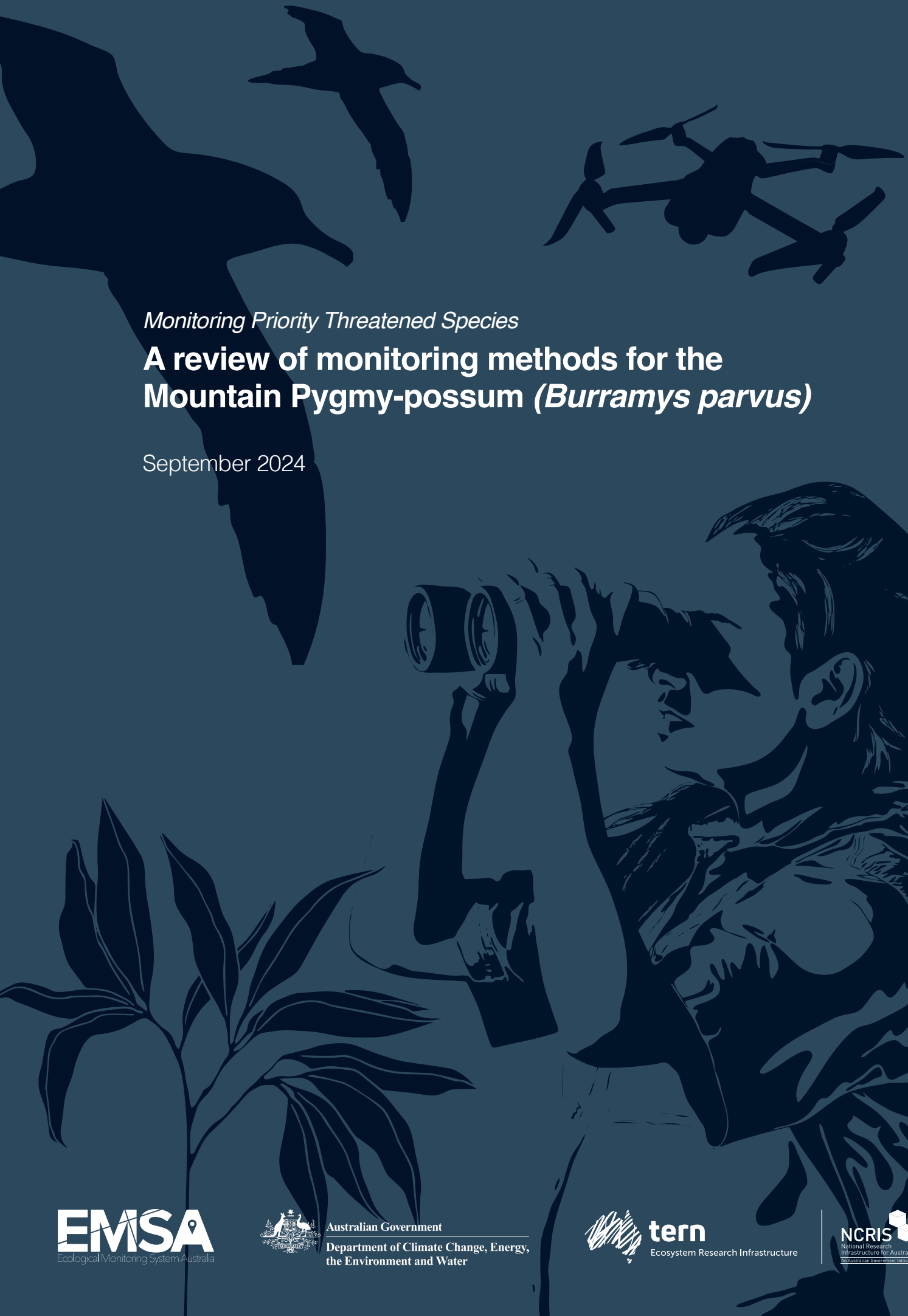

Monitoring Priority Threatened Species

A review of monitoring methods for the Mountain Pygmy-possum *(Burramys parvus)*

September 2024

EMSA
Ecological Monitoring System Australia

Australian Government
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Acknowledgement of Country

We acknowledge the Traditional Custodians of Australia and their continuing connection to land and sea, waters, environment and community. We pay our respects to the Traditional Custodians of the lands we live and work on, their culture, and their Elders past and present.

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About

This literature review collates information on one of the 110 priority threatened species identified in the *Threatened Species Action Plan 2022-2032* and has been reviewed by invited practitioners experienced in monitoring the species.

The *Survey Guidelines for Monitoring Threatened Species* project, a collaboration of the Department of Climate Change, Energy, the Environment, and Water (DCCEEW) and the Terrestrial Ecosystem Research Network (TERN), aims to improve our knowledge of threatened species by enhancing accessibility and sharing of quality scientific threatened species data. By developing best practice field survey guidelines and recommendations, practitioners will be better equipped to conduct standardised, repeatable surveys.

By identifying the monitoring methods typically implemented by practitioners, documenting and assessing the techniques known to work, and identifying opportunities to standardise the methods, we can move towards ensuring all monitoring is species-appropriate, comparable between practitioners and populations, and repeatable over time. Further, together with consistent terminology, guidelines, instructions, and data collection, we can refine efforts and resources to measure and share information. Data collected using robust, standardised methods will improve our knowledge of threatened species and underpin threatened species recovery at scale. This project is essential to establishing monitoring protocols and data repositories to enhance the accessibility and sharing of threatened species data.

TERN has prepared the literature reviews for the Department of Climate Change, Energy, the Environment, and Water. For further information, please visit the EMSA Threatened Species Survey Guidelines website. Additional information, particularly monitoring methods and techniques not included that should be considered, can be brought to the author's attention by emailing tern@adelaide.edu.au for consideration for future updates.

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1 Background

1.1 Species name

The Mountain Pygmy-possum (*Burramys parvus*), Broom 1896.

1.2 Conservation status

The Mountain Pygmy-possum is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) and under state legislation in South Australia and Victoria. It is also identified as Critically Endangered on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. This is because the extent of the entire species population is less than 10 km^2, is severely fragmented and their habitat continues to decline in extent and quality (IUCN 2008).

Table 1. National, international and state conservation status for the Mountain Pygmy-possum

Jurisdiction	Conservation status	Listing/legislation
Commonwealth	Endangered	*Environment Protection and Biodiversity Conservation Act 1999*
New South Wales	Endangered	*Biodiversity Conservation Act 2016*
Victoria	Endangered	*Flora and Fauna Guarantee Act 1988*
IUCN	Critically Endangered	IUCN Red List of Threatened Species

1.3 Summary of data held in the Threatened Species Index

The Threatened Species Index (TSX) provides reliable and robust measures of change in the relative abundance of Australia's threatened and near-threatened species at national, state and regional levels. Understanding these changes in species populations is crucial for monitoring Australia's conservation progress and allows users to measure and report on the benefits of conservation investments, and to justify and design targeted management responses. Currently, the index is restricted to birds, plants and mammals, with new groups to be added in the near future.

The TSX does not hold data on the Mountain Pygmy-possum. More information on the TSX, including how to contribute threatened species monitoring data to the index, can be found on the TSX website.

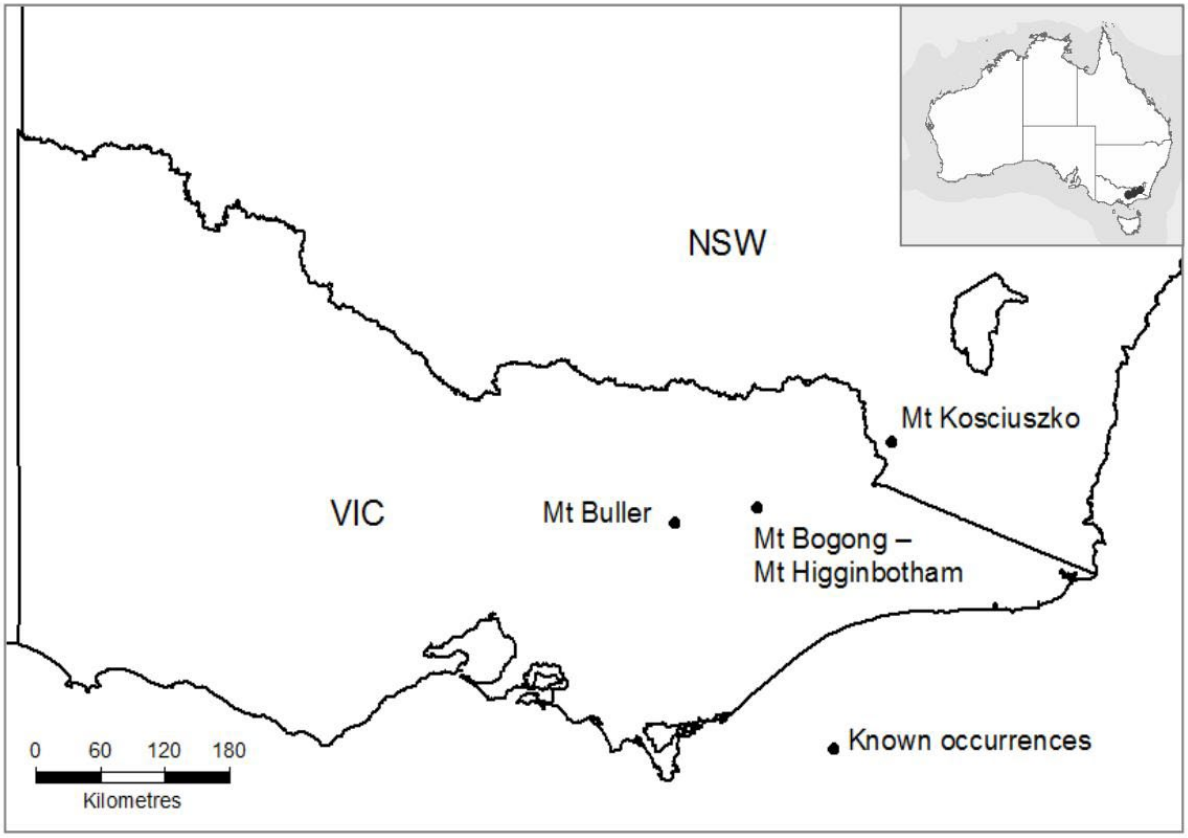
1.4 Distribution and abundance

The Mountain Pygmy-possum (*Burramys parvus)* is an Australian marsupial (Hawke et al. 2019; IUCN 2008), endemic to the Australian Alps IBRA bioregion (Broome 2001a; Department of Environment and Heritage (DEH) 2000; Shi et al. 2015). The species was first discovered as skeletal remains in 1895 within the southern highlands region of New South Wales (Broom 1895; NSW National Parks and Wildlife Service 2002), and was not found as a living specimen until 1966 when a population was discovered at Mount Hotham in Victoria (DELWP 2016). The Mountain Pygmy-possum's range is restricted to four populations within the alpine and sub-alpine zones (Broome 2008; NSW Scientific Committee 2009; Osborne et al. 2000). It is the only known Australian mammal to have a distribution entirely above the winter snow line at 1,200 m above sea level (DELWP 2020; Geiser & Broome 1991; Shi et al. 2015). Presently, populations are within three general geographic regions (Figure 1, Kosciuszko National Park (Broome et al. 2005; Broome et al. 2014; Schulz 2011; Schulz et al. 2012a, 2012b), Mount Bogong to Mount Higginbotham (including Mount Hotham (Broome 2001a)) and Mount Buller (DELWP 2016; Heinze et al. 2004; Mansergh et al. 1989), with two of the four populations occupying ski resort areas (Broome 2001b; NSW Office of Environment & Heritage 2022). The

Kosciuszko population is at the lowest elevation that can sustain the Mountain Pygmy-possum (Hawke et al. 2019). The populations in each of these regions are genetically distinct from one another (Osborne et al. 2000; Threatened Species Scientific Committee (TSSC) 2018).

The total population size of the Mountain Pygmy-possum has been estimated to be fewer than 2,600 individuals (Bates & Shi 2013; Osborne et al. 2000). Another study estimated that of the individuals present approximately 1,505 are females and 525 males (Smales 2013). Individuals exhibit up to 3 km movement between habitat patches (Broome 2001a), moving 500 m daily (Broome et al. 2013). The total occupancy area for the species is 10 km^2 (Cooper & Withers 2014).

Figure 1. Distribution of the Mountain Pygmy-possum in Australia.



Source: DELWP (2016).

Notes: Black indicates Mountain Pygmy-possum presence.

1.5 Habitat requirements

The habitat occupied by the Mountain Pygmy-possum is isolated and sparse (DELWP 2016, 2020), and limited to portions of the alpine and sub-alpine regions associated with shrubby heath vegetation and boulder patches (Heinze unpubl. data; DELWP 2016; Schulz et al. 2012a; Schulz et al. 2012b; Shi et al. 2015). A ground-dwelling species (NSW National Parks and Wildlife Service 2002), the Mountain Pygmy-possum prefers boulder fields (areas where boulders accumulate on or below mountain peaks) where Mountain Plum-pine (*Podocarpus lawrencei*) is dominant (NSW Office of Environment & Heritage 2022; Osborne et al. 2000; Shi et al. 2015) and where there are permanently flowing streams (Cooper & Withers 2014). The species selects microhabitats at higher elevations, where there are long periods of snow cover and where rocks are small in size with large cavities and multiple layers (Shi et al. 2015).

Mountain Pygmy-possum nest in boulder fields (Rosengren & Peterson 1989) where they are able to build nests that maintain a constant temperature during their hibernation period (Cooper & Withers

2014; NSW Scientific Committee 2009). Deeper boulder fields are preferred as the increased depth provides a more constant temperature (Shi et al. 2015)

Habitat use is partitioned according to sex, with females using better quality habitat, usually occurring at higher elevations (DELWP 2016, 2020). The lower evaluation areas generally occupied by males have less snow, fewer food resources and less insulated habitat (Broome 2001c; Heinze et al. 2004; Körtner & Geiser 1998; Mansergh 1988; Mansergh & Scotts 1990; Walter 1996). Males are able to successfully occupy these areas in part due to their different energy requirements and hibernation strategies (Broome 2001a).

1.6 Biology and ecology

The Mountain Pygmy-possum is a nocturnal marsupial with a forward-facing pouch and scaly prehensile tail (DELWP 2020; NSW National Parks and Wildlife Service 2002). It is the largest of the pygmy-possum species in Australia (Threatened Species Scientific Committee (TSSC) 2018) at an average weight of 40 grams (Broome 2001a; NSW National Parks and Wildlife Service 2002). Possums weighing 80 grams have been recorded (DELWP 2020). The Mountain Pygmy-possum pouch supports four young for 9-10 weeks (Heinze et al. 2004). Young are generally weaned between December and January (Mansergh & Broome 1994). Following weaning, young remain at their natal site for around a month before departing, and males tend to leave it earlier than females (DELWP 2020). Their reproductive cycle is annual, and individuals mature after a year (Broome 2001b). Males have a shorter lifespan than females, living up to five years, while females can live up to 12 years (DELWP 2016). Females rank above males within the species' social hierarchy (female resource polygyny), excluding males from good quality resources and habitat (Threatened Species Scientific Committee (TSSC) 2018).

To persist in an alpine environment, the Mountain Pygmy-possum has evolved to complete its reproduction, growth and independence within five months, which begins in spring (DELWP 2016). The onset of spring is associated with snow melt and the later emergence of the Bogong moth (*Agrotis infusa)*, which is the main prey item of the species (Broome 2001a; Gibson 2007; Mansergh et al. 1990; Smith & Broome 1992). The Mountain Pygmy-possum diet also consists of other invertebrates, seeds, berries, nectar and flowers (Gibson 2007; Hawke et al. 2019), which the species has been known to cache for consumption during hibernation (Cooper & Withers 2014; Heinze & Olejniczak 2000). After this five-month period of activity, Mountain Pygmy-possums have acquired just enough fat to begin their seven-month hibernation phase (or five months for juveniles) (Broome 2001a; Cooper & Withers 2014; DELWP 2016), which generally commences around June (Broome & Geiser 1995). During its hibernation, the species lowers its basal temperature from 36 °C to 2 °C, which it maintains for 5 to 20-day cycles (Geiser & Broome 1991; Shi et al. 2015). These cycles are considered "torpor bouts" (Geiser & Broome 1991), which provide the possum an opportunity to replenish water loss and return to physiological homeostasis (Cooper & Withers 2014).

1.7 Threats

The Mountain Pygmy-possum is threatened predominantly by habitat loss and fragmentation (Hawke et al. 2019; NESP Threatened Species Recovery Hub 2019; Smales 2013), with only disjointed patches of suitable habitat remaining (Smales 2013), creating a potential genetic bottleneck (Mitrovski et al. 2007). The loss of these few refuges will most likely result in the loss of the species. Habitat has been historically lost to road and ski resort development (Bates & Shi 2013; Hawke et al. 2019; Heinze & Olejniczak 2000; Threatened Species Scientific Committee (TSSC) 2018).

Climate change is another significant threat to the survival of Mountain Pygmy-possums (Cooper & Withers 2014; Gibson et al. 2018; Shi et al. 2015). The species is highly vulnerable to high temperatures

(Osborne et al. 2000), becoming hyperthermic at temperatures of 28 °C and above (Shi et al. 2015). Temperature increases influence snow depth and snow melt, which may cause the possums to emerge early from hibernation or increase the number and intensity of arousal during hibernation (Cooper & Withers 2014). Early emergence from hibernation may occur when in the Bogong moth population is not present, resulting in a resource scarcity for the possums (Bates & Shi 2013; Cooper & Withers 2014; Gibson et al. 2018). Climate change is also associated with increasingly frequent and intense fires, further reducing resource access (Gibson et al. 2018). These threats are exacerbated by invasive species, feral cats (*Felis catus*) and foxes (*Vulpes vulpes*), which prey on the Mountain Pygmy-possum (NESP Threatened Species Recovery Hub 2019). Invasive plant species such as clover and willow are also a threat, reducing habitat quality while providing habitat for rabbits (*Oryctolagus cuniculus*) and hares (*Lepus europeaus*), which support feral cat and fox populations (Threatened Species Scientific Committee (TSSC) 2018).

2 Existing monitoring

2.1 Overview of monitoring methods

Mountain Pygmy-possum habitat requirements are very specific. Their habitat is increasingly fragmented and declining in quality. The species' presence in an area is often determined using Elliott trapping, particularly in the preferred habitat of boulder fields, radio tracking, and signs that indicate the presence of Mountain Pygmy-possum in an area, including: nests, tracks (syndactyl hindfeet where their second and third toes are fused make tracks unique), scats, chewed Mountain Plum-pine seeds (a specific bite, cracking Mountain Plum-pine seeds transversely unlike other species, Bogong moth relative abundance), food sources and remains (DSEWPC 2011).

Key population monitoring indices of the Mountain Pygmy-possum include:

- population abundance
- population density
- area of occupancy
- area of suitable habitat
- prey species abundance.

2.2 Monitoring resources

Key resources with information for monitoring the Mountain Pygmy-possum include:

- The NESP Threatened Species Recovery Hub (2019) 'Threatened Species Strategy Year 3 scorecard for the Mountain Pygmy-possum' identifies data collection as an immediate priority for the species. Specific detail regarding the method of monitoring is not mentioned however it states that data collection will involve:
  - monitoring of population size
  - monitoring of trends in genetic heterogeneity
  - monitoring of key resources and habitat quality
  - monitoring of threats and management effectiveness
  - ongoing monitoring of Bogong moth abundance.
- The NESP Threatened Species Recovery Hub (2019) Threatened Species Strategy Year 3 scorecard and a study by Hawke et al. (2019) state that there has been annual monitoring by the NSW Office of Environment and Heritage conducted within Kosciuszko National Park. Specific detail has not been given, although monitoring has involved:
  - monitoring of the Pygmy-possum population size
  - monitoring of Bogong Moth relative abundance
  - monitoring of snow duration
  - genetic testing as part of the National Parks and Wildlife Services resort fund
  - camera trapping of cats and foxes (key predators of the species) from 2010 as part of Saving our Species program to monitor predator abundance
- The recovery plan for the Mountain Pygmy-possum (NSW National Parks and Wildlife Service 2002) discusses monitoring relevant to the Mountain Pygmy-possum that has taken place to date. This includes:
  - assessment of total possum population size
    - diet, hibernation, home range, survival and recruitment monitoring annually

at Mt Blue Cow
        - distribution mapping
        - genetic analysis using hair samples
    - habitat condition monitoring
        - five vegetation monitoring transects consisting of 20, 1 m x 1 m plots spaced at 5 m intervals. Plots were sampled three times.
        - photopoint images taken
        - annual seed productivity of the Mountain Plum-pine
    - Bogong moth relative abundance
        - aestivation sites monitored annually in November for 10 years
    - fox control and monitoring using baiting transects
- Mountain Pygmy-possum Action Statement (DELWP 2020)
    - trapping to investigate new populations
    - fire severity mapping
    - boulder field habitat feasibility study
    - habitat mapping
    - Bogong Moth survey
    - pest monitoring – foxes and cats
- National Recovery Plan for the Mountain Pygmy-possum (DELWP 2016)
    - annual population monitoring since 1981
        - populations size, change and dynamics (survival, sex-ratio, body weight, breeding condition)
        - genetic composition
    - habitat surveys – including snow duration, quality, impact by pest species and weed species
    - habitat mapping
    - mapping of fire severity
    - pest species monitoring – rabbit, fox, cat
    - attempts to discover new populations
    - diet monitoring
        - scat samples
        - Bogong moth abundance
        - Mountain Plum-pine seeds and fruits
    - climate change monitoring
    - citizen science, included in plan objectives,
- Recovery Plan for the Mountain Pygmy-possum on Mount Buller (Smales 2013)
    - long-term monitoring of distribution, relative abundance, biology and ecology
    - nine sites in 'Type 1 habitat' annually surveyed with live capture-mark-recapture techniques
    - habitat mapping
    - predator dietary assessment (scat and stomach sampling)
    - Bogong moth surveys using 'Trap design and surveys of bogon moths at Mount Buller' report

- Annual monitoring at Mt Buller, Mt Hotham, Mt Loch and the Bogong High Plains by Zoos Victoria (NESP Threatened Species Recovery Hub 2019)
- Survey Guidelines for Australia's threatened mammals (DSEWPC 2011)
  - hair sampling
  - Elliott trapping
  - four survey sites per 5 ha area should be used
  - sampling should occur during the warmer months
  - camera trapping
  - take consideration of segregation between sexes and migration

2.3 Survey methods

Physical trapping (using box traps, i.e. Elliott traps) alongside radio-tracking are the predominant methods used for monitoring Mountain Pygmy-possum populations (Heinze & Olejniczak 2000; Smales 2013). For instance, physical trapping of the Mountain Pygmy-possum has been conducted since 1970 for research purposes (NSW National Parks and Wildlife Service 2002). Direct observation can be problematic because the species is cryptic (Heinze & Olejniczak 2000; Smales 2013), so indirect observation is often preferred. Mountain Pygmy-possums hibernate, and monitoring the species from May to June should be avoided (Broome & Geiser 1995). Breeding season is optimal for conducting surveys (Broome et al. 2013). To maximise success, all surveys should be targeted in boulder field habitat (Broome et al. 2013) or alpine heathland (Department of Sustainability 2011). See below for a detailed discussion of the use of physical trapping, indirect observation, and radio-tracking of the Mountain Pygmy-possum.

2.3.1 Trapping

Physical capture of individual animals enables the surveyor to conduct health assessments, take biological material for genetic analysis and mark individuals so that capture-mark-recapture can be applied. Capture-mark-recapture is used to estimate a population's abundance, demographics and distribution. Elliott traps are a cage-style trap that is predominantly used in Australia. Elliott traps are designed as folding boxes that have a treadle release mechanism, they are available in three sizes (Freegard & Richter 2009). For Mountain Pygmy-possums it is advised that traps are sized 33 x 10 x 10 cm (Hawke et al. 2019; Shi et al. 2015), although size A or E can be used (DSEWPC 2011). Walnuts are an effective bait for the species (Broome et al. 2013; Department of Sustainability 2011; Hawke et al. 2019; Shi et al. 2015), other bait such as chocolate has been trialled and it is not as successful (Broome et al. 2013). To prevent possum distress, the traps should be lined, covered and they should be checked first thing on the morning after they have been set (Hawke et al. 2019; Shi et al. 2015). Trapping from December to January is not advised as this can impact juvenile survival (Broome et al. 2013). To maximise the success of trapping the species traps should be set for three consecutive nights (Hawke et al. 2019; Shi et al. 2015), a minimum of 10 traps should be set within a singular home range (Broome 2001b), equating to 25 traps at 5 m intervals (DSEWPC 2011). An overview of studies using traps to survey Mountain Pygmy-possum are outlined in Table 2.

Table 2. Methods overview of key studies using trapping surveys

Survey type	Study design	Survey effort	Location	Reference
Elliott trapping	▪ Type A Elliott aluminium live-capture traps were lined with Dacron batting, shielded with plastic bags ▪ Baited with walnuts	▪ Traps were set under 91 boulders for three consecutive nights ▪ 38 boulder units were selected ▪ Area surveyed 2400 km2	Kosciuszko National Park, NSW	(Shi et al. 2015)

Survey type	Study design	Survey effort	Location	Reference
Elliott trapping	▪ Traps were placed at 5-10 m intervals ▪ Traplines were placed within the bounds of boulder fields ▪ Scats also collected ▪ Walnuts used as bait ▪ Traps set for 3 or 4 consecutive days ▪ All trapped individuals were tagged with "fish lingering" aluminium ear tags	▪ Area surveyed 5 ha ▪ 199 traps used at Mt Cow ▪ 100 traps used at Charlotte Pass ▪ Annual trapping from December 1986 to 1988 and during March from 1986 to 1990 ▪ Additionally, trapping from 1996 to 1998	Mt Blue Cow and Charlotte Pass, NSW	(Broome 2001b)
Elliott trapping	▪ Elliott traps 33 x 10 x 10 cm ▪ Traps lined with Dacron batting and placed in a plastic bag ▪ Trapping over 3-4 nights ▪ Baited with walnuts ▪ Scat samples taken	▪ Area surveyed 40 km2 ▪ Northern population trapped from 2010 to 2014 ▪ Southern population trapped from 1994 to 2014 ▪ 1-4 transects ▪ 75-100 traps per site	Kosciuszko National Park, NSW	(Hawke et al. 2019)
Elliott trapping	▪ Type A Elliot traps ▪ Traps set in a grid pattern in four regions ▪ Ear tagged ▪ Tissue and hair samples taken	▪ Area surveyed 850 ha ▪ Annual trapping during spring from 1996 to 2013 ▪ 2919 trap nights	Mount Buller, Vic	(Weeks et al. 2017)
Elliott trapping	▪ Size A traps ▪ Baited with walnuts ▪ Radio-trapping also conducted	▪ 657 trap nights adjacent to soil pumps ▪ 108 trap nights on natural habitat ▪ Additional 408 and 350 trap nights after radio tracking	Happy Jacks Creek valley, NSW	(Schulz et al. 2012a)

2.3.2 Indirect observation

Direct observation of the Mountain Pygmy-possum is not always possible because of its cryptic behaviour (Heinze & Olejniczak 2000; Smales 2013). As such, the characteristic signs of Mountain Pygmy-possum presence are used as an alternative and can indicate range and provide an estimation of abundance. Sign-based survey methods include hair, scats and discarded food material (Table 3). Mountain Pygmy-possums leave characteristic bite marks on Mountain Plum-pine seeds when chewing. The marks are distinct for this species and they can be differentiated from the bite marks of other small mammal species (Shi et al. 2015).

Table 3. Methods overview of key studies using sign-based surveys

Survey type	Study design	Survey effort	Location	Reference
Sign-based	▪ Observations of chewed seeds recorded to determine habitat preference	▪ Area surveyed 2400 km^2 ▪ 38 boulder field units were surveyed	Kosciuszko National Park, NSW	(Shi et al. 2015)
Hair and tissue sampling	▪ Hair and tissue analysed using the Qiagen DNA plasmid kit then DNA was sequenced with a Promega fmol thermal cycle sequencing kit	▪ Area surveyed 10 km^2 ▪ 21 wild caught individuals from 5 sampling localities	Northern, central and southern Australian alps, NSW and Vic	(Osborne et al. 2000)
Scat sampling	▪ Traps baited with chocolate or walnut oil on the first night to prevent contamination of faecal samples ▪ Faecal samples from subsequent nights used when trap numbers low ▪ Relative abundance of food items in faeces determined	▪ Trapping and faecal-sample collection across the study area each spring from 1994 to 2011	Kosciuszko National Park, NSW	(Gibson et al. 2018)

2.3.3 Radio-tracking

Radio-tracking is useful for monitoring the movement, habitat preferences, home ranges and behaviour small mammals such as the Mountain Pygmy-possum (Table 4). Radio-collars are attached to individual possums, requiring their physical capture. Collars then transmit a radio frequency which is used to locate collared animals. As the Mountain Pygmy-possum is small in size, collars should not weigh more than 3 grams (Broome & Geiser 1995). A limiting factor to be considered when conducting surveys of the Mountain Pygmy-possum is the short battery life of the collars, a consequence of low temperatures in the alpine region (Broome & Geiser 1995).

Table 4. Methods overview of key studies using radio-tracking surveys

Survey type	Study design	Survey effort	Location	Reference
Temperature-sensitive radio-collars	▪ 4 females and 4 males captured, collared and released and tracked ▪ Trapped in April ▪	▪ Animals were tracked for several days manually ▪ Temperature data was automatically collected for 30s every hour	Mt Blue Cow, NSW	(Broome & Geiser 1995)
Radio-tracking	▪ Elliott aluminium live-capture traps were lined with Dacron batting, shielded with plastic bags ▪ Baited with walnuts ▪ Scats also collected ▪ Mouse style transmitters mounted on collar ▪ Collar made with heat-shrink and cable ties	▪ Trapping grids 1.5-2 ha in size ▪ Traps spaced at 5-10 m intervals ▪ 48 individuals radio-tracked during snow-free months ▪ 21 individuals tracked during winter ▪ Study conducted for 3 years ▪ Tracked for 2-3 weeks during snow-free months from April 1986- January 1989 ▪ Nest sites recorded every 1-2 days when snow-free and every 2-3 days during winter ▪ Night tracking 4 nights a week	Mt Blue Cow, NSW	(Broome 2001a)

2.3.4 Other survey methods

Other monitoring methods that have been used, but have not been widely implemented include:

- Camera trapping
- DNA hair sampling (Mitrovski et al. 2007)

Additional methods that may have future application include:

- Detection dogs
- Predator monitoring

3 Key agencies and organisations involved in the species research and recovery

Key agencies, organisations or individuals identified as previously, or currently actively involved in monitoring the Mountain Pygmy-possums include:

- North East Catchment Management Authority
- Zoos Victoria
- Goulburn Broken Catchment Management Authority
- Department of Planning, Industry and Environment
- Jerry Alexander, DEWLP
- Linda Broome, NSW NPWS
- Hajing Shi, UNSW

4 Survey guideline recommendations gathered from the literature

The literature review of monitoring methods for the Mountain Pygmy-possum has identified some key points to be addressed when developing species-specific guidelines. These points include:

- The presence and abundance of Mountain Pygmy-possums is often detected with a trapping grid using Elliott aluminium live-capture cage traps. (NESP Threatened Species Recovery Hub 2019).
- Indirect observation through signs of Mountain Pygmy-possum presence, includes nests, tracks (syndactyl hindfeet where their second and third toes are fused make tracks unique), scats, chewed Mountain Plum-pine seeds (specific bite, cracking Mountain Plum-pine seeds transversely unlike other species), Bogong moth relative abundance and possum remains. (NESP Threatened Species Recovery Hub 2019; NSW National Parks and Wildlife Service 2002; Shi et al. 2015).
- The Mountain Pygmy-possum is a ground-dwelling species, preferring boulder fields where Mountain Plum-pine (*Podocarpus lawrencei*) is dominant. Monitoring is focused in this habitat type.(NSW Office of Environment & Heritage 2022; Osborne et al. 2000; Shi et al. 2015).
- Vegetation and habitat mapping for suitable habitat may be useful in discerning areas of focus for future searches to better understand extent of occupancy.
- Threats to Mountain Pygmy-possum population persistence such as high temperatures, presence of predators (cats and foxes), presence of food sources (such as Bogong moths and Mountain Plum-pine) and snow duration should be monitored (Bates & Shi 2013; Cooper & Withers 2014; Gibson et al. 2018; NESP Threatened Species Recovery Hub 2019).

References

Bates, H & Shi, H 2013, *Australian endangered species: mountain pygmy-possum*, <https://theconversation.com/australian-endangered-species-mountain-pygmy-possum-13149>.

Broom, R 1895, 'On a new fossil mammal allied to *Hypsiprymnus* but resembling in some points the Plagiaulacidae', *Proceedings of the Linnean Society of N.S.W*, vol. 1 June 26, p. 11.

Broome, L, Dawson, M, Ford, F, Green, K, Little, D & McElhinney, N 2005, 'Re-assessment of mountain pygmy-possum *Burramys parvus* population size and distribution of habitat in Kosciuszko national park. ', Department of Environment and Conservation, Queanbeyan, NSW.

Broome, L, Ford, F, Dawson, M, Green, K, Little, D & McElhinney, N 2013, 'Re-assessment of mountain pygmy-possum '*Burramys parvus*' population size and distribution of habitat in Kosciuszko national park', *Australian Zoologist*, vol. 36, no. 4, pp. 381-403.

Broome, L, Ford, F, Dawson, M, Green, K, Little, D & McElhinney, N 2014, 'Re-assessment of Mountain Pygmy-possum *Burramys parvus* population size and distribution of habitat in Kosciuszko National Park', *Australian Zoologist*, vol. 36, no. 4, pp. 381-403.

Broome, LS 2001a, 'Density, home range, seasonal movements and habitat use of the mountain pygmy-possum *Burramys parvus* (Marsupialia: Burramyidae) at Mount Blue Cow, Kosciuszko national park', *Austral Ecology*, vol. 26, no. 3, pp. 275-292.

Broome, LS 2001b, 'Intersite differences in population demography of Mountain Pygmy-possums *Burramys parvus* Broom (1986–1998): implications for metapopulation conservation and ski resorts in Koskiuszko National Park, Australia', *Biological Conservation*, vol. 102, no. 3, 2001/12/01/, pp. 309-323.

Broome, LS 2001c, 'Seasonal activity, home range and habitat use of the mountain pygmy-possum *Burramys parvus* (Marsupialia: Burramyidae) at Mt Blue Cow, Kosciuszko national park', *Austral Ecology*, vol. 26, pp. 275-292.

Broome, LS 2008, 'Mountain pygmy-possum', in S Van Dyke & R Strahan (eds), *The mammals of Australia 3rd edition*, Reed New Holland, Australia, pp. 210-212.

Broome, LS & Geiser, F 1995, 'Hibernation in free-living mountain pygmy-possums, *Burramys parvus* (Marsupialia, Burramyidae)', *Australian Journal of Zoology*, vol. 43, no. 4, pp. 373-379.

Cooper, C & Withers, P 2014, 'Ecological consequences of temperature regulation: why might the mountain pygmy possum *Burramys parvus* need to hibernate near underground streams?', *Temperature*, vol. 1, no. 1, pp. 32-36.

DELWP 2016, *National Recovery Plan for the Mountain Pygmy-possum Burramys parvus*, Department of Environment, Land, Water and Planning, Canberra, ACT.

DELWP 2020, *Mountain pygmy-possum Burramys parvus*, Action statement No. 2. flora and fauna guarantee act 1988, Department of Environment, Land, Water and Planning, Canberra, ACT.

Department of Environment and Heritage (DEH) 2000, *Revision of the Interim Biogeographic Regionalisation of Australia (IBRA) and the Development of Version 5.1. - Summary Report*, Department of the Environment and Heritage, Canberra, ACT.

Department of Sustainability, Environment, Water, Population and Communities 2011, *Survey guidelines for Australia's threatened mammals. Guidelines for detecting mammals listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999*, Department of Sustainability, Environment, Water, Population and Communities, Canberra.

DSEWPC 2011, *Survey guidelines for Australia's threatened mammals*, Guidelines for detecting mammals listed as threatened under the *Environment Protection and Biodiversity Conservation Act 1999*, Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Freegard, C & Richter, V 2009, *Elliott traps for live capture of terrestrial vertebrates*, 9.1 edn, Western Australia.

Geiser, F & Broome, LS 1991, 'Hibernation in the mountain pygmy possum *Burramys parvus* (Marsupialia)', *Journal of Zoology*, vol. 223, no. 4, pp. 593-602.

Gibson, R 2007, 'The role of diet in driving population dynamics of the mountain pygmy-possum, *Burramys parvus*, in Kosciuszko national park, NSW', Honours thesis thesis, Australian National University, Canberra, ACT.

Gibson, RK, Broome, L & Hutchinson, MF 2018, 'Susceptibility to climate change via effects on food resources: the feeding ecology of the endangered mountain pygmy-possum (*Burramys parvus*)', *Wildlife Research*, vol. 45, no. 6, pp. 539-550.

Hawke, T, Bates, H, Hand, S, Archer, M & Broome, L 2019, 'Dietary analysis of an uncharacteristic population of the mountain pygmy-possum (*Burramys parvus*) in the Kosciuszko national park, New South Wales, Australia', *PeerJ*, vol. 2019, no. 1, pp. e6307-e6307.

Heinze, D, Broome, L & Mansergh, I 2004, 'A review of the ecology and conservation of the mountain pygmy-possum *Burramys parvus*', in RL Goldingay & SM Jackson (eds), *The Biology of Australian Possums and Gliders*, Surrey Beatty & Sons, Chipping Norton, pp. 254-267.

Heinze, DA & Olejniczak, AM 2000, 'First observations of the mountain pygmy-possum *Burramys parvus* nesting in the wild', *Australian Mammalogy*, vol. 22, no. 1, pp. 65-67.

IUCN 2008, *IUCN Red List mountain pygmy possum*, <https://www.iucnredlist.org/species/3339/9775825>.

Körtner, G & Geiser, F 1998, 'Ecology of natural hibernation in the marsupial mountain pygmy-possum (*Burramys parvus*)', *Oecologia*, vol. 113, no. 2, pp. 170-178.

Mansergh, I 1988, 'The conservation and management of the mountain pygmy-possum (*Burramys parvus*) in Victoria with reference to New South Wales', PhD thesis, PhD thesis, La Trobe University, Melbourne.

Mansergh, I, Baxter, B, Scotts, D, Brady, T & Jolley, D 1990, 'Diet of the Mountain Pygmy-possum, *Burramys parvus* (Marsupialia: Burramyidae) and other small mammals in the alpine environment at Mt Higginbotham, Victoria', *Australian Mammalogy*, vol. 13, no. 2, pp. 167-177.

Mansergh, I & Broome, L 1994, *The mountain pygmy-possum of the Australian alps*, New South Wales University Press, Kensington, NSW.

Mansergh, I, Kelly, P & Scotts, D 1989, *Management strategy and guidelines for the conservation of the mountain pygmy-possum, Burramys parvus, in Victoria.* , Technical report series number 66, Arthur Rylah Institute for Environmental Research, Heidelberg, Victoria.

Mansergh, IM & Scotts, DJ 1990, 'Aspects of the life history and breeding biology of the Mountain Pygmy-possum (*Burramys parvus*), (Marsupialia: Burramyidae) in alpine Victoria', *Australian Mammalogy*, vol. 13, no. 2, pp. 179-191.

Mitrovski, P, Heinze, DA, Broome, L, Hoffmann, AA & Weeks, AR 2007, 'High levels of variation despite genetic fragmentation in populations of the endangered mountain pygmy-possum, *Burramys parvus*, in alpine Australia', *Molecular Ecology*, vol. 16, no. 1, pp. 75-87.

NESP Threatened Species Recovery Hub 2019, *Threatened species strategy year 3 scorecard*, National Environmental Science Program Threatened Species Research Hub, Canberra, ACT.

NSW National Parks and Wildlife Service 2002, *Approved recovery plan for the mountain pygmy-possum, Burramys parvus.*, Hurstville, NSW.

NSW Office of Environment & Heritage 2022, *Mountain pygmy-possum - profile*, <https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10114 >.

NSW Scientific Committee 2009, 'Mountain pygmy-possum *Burramys parvus* review of current information in NSW July 2009.', NSW Scientific Committee, Hurstville, NSW.

Osborne, MJ, Norman, JA, Christidis, L & Murray, ND 2000, 'Genetic distinctness of isolated populations of an endangered marsupial, the mountain pygmy-possum, *Burramys parvus*', *Molecular Ecology*, vol. 9, no. 5, pp. 609-613.

Rosengren, NJ & Peterson, JA 1989, 'Heritage values and the geological and geomorphological significance of the Australian alpine zone', in R Good (ed.), *The scientific significance of the Australian alps*, Australian Academy of Science, Canberra, ACT, pp. 187-204.

Schulz, M 2011, *Targeted Mountain Pygmy-possum survey, Happy Jacks Valley, January 2011. Consultants Report to the National Parks and Wildlife Service*, Tumut.

Schulz, M, Wilks, G & Broome, L 2012a, 'Occupancy of spoil dumps by the mountain pygmy-possum *Burramys parvus* in Kosciuszko national park', *Ecological Management & Restoration*, vol. 13, no. 3, pp. 290-296.

Schulz, M, Wilks, G & Broome, L 2012b, 'An uncharacteristic new population of the Mountain Pygmy-possum *Burramys parvus* in New South Wales', *Australian Zoologist*, vol. 36, no. 1, pp. 22-28.

Shi, H, Paull, D, Broome, L & Bates, H 2015, 'Microhabitat use by mountain pygmy-possum (*Burramys parvus*): Implications for the conservation of small mammals in alpine environments', *Austral Ecology*, vol. 40, no. 5, pp. 528-536.

Smales, I 2013, *Recovery plan for the mountain pygmy possum Burramys parvus on Mount Buller, Victoria 2011 to 2016*, ARMB, BP Ltd.

Smith, AP & Broome, L 1992, 'The effects of season, sex and habitat on the diet of the mountain pygmy-possum (*Burramys parvus*)', *Wildlife Research*, vol. 19, no. 6, pp. 755-767.

Threatened Species Scientific Committee (TSSC) 2018, *Conservation Advice on Burramys parvus (Mountain Pygmy-Possum)*, Threatened Species Scientific Committee (TSSC), W Department of the Environment, Heritage and the Arts, Canberra.

Walter, M 1996, 'The ecology of hibernating mountain pygmy-possums (*Burramys parvus*) in Kosciusko national park', Ecology Research Group, Honours thesis thesis, University of Canberra, Canberra, ACT.

Weeks, AR, Heinze, D, Perrin, L, Stoklosa, J, Hoffmann, AA, van Rooyen, A, Kelly, T & Mansergh, I 2017, 'Genetic rescue increases fitness and aids rapid recovery of an endangered marsupial population', *Nat Commun*, vol. 8, no. 1, Oct 20, p. 1071.

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