Targeted surveys for two nationally threatened small mammals in the Otway National Park

Informing the implementation of the Great Ocean Road Coastal Trail

J.K. Cripps

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Front cover photo: The Grey River, looking west (Jemma Cripps).

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it.

We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

DEECA is committed to genuinely partnering with Victorian Traditional Owners and Victoria's Aboriginal community to progress their aspirations.

Targeted surveys for two nationally threatened small mammals in the Otway National Park

Informing the implementation of the Great Ocean Road Coastal Trail

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Unpublished Report for Bushfire and Forest Services, Barwon South West Region

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Summary

Context:

The Great Ocean Road Coastal Trail is proposed as a new, 75 km, six-day walking trail located on Victoria's south-western coastline between Fairhaven and Grey River, approximately 100 km from Melbourne. The Arthur Rylah Institute (ARI) was commissioned by the Bushfire and Forest Services Barwon South West team within the Department of Energy, Environment and Climate Action (DEECA) to complete a targeted survey for two nationally threatened mammals, the Swamp Antechinus (*Antechinus minimus maritimus*) and the Broad-toothed Rat (*Mastacomys fuscus mordicus*), along sections of the proposed walking trail within the Otway National Park.

Aims:

The key objective of this work was to conduct a targeted survey in autumn 2024 to determine the presence of the Swamp Antechinus and Broad-toothed Rat, in two locations containing potential habitat that may be impacted by the construction of the Great Ocean Road Coastal Trail. This ARI survey would further contribute to assessments for trail construction and provide additional information to DEECA for planning, as well as recommendations to minimise potential impacts on these two threatened species.

Methods:

Elliott trapping surveys were undertaken over four nights in May 2024, at two sites in the Otway National Park – Grey River and Kennett River. Sixty Elliott traps were installed in dense habitat and checked twice daily, in the early morning and late afternoon. In addition to Elliott trapping, five areas with suitable Broad-toothed Rat habitat were identified and timed scat searches were undertaken (using standard methods) within these areas to determine if the species was present or had used these habitats recently. Scats of Broad-toothed Rat are distinctive from other species, especially when they are fresh and appear fibrous and green.

Results:

Trapping for 210 trap nights resulted in 46 total captures of small mammals, with four small mammal species being captured in total (three native species and one introduced species). Neither the Swamp Antechinus nor the Broad-toothed Rat were captured during Elliott trapping surveys. Evidence of Broad-toothed Rat presence could not be confirmed during the standardised scat search surveys. Despite locating some runways, none of these contained evidence of grass clippings or scats indicative of Broad-toothed Rats.

Conclusions and Implications:

Although neither of the target threatened species were detected in this survey, there is still a medium likelihood of occurrence of Swamp Antechinus within the study area at Grey River, based on a previous camera trap record from 2023. It's possible that the Swamp Antechinus population here occurs at low abundance, reducing detectability through Elliott trapping methods. However there appears to be a low likelihood of occurrence of the Broad-toothed Rat within the study area due to marginal habitat and the lack of observed scats or runways distinctive to the species.

The Great Ocean Road Coastal Trail is unlikely to have major impacts at Grey River or Kennett River on either of the threatened species targeted, as neither species was detected during these surveys and the construction footprint of the trail is low. However, the riparian habitat along the Grey River could be an important corridor for both of these species, allowing them to move between coastal areas (e.g. dune refuges) into inland habitat, and therefore it is worth protecting and restoring suitable habitat in this area as it may be occupied by both species in the future. The recommendations provided align with the two previous reports produced by Biosis (2022) and State of the Environment Pty Ltd. (2023).

1 Introduction

The Arthur Rylah Institute (ARI) was commissioned by the Bushfire and Forest Services Barwon South West team within the Department of Energy, Environment and Climate Action (DEECA) to complete a targeted survey for two nationally threatened mammal species along sections of the proposed Great Ocean Road Coastal Trail, in the Otway National Park.

The Great Ocean Road Coastal Trail is proposed as a new, 75 km, six-day walking trail located on Victoria's south-western coastline between Fairhaven and Grey River, approximately 100 km from Melbourne. It is situated on Gadubanud Country, within the Eastern Maar Nation. The trail alignment intersects several land tenures, including national park and multiple coastal reserves. It consists of seven segments, with a mixture of new and existing trails integrated into the proposed design. All of the trail has been ground-truthed and marked with tape. Construction will be undertaken both by hand and using small machinery and requires the removal of native vegetation up to 2.5 m width along the trail, although the final trail will be about 1 m wide as vegetation regenerates either side of the new trail footprint (Biosis 2022). Additional impacts of construction also include potential soil disturbance, altered drainage patterns, increased human activity, risk of weed spread and increased risk of the spread of the pathogen Cinnamon Fungus (*Phytophthora cinnamomi*) (Biosis 2022).

In 2022, Biosis completed a detailed fauna and flora assessment for the Great Ocean Road Coastal Trail. This work included desktop mapping of biodiversity values, field surveys of flora, diurnal bird and owl surveys and remote camera surveys. This work was detailed and provided new information on the potential impacts for threatened species and the approvals and mitigations required. It recommended targeted surveys for some species in suitable habitat, including the Swamp Antechinus (*Antechinus minimus maritimus*) and the Broad-toothed Rat (*Mastacomys fuscus mordicus*, Biosis 2022). An additional report providing advice on *Phytophthora* dieback management during construction also recommended surveys for these two target species at the mouth of the Grey River (State of the Environment Pty Ltd., 2023).

1.1 Nationally listed small mammals in the Otway region

1.1.1 The Swamp Antechinus, Antechinus minimus maritimus

The Swamp Antechinus (*A. minimus*, Figure 1) is one of 15 marsupial species belonging to the Antechinus genus. Two distinct sub-species of Swamp Antechinus are recognised: *A. minimus minimus*, which resides in Tasmania, and *A. minimus maritimus*, which occupies the south-eastern corner of mainland Australia (Baker and Van Dyck 2015). The Swamp Antechinus is officially considered threatened at both a Victorian and national scale, and is listed as Vulnerable under both the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and the *Flora and Fauna Guarantee Act* 1988 (FFG Act). In South Australia it is listed as Endangered (*National Parks and Wildlife Act 1972*). Swamp Antechinus have a fairly restricted distribution, with populations predominantly occurring along coastal areas from Wilsons Promontory (and nearby islands) in the east and as far as Robe in South Australia, in the west (Figure 2). Populations are fragmented, and recent genetic analysis suggests limited connectivity between populations, especially in the Otway region (Cripps and Parrott 2023).

Figure 1. A Swamp Antechinus from southwestern Victoria, *A. minimus maritimus* (source: Jemma Cripps).

The Swamp Antechinus is a terrestrial, insectivorous marsupial. Mating is highly synchronised, with females giving birth to up to eight young in June−August (Wilson 1986). A distinctive feature of the lifecycle of Antechinus is the death of all males after mating (semelparity). Antechinus are thought to have evolved in stable environments where the seasonal (spring) flush of insect prey is regular from year to year, resulting in high juvenile survival (Braithwaite and Lee 1979). The life history strategy of this species makes it particularly vulnerable to declines. Disturbance events impacting females and/or juveniles following the breeding season can result in localised population extirpation or declines and most females only have a single breeding opportunity within their lifetime.

Swamp Antechinus favour damp areas, and particularly sites with dense vegetation up to 1−2 m above ground level. However, the species' habitat varies considerably across its range and includes dense wet heathlands, tussock grasslands, sedgelands, damp gullies, swamps and some shrubby woodlands (Menkhorst 1995), often in landscape settings with little exposure to the sun (Wilson *et al.* 2001) and along drainage lines and gullies. Recent analysis shows selection for the Ecological Vegetation types of Sand Heathland, Coastal Tussock Grassland and Coastal Dune/Headland Scrub (Wilson and Garkaklis 2022). The Australian Government's *Wild Otways Initiative* program (2020-23) has improved knowledge of Swamp Antechinus occurrence within the Otway region and has identified refuge habitat for the species. This work showed that micro-refuges were predominantly Coastal Dune Scrub with long unburnt, structurally complex vegetation, and high moisture and nutrient levels (Wilson *et al.* in prep). Many of these refuges are small, linear and fragmented, with a high probability of destruction due to sea level rise (Wilson *et al.* in prep).

Swamp Antechinus face multiple, interacting threats, including introduced predators, changes in hydrology, fragmentation and destruction of habitat, small population size and genetic isolation, changes in climatic conditions (e.g. rainfall) and changes to habitat structure caused by incompatible fire regimes and pathogens such as *P. cinnamomi* (DCCEEW 2016).

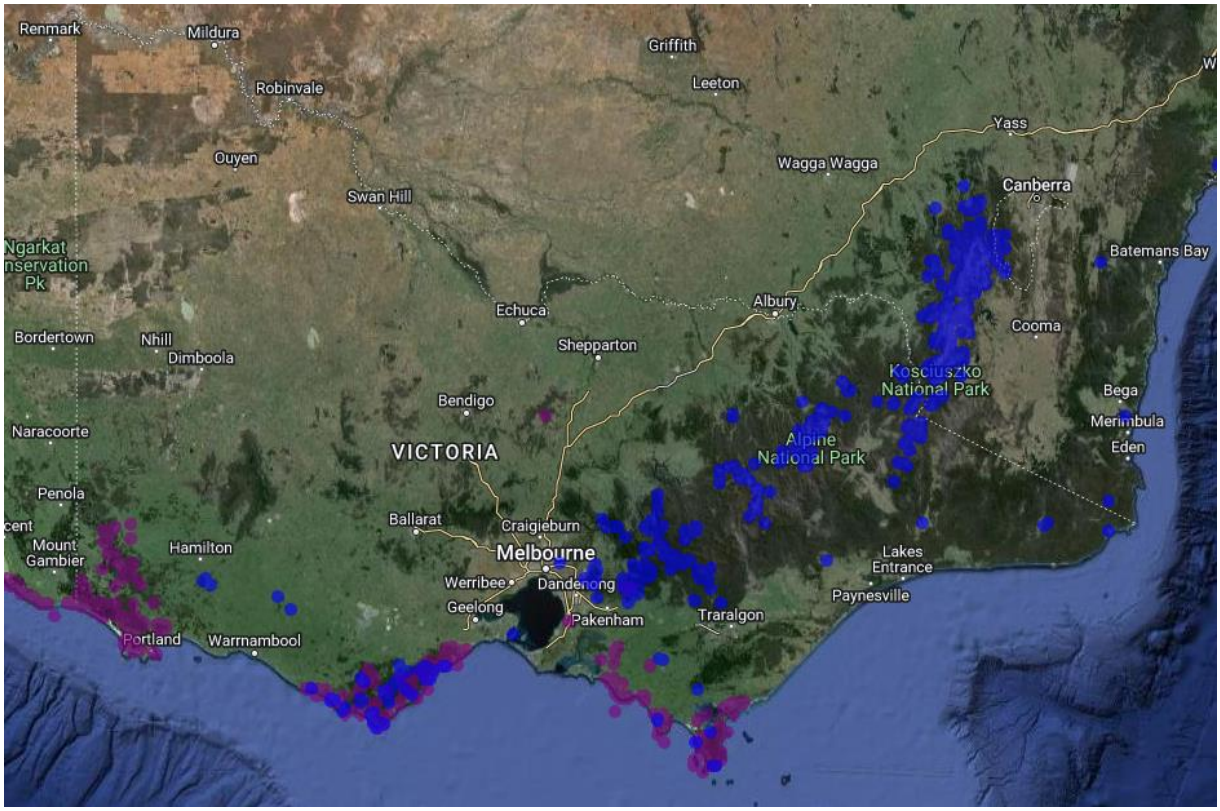

Figure 2. The distribution of the Swamp Antechinus (purple dots) and the Broad-toothed Rat (blue dots) in south-eastern Australia (Atlas of Living Australia, June 2024).

1.1.2 The Broad-toothed Rat, Mastacomys fuscus mordicus

The Broad-toothed Rat is a small native rodent (Figure 3), superficially very similar in appearance to the native Swamp Rat, *Rattus lutreolus*. Two distinct sub-species of Broad-toothed Rat are recognised: *M. fuscus fuscus*, which lives in Tasmania, and *M. fuscus mordicus*, which resides on mainland Australia. The Broad-toothed Rat is officially considered threatened at both a Victorian and national scale, where it is listed as Endangered under the EPBC Act 1999 and Vulnerable under the FFG Act 1988. The species was transferred to the national Endangered category in late 2023, following an assessment after the extensive 2019/2020 bushfires. The historical distribution of the Broad-toothed Rat (mainland) is known from New

South Wales, the Australian Capital Territory, Victoria and South Australia. In Victoria, subpopulations are poorly defined, however the species occurs in geographically distinct regions all the way from the alps to coastal Victoria in the east and west of the state (Figure 2).

Figure 3. A Broad-toothed Rat, *M. fuscus mordicus* (source: David Paul, Museums Victoria).

The Broad-toothed Rat is a terrestrial, nocturnal rodent. It is strictly herbivorous, with grasses a key component of its diet (Carron *et al.* 1990, Green *et al.* 2014). Broad-toothed Rats use and maintain tunnels under dense vegetation allowing them to travel between foraging locations and burrows in the soil, which they use for nesting. In alpine areas in winter, they den communally in nests of shredded grass situated under logs, beneath the soil, or in dense ground cover (Happold 2011). Breeding is seasonal, with one or two litters produced between October and March (Happold 2011).

Broad-toothed Rats favour sites that have a cool climate, high annual rainfall and dense vegetative cover. Currently, populations are mostly found at high elevations in alpine and subalpine areas, although there are known coastal populations and populations in the foothills. On the mainland the species inhabits heathland, grassland, sedgelands, swamps and coastal grassy or shrubby dunes, as well as drainage lines (Green and Osborne 2003). In the Otway Ranges the Broad-toothed Rat is known to co-occur with the Swamp Antechinus at locations such as Cape Otway and Painkalac Creek (DEECA 2024a) and is persisting in small roadside patches of grass and sedge, often not more than a few square metres in size (S. Kazi, *pers. comm*.).

Broad-toothed Rats face multiple interacting threats including introduced predators, fragmentation and destruction of habitat (including by feral animals such as horses), changes in climatic conditions, small population size, and changes to habitat structure caused by fire and pathogens such as *P. cinnamomi* (DCCEEW 2023).

1.1.3 Other threatened mammals in the Otway region

Additional small, terrestrial, EPBC-listed mammals that are found within the Otway National Park include the White-footed Dunnart (*Sminthopsis leucopus*), the Southern Brown Bandicoot (*Isoodon obesulus obesulus*) and the Long-nosed Potoroo (*Potorous tridactylus trisulcatus*). These species were not the key focus of these surveys and were not targeted by the methods used in these surveys. The New Holland Mouse (*Pseudomys novaehollandiae*) and the Smoky Mouse (*Pseudomys fumeus*) are considered locally extinct in this region.

1.2 Survey Objectives

The key objective of this work was to conduct a targeted survey in autumn 2024 for the Swamp Antechinus and Broad-toothed Rat, in two locations containing potential habitat that may be impacted by the construction of the Great Ocean Road Coastal Trail. Targeted surveys for these two threatened mammals were recommended by both Biosis (2022) and by State of the Environment Pty Ltd (2023), especially around the mouth of the Grey River. This ARI survey would further contribute to assessments for trail construction and provide additional information to DEECA for planning, as well as recommendations to minimise potential impacts on these two threatened species.

2 Methods

2.1 Great Ocean Road Coastal Walking Trail

The key area identified for targeted surveys was located at the end of the proposed Great Ocean Road Coastal Trail near the mouth of the Grey River and south of the locality Kennett River (Figure 4). Surveys focused on the areas of proposed new trail, where construction impacts would be greatest. The location around the Grey River has also been identified as one of several important small mammal refuge areas in the Otway region (Wilson *et al.* in prep), hence the focus at this locality.

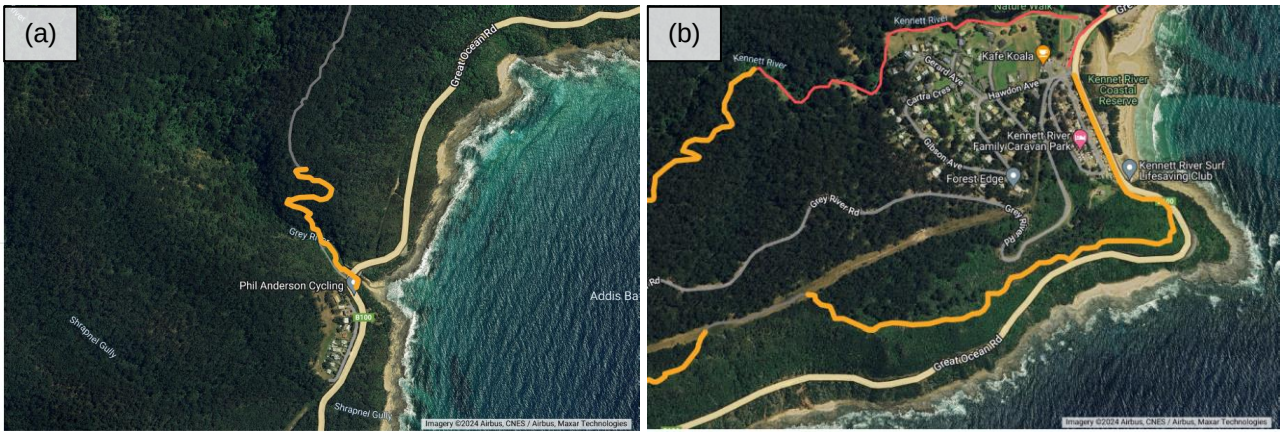

Figure 4. Maps showing the proposed Great Ocean Road Coastal Trail new route alignment (yellow) at (a) Grey River and (b) Kennett River (source: MVP Master Plan map, DEECA).

2.2 Survey methods

2.2.1 Elliott trapping

Funding was available to undertake a week of survey work, and live trapping was chosen as the primary survey method as it can be undertaken quickly within a single trip. Trapping also provides demographic data and genetic data, and thus could contribute to genetic analyses that are currently underway for both Swamp Antechinus (J. Cripps unpublished data) and Broad-toothed Rat (K. Rowe unpublished data).

Live trapping surveys were undertaken over four nights 13-17 May 2024. Trapping occurred during the autumn period, prior to the Swamp Antechinus breeding season. This timing was chosen as it represents the time that Swamp Antechinus populations should be at their highest densities (Magnusdottir *et al.* 2008) prior to the complete male die-off after the breeding season over winter (semelparity) when the population dramatically reduces in size. The Broad-toothed Rat breeds earlier in the year (October – March) but does not exhibit the same rapid changes in population density as the Swamp Antechinus.

Two locations were chosen for live trapping – Grey River (-38.682003, 143.838624, Figure 5) and Kennett River (-38.670447, 143.862796, Figure 6). These two trapping locations are separated by approximately 2.3 kilometres. Locations were chosen based on the occurrence of high probability of modelled habitat for the Swamp Antechinus along the proposed walking trail (Habitat Distribution Models [HDMs] available on DEECA NatureKit (DEECA 2024b) and the confirmed presence of the Swamp Antechinus on a camera trap at the mouth of the Grey River (State of the Environment Pty. Ltd. 2023). While there was no modelled habitat predicted for the Broad-toothed Rat at these sites, there was a dense cover of Kikuyu Grass (*Pennisetum clandestinum*) south of the river. It is now recognised that this type of weedy grassy habitat close to riparian vegetation does provide habitat for the species in other nearby locations (e.g. Parker Inlet, DEECA 2024a). Thus, the habitat looked potentially suitable and it was only 3.2 kilometres from an older (1990) record in the Victorian Biodiversity Atlas (DEECA 2024a). However, there wasn't capacity to spend great lengths of time searching for suitable inland habitat in which to place traps (which would have needed to be done on foot). As such, desktop assessments using Ecological Vegetation Classes (EVCs) were undertaken. This showed that forested habitats dominated the inland sections of the trail, and these were assessed as unlikely to contain much suitable habitat for either of the target species. It should be noted that ground-truthing of these locations did not occur and consequently suitable habitat may exist inland that was not assessed in these surveys.

At each location, small Elliott type A traps (Elliott Scientific Equipment, Upwey, Australia, size 90 mm x 100 mm x 330 mm) were placed approximately 10 m apart and left open for a period of three to four consecutive

nights. Each trap had bedding material placed inside to provide warmth (Excel Fibre Hobby Fill) and a plastic cover around each trap to protect it from wet conditions. Traps were placed amongst vegetation to provide insulation and protect the traps from the elements (Figure 7), with 60 traps installed during the trapping period. They were checked twice daily, in the early morning and late afternoon. Traps were baited with a ball of rolled oats, peanut butter and honey, and baits were replaced if consumed by trapped animals.

All small mammals that were captured were sexed, measured, weighed and their reproductive state assessed, before they were released. Tissue biopsies were collected from antechinus using sterilised tweezers and a single use 2 mm biopsy punch, for genetic analyses. Tissue biopsies were immediately stored in ≥70% ethanol. To record recaptures of trapped individuals, non-toxic coloured texters were used to colour the ears of captured animals, with a different colour used each day.

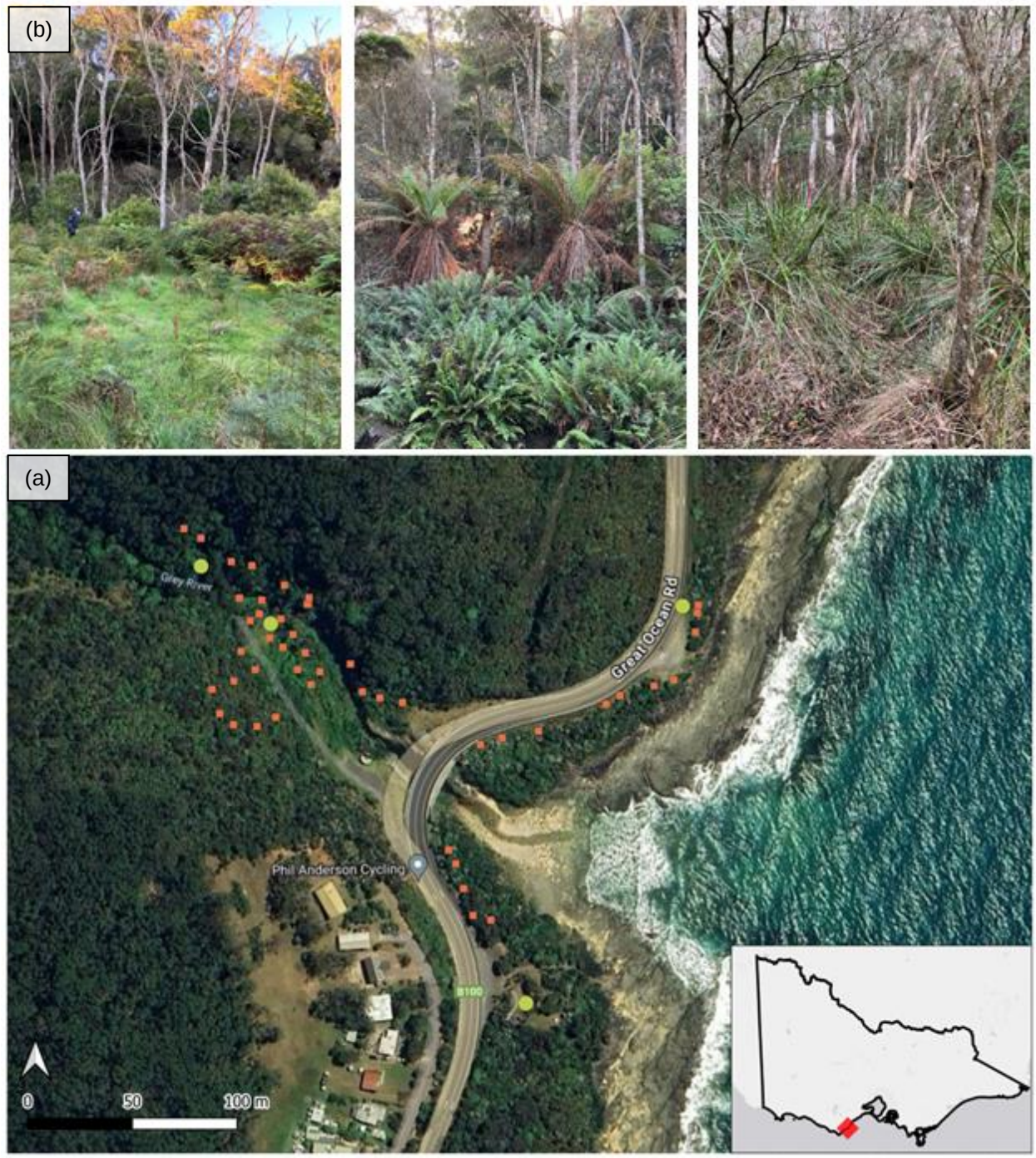

Figure 5 (a) The location of Elliott traps (orange squares) and scat survey areas (green dots) at Grey River, Otway National Park, Victoria. These sites were surveyed for two target threatened species in May 2024. (b) photographs showing the mix of dense habitats suitable for small mammals at this location.

Figure 6 (a) The location of Elliott traps (orange squares) and scat survey areas (green dots) at Kennett River, Otway National Park, Victoria. These sites were surveyed for two target threatened species in May 2024. Traps were located along a boundary due to the lack of suitable habitat for either species along other sections of the proposed track route. Traps also needed to be easily accessible on foot as they were checked twice per day. (b) photographs showing the mix of dense habitats targeted for small mammals at this location.

Figure 7. Placement of Elliott traps in dense vegetation to target small, threatened mammals during surveys undertaken in the Otway region, Victoria in 2024.

Trap success rate (Caughley 1977) was calculated for each species captured. This can be used as a measure of relative activity and to compare trapping rates across years and between sites. Trap success was standardised using the formula:

*TS = (Total captures/ total number of trap nights *100)*

2.2.2 Broad-toothed Rat scat searches

Areas of potential Broad-toothed Rat habitat (e.g. wet areas with a high density of sedges or grasses providing good ground cover, often close to drainage lines) were visually identified within the two sites. Five areas were identified (Figure 8) and timed scat searches were undertaken within these areas to determine if the species was present or had used these habitats recently. Scats of Broad-toothed Rats are distinctive from other species, especially when they are fresh and appear fibrous and green (Shipway *et al.* 2020). They also persist in the environment for up to five years (Happold 1989). Previous surveys have shown that Broad-toothed Rats are highly detectable using timed scat surveys and scats are usually located within the first five minutes of searching (Green and Osborne 2003, Shipway *et al.* 2020).

Within each area of potential habitat, timed 10-minute searches were undertaken, with two people simultaneously searching for scats, runways and fresh clippings underneath dense shrubs, sedges and within grassy areas (Figure 8). Runways alone were not considered as evidence of the species presence. For each search multiple data were recorded, including GPS coordinates of the starting location, a GPS track of the area searched, the search time rounded to the closest minute and the survey outcome (detection or non-detection). Timed searches were halted if fresh Broad-toothed Rat scats were found. Reference photos of scats were collected and these were classified into categories on the basis of age (as per Shipway *et al.* 2020): (1) fresh scat (bright green, fresh, wet and fibrous and (2) old scats (straw-coloured and dry). Each site was also given a score: (1) Active (fresh scats present), (2) Active (old scats and clippings), (3) Inactive (old scats only) or (4) No scats found.

Figure 8. Timed scat searches within suitable habitat were undertaken at five locations to determine the presence of Broad-toothed Rat along the Great Ocean Road Walking Trail.

The areas searched for scats were located close to where Elliott traps were set in suitable Broad-toothed Rat habitat, which is characterised by wet areas containing a high density of sedges or grasses providing good ground cover (in this case, kikuyu grass and bracken fern).

2.2.3 Incidental records of threatened species

Any incidental records of threatened species located during survey work were recorded and uploaded to iNaturalist, FrogID (Australian Museum) or to the Victorian Biodiversity Atlas (VBA). These species were usually observed incidentally while staff were in transit or outside of the times dedicated to standardised surveys.

2.2.4 Vegetation

The vegetation of these areas was classified according to mapped Ecological Vegetation Classes (EVCs), which are the standard unit for classifying vegetation types in Victoria, based on floristics, lifeforms, and ecological characteristics (DEECA 2024c). Detailed flora surveys and habitat assessments were not undertaken as these are already available for the walking trail (Biosis 2022).

3 Results

3.1 Survey results

3.1.1 Elliott trapping

During the Elliott trapping survey, four small mammal species were captured, including three native species (42 total captures) and one introduced species (4 total captures). Trapping for 210 trap nights resulted in 46 total captures of small mammals (Table 1), with 41% of these recaptures of the same individuals. The most widespread mammal captured was the Bush Rat (*Rattus fuscipes*), followed by the Swamp Rat, the House Mouse (*Mus musculus*) and the Agile Antechinus (*Antechinus agilis)* (Table 1). Neither of the target species, Swamp Antechinus or Broad-toothed Rat, were captured in Elliott traps. All captures occurred at the Grey River site - no small mammals were captured in traps set at Kennett River.

Overall captures of small mammals were highest in the morning (87% captures) meaning overnight was a time of increased competition for available traps. All mammal capture data from May 2024 has been uploaded to the Victorian Biodiversity Atlas (VBA) under Project ID 7923.

Table 1. Summary of small mammal captures in May 2024 in the Otway National Park.
In total, 210 trap nights were undertaken, resulting in the capture of four small mammal species. Trap success is the number of captures per 100 trap nights.

Species	No. of captures	Trap success	Location/s trapped
Bush Rat, *Rattus fuscipes*	36	17.1	Grey River
House Mouse, *Mus musculus*	4	1.9	Grey River
Agile Antechinus, *Antechinus agilis*	2	0.95	Grey River
Swamp Rat, *Rattus lutreolus*	4	1.9	Grey River

3.1.2 Broad-toothed Rat scat searches

Evidence of Broad-toothed Rat presence could not be confirmed during the standardised scat search surveys. Despite locating some runways, none of these had evidence of grass clippings or scats indicative of Broad-toothed Rat. The distance surveyed at each site from the start to the end of the survey ranged from 133-194 m (average 150 m), with all surveys lasting for at least 10 minutes.

3.1.3 Incidental records of threatened species

Three nationally (EPBC Act) or state listed (FFG Act) species were identified during the field surveys in May 2024. Two birds and one invertebrate were located (Table 2), as well as one frog species which has recently been described (Parkin *et al.* 2023) and is not yet listed. For each detection a GPS location was recorded, and the record was submitted to either iNaturalist, FrogID or the VBA.

Table 2. Threatened species incidentally detected during surveys at Grey River and Kennett River in the Otway National Park, May 2024.

Species name	Listing status	Detection type	Notes
Rufous Bristlebird (Otway), *Dasyornis broadbenti broadbenti*	Vulnerable under FFG Act	Seen and heard	One individual heard calling on edge of Great Ocean Road and then viewed through binoculars.
Gang-gang Cockatoo, *Callocephalon fimbriatum*	Endangered under both FFG and EPBC	Seen and heard	Multiple pairs seen and heard on the inland side of the Great Ocean Road.
Otway Black Snail, *Victaphanta compacta*	Endangered under FFG Act	Seen	One individual seen on the northern side of Grey River, within Wet Forest EVC.
Otway Smooth Frog, *Geocrinia sparsiflora*	Recently described species, not yet listed	Heard	Multiple individuals heard calling along Grey River.

3.1.4 Vegetation

The two areas surveyed occurred at 12 to 28 m above sea level. The key Ecological Vegetation Classes (EVCs) present along the banks of Grey River were Riparian Forest (EVC 18) and Shrubby Foothill Forest (EVC 45), which transitioned into dense Coastal Headland Scrub (EVC 161) on the ocean side of the Great Ocean Road. The remainder of the proposed trail between Kennett River and Grey River is mapped as EVC types Shrubby Foothill Forest or Shrubby Wet Forest.

Within trap sites, cover was structurally complex and was provided by native flora common to this region, such as Prickly Currant-bush (*Coprosma quadrifida)*, Austral Mulberry (*Hedycarya angustifolia*), Musk Daisy-bush (*Olearia argophylla*), Hop Goodenia (*Goodenia ovata*), Austral Bracken (*Pteridium esculentum*), Common Boobialla (*Myoporum insulare*), Coast Beard-heath (*Leucopogon parviflorus)*, Prickly Moses (*Acacia verticillata)*, Tall Sword-sedge (*Lepidosperma elatius*), Kangaroo Apple (*Solanum aviculare*) and Forest Wire-grass (*Tetrarrhena juncea)*. Overstorey species included Brown Stringybark (*Eucalyptus baxteri*), Mountain Grey-gum (*Eucalyptus cypellocarpa*), Blackwood (*Acacia melanoxylon*), Banyalla (*Pittosporum bicolor*) and small patches of Drooping Sheoak (*Allocasuarina verticillata*).

The habitat at Grey River was quite disturbed, with a high proportion of exotic species, especially along the banks of the Grey River. Exotic weeds such as Common Blackberry (*Rubus anglocandicans)*, Agapanthus (*Agapanthus praecox*) and White Arum-lily (*Zantedeschia aethiopica*) were present in many locations. Grassy areas of potentially suitable Broad-toothed Rat habitat were dominated by Kikuyu Grass (*P. clandestinum*).

At Kennett River, traps were installed in areas of disturbed Coastal Headland Scrub (EVC 161) along the edge of a mowed boundary near the Surf Club. In this location, habitat upslope further into the patch of remnant vegetation was limited in suitability for small mammals as it was dominated by Banyalla, which had shaded out all the understorey flora and significantly reduced structural complexity at the ground/shrub layer. As such, the nearest locations with suitable vegetation and structural complexity were targeted for trapping, due to the logistics of checking traps twice per day.

4 Conclusion

Neither of the two target species, Swamp Antechinus or Broad-toothed Rat, were captured in this survey, despite a recent record of the Swamp Antechinus at Grey River during a 2023 camera trap survey (State of the Environment Pty. Ltd. 2023), and preferred habitat for this species nearby (especially in the Coastal Headland Scrub on the ocean side of the Great Ocean Road). A limitation of any survey method is that species are not perfectly detectable and even when present, may remain undetected during targeted survey effort. Detectability varies with several factors, including population abundance, weather conditions, seasonality, and survey technique (e.g. Burns *et al.* 2019, Wintle *et al.* 2005). Ideally, if there had been more funding and time, multiple survey techniques would have been used at these two sites, including remote cameras which can be set to collect non-invasive survey data over much longer time frames. While movement patterns of the Swamp Antechinus tend to be small (1.7-2.7 ha, Sale and Arnould 2009) which makes live trapping a good technique in highly suitable habitat, males can move much larger distances ahead of and during the breeding season (Sale and Arnould 2009). Repeat surveys would yield a more reliable indication of occurrence and abundance of Swamp Antechinus at these sites. If these were undertaken, multiple techniques (e.g. Elliott trapping paired with white-flash cameras set at short distances (~1m) to bait lures) are recommended to survey for the Swamp Antechinus and the Broad-toothed Rat. This would improve survey effort along the proposed trail as cameras are logistically easier to install at further distances inland, and additional ground-truthing of potential habitat could occur in these inland locations.

Despite there being no captures of Swamp Antechinus at either of these sites during this study, there could still be a medium likelihood of occurrence of the species within the study area at Grey River, based on the previous camera record from 2023. It's possible that the Swamp Antechinus population here is at low abundance, reducing detectability through live trapping. There have been other instances of non-detection of Swamp Antechinus using Elliott trapping methods followed by detection on remote cameras during re-surveys of sites over longer periods of time (e.g. Cripps and Parrott 2023). More work is required to characterise the variable detection rates of this species and to determine minimum survey requirements for reliable detection.

In contrast, there is published literature suggesting that 10-minute scat searches are highly suitable for detecting the Broad-toothed Rat (Green and Osborne 2003, Shipway et al. 2020). As such, it seems probable there is a low likelihood of occurrence of the Broad-toothed Rat within the study area at this point in time. In contrast to the Swamp Antechinus, the habitat for the Broad-toothed Rat at both sites seemed marginal, and no runways or scats distinctive to the species were seen. While this type of weedy grassy habitat close to riparian vegetation has been recognised as potentially suitable for the species, close examination of the habitat during vegetation assessments suggested it does not currently provide enough dense cover for protection from predators. It also showed signs of disturbance by humans and native herbivores (e.g. flattening of tussocks). While the habitat at Grey River was similar to that occupied by the species at Parker Inlet, it was much more disturbed, open and contained less densely clumped tussocks compared with the Parker Inlet site. In the future, if disturbance reduced and habitat recovers, Grey River could be occupied by the species.

The areas sampled in these surveys are not representative of habitat along the entire length of the proposed trail as they were undertaken in different EVC types (e.g. Coastal Headland Scrub, Riparian Forest) close to the river or the coast. The remainder of the trail between Kennett River and Grey River is mapped as Shrubby Foothill Forest or Shrubby Wet Forest and is topographically different to the habitat assessed in these surveys. Therefore, there could be sections of suitable habitat for these two EPBC-listed target species that have not been assessed or ground-truthed as part of this survey effort. As such, the results of these surveys cannot be extrapolated along the entire length of the proposed walking trail.

The four non-threatened mammal species captured in this trapping survey are common across the region and in southeastern Australia. Surveys in the Otway Ranges in 2022 found similar rates of trap success for Bush Rats, but trap rates were lower in this survey for Swamp Rats and House Mice (Cripps and Parrott 2023). Trap success of Agile Antechinus was slightly higher in this survey than in 2022 surveys (Cripps and Parrott 2023). Trail construction will likely reduce habitat for these small mammal species in the short-term, potentially reducing foraging habitat and increasing the risk of predation, but as the construction footprint of the trail is relatively low it is unlikely it will have major impacts on any of these species over the long-term.

4.1 Recommendations

The Great Ocean Road Coastal Trail is unlikely to have major impacts at Grey River or Kennett River on either of the threatened species targeted, as neither species was detected during these surveys. However, to

increase certainty for the Swamp Antechinus, which may be persisting at low densities, implementing an additional round of survey work (e.g. with remote camera traps) would be advised. The riparian habitat along the Grey River could be an important corridor for both of these species to move between coastal areas (e.g. dune refuges) into inland habitat, so it is therefore worth retaining and restoring suitable habitat in this area as it may be occupied or used by both species in the future. Detailed recommendations for persistence and conservation have been documented for Swamp Antechinus (e.g. Cripps and Parrott 2023, Wilson and Garkaklis 2023) and the Broad-toothed Rat (DCCEEW 2023) across their range and are not repeated here. The primary measure to reduce potential impacts to these species within the study area is to avoid and minimise removal of dense, structurally complex native vegetation. Recommendations align with the two previous reports produced by Biosis (2022) and State of the Environment Pty Ltd. (2023). To avoid repetition, just the key impact minimisation strategies and mitigation measures are listed below:

- To the fullest extent practicable, minimise disturbance to native vegetation within the project area and constrain trail construction to areas of natural pathways (e.g. macropod paths), which have already flattened habitat and opened up vegetation.
- Consider improving habitat for small mammals after trail construction has finished, especially along Grey River, through habitat restoration activities, such as accelerating vegetation structure and complexity through revegetation with native plants. Processes that reduce habitat complexity are strong facilitators of invasive predator impacts (Doherty *et al.* 2015), so quickly enhancing habitat structure for small mammals will be the best strategy to buffer against predation. Installation of signage will help communicate the importance of staying on trails and reducing the spread of *Phytophthora* through these areas.
- Control *Phytophthora* along trail network in accordance with the 'Phytophthora Dieback Management Report' (State of the Environment Pty Ltd. 2023). Of particular note:
    - High risks of pathogen transfer are associated with infested soil adhering to earth moving equipment, other machinery, vehicles, equipment (such as shovels) and footwear. Conducting work in dry weather will reduce this risk, as will hygiene measures such as using Phytoclean™ (or approved equivalent) to sterilise boots and equipment prior to entering the walking trail. Good hygiene measures will reduce spread of *Phytophthora* and other pathogens (such as myrtle rust or invasive weeds) and appropriate management of construction activities will significantly reduce the *Phytophthora* risk, and therefore reduce risks to habitat damage.
    - Incorporate hygiene stations along the walking trail, especially in areas where there is *Phytophthora* infestation. Consult with Corangamite Catchment Management Authority who have developed good standards for this under the recent *Wild Otways Initiative*.
    - Grey River and Kennett River are not deemed high risk sections nor confirmed as Active *Phytophthora* dieback disease locations along the walking track (State of the Environment Pty Ltd. 2023). However, it is worth documenting that during field surveys, a patch of tree and shrub dieback was seen upslope, south of the Grey River. It's possible this dieback could be indicative of *Phytophthora*, but testing would be required to confirm this as the cause.
- Construct elevated boardwalks to reduce impacts on native vegetation, hydrology and soil compaction, along Grey River. This will protect critical habitat for small mammals and will also provide sediment management.
- Develop a weed control strategy to reduce and minimise weed invasion along trails. This would be especially prudent around Grey River where high numbers of weedy plants were seen during field surveys. At Kennett River, the quality of the habitat had diminished for small mammals due to overabundance of Banyalla (*P. bicolor)*. Consider undertaking woody removal during trail construction and restoring flora species common to EVC 161 Coastal Headland Scrub in this area.

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