Fat-tailed dunnarts (Sminthopsis crassicaudata) of the Werribee grasslands: a case study of a species in decline

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Fat-tailed dunnarts (*Sminthopsis crassicaudata*) of the Werribee grasslands: a case study of a species in decline

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ABSTRACT

Grasslands are among the most endangered ecosystems, with <1% of Victorian grasslands remaining. Extinctions of many grassland fauna species have occurred since European settlement due to loss of suitable habitat, and dramatic range reductions continue for those that still exist. Fat-tailed dunnarts (*Sminthopsis crassicaudata*) are the only small ground-dwelling marsupial known to persist in Victorian grassland habitats. The last long-term targeted surveys for this species were conducted in Victoria in the 1970s. Incidental findings from more recent short-term targeted and non-targeted surveys in the same area suggest a decline. We performed direct targeted surveys for fat-tailed dunnarts at the 1970s survey site over a 12-month period in 2019 and found no evidence of fat-tailed dunnart presence. The species is classified as Near Threatened in the state and Least Concern internationally. Our work highlights the importance of targeted surveys to assess the stability of this species across Victoria, and the need for collection of long-term data to better identify population declines.

Keywords: active searching, basalt grasslands, conservation, dasyurid, marsupial, small mammal, tile surveys, Western Treatment Plant.

Introduction

Since European settlement, the grasslands of south-eastern Australia have suffered extensive landscape modification through cropping and livestock production and are now one of the most threatened terrestrial ecosystems in the country (Department of Conservation and Environment (DCE) 1990, 1992; Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) 2011). Although grasslands once covered 30% of Victoria, there is now <1% of the original habitat remaining (Lunt *et al.* 1998), with 55% of the state being freehold agricultural land (State of Victoria (Agriculture Victoria) 2020).

The main cause of decline for grassland species is the loss of suitable habitat (McDougall and Kirkpatrick 1994; Williams and Morgan 2015). Accordingly, 26 of the 30 Australian mammals to have become extinct after European settlement were entirely or somewhat reliant on grassland ecosystems (Lunt *et al.* 1998; Gott *et al.* 2015). The fat-tailed dunnart (*Sminthopsis crassicaudata*) is renowned for being the only small ground-dwelling marsupial persisting in basalt grassland ecosystems across Victoria (Lunt *et al.* 1998), while tolerating degraded landscapes (Menkhorst 1995; Morton 1995; Antos and Williams 2015).

In Victoria, fat-tailed dunnart populations are fragmented across western Victorian grasslands in public and (predominantly) private properties (Menkhorst 1995), typically nesting under rocks, logs, or in deep soil cracks (Morton 1978*a*, 1978*b*, 1978*c*, 1995). They are dependent on habitat consisting of intertussock spaces, which are a distinguishable characteristic of Australian lowland temperate grasslands (Williams and Morgan 2015).

Although it is broadly accepted that fat-tailed dunnart populations are stable (Hadden 2002; Michael *et al.* 2003; Menkhorst and Knight 2011; Homan 2012), the last targeted surveys in Victoria were conducted almost five decades ago in Werribee at The Western Treatment Plant (WTP) (Morton 1978*a*, 1978*b*, 1978*c*). The WTP is presumed to support the largest known densities of fat-tailed dunnarts in greater Melbourne (Beardsell 1991) and is considered one of the most important sites in Victoria for the species (Schulz 1987; Beardsell 1991; Peake and Carr 1994; Organ 2003; Schmidt 2012). Hundreds of individuals were recorded across this area in the 1970s and 1980s (Morton 1978*a*, 1978*b*, 1978*c*; Schulz 1987), despite it being grazed by cattle and dominated by introduced flora (Morton 1978*a*).

The state conservation status of the species is based on the results of these surveys in combination with opportunistic records, subsequently being classified as Near Threatened (State of Victoria (Department of Sustainability and Environment) (DSE) 2013). However, findings from short-term targeted and non-targeted surveys since the 1990s onward suggest a dramatic population decline (Table 1). Current and accurate population estimates of this species are unknown. Due to known changes in suitable habitat at WTP since the last major survey effort over 40 years ago, our study sought to resurvey this site for fat-tailed dunnarts. Changes in this population may indicate more widespread issues that necessitate subsequent changes in the conservation status of the species and may highlight the need to implement targeted surveys to assess the stability of this species across Victoria.

Table 1. Records of fat-tailed dunnarts at Western Treatment Plant (Werribee, Victoria).

Survey period	Survey technique and effort	No. of dunnarts	Source	Location at WTP
1972–1976	Active searching (350 rocks × 48 surveys = 16 800 rocks)	482	Morton (1978*a*)[A]	Site 1 (McIntosh's Paddock)
1972–1973	275 eastern barn owl (*Tyto delicatula*) pellets dissected (12 prey items out of 952 = 1.3%)	12	Morton (1975)[A]	Not reported
1979–1980	Unknown number of eastern barn owl (*Tyto delicatula*) pellets dissected (11 prey items out of 527 = 2%)	11	Baker-Gabb (1984)	Not reported
Feb–Mar 1987	Active searching and spotlighting (44 h)	133	Schulz (1987)[B]	Site 1 (McIntosh's Paddock) and paddocks within 13 km
Nov 1988–Jan 1989	Pitfalls (900 trap-nights)	15	Coulson (1990)[C]	Site 1 (McIntosh's Paddock)
9–21 Nov 1994	Active searching (12.5 h) Spotlighting (2.5 h)	0	Peake and Carr (1994)[D] *Ecology Australia*	Site 1 (McIntosh's Paddock)
8–14 Mar 2002	Active searching (70 h)	0	Cropper (2002)[D] *Botanicus Australia*	Site 1 (McIntosh's Paddock) and paddocks within 5 km
25 Sep 2002–9 Jun 2003	Pitfalls (212 trap-nights) Active searching (44 h) Elliot traps (100 trap-nights) Tiles (82 tiles × 11 nights = 902 tiles) Hair funnel traps (756 nights) Spotlighting (51 h)	10	Organ (2003)[B] *Biosis*	Site 1 (McIntosh's Paddock) and paddocks within 5 km
10 Jun–30 Sep 2005	Active searching (60 h)	5	Organ (2006)[A] *Ecology Partners*	Paddocks within 3 km of Site 1 (McIntosh's Paddock)
2008	Opportunistic specimen located	1 deceased	W. Steele, pers. comm. (2019) *Melbourne Water*	Not reported
2008–2019	498 eastern barn owl (*Tyto delicatula*) pellets dissected (0 prey items out of 320 = 0%)	0	W. Steele, pers. comm. (2020) *Melbourne Water*	Site 1 (McIntosh's Paddock)
Oct 2010–Jan 2011	Tiles (1100 tiles × 4 nights = 4400 tiles) Active searching (33.5 h)	6	Schmidt (2012)[B] *Ecology Australia*	Paddocks within 3 km of Site 1 (McIntosh's Paddock)
Jan–Dec 2019	Tiles (180 tiles × 12 months = 2160 tiles) Active searching (250 rocks × 12 surveys = 3000 rocks)	0	This study[A]	Site 1 (McIntosh's Paddock)

Active searching involves checking under rocks, logs and debris for sheltering animals.
[A]Targeted *Sminthopsis crassicaudata* survey.
[B]Fauna survey.
[C]Targeted *Delma impar* survey.
[D]Flora and fauna survey.

Materials and methods

From January to December 2019 we performed targeted surveys for fat-tailed dunnarts at Werribee WTP, at the same site that was the focus of the last targeted surveys for the species in the 1970s (37°57′S, 144°34′E) (Morton 1978*a*, 1978*b*, 1978*c*). Morton's surveys were performed across four sites at the WTP that are located within a 4.5 km radius, and were each ~2 km from each other (Fig. 1; Morton 1978*a*). We revisited each site to find that Site 1 (McIntosh's Paddock) was the only remaining site of the four suitable for surveying. Between 2000 and 2013, Sites 2 and 4 had been leased for agricultural use (stripped of all rocks and cropped) and Site 3 had been stripped of rocks for the construction of a large concrete slab, truck depot and grain silos. Site 1 was grazed until ~2006 but was otherwise relatively undisturbed. We searched for other suitable sites but found very few areas where surface basalt rock had not been cleared, or what remained was too deeply embedded to provide suitable habitat for fat-tailed dunnarts. This substantial loss of habitat within 4.5 km indicated that any remaining fat-tailed dunnarts would likely be occupying the only suitable habitat at Site 1. Morton (1978*a*) recorded that 90% of the 349 rocks at Site 1 could be overturned for surveying, therefore ~315 rocks were surveyed in his study. Rocks that were not able to be lifted by three people together were excluded in our study due to both the safety risk to surveyors and the increased crush risk for animals. We located 250 rocks to survey and numbered each to allow ease of surveying and ensure none were missed at each survey. We suspect that displacement and soil concealment of rocks over time, along with the possibility of Morton including rocks smaller or larger than those we included, accounted for the variation in total rocks surveyed.

We additionally laid a total of 180 terracotta roof tiles (265 mm × 165 mm) as artificial shelter along five transect lines to increase our survey effort (Fig. 1). Roof tiles were laid six months prior to commencement of the first survey to allow adequate time for occupancy. Surveys were then conducted one day per month for 12 months, with the aim of identifying fat-tailed dunnart presence including individuals, scats or nests. Other survey methods were not utilised due to reported poor trapping success with Elliot traps (Morton 1978*a*) and the physical limitations of the environment for the installation of pitfall traps (heavily embedded basalt rocks underlying the top layer of soil on the site).

Results

No evidence of fat-tailed dunnart presence was found at WTP, including deceased or live animals, their scats or nests, over the 1-year survey period, with a total of 2160 tiles and 3000 rocks surveyed during this period.

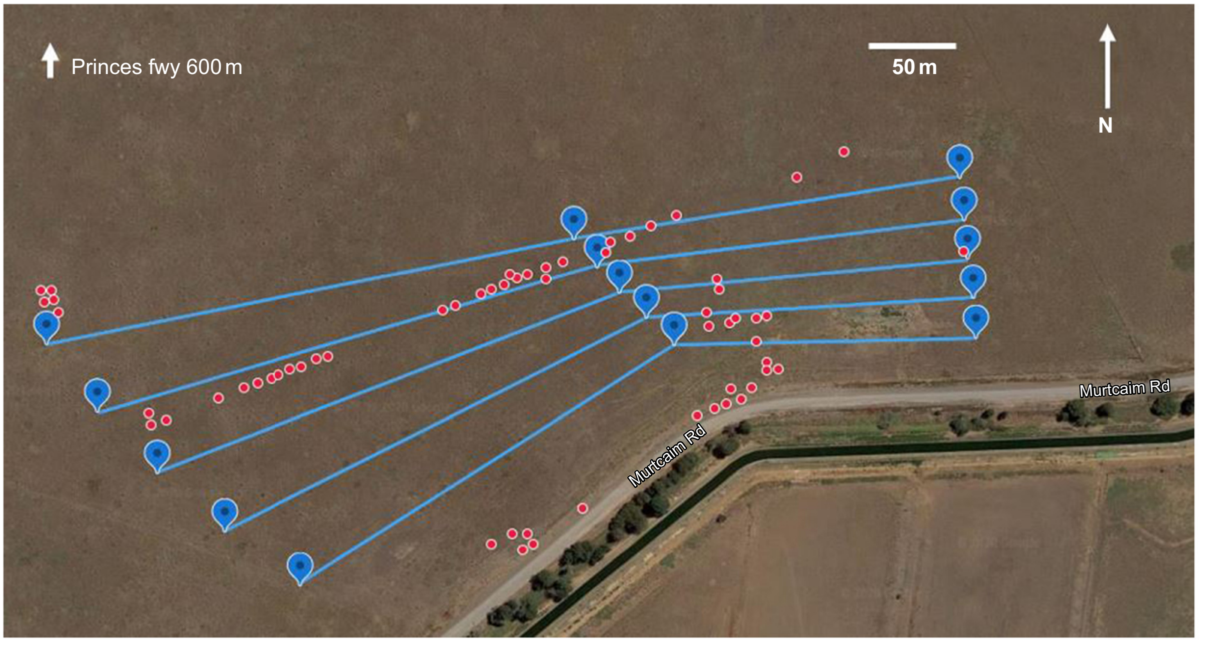

Fig. 1. Map illustrating locations of rocks under which Morton (1978*a*, 1978*b*, 1978*c*) located fat-tailed dunnarts (red circles) at Site 1, and tile transects of this study (blue lines). Figure modified from Morton (1976) and Google Earth, Maxar Technologies, 2020.

Discussion

Morton (1978*a*) surveyed between 1972 and 1976, recording over 700 fat-tailed dunnart captures (of 482 individuals) across four sites at WTP, with an average monthly capture rate at Site 1 (Fig. 1) ranging between 17 and 89 captures (Morton 1978*b*) (Table 1). In stark contrast, we found no traces of fat-tailed dunnart presence (individuals, scat or nests) during our 12-month survey, despite performing twice the monthly survey effort that Morton conducted at this site. Recent short-term targeted and non-targeted surveys in the same area suggest a population decline (Table 1). Further evidence for population decline comes from the lack of presence of fat-tailed dunnart remains in regurgitated Eastern barn owl (*Tyto delicatula*) pellets. Morton (1975) and Baker-Gabb (1984) found that fat-tailed dunnart remains represented ≤2% of prey items in owl pellets at WTP, and W. Steele (pers. comm.) recorded no dunnart remains in 496 pellets collected between 2008 and 2019. In Australia, barn owls predominantly feed on invasive house mice (*Mus musculus*) when this species is abundant (Morton 1975), though will eat a variety of prey items when rodents are less prevalent (Morton and Martin 1979). That said, while this non-invasive survey method can be used for determining presence or absence of small mammal species, it is not reliable for establishing population estimates. These findings contribute to a concerning perspective on what is supposedly the most significant population of this species in Victoria.

There are a number of possible explanations for why fat-tailed dunnart presence has declined at WTP. Firstly, loss of appropriate habitat caused by biomass accumulation may be a cause for concern. Due to their reliance on intertussock spaces, livestock grazing may in fact favour the species (Morton 1976; Morgan 2015) in the absence of fire regimes that would normally limit biomass accumulation. At the time of Morton's surveys, WTP was grazed by cattle and the landscape was dominated by introduced flora (Morton 1978*a*). In the ~50 years since Morton's study there have been numerous changes to this landscape. Livestock was removed from Site 1 in ~2006, which means grazing has not been a method of biomass reduction for ~14 years. Presumably due to increasingly limited appropriate climatic windows for fuel reduction burning, the last time this landscape was burnt was prior to its management by Melbourne Water, more than 70 years ago (W. Steele, pers. comm.). Absence of fire and/or (if appropriate fire regimes are unable to be implemented) grazing leads to biomass accumulation and loss of intertussock spaces (Morgan 2015) used for movement, nesting, foraging and detection of potential predators (Marchant and Higgins 1993). Morton (1978*a*) recorded the grass to be highest (60 cm) in winter, whereas we observed the site to now have invasive species (predominantly *Phalaris* sp.) as tall as 1.5 m (E. Scicluna, pers. obs.), indicating structural change of the habitat.

Secondly, loss of habitat due to construction and cropping is another concern for this population. Between 2000 and 2013, Sites 2, 3 and 4 were ploughed and levelled (with rocky habitat removed), cropped, or impacted by the construction of a grain silo and truck depot. Given that the last observations of fat-tailed dunnarts were made in 2010 (Schmidt 2012), these large habitat disturbances are likely to have had a negative impact on the population.

Thirdly, ongoing predation pressure from foxes and cats on fat-tailed dunnart populations is unlikely to be negligible, considering the widespread impacts of these invasive species on native Australian fauna (Abbott *et al.* 2014). Although Melbourne Water does have fox and cat control measures in place at WTP, no baiting or trapping has been undertaken across the dry grasslands (W. Steele, personal communication).

The fourth potential reason for this population's decline is climatic variation. The effects of rainfall on dasyurid marsupial abundance varies between species, with some studies finding increases in some species following rain (Finlayson 1933; Denny 1975) and decreases recorded in others (Woolley 1984). Fat-tailed dunnart populations do experience fluctuations, but they are not currently categorised as a 'boom–bust' species driven by rainfall events. Morton (1978*b*, 1978*c*) recorded capturing most fat-tailed dunnarts at WTP in April–July (prior to breeding), and although breeding appeared to be timed so that weaning aligns with high invertebrate abundance, there was minimal evidence to suggest a correlation with rainfall or invertebrate abundance with capture rates. Read (1984) also found no relationship between fat-tailed dunnart population size and rainfall or vegetation cover.

Conclusion

Fat-tailed dunnarts occur in lowland regions of western Victoria, including grasslands, grassy woodlands and shrublands; however, the vast majority of the Victorian population persists on farmland (Menkhorst 1995). Literature discussing the abundance and conservation status distribution of fat-tailed dunnarts often refers to Morton (1976, 1978*a*, 1978*b*, 1978*c*) and the large population at WTP; however, given that these surveys were conducted just short of 50 years ago, we emphasise caution when referencing historical surveys, particularly in the current climate of rapidly evolving ecological modification.

We highlight the need for future state-wide surveys to assess the stability of other fat-tailed dunnart populations across Victoria, as widespread decline may have severe implications for long-term species persistence. Although they have been known to tolerate degraded landscapes, reliance on agricultural land to support persistence of fat-tailed dunnarts in Victoria is far from ideal.

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Data availability. The data that support this study will be shared upon reasonable request to the corresponding author.

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