	T	E1	E2	E3	T	E1	E2	E3	T
<i>Acarina</i>	sp.	5	30	11	46												
<i>Aeshnidae</i>	<i>Adveraeschna brevistyla</i>					2	26	8	36								
<i>Amphipoda</i> *	sp.					2			2								
<i>Chiltoniidae</i>	sp.						5		5								
<i>Chironomidae</i> *	sp.							1	1								
<i>Chironominae</i>	sp.	6	5	1	12	15	10	13	38					1			1
<i>Coleoptera</i> *	sp.						1		1								
<i>Corduliidae</i>	<i>Hemicordulia</i>					3	1	2	6								
<i>Corixidae/Micronectidae</i> *	sp.					3	2	1	6								
<i>Culicidae</i>	sp.	10	10	12	32		1	1	2					1			1
<i>Dytiscidae</i>	sp.	2	1	1	4	58	36	69	163	35	56	66	157	34	29	5	68
<i>Gyrinidae</i>	sp.							1	1								
<i>Hydraenidae</i>	sp.			1	1												
<i>Hydrochidae</i>	sp.		1		1		2		2								
<i>Hydrophilidae</i>	sp.					12	16	6	34	28		21	49				
<i>Janiridae</i>	sp.	1			1	2	51	16	69					3			3
<i>Muscidae</i>	sp.						1		1								
<i>Nannochoristidae</i>	sp.		1		1												
<i>Nanophyidae</i>	sp.											1	1				
<i>Notonectidae</i>	sp.					11	10	13	34								
<i>Odonata (Epiprocta)</i> *	sp.						3		3								
<i>Oligochaeta</i>	sp.	2	5		7		1		1								
<i>Orthocladinae</i>	sp.	2	2	2	6	6		2	8						2		2

Order, Family or Sub-family	Genus/species	SC1				UAR2				W2				W3			
		E1	E2	E3	T	E1	E2	E3	T	E1	E2	E3	T	E1	E2	E3	T
<i>Paramelitidae</i>	sp.	1	11	12	24	34	62	44	140								
<i>Parastacidae</i>	<i>Geocharax tasmanicus</i>	3	4	4	11												
<i>Parastacidae</i>	<i>Cherax destructor</i>							4	4								
<i>Podonominae</i>	sp.	1	1		2												
<i>Saldidae</i>	sp.										2		2				
<i>Scirtidae</i>	sp.	3		1	4					38	35	24	97	81	90	98	269
<i>Tanypodinae</i>	sp.	5	2	5	12											1	1
<i>Veliidae</i>	sp.	15	5	2	22			1	1								
Total		56	78	52	186	148	228	182	558	101	93	112	306	120	121	104	345

*Damaged or immature specimens unable to be taken to a lower taxonomic resolution.

Appendix 6 Photos of the two target aquatic species taken during the aquatic ecological monitoring.



Male (top) and female (bottom) southern pygmy perch



Otway bush yabby

Appendix 7 Photo points for AS2 (A) and AS3 (B) at 0 m, 25 m, 50 m and 75 m.

A.



0 – 25 m



25 – 50 m



50 – 75 m



75 – 100 m

B.



0 – 25 m



25 – 50 m

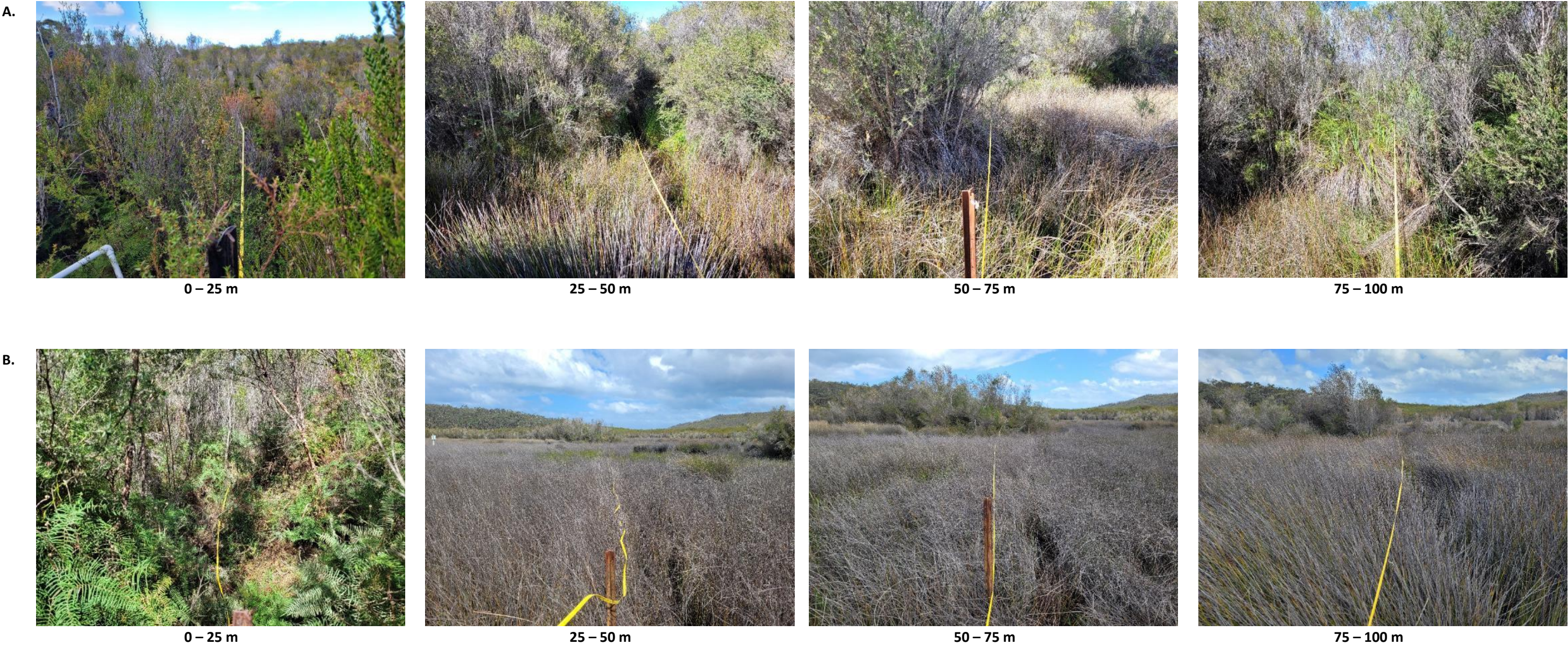


50 – 75 m

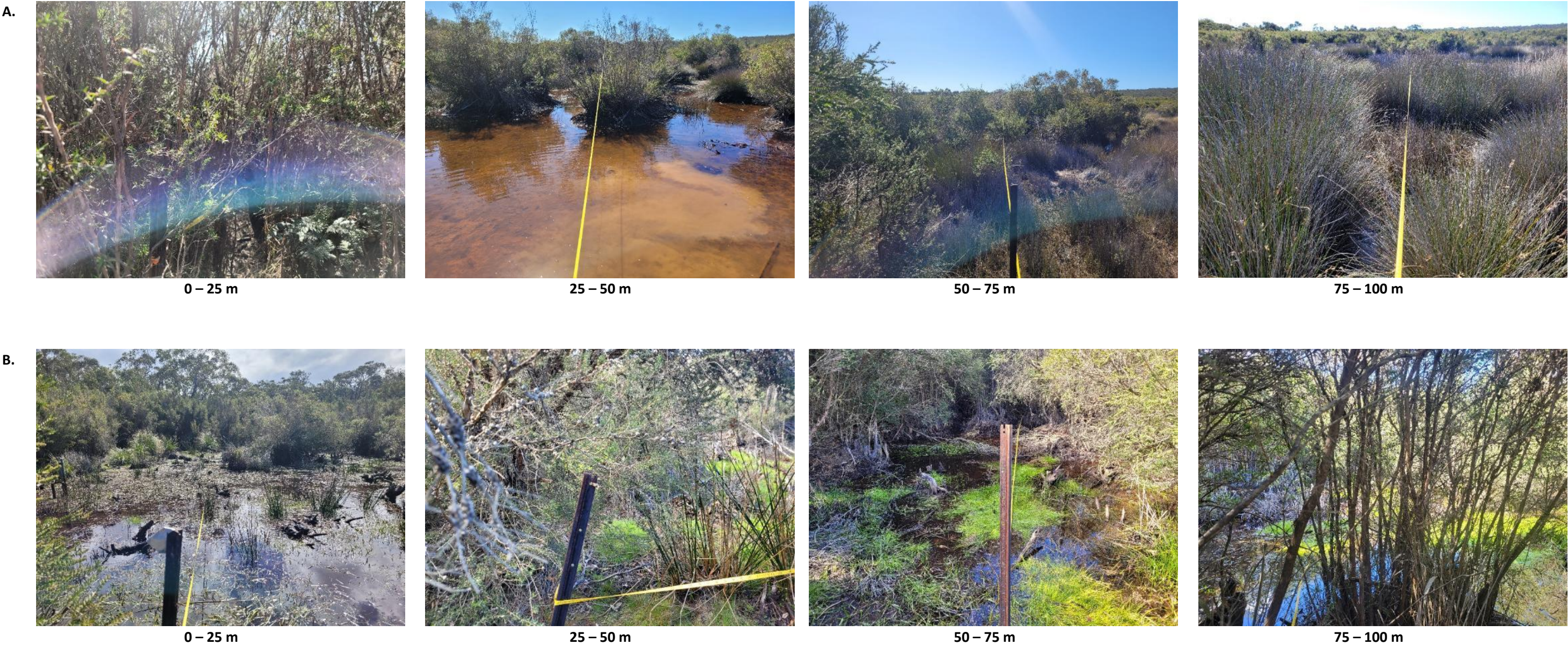


75 – 100 m

Appendix 8 Photo points for AS4 (A) and ASP7_2014 (B) at 0 m, 25 m, 50 m and 75 m.



Appendix 9 Photo points for AS1_2014 (A) and AGP2_2014 (B) at 0 m, 25 m, 50 m and 75 m.



Appendix 10 Anglesea Estuary photo point monitoring photos. Clockwise from top left: LAR1, LAR2, LAR3 and LAR4 (0 m).

