# Survey and monitoring guidelines for the Sandhill Dunnart (*Sminthopsis psammophila*) in Western Australia

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# Contents

# Introduction

The Great Victoria Desert Biodiversity Trust was established by the Tropicana Joint Venture as a part of its offsets strategy for the Tropicana Gold Mine in Western Australia (GVDBT 2014). The Trust aims to increase the availability of knowledge to researchers, industry, government and the community to improve outcomes for threatened species and conserve biodiversity and ecological function across the Great Victoria Desert (GVDBT 2014).

In 2014, the Trust held workshops with scientific experts, non-government organisations, industry representatives and government agencies to examine existing knowledge and set priorities for threatened species. One of these workshops focused on the sandhill dunnart (*Sminthopsis psammophila*). Several research and on-ground management priorities were identified (GVDBT 2015) with the aim to conserve viable populations of the sandhill dunnart in the Great Victoria Desert of Western Australia.

In Western Australia, there is little understanding of the influence of threatening processes (or interactions among these) on sandhill dunnart populations. This is exacerbated by a lack of knowledge of their ecology, biology and habitat requirements (Robinson *et al.* 2008; Woinarski *et al.* 2014). In South Australia, comprehensive surveys and ecological studies (McLean 2015; Moseby 2013; Moseby *et al.* 2016; Read *et al.* 2015; Ward 2009; Ward *et al.* 2008; Way 2008) have indicated that the sandhill dunnart is difficult to detect, even in areas of apparently suitable habitat (Moseby *et al.* 2016; Read *et al.* 2015).

Surveys, ecological studies and impact assessments have been conducted in the Great Victoria Desert area of Western Australia (Brennan *et al.* 2012; Burbidge *et al.* 1976; Ecologia 2009b; Gaikhorst and Lambert 2001, 2002, 2003a, b, c, 2004, 2006, 2007, 2008, 2009a; Gaikhorst and Lambert 2009b; GHD 2010; Martinick 1986; Morris and Rice 1981; Ninox Wildlife Consulting 2010; Outback Ecology 2014; Pearson and Robinson 1990; Turpin 2015b, c; Turpin and Lloyd 2014; Vimy Resources Limited 2015), but the data have not previously been collated or analysed to inform future surveys and monitoring programs.

This document forms part of a project to: review and collate existing information on the distribution, ecology, biology and habitat requirements of the sandhill dunnart; and develop standardised survey and monitoring protocols to maximise the value of the information collected during future surveys in Western Australia.

# Description, biology and ecology

## DESCRIPTION

The sandhill dunnart (*Sminthopsis psammophila*, Spencer 1895) is the second largest of the 19 species of *Sminthopsis*, reaching 25 to 55 g at maturity (Pearson and Churchill 2008). It is distinguished from other dunnarts by the combination of dark eye rings, large ears, a dark forehead and a tapering tail that is pale grey above and dark grey below, with a crest of stiff black hairs on the distal portion (Archer 1981). The head-body length is 85-114 mm and the tail length is 107-128 mm (Pearson and Churchill 2008). Identification guides are provided in Appendix 1. Tracks are quadruped with a gait of 60-80 mm and a foot length of approximately 22-26 mm (see Ward *et al.* 2008; Plate 2).

## DISTRIBUTION

The holotype of the sandhill dunnart was captured in the Northern Territory by C.E. Cowle between Kurtitina Well and Uluru (Figure 1), near Lake Amadeus in 1894 (Spencer 1896). There have been no other records of live animals in the Northern Territory, but remains have been found in owl pellets collected from caves at the base of Uluru (Archer 1981; Parker 1973).

Three extant populations are currently known (Figure 1):

1. The south-western Great Victoria Desert in Western Australia
2. Yellabinna Regional Reserve in the south-eastern Great Victoria Desert in South Australia; and
3. Eyre Peninsula in South Australia.

Genetic similarity suggests that the three populations were joined historically (Gaikhorst *et al.* submitted).


**Figure 1 Generalised distribution of the sandhill dunnart, modified from Van Dyck *et al.* (2013). NT = Northern Territory, GVD = Great Victoria Desert, Western Australia, Y = Yellabinna Regional Reserve, South Australia and EY = Eyre Peninsula, South Australia.**

## STATUS, THREATS AND KNOWLEDGE GAPS

In Western Australia, the sandhill dunnart is listed as Threatened (Endangered) due to the following estimates (Robinson *et al.* 2008; Woinarski *et al.* 2014):

- an area of occupancy < 500 $km^2$
- an extent of occurrence < 5,000 $km^2$
- all individuals known from < six locations
- a population of < 2,500 mature individuals
- a range decline of > 20% over the last five years, and
- a continuing decline in range.

Since the above assessment, additional information collected up to March 2016 shows that the sandhill dunnart has been detected in 15 locations in a 4,674 $km^2$ area using concave hull polygon (Department of Parks and Wildlife 2016).

The sandhill dunnart is believed to be threatened by predation by feral cats and foxes, inappropriate fire regimes, habitat loss and fragmentation, introduced flora and introduced herbivores (Churchill 2001a). Remains of sandhill dunnarts have recently been found in feral cat scats in the Great Victoria Desert of Western Australia (Turpin 2015c). There are substantial gaps in our knowledge of the specie's biology, distribution, habitat requirements and threatening processes, especially the impact of fire and feral animals (Churchill 2001a).

### DIET

Sandhill dunnarts are primarily insectivorous (Pearson and Churchill 2008), although the occasional small mammal or reptile is also consumed (D. Pearson pers. comm.). The invertebrates found in analysed faecal samples include ants, beetles, spiders, grasshoppers, termites, wasps and centipedes (Pearson and Churchill 2008). Scats collected from five sandhill dunnarts in the Great Victoria Desert of Western Australia contained predominantly (40-80%) ants (especially *Camponotis* sp.) and termites (Turpin 2015c).

### REPRODUCTION

Based on a study of a captive population at Perth Zoo, Lambert *et al.* (2011) classified the sandhill dunnart as having Life Strategy V (after Lee *et al.* (1982) and Krajewski *et al.* (2000)). Females are polyoestrus with 22-23 days between cycles. Males and females reached sexual maturity at 8-11 months and males were recorded living for more than one year.

Field studies have recorded mating in August and September, pouch young in September and October and juveniles emerging in December and January (Churchill 2001b). Females usually produce a single litter each year, but may produce a second litter during good seasons (Churchill 2001b). Alternatively, breeding may be delayed or reduced in duration in response to limited food resources resulting from low rainfall (McLean 2015).

Females have eight teats and up to eight pouch young per female have been recorded both in captivity and the wild (Churchill 2001b; Lambert *et al.* 2011; McLean 2015). In captivity, the gestation period was 16-19 days and young were in the pouch for approximately 45 days before starting to wean (Lambert *et al.* 2011). Field bservations of females with distended nipples, but without pouch young (in October), suggested young may be deposited in a nest at that time of year (Gaikhorst and Lambert 2014). Detailed information on reproduction can be found in Gaikhorst and Lambert (2014).

### HABITAT

#### South Australia

In South Australia, sandhill dunnarts occur in open mallee (*Eucalytpus oleosa* and *E. socialis*) habitats with an understory of *Triodia* sp. hummocks and a diverse range of shrubs like *Acacia* sp. and *Hakea* sp. (Churchill 2001b; Ward 2009; Ward *et al.* 2008). The species has been captured in habitats with sand dunes 5-30 m high in association with 10-70% cover of spinifex (*Triodia* sp.) hummocks (Churchill 2001b; Ward 2009; Ward *et al.* 2008).

Modelling of spinifex hummock characteristics by Moseby *et al.* (2016) found that a good predictor of sandhill dunnart detection was *Triodia* sp. cover and detection rates increased when cover exceeded 25%. Sandhill dunnart abundance and breeding (presence of subadults) was best explained by the 90$^{th}$ percentile hummock height over 40 cm.

However, McLean (2015) found a negative association between sandhill dunnart abundance and mean *Triodia* height and suggested that other elements of *Triodia*, such as hummock size and foliage density may be better predictors. In the same study, there was no association between sandhill dunnart abundance and post-fire age of vegetation. McLean (2015) also found a positive association between sandhill dunnart abundance and the number of logs ≥ 5 cm diameter, and vertical habitat complexity. McLean (2015) suggested that logs may be an important resource for shelter and protection from predators, and vertical habitat complexity may not only provide protection from predators, but may also be positively correlated with invertebrate abundance. Of seven sandhill dunnarts radio tracked in Western Australia, three have used logs for shelter, suggesting logs may also be an important resource here (J. Turpin and J. Riley unpublished data).

### Western Australia

In Western Australia, sandhill dunnarts have been captured in habitats comprising tall and low open mallee (<10-30 % cover), with emergent (<10 %) marble gum (*E. gongylocarpa*), over mixed shrublands (10-30 % cover) and spinifex (10-70 % cover) on yellow or yellow/orange sand (Gaikhorst and Lambert 2014).

Churchill (2001b) suggested sandhill dunnart habitats typically have mixed sized spinifex hummocks, dominated by those in Stage 2 and Stage 3 (shown in Figure 2). *Triodia* is a fire-adapted species with hummocks regenerating from seed or rootstock, and progressing through five life-stages, reaching Stage 5 at 20-30 years post-fire (Haslem *et al.* 2011; Noble and Vines 1993; Wright and Clarke 2007).

Of seven sandhill dunnarts radio tracked in Western Australia, most sheltered in burrows, commonly constructed under hummocks in stages 3-5 (J. Turpin and J. Riley unpublished data). J. Turpin and J. Riley (pers. comm.) have trapped sandhill dunnarts in stage 2-5 *Triodia dessertorum*, *T. baseddowii* and *T. rigidissima* habitats.

They suggested that only *T. dessertorum* grows in rings, while the other two species rarely develop beyond stage 3 (J. Turpin and J. Riley pers. comm.).

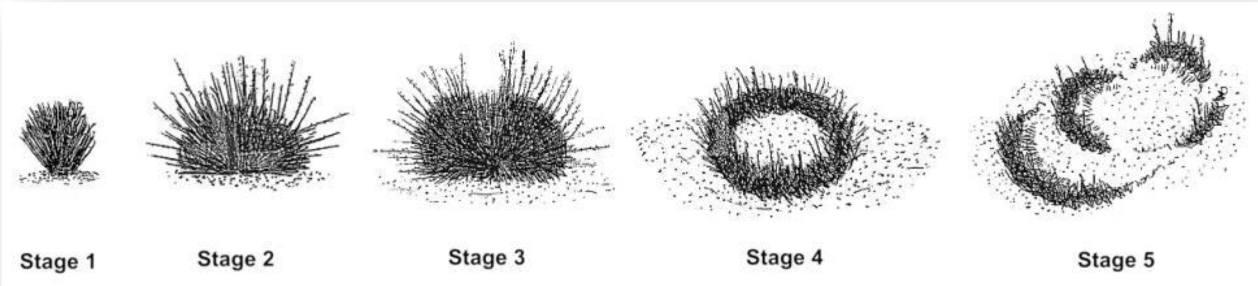


**Figure 2 Life stages of spinifex hummocks drawn by Vicki Reynolds, from Churchill (2001a).**

## POPULATION DYNAMICS AND BEHAVIOUR

Little is known about the population dynamics and behaviour of the sandhill dunnart in the wild, but most dasyuirds are solitary, coming together only during the breeding season (Dickman *et al.* 2001). Individuals are highly mobile, move long distances and their population dynamics appear to be regulated by complex interactions between rainfall, fire, resource abundance, competition and predator abundance (Kelly *et al.* 2013; Letnic and Dickman 2010; Letnic *et al.* 2004). In a study of sandhill dunnarts at three sites in South Australia, mean home range size was 10.7 ha (s.e. 5.4, $n$ = 7) for females and 14.1 ha (s.e. 5.3, $n$ = 7) for males (Churchill 2001b). A more recent study in Western Australia has recorded home ranges of 118 ha and 206 ha for two males, respectively, and 19 ha for a female (Turpin 2015c).

## NESTS AND SHELTERS

Sandhill dunnarts have been radio tracked to shelters in *Triodia* sp. hummocks, burrows, hollow logs, bark and the burrows of other animals (Churchill 2001b; Turpin 2015b). They have also been observed making a nest chamber of spinifex needles in the centre of Stage 3 hummocks and females dig burrows with chambers containing plant litter (Churchill 2001b). The temperature and humidity of both hummocks and burrows are moderate in comparison with ambient conditions (Churchill 2001b). Shelters are thought to be used for refuge from predators and subterranean nests may be used for deposition of pouch young (Gaikhorst and Lambert 2014), but this has yet to be demonstrated.

# Review of previous surveys in Western Australia

The three methods recommended for capturing / detecting sandhill dunnarts are pitfall traps, Elliott traps and camera traps (DSEWPaC 2011). Capture rates are reviewed for these three methods in the text and table below. For the purposes of this analysis, camera trap observations are regarded as a 'capture'. However, it should be acknowledged that, compared with pitfall and Elliott traps, there is greater uncertainty regarding species identification by a camera image alone.

Surveys, research studies and impact assessments targeting small mammals that have been conducted in the Great Victoria Desert of Western Australia include (but may not be limited to) those summarised in Table 1. Further details are given in the text below in chronological order by survey name. For those surveys where data were available, the survey sites and sandhill dunnart capture locations are shown in Figure 3.

In total, there have been 84 captures of sandhill dunnarts in Western Australia; 46 in pitfall traps (21,383 trap nights), 11 in Elliott traps (38,264 trap nights), 25 by camera traps (10,198 trap nights) and two in a trench built to install the Sunrise Dam to Tropicana gas pipeline (Table 1). These tallies include recaptures. One other observation was made by Harry Butler in Queen Victoria Spring Nature Reserve (Figure 3), but no further details are known (G. Gaikhorst pers. comm.).

### Burbidge *et al.* 1975

During the 1970s, the Western Australian Department of Fisheries and Wildlife conducted vertebrate fauna surveys in the existing and proposed reserves of the desert regions of Western Australia. Within the Great Victoria Desert, Queen Victoria Spring Nature Reserve and the (then) proposed reserves in the Plumridge Lakes and Neale Junction areas were surveyed. The surveys were conducted at nine sites in March 1975, November to December 1975 and March 1976 using large (50 cm x 17 cm x 17 cm), medium (32 cm x 10 cm x 8 cm) and small (23 cm x 9 cm x 8 cm) Elliott traps (Elliott Scientific, Upwey Victoria), Sherman traps, break-back traps, PVC pitfall traps (10 cm in width, depth not reported) and dug pitfall traps 30 $cm^2$ x 60-70 cm deep (Burbidge *et al.* 1976; McKenzie and Burbidge 1979). No sandhill dunnarts were captured during these surveys.

### Morris and Rice 1977

A vertebrate fauna survey of Queen Victoria Spring was conducted at four sites from 30/11/1977 to 13/12/1977 (Morris and Rice 1981), using Elliott traps and pitfall traps of unknown size (K. Morris pers. comm.). No sandhill dunnarts were captured (Morris and Rice 1981).

### Martinick and Associates 1985

A baseline flora and fauna survey was undertaken for the Power Reactor and Nuclear Fuel Development Corporation of Japan in the Mulga Rock area in 1985 (Martinick 1986). Trapping was undertaken for 6–13 nights at 14 sites using 16 cm wide x 55 cm deep pitfall traps. This led to the first record of the sandhill dunnart in Western Australia (Hart and Kitchener 1986). Five specimens, one female and four male adults, were collected from four sites and lodged in the Western Australian Museum. One male was captured in an Elliott trap and the remainder were captured in pitfall traps. The habitat at the capture sites was described as sandplain with yellow deep sand. The vegetation was a mosaic of *Eucalyptus gongylocarpa* woodland and mallee over spinifex (*Triodia basedowii*), averaging about 30 cm high, in 'small clumps' and about 50% bare ground.

### Pearson and Robinson 1987-2000

A fire impact study was conducted at five sites in a 4 $km^2$ area, 25 km NNE of Queen Victoria Spring in Queen Victoria Spring Nature Reserve, from March 1987 to June 1989. Each site had Elliott traps, 16 cm and 25 cm wide x 60 cm deep PVC pitfall traps and 20 litre buckets (Pearson and Robinson 1990; and D. Pearson unpublished data). Additional surveys were conducted at the same sites, with pitfall traps only, in 1990, 1991, 1998 and 2000, but these data have yet to be published (D. Pearson pers. comm.). The study was discontinued after a bushfire burnt 51,566 ha in August 2002. During these surveys, 21 sandhill dunnarts were captured in sand plain with deep yellow sand. The habitat was low open *Eucalyptus gongylocarpa* woodland and mallee over shrubs and 25% cover of *Triodia desertorum* (Pearson and Robinson 1990).

### Churchill 1999

In 1999, Churchill (2001b) conducted surveys in South Australia and at seven locations in Western Australia. Elliott traps and pitfall traps (25 cm wide x 60 cm deep) were set at five of these sites and Elliott traps alone were set at the other two sites. Traps were open for three nights per site and no sandhill dunnarts were captured.

### Gaikhorst and Lambert 2000-2008

The most comprehensive survey of sandhill dunnarts undertaken in Western Australia was conducted across 62 sites in the Great Victoria Desert between 2001 and 2007 (Gaikhorst and Lambert 2001, 2002, 2003a, b, c, 2004, 2006, 2007, 2008, 2009a). At each site, 20 Elliott traps and 14 pitfall traps at least 22.5 cm wide x 60 cm deep were open for between four and five nights per site. The total number of sandhill dunnart captures was 21 at eleven sites; 18 in pitfall traps and three in Elliott traps.

Sites where sandhill dunnarts were captured in these surveys had yellow or yellow / orange soils. Gaikhorst and Lambert (2014) suggested that these soils may be easier for the dunnarts to dig compared with harder red soils with clay or rock content. Vegetation communities at the sites where the dunnarts were captured typically consisted of tall and low open mallee over mixed shrub lands and spinifex (Gaikhorst and Lambert 2014). Time since last fire was 8-26 years and most captures were in habitat last burnt 17-26 years prior to the survey (Gaikhorst and Lambert 2014).

### Ecologia 2007

A vertebrate fauna assessment was conducted in the Tropicana gold mine operational area in 2007. Sandhill dunnarts were targeted at two sites, using 40 Elliott traps and 20 pitfall traps (60 cm wide x 100 cm deep) (Ecologia 2009b). The traps were set at one site for nine nights and the other site for seven nights but they failed to detect the species.

### Ecologia and DEC c. 2008

Ecologia and the Department of Environment and Conservation conducted fauna surveys in the Neale Junction Nature Reserve and Plumridge Lakes areas for Tropicana Joint Venture in c. 2008 but no further details are known and the report (Ecologia 2009a) could not be obtained.

### Gaikhorst and Lambert 2009

In 2008, Gaikhorst and Lambert (2009b) targeted sandhill dunnarts for impact assessment at 14 sites in the Tropicana gold mine operational area and infrastructure corridors. Each site had 20 Elliott traps and 14 pitfall traps (25 cm wide x 60 cm deep, with a 30 cm high x 50 m drift fence) and the traps were open for between four and seven nights. They did not detect the species.

### GHD 2009

In 2009, GHD (2010) targeted sandhill dunnarts for impact assessment at 14 sites in the Tropicana gold mine operational area and infrastructure corridors. Each site had 40 Elliott traps and 14 pitfall traps (25 cm wide x 60 cm deep, with a 40 cm high x 60 m drift fence). Traps were open for 10 nights per site. Again, no sandhill dunnarts were detected.

### Ninox 2009

A fauna survey was undertaken for impact assessment in the Mulga Rock project area by Ninox in 2009 (Ninox Wildlife Consulting 2010). Ten sites were surveyed for six consecutive nights and each site had 16 Elliott traps, two cage traps and two funnel traps. Ten pitfall traps were set, each bisected by a 30 cm high x 10 m flywire drift fence. Five were 15 L plastic drums and five were PVC pipes 16 cm wide x 60 cm deep. Two camera traps were also set for three nights. No sandhill dunnarts were captured.

### Brennan 2010

Fauna surveys were conducted with the Pila Nguru or Spinifex People in their Native Title Area in 2010 (Brennan *et al.* 2012). Eight sites were established in the Ilkurlka Roadhouse area targeting small fauna. Each site had 24 Elliott traps, two cage traps, eight funnel traps, ten 20 L buckets and two 200 L buckets (approximately 1 $m^2$ x 1 m deep). Trapping was undertaken for seven nights at each site, but no sandhill dunnarts were detected.

### Gaikhorst and Lambert 2011, 2013

Twelve sites, targeting sandhill dunnarts, were trapped in the Yeo Lakes, Neale Junction and Plumridge Lakes areas by Gaikhorst and Lambert in 2011 and 2013. The same trapping techniques were used as for their previous study, from 2000-2008, but no sandhill dunnarts were captured (Gaikhorst and Lambert pers. comm.).

### Outback Ecology 2013, 2014

In 2013 and 2014, a fauna survey for an assessment of the impact of the Cyclone Mineral Sands Project (Lost Sands Pty Ltd) was undertaken in the Great Victoria Desert Nature Reserve area, but no sandhill dunnarts were detected (Outback Ecology 2014). Eleven sites were surveyed for seven nights using five buckets (40 cm wide x 50 cm deep) and five PVC pitfall traps (15 cm wide x 50 cm deep) at each site.

### Turpin and Lloyd 2014

Between October 2013 and June 2014, an impact assessment targeting sandhill dunnarts was conducted along the Sunrise Dam – Tropicana Gas Pipeline Corridor (Turpin and Lloyd 2014). Trapping for sandhill dunnarts was undertaken in May 2014 at nine sites for between four and seven nights. Each site had 14 pitfall traps

(65 cm deep, width not reported, with a 50 m drift fence), 15 Elliott traps, funnel traps and one camera trap. Sandhill dunnarts were detected at three sites; one in a pitfall trap and two by camera traps.

### Vimy 2014

Camera trapping was conducted in association with the Mulga Rock Uranium project at 15 sites over 840 trap nights from 10/10/2014 to 8/11/2014 (Vimy Resources Limited 2015). No sandhill dunnarts were detected. A bushfire burnt the area in November 2011, including all the camera trap locations.

### Turpin Apr 2015

In April 2015, eight sites were sampled in association with the Tropicana Gold Mine. Each site had 30 Elliott traps, 12 pitfall traps (22.5 cm wide and at least 60 cm deep with a 30 cm high x 60 m long drift fence), 12 funnel traps and two camera traps baited with universal bait (Turpin 2015b). Sandhill dunnarts were captured at three sites; two in pitfall traps and four by camera traps. Two additional sandhill dunnarts were captured in the gas pipeline trench during construction.

### Vimy 2014-2015

A second phase of camera trapping was conducted, at the same 15 sites as previously used, between November 2014 and September 2015. Four sandhill dunnarts were detected at two sites; one site had been burnt and the other was unburnt and described as a 'post-fire refugia' (Vimy Resources Limited 2015 and unpublished data).

### Turpin Sept 2015

In September 2015, trapping was conducted at nine sites using the same trapping regime as for Turpin April 2015. Sandhill dunnarts were captured at two sites; one in a pitfall trap and one in an Elliott trap (Turpin 2015c).

### Turpin 2016

Monitoring by Turpin continued in March 2016 at 12 sites using the same trapping techniques as previously employed. Sandhill dunnarts were captured at nine sites: five captures were in pitfall traps and seven observations were by camera traps.

**Table 1 Summary of trap effort and sandhill dunnart (SHD) captures in the Great Victoria Desert of Western Australia (Cam. = camera, T. = trench, N.R. = not reported). SHD captures include recaptures.**

| Survey | Purpose | Location | Sites | | Trap nights | | | | SHD Captures | | | | | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. | With SHD captures | Pit | Elliott | Cam. | Total | P | E | C | Tr. | Ttl | |
| **Burbidge *et al.* 1975** | Survey | Existing and proposed reserves of the Great Victoria Desert | 9 | 0 | N.R. | N.R. | - | N.R. | 0 | 0 | - | - | 0 | (Burbidge *et al.* 1976) |
| **Morris and Rice 1977** | Survey | Queen Victoria Spring | 4 | 0 | N.R. | N.R. | - | N.R. | 0 | 0 | - | - | 0 | (Morris and Rice 1981) |
| **Martinick and Associates 1985** | Impact assess. | Mulga Rock | 14 | 4 | N.R. | 2,100 | - | 2,100 | 4 | 1 | - | - | 5 | (Martinick 1986) |
| **Pearson and Robinson 1987-2000** | Survey | Queen Victoria Spring Nature Reserve | 5 | 5 | 7,400 | 2,700 | - | 10,100 | 15 | 6 | - | - | 21 | (Pearson and Robinson 1990, D. Pearson pers. comm.) |
| **Churchill 1999** | Research | Carmel Lake, Mulga Rock, Neale Junction, Queen Victoria Spring Nature Reserve, Serpentine Lakes, Wanna Lake, Yeo Lake | 7 | 0 | 654 | 3,296 | - | 3,950 | 0 | 0 | - | - | 0 | (Churchill 2001b, 2009) |
| **Gaikhorst and Lambert 2000-2008** | Survey | Plumridge Lakes Nature Reserve, Pinjin, Mulga Rock | 62 | 11 | 5,463 | 9,984 | - | 15,447 | 18 | 3 | - | - | 21 | (Gaikhorst and Lambert 2001, 2002, 2003a, b, c, 2004, 2006, 2007, 2008, 2009a) |
| **Ecologia 2007** | Impact assess. | Tropicana gold mine operational area | 2 | 0 | 320 | 640 | - | 960 | 0 | 0 | - | - | 0 | (Ecologia 2009b) |
| **Ecologia and DEC c. 2008** | Impact assess. | Neale Junction Nature Reserve and Plumridge Lakes areas | 6 | 0 | | | - | | | | | | 0 | (Ecologia 2009a)* Report could not be |

| Survey | Purpose | Location | Sites | | Trap nights | | | | SHD Captures | | | | | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. | With SHD captures | Pit | Elliott | Cam. | Total | P | E | C | Tr. | Ttl | |
| | | | | | | | | | | | | | | obtained |
| **Gaikhorst and Lambert 2009** | Impact assess. | Tropicana gold mine operational area and infrastructure corridors | 14 | 0 | 947 | 1,120 | - | 2,067 | 0 | 0 | - | - | 0 | (Gaikhorst and Lambert 2009b) |
| **GHD 2009** | Impact assess. | Tropicana gold mine operational area and infrastructure corridors | 14 | 0 | 910 | 2,600 | - | 3,510 | 0 | 0 | - | - | 0 | (GHD 2010) |
| **Ninox 2009** | Impact assess. | Mulga Rock | 10 | 0 | 610 | 1,058 | 6 | 1,674 | 0 | 0 | 0 | - | 0 | (Ninox Wildlife Consulting 2010) |
| **Brennan 2010** | Survey | Ilkurlka Roadhouse area | 8 | 0 | 1,008 | 2,016 | 112 | 3,136 | 0 | 0 | 0 | - | 0 | (Brennan *et al.* 2012) |
| **Gaikhorst and Lambert 2011, 2013** | Survey | 15 km SE Yeo Lake Nature Reserve, Neale Junction area, Plumridge Lakes area | 12 | 0 | 1,120 | 1,600 | - | 2,720 | 0 | 0 | - | - | 0 | G. Gaikhorst pers. comm. |
| **Outback Ecology 2013, 2014** | Impact assess. | Cyclone mineral sands project - Great Victoria Desert Nature Reserve | 13 | 0 | 210 | 4,340 | 262 | 4,812 | 0 | 0 | 0 | - | 0 | (Outback Ecology 2014) |
| **Turpin and Lloyd May 2014** | Impact assess. | Sunrise Dam – Tropicana Gas Pipeline Corridor | 9 | 3 | 693 | 1,680 | 9 | 2,382 | 1 | 0 | 2 | - | 3 | (Turpin and Lloyd 2014) |
| **Vimy 10/10/2014 to 8/11/2014** | Impact assess. | Mulga Rock Project Area | 15 | 0 | - | - | 840 | 840 | - | - | 0 | - | 0 | (Vimy Resources Limited 2015) |
| **Turpin Apr 2015** | Impact assess. | Tropicana gold mine operational area and infrastructure corridors | 8 | 3 | 636 | 1,590 | 14 | 2,240 | 2 | 0 | 4 | 2 | 8 | (Turpin 2015b) |
| **Vimy 15/11/2014 to 5/9/2015** | Impact assess. | Mulga Rock Project Area | 15 | 2 | - | - | 8,700 | 8,700 | - | - | 4 | - | 4 | (Vimy Resources Limited 2015) |
| **Turpin Sept 2015** | Impact assess. | Tropicana gold mine operational area and | 9 | 2 | 660 | 1,650 | 55 | 2,365 | 1 | 1 | 2 | - | 4 | (Turpin 2015c) |

| Survey | Purpose | Location | Sites | | Trap nights | | | | SHD Captures | | | | | References |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | No. | With SHD captures | Pit | Elliott | Cam. | Total | P | E | C | Tr. | Ttl | |
| | | infrastructure corridors | | | | | | | | | | | | |
| **Turpin March 2016** | Impact assess. | Tropicana gold mine operational area and infrastructure corridors | 12 | 9 | 752 | 1,890 | 200 | 2,842 | 5 | 0 | 13 | - | 18 | J. Turpin pers. comm. |
| **Total** | | | 248 | 39 | 21,383 | 38,264 | 10,198 | 69,845 | 46 | 11 | 25 | 2 | 84 | |
| **Catures per 100 Trap nights** | | | | | 0.22 | 0.03 | 0.25 | | | | | | | |
| **Catures per trap night** | | | | | 0.0022 | 0.0003 | 0.0025 | | | | | | | |
| **Nights for 1 capture** | | | | | 465 | 3,479 | 408 | | | | | | | |
| **Nights for 10 captures** | | | | | 4,648 | 34,785 | 4,079 | | | | | | | |

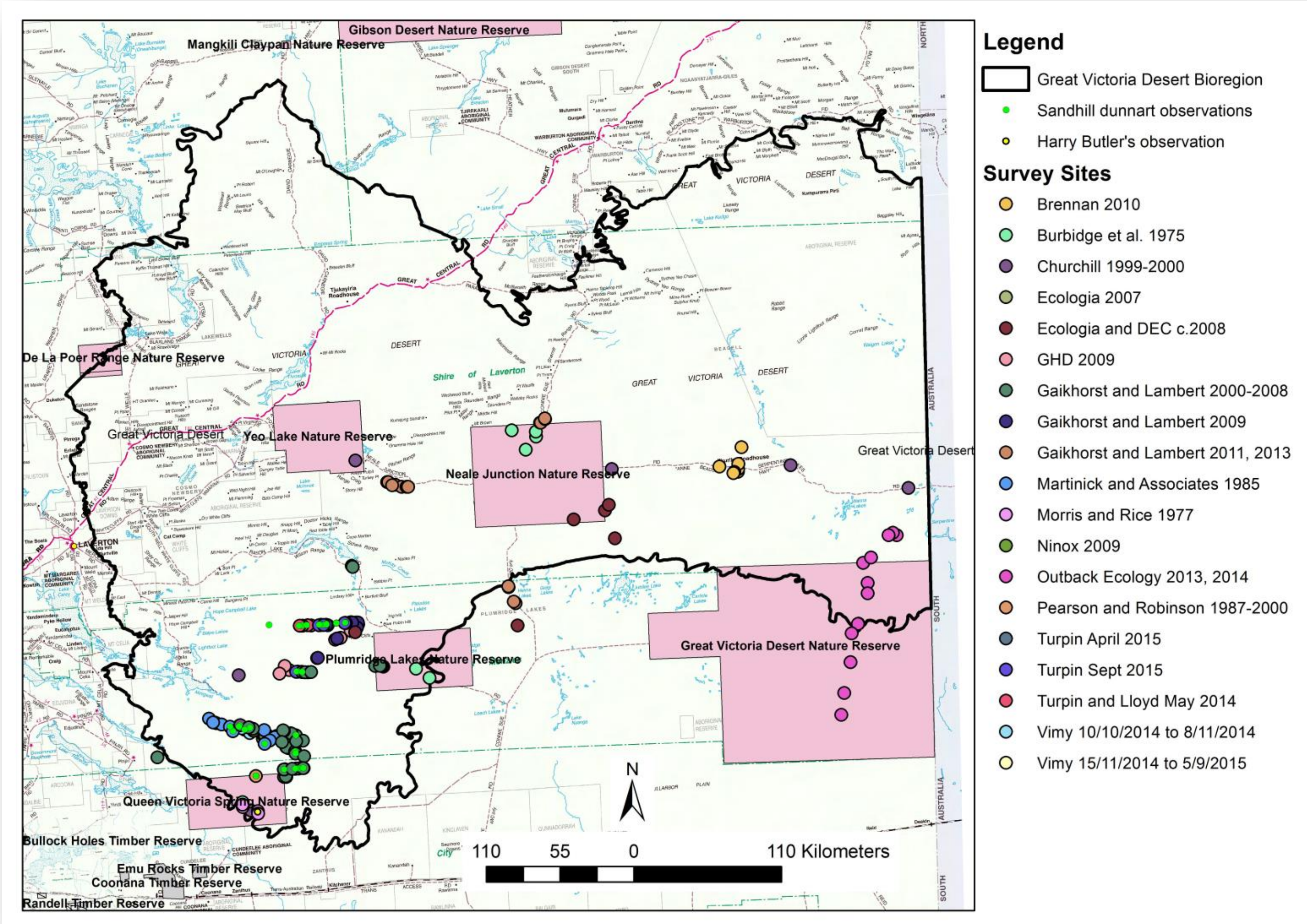


**Figure 3 Sites (*n* = 240) where fauna surveys have been conducted in the Great Victoria Desert of Western Australia, shown with sandhill dunnart observations (*n* = 85). Note that not all site locations were reported and some sites are duplicated and thus may not be visible.**

## METHODS FOR CAPTURE

The review of surveys for Western Australia (Table 1) show that sandhill dunnart capture rates have been higher for pitfall traps and camera traps than for Elliott traps. These results are based on 82 captures (including recaptures, but excluding two captures in a trench) across 69,845 trap nights in potential sandhill dunnart habitat since the mid-1970s (Table 1).

Capture rates per 100 trap nights were 0.22 for pitfall traps, 0.03 for Elliott traps and 0.25 for camera traps. This is low in comparison with a study in South Australia, where sandhill dunnart captures per 100 trap nights were 2.7 for pitfall and 0.5 for Elliott traps (Read *et al.* 2015). Thus, capture rates in South Australia were 13 times higher for pitfall traps and 17 times higher for Elliott traps than in Western Australia. However, in both cases, capture rates for pitfall traps were around seven times higher than in Elliott traps. Camera traps were not used by Read *et al.* (2015), so no comparisons can be made for this technique.

The higher capture success of sandhill dunnarts in pitfall traps and camera traps, than in Elliott traps suggests that these two methods are likely to be the most successful for detecting sandhill dunnarts in Western Australia.

# Preparation for surveys and monitoring

## LICENCING AND TRAINING

A Regulation 17 Licence to Take Fauna for Scientific Purposes, issued under the Wildlife Conservation Act 1950, is needed to conduct fauna surveys and monitoring programs. Applicants must submit an application for review which demonstrates the significance and potential value of the study to science and conservation, the techniques to be used, and the applicant's relevant skills and experience in the techniques being used.

As a condition of the licence, the licensee is required to submit a return detailing the species, and numbers that were captured or sighted, via the Department of Parks and Wildlife's Fauna Survey Returns System within one month of expiry. Any reports or papers produced must also be forwarded to the Department on completion.

To undertake a survey on Department of Parks and Wildlife managed land (reserves shown in Figure 4), a Regulation 4 Lawful Authority permit is also required.

Applications for licences and associated information can be found on the Department of Parks and Wildlife Licences and permits webpage (www.dpaw.wa.gov.au/plants-and-animals/licences-and-permits).

## ABORIGINAL LANDS

Permits are required for entry onto or through Aboriginal Lands Trust reserves that are subject to Part III of the Aboriginal Affairs Planning Authority Act 1972. These reserves are shown in Figure 4.

## ANIMAL WELFARE CONSIDERATIONS

Anyone using animals for scientific purposes in Western Australia, including the trapping of fauna, must comply with:

1. The Western Australian Animal Welfare Act 2002, the Animal Welfare (General) Regulations 2003 and the Animal Welfare (Scientific Purposes) Regulations 2003, which are administered by the Department of Agriculture and Food (DAFWA). The act and associated regulations provide for the welfare, safety and health of animals and regulate the use of animals for scientific purposes.
2. The Australian code for the care and use of animals for scientific purposes 8th edition (2013), which promotes the ethical, humane and responsible care and use of animals used for scientific purposes.

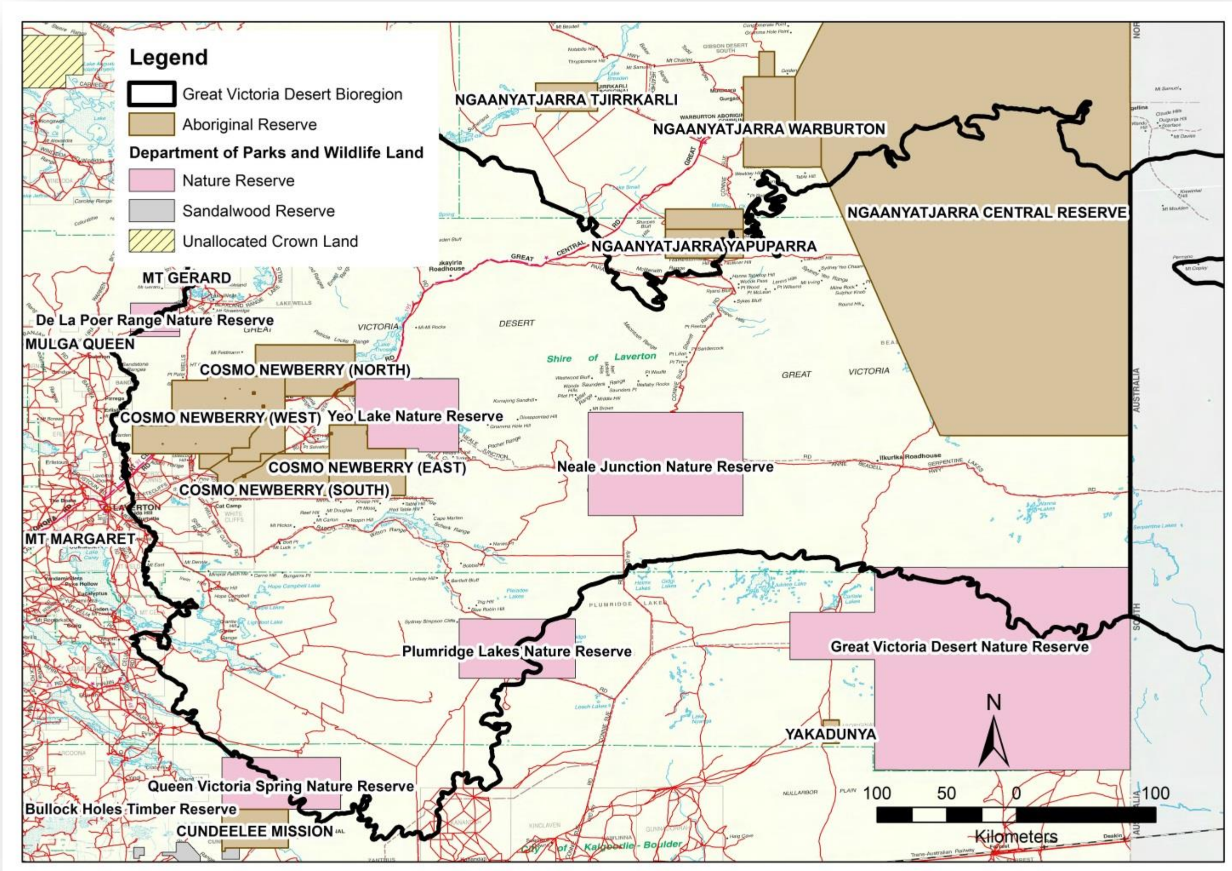


**Figure 4 Reserves in the Great Victoria Desert Bioregion of Western Australia.**

## Pitfall trapping

### TRAP SIZE

In South Australia, Read *et al.* (2015) compared capture success of sandhill dunnarts using three different size combinations of pitfall traps. They showed that wide deep pitfall traps (22.5 cm wide x 60-70 cm deep) captured significantly more sandhill dunnarts than both narrower pitfalls (15 cm wide x 60-70 cm deep) and shorter, narrower pitfall traps (15 cm wide x 50 cm deep). This study also determined that a 70 cm deep trap offered little advantage over the 60 cm deep trap. Given current evidence, and in accordance with the survey guidelines given in DSEWPaC (2011), the use of pitfall traps measuring 22.5 cm wide x 60 cm deep is recommended.

### TRAP NUMBER AND LAYOUT

The number of traps used, and the trap design, should maximise the chance of detecting sandhill dunnarts by intercepting their home range. The following layout is recommended, as shown in Figure 5:

- Two parallel lines of pitfall traps (22.5 cm wide x 60 cm deep) with each trap line spaced 100 m apart
- Six pitfall traps on each trap line, each approximately 10 m apart
- A 60 m long and 30 cm high aluminium fly wire fence placed along each trap line and across the centre of each pitfall trap, extending 5m beyond the last trap in each trap line.

### TRAP NIGHTS

General guidelines for level two small mammal surveys in Western Australia recommend seven consecutive sampling nights (EPA 2010). Read *et al.* (2015) found that the capture rates for sandhill dunnarts were highest on the first night and recaptures highest on the third night. Nightly capture rates have yet to be analysed for surveys in Western Australia and thus seven nights is recommended until this can be refined. Where a species is difficult to detect, such as the sandhill dunnart, a longer trapping duration is likely to increase the probability of detection.

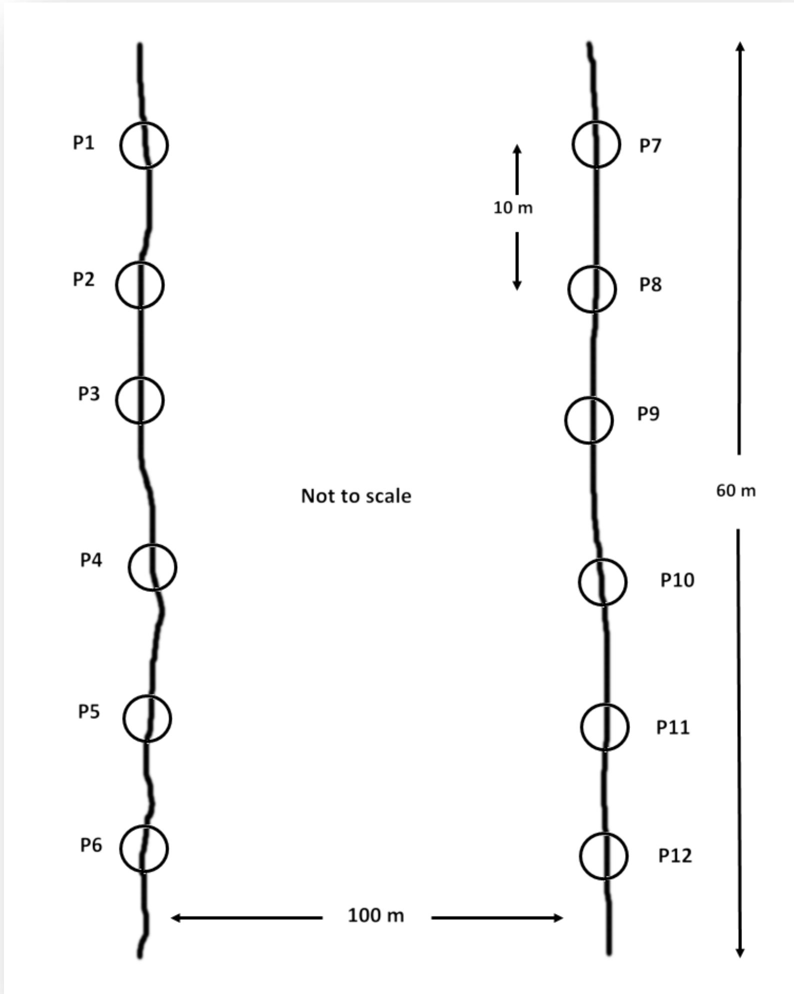


**Figure 5 Diagrammatic representation of the recommended sandhill dunnart trapping grid. Numbers show trap numbers P = pitfall.**

## TRAP SITES

The number of personnel available, their skill levels, the time anticipated to check the traps, process the captured animals and travel between sites should all be considered in determining how many sites can be surveyed. As the effectiveness of increasing the number of traps, or the number of sampling nights at a site, is not well understood, the minimum amount of sampling effort to provide a reasonable chance of detecting sandhill dunnarts should be used at each site. As a general principle, provided the sampling effort at each site is sufficient to ensure a reasonable chance of detection, additional sampling sites are more useful than additional effort (traps, trap lines or sampling nights) at the same site.

The probability of detecting a sandhill dunnart in a pitfall trap, at sites where the species was known to be present, from captures and / or camera trap observations, was calculated and is shown in Table 2. The detection rate for pitfall traps at these sites was 0.0124 sandhill dunnarts / pitfall trap night (26/2,090).

The probability of one or more detections is 1-the probability of no detections:

$$1-(1-d)^{sxt}$$

where $d$ is detection rate per site (the total number of captures per trap night divided by the total number of trap nights), $s$ is the number of sites (or the number of times a site is sampled), $x$ is the number of traps and $t$ is the number of trap nights.

**Table 2 Detection rate for sites where sandhill dunnarts (SHD) were known to be present because they were trapped or captured on camera trap images.**

| Survey | Site No. | Date | Pit trap nights | SHD captures |
|---|---|---|---|---|
| (Gaikhorst and Lambert 2001, 2002, 2003a, b, c, 2004, 2006, 2007, 2008, 2009a) | 3-1 | March 2001 | 96 | 1 |
| | 3-1 | October 2001 | 75 | |
| | 3-1 | March 2005 | 96 | 3 |
| | 3-1 | October 2005 | 64 | 1 |
| | 3-3 | March 2001 | 176 | 2 |
| | 3-3 | October 2001 | 56 | |
| | 3-3 | March 2005 | 96 | |
| | 3-3 | October 2005 | 64 | |
| | 3-5 | March 2001 | 96 | |
| | 3-5 | October 2001 | 70 | |
| | 3-6 | March 2005 | 96 | |
| | 3-7 | March 2005 | 112 | 1 |
| | 3-7 | October 2005 | 64 | |
| | 3-14 | April 2007 | 70 | 1 |
| | 4-7 | March 2001 | 80 | 1 |
| | 5-2 | October 2001 | 56 | 3 |
| | 5-2 | October 2003 | 80 | |
| | 9-1 | April 2006 | 56 | 1 |
| | 11-1 | March 2008 | 70 | 1 |
| | 12-1 | March 2008 | 56 | 2 |
| | 12-3 | March 2008 | 60 | 1 |
| (Turpin and Lloyd 2014) | 2 | May 2014 | 98 | 1 |
| (Turpin 2015b) | 1 | April 2015 | 96 | 1 |
| | 5 | April 2015 | 60 | 1 |
| | 7 | April 2015 | 72 | |
| Turpin March 2016 unpublished data | 9 | March 2016 | 6 | 1 |
| | 10 | March 2016 | 6 | 1 |
| | 11 | March 2016 | 6 | 1 |
| | 14 | March 2016 | 6 | 1 |
| | 15 | March 2016 | 6 | 1 |
| **Total** | | | **2,090** | **26** |

| Survey | Site No. | Date | Pit trap nights | SHD captures |
|---|---|---|---|---|
| *d* | | | 0.0124 | |

Applying the equation above to the recommended trapping design of 12 pitfall traps per site over seven nights, the probability of detecting a sandhill dunnart, for 2-6 sites per survey (based on the survey data in Table 2) is shown in Table 3. Spacing between pitfall traps and between pitfall trap lines may also influence the probability of capture, but there are no data available on the influence of these to date.

**Table 3 Probability of detecting a sandhill dunnart based on 0.0124 captures per trap night (26 captures across 2,090 trap nights), 12 traps per site and seven trap nights per site.**

| Sites | Pitfall trap nights (traps x trap nights) | Probability of detection |
|---|---|---|
| **2** | 168 | 0.88 |
| **3** | 252 | 0.96 |
| **4** | 336 | 0.99 |
| **5** | 420 | 0.99 |
| **6** | 504 | 1.00 |

Thus, four sites per survey, sampled using the recommended trapping protocol, gives a high probability (0.99) of detecting sandhill dunnarts, if they are present. It is important to note that this calculation was based on the sites where sandhill dunnarts were known to be present and so the probability of detection is likely to be biased high.

## DISTANCE BETWEEN SITES

The home range of the sandhill dunnart is around 12 ha (Churchill 2001b) and a minimum distance of 2 km between sites is recommended to ensure captures are independent (Read *et al.* 2015). This distance is important for further analyses to determine habitat suitability and for building a predictive distribution model. However, home ranges for sandhill dunnarts in Western Australia may be larger than previously thought (Turpin 2015c) and thus the minimum distance between sites may have to be refined as more information is gathered.

## TIMING OF TRAPPING

As most captures of sandhill dunnarts in Western Australia have been in March / April and September / October (refer to Table 2), the optimal time of year to survey sandhill dunnarts appears to be in autumn and spring. Winter should be avoided to prevent trap deaths in sub-zero temperatures. March is the ideal time to capture sub-adults (J. Turpin pers. comm.), but an assessment of the maximum temperatures forecasted should be made to minimise the chances of heat stress. Trapping should be avoided during the period when young are deposited in the nest, which occurs from mid-October to January (Gaikhorst and Lambert 2014).

Moon phase / illumination has been suggested as a possible factor influencing small mammal capture success, but its effect on sandhill dunnart captures remains ambiguous. For example, Read *et al.* (2015) recorded more captures at one site when moon illumination was less than 40%, but no influence of moon illumination at another site. For the Gaikhorst and Lambert surveys (Table 1), captures were highest at 0-30% illumination (Figure 6), but the sample size was small (*n* = 21 captures). Similarly, other factors like habitat density, cloud cover and the resulting intensity of night light may affect illumination and therefore captures. Until more data have been analysed on the effects of moon illumination on sandhill dunnart capture success, no recommendation can be made in regard to this factor.

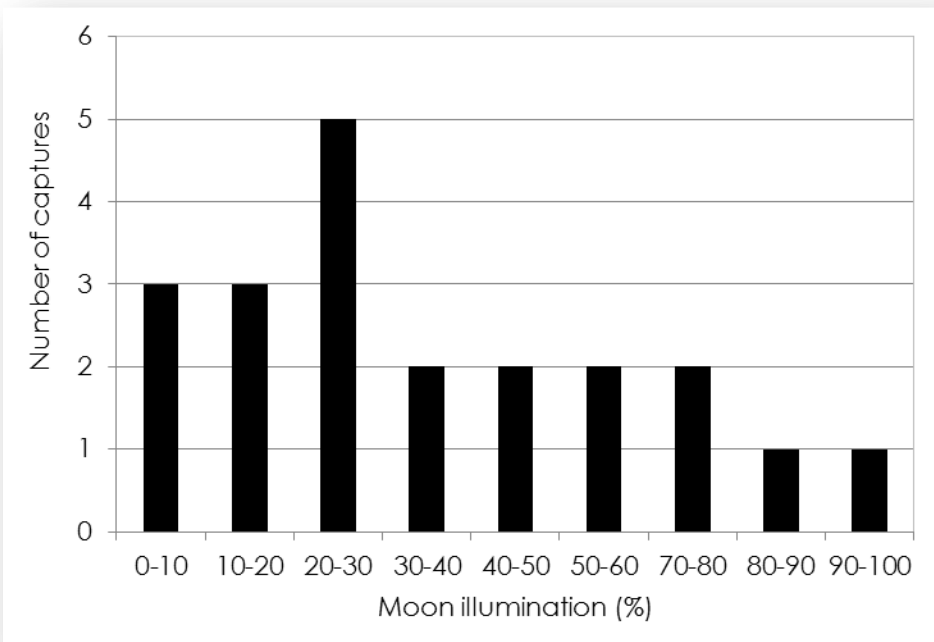


**Figure 6 Number of sandhill dunnart captures by moon illumination for 21 captures (by Gaikhorst and Lambert 2001, 2002, 2003a, b, c, 2004, 2006, 2007, 2008, 2009a).**

## PITFALL TRAP MANAGEMENT

Detailed advice on managing dry pitfall traps can be found in Department of Parks and Wildlife (2013a) [SOP No. 9.3 Dry pitfall trapping for vertebrates and invertebrates](), the Survey Guidelines for Australia's Threatened Mammals

(DSEWPaC 2011), Bamford *et al.* (2013) and Petit and Waudby (2013). Misuse or neglect of traps will result in unnecessary harm or deaths of fauna and could lead to prosecution under the *Animal Welfare Act 2002*.

### ANIMAL HANDLING

Removal of fauna from traps and animal handling should be done by (or under the guidance of) experienced personnel in accordance with DEC (2009b) SOP No. 10.2 Hand restraint of wildlife and DEC (2009a) SOP No. 10.1 Animal handling/restraint using soft containment. If injuries to captured animals occur, refer to DEC (2009d) SOP No. 14.2 First aid for animals and DEC (2013b) SOP No. 15.1 Humane killing of animals under field conditions in wildlife management. For projects approved by the Department of Parks and Wildlife Animal Ethics Committee, if an unexpected death occurs, a report must be made in writing to the Executive Officer of the committee.

### MARKING AND DNA SAMPLING OF SANDHILL DUNNARTS

Given the very low capture rate of sandhill dunnarts in Western Australia, there is currently little or no value in permanently marking individual animals for surveys, but permanent marking is likely to be of value for ongoing monitoring programs (see the section on 'Monitoring', on page 35 below).

For surveys, individuals may be temporarily marked using a technique described in DEC (2013a) SOP No. 12.9 Temporary marking of mammals, reptiles and birds. A DNA sample (ear notch) should be collected from each individual sandhill dunnart trapped and this would also serve as a temporary mark. Tissue samples should be collected, labelled and stored in accordance with Department of Parks and Wildlife (2015) SOP No. 8.4 Tissue sample collection and storage for mammals.

### DISEASE RISK MANAGEMENT

In fauna trapping programs, the health and safety of both personnel and fauna must be taken into consideration. Guidelines to minimize disease risk to humans and fauna can be found in Department of Parks and Wildlife (2013b) SOP No. 16.2 Managing Disease Risk in Wildlife Management.

### DATA COLLECTION AND REPORTING

Careful data collection and reporting is critical to the success of any fauna survey or monitoring program. Quantitative data are needed to better understand the biology and ecology of the species and to build and refine detection, population and habitat models. Because capture rates of sandhill dunnarts in Western

Australia have been very low, it may be that many studies will have to be collated to build these models. Ideally, information should be collected in the same manner, and using the same standard protocol, across each trapping program. It is recommended that the following information be recorded. Each sub-heading below corresponds with the datasheet of the same name in Appendix 2.

### Survey and conditions

For each survey, the following should be documented:

- Survey name
- Observers
- Purpose (survey or monitoring)
- General location
- GPS coordinates of pitfall trap 1 and datum
- Type and size of traps used, drift fence length and height
- Trap layout (number of trap lines, number of traps per line, distance between lines, distance between traps and a diagram)
- Total trap nights
- Total sandhill dunnarts captured

For each date of trapping, the following environmental conditions should be documented:

- Daily minimum and maximum temperatures, and any rainfall, at the site
- Moon illumination (%) – this Information can be obtained from http://www.astronomyknowhow.com/month-percentage.php after the survey
- Night light - Very dark, Dark, Detail seen, Bright
- Wind – Calm, Light, Moderate, Strong, Gusty
- Local rain conditions – Nil, Drizzle, Showers, Moderate, Heavy, Fog

### Broad scale site information

The broad-scale parameters for each site can be obtained from the GIS layers shown in Table 4, in the office.

**Table 4 Spatial data obtained from GIS layers.**

| GIS Layer | Data |
|---|---|
| Geology map of WA | Geology code |
| Regolith map of WA | Regolith |
| Soils of WA | Soil code |
| Landscape character types | Landscape character |
| | Landscape character type |
| Physiognomic vegetation | Form |
| | Structure |
| | Floristic description |

## Local site information

The following local site parameters should be documented:

- Survey name
- Observers
- Date start and end for survey
- Site Number
- Last fire (obtained from Landgate Firewatch website): Year of last fire, Season of last fire, Size of last fire (hectares)
- Location (Longitude, Latitude and datum)
- Landform - Dune crest, Dune slope, Dune foot-slope, Swale, Floodplain, Hillslope, Hillcrest, Stony plain, Sandy rise
- Dry soil surface characteristics – Description, Cracking, Loose, Soft, Firm, Hard, Surface crust, Surface flake.
- Soil colour – Red, Orange, Yellow, Brown and shade (pale or dark).

## Recent fire and disturbance

- Evidence of recent fire – No evidence, < 1 year, 1-3 years, 3-10 years
- Recent fire intensity – Patchy, Low, Moderate, High, Extreme
- Intensity of disturbance - tracks, cleared re-growth, fence lines, power lines, rubbish, watering points
- Presence and extent of fauna activity - Dung, tracks, trails, burrows, grazing, sighting, carcass, wallow, diggings, latrine

## Vegetation structure

Specht/Muir habitat classification using the table provided on the back of the datasheet.

For the upper, mid-level and lower strata, record by eye:

- Growth form
- Height
- Dominant taxa (including voucher specimens as required)

- Cover
- Extent of budding, flowering, fruiting and seeding
- Cover of bare ground, stones, coarse woody debris, rocks, logs, litter

For spinifex, document by eye:

- Dominant life stage
- Cover
- Average height
- Maximum height
- Average inter-hummock distance

### Point-intercept transect

Comprehensive methods for quantifying the structure of vegetation in sandhill dunnart habitats have been developed by Ward *et al.* (2008), and subsequently used to determine predictors of dunnart capture rates and relative abundance (Moseby *et al.* 2016). This procedure can be used to calculate percent cover for each feature, and vertical habitat complexity, based on the number of 'hits' relative to the total number of intercept points surveyed (White *et al.* 2012).

Run a 50 m tape measure (or point wheel), offset by 5m, and parallel to each trapline. At 1m intervals, record the categories and height for the features shown in Table 5 for ground, lower, mid and upper level vegetation (if present). Triodia hummocks are defined as contiguous areas of live Triodia (not dead stalk material lying prostrate) after Moseby *et al.* (2016).

### Point-intercept spinifex

At 10 m intervals on the point-intercept transect, record the following data on Triodia hummocks:

- Height of the nearest Triodia hummock (height of tallest leaf, measured with a 1m ruler and determined by lowering hand until touching the uppermost leaf)
- Diameter at widest part
- Distance to nearest spinifex hummock
- Life stages present and dominant life stage
- Canopy density

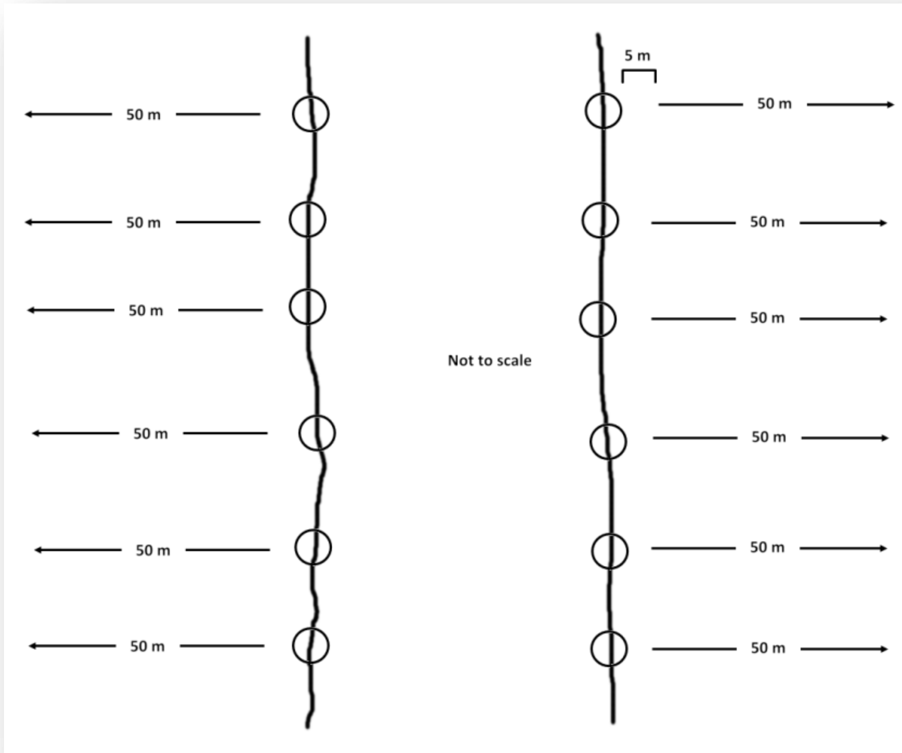


**Figure 7 Diagrammatic representation of point-intercept transect surveys.**

**Table 5 Features recorded at 1m intervals along the 50 m transect for four levels of strata.**

| Ground | Lower + height (m) | Mid + height (m) | Upper + height (m) |
|---|---|---|---|
| Sand | Succulent | Chenopod shrub | Shrub mallee |
| Crust | Weed | Heath shrub | Tree mallee |
| Stones | Hummock | Woody shrub | Tree |
| Rocks | Tussock | | |
| Litter | Sedge | | |
| Course woody debris | Rush | | |
| Small logs (< 50 mm) | | | |
| Large logs (≥ 50 mm) | | | |

## Fauna Captures

For all animals captured record:

- Date
- Species
- Site
- Trap type and number

- New capture, re-trap or recapture
- Age (adult or juvenile) and sex
- Weight
- Head-body length (from snout to base of tail)
- Head length
- Long pes
- Tail length
- For males - scrotal width
- For females - stage of pouch development (after McLean (2015) shown on the back of the datasheet ) and number of pouch young present
- Notes – for animal numbers, markings, DNA samples, scats etc.

## Data management and analysis

The data collected can be entered into the electronic forms (corresponding with the paper datasheets) in the database that has been prepared in conjunction with these guidelines.

The commonly used measure of relative abundance for small mammals is the number of animals trapped relative to the number of trap nights (also known as the trap success rate). This can be calculated per survey, site, sampling night or for each trap type. The equation is:

$$\text{Captures per 100 trap nights} = \frac{\text{number of animals captured} * 100}{\text{number of trap nights}}$$

Examples of the types of analyses that can be performed when sufficient data has been consistently collected include:

- Annual, seasonal and spatial variation in the relative abundance (e.g. captures per 100 trap nights) of the sandhill dunnart population
- Drivers of temporal and spatial variation in the sandhill dunnart population
- Factors affecting detectability, including trap effort and environmental conditions
- Influence of habitat type and structure on relative abundance and detectability

## Camera trapping

Camera traps have a number of advantages over conventional trapping, most notably that they can be used autonomously for extended periods, and as such are efficient both logistically and in terms of cost. The main disadvantages of camera trapping are that smaller species can be difficult to identify and that generally it is not possible to differentiate between individuals of a species. However, camera traps are likely to be useful for initial detection surveys and as an adjunct method for surveying and monitoring of a rare and sparsely distributed species (Meek *et al.* 2012), such as the sandhill dunnart.

Trials are currently underway to determine the most effective protocols for camera trapping of sandhill dunnarts in the Great Victoria Desert of Western Australia (Turpin 2015a, b, c; Turpin and Lloyd 2014; Vimy Resources Limited 2015). Until more specific information is available, the following general guidelines are summarised from Meek et al. (2012) and DEC (2011) SOP No.5.2 Remote operation of cameras. Jeff Turpin (pers. comm.) also provided advice.

- Use of a camera that has a video function is recommended such as the Bushnell Trophy Cam Max
- Place cameras on flat or gently sloping ground with a limited amount of vegetation in the field of view, to limit false triggers by the movement of vegetation in windy conditions
- Set the camera 20-30 cm above ground, 1-1.5 m from the target area
- Face the camera in a southerly direction to avoid sun glare during daytime shots
- Set the camera on video for 5-10 seconds with one minute interval between video recording periods
- Careful consideration of whether to use baits or lures should be given, as their use may interrupt the natural behaviour of animals. It may also bias the capture rate at the site and potentially increase the chance of encountering a predator. However, it may also increase the likelihood of detecting a sandhill dunnart during surveys.

### Data collection, storage and analysis

For each camera set, the following datasheets should be completed (see Appendix 2):

- Local site information

- Recent fire and disturbance
- Vegetation structure
- Camera trapping

There are a number of open source wildlife camera trapping software programs available, which can be used to store and analyse wildlife camera trapping data. Two widely used packages include:

- CameraBase (www.atrium-biodiversity.org/tools/camerabase/)
- CPW Photo Warehouse (http://cpw.state.co.us/learn/Pages/ResearchMammalsSoftware.aspx)

# Monitoring

One of the priorities arising from the Great Victoria Desert Biodiversity Trust sandhill dunnart workshop was the need to establish a long-term monitoring program. A standardised program will provide a consistent approach by controlling for variation in monitoring techniques.

The long-term monitoring protocol follows on from the survey guidelines above, whereby the collection of data on a number of local habitat, environmental and disturbance parameters is also recommended. Monitoring will mean that changes in these parameters will be also captured. However, additional data will be required to answer specific questions related to the influence of threatening processes on the sandhill dunnart such as predation pressure and fire.

### SITE SELECTION

Sandhill dunnarts are rare, infrequently detected, and highly mobile and have an unknown distribution in Western Australia, making site selection for monitoring challenging. It is therefore recommended that once the sandhill dunnart has been detected in an area, then an ongoing monitoring program should be established at that site. The number of sites, and survey design, should follow the pitfall trapping protocol above with at least four sites (2 km apart) established within each monitoring area. The establishment of two camera traps (based on the camera trapping protocol above) is also recommended. These should be placed at least 100 m away from the pitfall trap array. Cameras should be set to operate for the duration of the trapping period.

### FREQUENCY OF MONITORING

Once a site has been selected for monitoring, then bi-annual monitoring should be undertaken, in Autumn and Spring each year, excluding the period when young are deposited in nests from mid-October onwards.

### TIME PERIOD OF MONITORING

High variability in fauna populations and environmental variables means that long-term data sets are needed to ensure sufficient statistical power to detect an effect of covariates on relative abundance and detectability (Field *et al.* 2007; Field *et al.* 2005). Long-term monitoring is especially important for adaptive management programs (DSEWPaC 2011; Lindenmayer and Likens 2009) such as that proposed for the sandhill dunnart in Western Australia. A minimum of six, but preferably at least 12 years is required to account for population variability of fauna in the semi-arid and arid regions of Australia, with sufficient certainty (Kutt *et al.* 2009). This is likely to be the case for a highly mobile species with low detection rates, like the sandhill dunnart.

## MARKING ANIMALS

If long-term monitoring is planned, then permanent marking is recommended to gain information on site fidelity, longevity and movements. Each sandhill dunnart trapped should be marked with coded ear notches as described in DEC (2009c) SOP No. 12.2 Permanent marking of mammals using ear notching.

## DATA COLLECTION AND REPORTING

Table 6 shows which datasheets should be filled out during each stage of a monitoring program. Broad scale site information will not change in the short or medium term and thus, this datasheet will only have to be filled out during the first survey / round of monitoring. Datasheets on survey and conditions, local site information, fire, disturbance, fauna captures and camera trapping should be filled out during each round of monitoring. Vegetation structure may change in the medium term and thus the vegetation structure and point intercept datasheets should be filled out initially and then annually in spring, when the intensity of resource abundance (e.g. flowering and seeding) can be scored.

Data collected during each round of monitoring can be entered into the sandhill dunnart database being prepared in conjunction with these guidelines.

**Table 6 Datasheets to be filled out during each stage of monitoring**

| Frequency | Datasheet |
|---|---|
| **First survey/round of monitoring** | Survey and Conditions |
| | Broad Scale Site Information |
| | Local Site Information |
| | Recent Fire and Disturbance |
| | Vegetation Structure |
| | Point Intercept |
| | Point Intercept Spinifex |
| | Fauna Captures |
| | Camera Trapping |
| **Each 'round' of monitoring** | Survey and Conditions |
| | Local Site Information |
| | Recent Fire and Disturbance |
| | Fauna Captures |

| Frequency | Datasheet |
|---|---|
| | Camera Trapping |
| **Additional to above during spring annually** | Vegetation Structure |
| | Point Intercept |
| | Point Intercept Spinifex |

## PROGRAM REVIEW

The survey and monitoring guidelines presented in this report are based on the national survey guidelines for threatened mammals, results from sandhill dunnart surveys in South Australia, and surveys in Western Australia where detection rates have been low. It is anticipated that as more data are collated and analysed, the recommendations for surveying and monitoring the sandhill dunnart in Western Australia will be revised and improved upon as part of an adaptive process.

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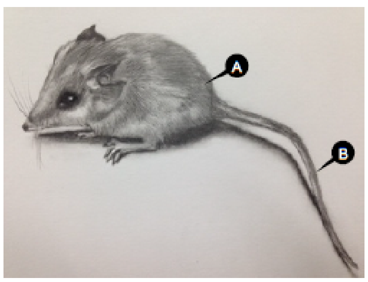
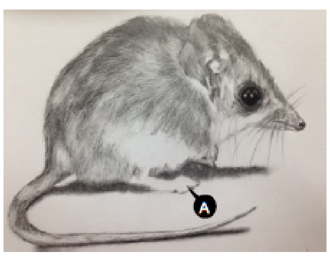
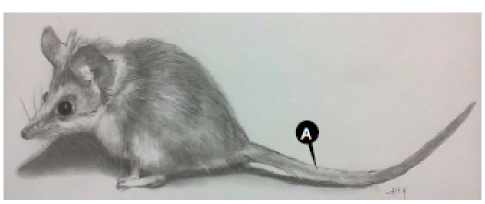
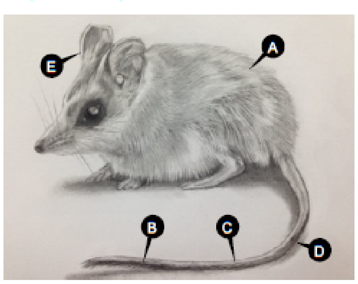
# Appendix 1

## Identification guide from Vimy Resources Limited (2015), p 72.

| Species | Physical Characteristics and Identifying Features | | | |
|---|---|---|---|---|
| | Head / ears / feet | Tail | General body | |
| ***S. crassicaudata***  | Large eyes, blaze patch but in WA generally no pronounced head stripe, prominent ears extended and large (15mm) | A Tail fat, carrot-shaped and less than H/B length (mean 55mm) | **Weight:** | 15gm |
| | | | **Head/Body (H/B) length:** | 75mm |
| | | | **Body size:** | Very small |
| | | | **Colour:** | Dorsal surface sandy pale brown to grey, ventral fur white |
| ***S. dolichura***  | Large eyes with thin black eye-ring. Ears large, mean length 18mm | B Tail thin, 20% longer than head/body length (mean 90mm). Dorsal surface grey with white base | **Weight:** | 13gm |
| | | | **H/B length:** | 74mm |
| | | | **Body size:** | Very small |
| | | | **Colour:** | A Dorsal fur pale to dark grey.<br>Cheeks brownish. Ventral fur – white |
| ***S. hirtipes***  | Large eyes.<br>A Long broad hind feet (16-19mm) covered with silvery hairs. Ears 15mm | Base of tail thickened. Tail length - mean 85mm. Tail colour pinkish white | **Weight:** | 15gm |
| | | | **H/B length:** | 77mm |
| | | | **Body size:** | Very small |
| | | | **Colour:** | Brown to yellow brown above white fur below |
| ***S. ooldea***  | Large eyes and ears, triangular dark patch on crown and forehead in front of eyes | A Tail thickened, slightly longer than body (mean 78mm) | **Weight:** | 11gm |
| | | | **H/B length:** | 72mm |
| | | | **Body size:** | Very small |
| | | | **Colour:** | Greyish/brown yellow above, white below |
| ***S. psammophila***  | Large eyes, black eye rings<br>E Large ears with black anterior bristles.<br>Dark patch on forehead.<br>Long rear legs. All legs and underbelly white fur. | C Tail thin and tapered, longer than H/B length (mean 118mm).<br>B Black grey ventral hair fin in final quarter.<br>D Tail bi-colour – dorsal light grey/buff, with darker grey base | **Weight:** | 36gm |
| | | | **H/B length:** | 97mm |
| | | | **Body size:** | A Larger body than any other Dunnart recorded in the region |
| | | | **Colour:** | Dorsal fur grey to brindle, underside white |

## Identification guide modified from Turpin (2015b)

The table below shows the species of small mammal likely to be trapped in the Great Victoria Desert and their distinguishing features.

| Common Name | Distinguishing features | Typical habitat |
|---|---|---|
| **Dasyurids** | | |
| **Sandhill Dunnart** *Sminthopsis psammophila* | Large, black-forehead, bi-coloured tail with a crest of stiff black hairs along underside. Tail length (up to 128 mm) is longer than the head-body length (up to 114 mm) | Sand dunes or sandplains |
| **Ooldea Dunnart** *Sminthopsis ooldea* | Tail slightly longer than head-body length (average body length is 55-80 mm with a tail of 60-93 mm) | Sand dunes or sandplains |
| **Little Long-tailed Dunnart** *Sminthopsis dolichura* | Tail > head-body, interdigital footpads with 5 enlarged granules. | Sand dunes or sandplains |
| **Stripe Faced Dunnart** *Sminthopsis macroura* | Tail usually fat, about 1.25 times head-body length. Dark line on centre of forehead | Low shrubland or spinifex grassland on sandy soils |
| **Hairy-footed Dunnart** *Sminthopsis hirtipes* | Tail slightly longer than head-body, interdigital footpads covered in hairs. | Sand dunes or sandplains |
| **Fat-tailed Dunnart** *Sminthopsis crassicaudata* | Tail swollen at base and shorter than head-body length | Salt lake fringes, sandplains |
| **Woolley's Pseudantechinus** *Pseudantechinus woolleyae* | Large False-antechinus with tapering tail, often swollen at base. | Rocky outcrops |
| **Brush-tailed Mulgara** *Dasycercus blythi* | Large (can be over 100 g, tail up to 900 mm, head-body up to 150 mm) Mulgara with tail ending in a dark terminal brush. Pelage is sandy brown. | Sand dunes or sandplains |
| **Wongai Ningaui** *Ningaui ridei* | Small, head-body = tail, around 65 mm, separated from dunnarts by footpads. | Sandplains, salt lake fringes |
| **Mallee Ningaui** *Ningaui yvonneae* | Small, head-body = tail, around 65 mm, separated from dunnarts by footpads. | Mallee |
| **Rodents** | | |
| **Sandy Inland Mouse** *Pseudomys hermannsburgensis* | No incisor notch, no eye ring, sandy coloured above with pale white below. | Sand dunes or sandplains |
| **Desert Mouse** *Pseudomys desertor* | No incisor notch, chestnut eye ring. | Sand dunes or sandplains |
| **Spinifex Hopping Mouse** *Notomys alexis* | Large (95 – 115 head-body), with long, brush-tipped tail (140 mm). Elongate hindlegs. | Sand dunes or sandplains |
| **Mitchell's Hopping Mouse** *Notomys mitchelli* | Large (100-125 head-body), with long tail (150 mm) with tuft of black hair at tip. Shiny white hair from throat to chest. | Mallee woodland with sandy soil |
| **House Mouse** *Mus musculus* | Notch on inner surface of upper incisor | Most habitat types |

The footpads of Dasyurids can be used as an aid to identification and the five that are likely to be encountered in the Great Victoria Desert are shown below (from Gomez *et al.* undated).

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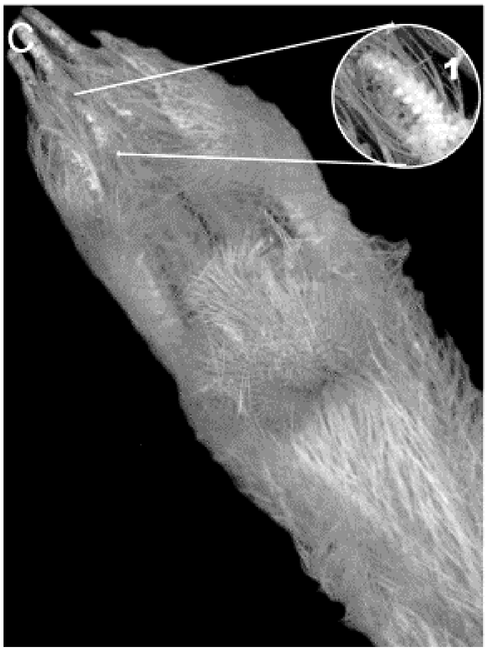
<tr>
<td>
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<tr>
<td>Sminthopsis hirtipes pads - covered in small granules and long hairs</td>
<td>Sminthopsis crassicaudata pads - small rounded granules</td>
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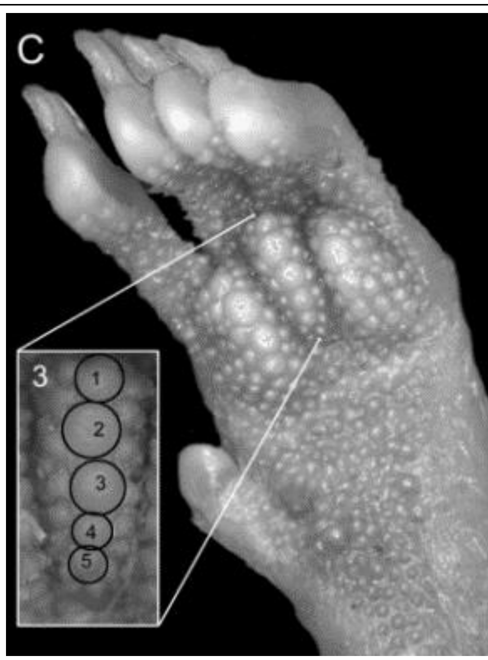
<td>
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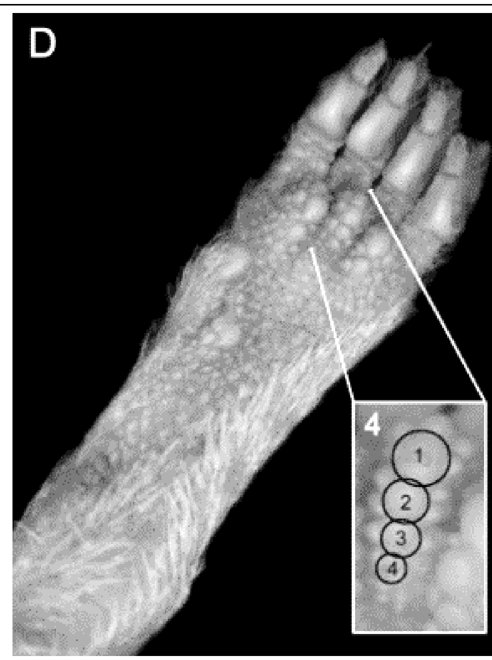
<td>
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<tr>
<td>Sminthopsis dolichura pads – 5 enlarged granules</td>
<td>Sminthopsis ooldea pads - 3 – 4 enlarged granules</td>
</tr>
</table>


***Sminthopsis psammophila*** pads - bifid, Small angular granules

# Appendix 2

**Survey and Conditions**

| | | | | | | |
|---|---|---|---|---|---|---|
| Survey name | | Purpose (cross) | | Survey | | Monitoring |
| Observers | | | | | | |
| General location | | | | | | |
| GPS of pit 1 and datum | | | | | | |

**Traps and captures**

| | | | | |
|---|---|---|---|---|
| Trap size (cm) | Width | | Depth | |
| | Number | | Distance between (m) | |
| Trap lines | | | | |
| Pitfall traps per line | | | | |

| Total | |
|---|---|
| Trap nights | SHD Captures |
| | |

**Describe trap layout:**

| |
|---|
| |
| |
| |
| |

| | |
|---|---|
| Diagram over page (cross) | |

**Conditions**

| | Temp. (°C) | | Rain | Fill with codes in bold in table below | | | |
|---|---|---|---|---|---|---|---|
| Date | Min. | Max. | mm | Moon illumination (%) | Night light | Wind | Rain |
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**Condition codes**

| NIGHT LIGHT | Description | WIND | Description | RAIN | Description |
|---|---|---|---|---|---|
| **Very dark** | no moon and cloud | **Calm** | None | **Nil** | Dry |
| **Dark** | ¼ moon, or moon and heavy cloud | **Light** | Leaves rustle | **Drizzle** | Drizzle or light rain |
| **Detail seen** | moon and clear sky | **Moderate** | Branches move | **Showers** | Isolated showers |
| **Bright** | ½ moon and no cloud | **Strong** | Impedes progress | **Moderate** | Steady moderate rain |
| | | **Gusty** | Strong with gusts | **Heavy** | Heavy rain in past 24hrs |
| | | | | **Fog** | Fog/mist |

## Broad Scale Site Information

| | | | |
|---|---|---|---|
| Survey | | Observer | |
| Date of documentation | | Note | |
| *Spatial data | The spatial are obtained from the corresponding fields in the layers specified in the first row of the table below. | | |

| Spatial layer* | Geology map of WA | Regolith map of WA | Soils of WA | Landscape Character Types | | Physiognomic vegetation | | |
|---|---|---|---|---|---|---|---|---|
| Site No. | Geology code | Regolith | Soil code | Landscape character | Landscape character type | Form | Structure | Floristic description |
| 1 | Qs | Sandplain | AB47 | Great Victoria Desert Dunefields | Leeman Sandplains | Spinifex grassland | Tree- and shrub-steppe | Hummock grassland (*Triodia* spp.) with scattered eucalypts (*Eucalyptus gongylocarpa*) over wattle scrub (Acacia spp.) or mallee (*E. youngiana*) |
| | | | | | | | | |
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## Local Site Information

| Survey name | | Observers | | | |
|---|---|---|---|---|---|
| Date start | | Date end | | GPS datum | |

*Up to date fire data can be obtained from the Landgate Firewatch website.

**Landform:** Dune crest, Dune slope, Dune foot-slope, Swale, Floodplain, Hillcrest, Hillslope, Stony plain, Sandy rise
**Dry soil surface:** Cracking, Loose, Soft, Firm, Hard, Surface crust, Surface flake
**Soil colour:** Red, Orange, Yellow, Brown **Soil Shade:** Pale, Dark

| Site No. | Locations | | Last fire* | | | Fill from lists above | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Longitude (E) | Latitude (N) | Year | Season | Hectares | Landform | Dry soil surface | Soil colour | Soil Shade |
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## Recent Fire and Disturbance

| | | | |
|---|---|---|---|
| Survey name | | Observers | |
| Site No. | | Date | |

| Cross | Evidence of recent fire |
|---|---|
| | No evidence |
| | < 1 year |
| | 1-3 years |
| | 3-10 years |
| | 10-20 years |
| | 20+ years |
| **Fill** | **Burn** |
| | % site burnt |
| | Scorch height (m) |

| Cross | Recent fire intensity |
|---|---|
| | Patchy |
| | Low |
| | Moderate |
| | High |
| | Extreme |

| Intensity score 0 = No evidence 1 = light, 2 = moderate, 3 = heavy | |
|---|---|
| **Disturbance (cross out below if none)** | **Intensity score if present** |
| Tracks | |
| Clearing | |
| Cleared re-growth | |
| Earthworks | |
| Fence lines | |
| Mining | |
| Power lines | |
| Rubbish | |
| Watering points | |

**Fauna activity**

| Cross out below if none | If present fill with intensity score 1 = light, 2 = moderate, 3 = heavy | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Dung** | **Tracks** | **Trails** | **Burrow** | **Grazing** | **Sighting** | **Carcass** | **Wallow** | **Diggings** | **Latrine** |
| Cat | | | | | | | | | | |
| Dog | | | | | | | | | | |
| Fox | | | | | | | | | | |
| Goat | | | | | | | | | | |
| Rabbit | | | | | | | | | | |
| Goanna | | | | | | | | | | |
| Cattle | | | | | | | | | | |
| Camel | | | | | | | | | | |
| Sheep | | | | | | | | | | |
| Echidna | | | | | | | | | | |
| Emu | | | | | | | | | | |
| Kangaroo | | | | | | | | | | |

| Notes |
|---|
| |
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## Vegetation Structure

| Survey name | | Obervers | | | Date | |
|---|---|---|---|---|---|---|
| Site No. | | Photo Nos | | | | |
| Specht / Muir Classification (See over) | | | | | | |

**Codes**

| Growth Form |
|---|
| Tree |
| Tree mallee |
| Shrub mallee |
| Woody shrub |
| Heath shrub |
| Chenopod shrub |
| Tussock |
| Hummock |
| Succulent |
| Weed |
| |

| Cover | % |
|---|---|
| Dense | > 70 |
| Mid-dense | 30-70 |
| Sparse | 10-30 |
| Very sparse | <10 |
| Isolated plants | <1 |
| Isolated clumps | <1 |

**Ground features**

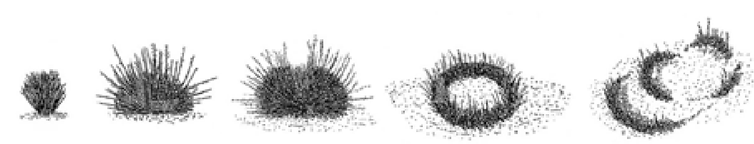
| | Cover (%) |
|---|---|
| Bare ground | |
| Crust | |
| Stones | |
| Rocks | |
| Litter | |
| Coarse woody debris | |
| Logs < 50 mm | |
| Logs ≥ 50 mm | |

**Vegetation**

| Strata | Growth form | Ht (m) | Cover | Dominant taxa | Voucher No. | Emergent taxa | Voucher No. | Fill with intensity score 0 = None, 1 = light, 2 = moderate, 3 = heavy | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Buds | Flowers | Fruits | Seeds |
| Lower | | | | | | | | | | | |
| Mid 1 | | | | | | | | | | | |
| Mid 2 | | | | | | | | | | | |
| Upper | | | | | | | | | | | |

**Spinifex**

| | |
|---|---|
| Spinifex dominant stage (1-5 see right) | |
| Spinifex cover (%) | |
| Spinifex average height (m) | |
| Spinifex maximum height (m) | |
| Spinifex average inter hummock distance (cm) | |



Stage 1 Stage 2 Stage 3 Stage 4 Stage 5

**Specht / Muir Habitat Classification**

| | Dense (70-100%) | Mid-dense (30-70%) | Sparse (10-30%) | Very sparse (<10%) |
|---|---|---|---|---|
| Trees 5-10m | Low closed forest | Low open forest | Low woodland | Low open woodland |
| Trees <5m | Very low closed forest | Very low open forest | Very low woodland | Very low open woodland |
| Mallee (>3m) | Closed mallee | Mallee | Open mallee | Very open mallee |
| Low Mallee (<3m) | Closed low mallee | Low mallee | Open low mallee | Very open low mallee |
| Shrubs > 2m | Tall closed shrubland | Tall shrubland | Tall open shrubland | Tall very open shrubland |
| Shrubs 1-2m | Closed shrubland | Shrubland | Open shrubland | Very open shrubland |
| Shrubs < 1m | Low closed shrubland | Low shrubland | Low open shrubland | Low very open shrubland |
| Mat plants | Closed mat plants | Mat plants | Open mat plants | Very open mat plants |
| Hummock grasses | Closed Hummock grassland | Hummock grassland | Open hummock grassland | Very open hummock grassland |
| Tussock grasses | Closed (tussock) grassland | (Tussock) grassland | Open (tussock) grassland | Very open (tussock) grassland |

**Point-Intercept Transect**

| Survey name | | Observer | |
|---|---|---|---|
| Site | | Scribe | |
| Date | | Note | |

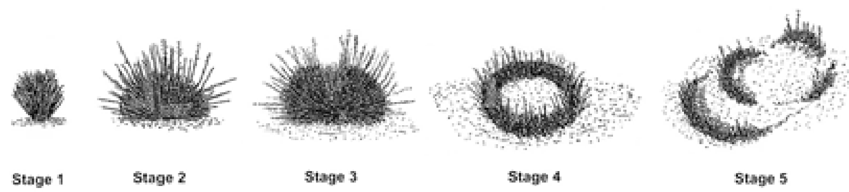
| Point | Fill from table below, giving height in metres to nearest 0.5 m | | | | | | |
|---|---|---|---|---|---|---|---|
| (m) | Ground | Lower | Ht | Mid | Ht | Upper | Ht |
| 1 | | | | | | | |
| 2 | | | | | | | |
| 3 | | | | | | | |
| 4 | | | | | | | |
| 5 | | | | | | | |
| 6 | | | | | | | |
| 7 | | | | | | | |
| 8 | | | | | | | |
| 9 | | | | | | | |
| 10 | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |
| 21 | | | | | | | |
| 22 | | | | | | | |
| 23 | | | | | | | |
| 24 | | | | | | | |
| 25 | | | | | | | |

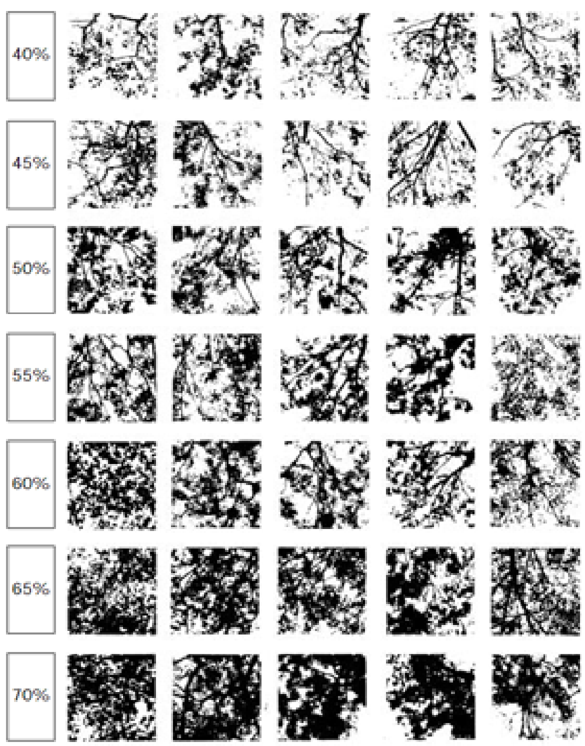
| Ground | Lower | Mid | Upper |
|---|---|---|---|
| Sand | Succulent | Chenopod shrub | Shrub mallee |
| Crust | Weed | Woody shrub | Tree mallee |
| Stones | Hummock | | Tree |
| Rocks | Tussock | | |
| Litter (including dead / black spinifex) | | | |
| Coarse woody debris | | | |
| Small logs (< 50 mm) | | | |
| Large logs (≥ 50 mm) | | | |

**Point-Intercept Spinifex**

| Survey name | | Observer | |
|---|---|---|---|
| Site | | Scribe | |
| Date | | Note | |

| Spinifex | Height | Max. diam. | Separation | Life stages present | Dominant life stage | Hummock canopy density |
|---|---|---|---|---|---|---|
| Point | cm | cm | cm | 1-5 (pic. below) | 1-5 (pic. below) | % (pic. below) |
| 10 m | | | | | | |
| 20 m | | | | | | |
| 30 m | | | | | | |
| 40 m | | | | | | |
| 50 m | | | | | | |



## Fauna Captures

| Survey | | Animal handler | |
|---|---|---|---|
| Note | | Scribe | |

**Trap #: P** = Pit, **E** = Elliot **AGE: A** = Adult, **SA** = Sub-Adult, **J** = Juvenile **N/R/RT: N** = New, **RT** = Re-Trapped during same survey **R** = Recapture from previous survey

**Pouch (See pictures over): UD** = Undeveloped, **DE** = Developing, **MA** = Mating, **PR** = Pregnant, **PY** = Pouch young, **NY** = Nest young, **RE** = Regressing

| Date | Species | Site | Trap | Age / Sex | Weight | N/RT/R | Head Body length | Head length | Long pes | Tail length | Scrotal width | Pouch | PY | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | # | # | | (g) | | | | (mm) | | | CODE | No | |
| 24/09/2015 | | 3 | P7 | AF | 32.7 | N | 97 | 33.5 | 26.5 | 114.5 | | PY | 3 | |
| | | | | | | | | | | | | | | |
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| Stage | Pouch description | Life stage (Months) | Photo |
|---|---|---|---|
| 0 | Pouch small (hard to find in first year females), clean, no middle or edge ridge visable, pale. Teats small and pale (first year female, button shape; second year female, elongated). | Undeveloped (Jan-Mar) | |
| 1 | Pouch small, clean and edge ridge just visible. Teats pale pink and slightly larger than Stage 0. | Developing (Apr-Jul) |  |
| 2 | Pouch small to medium, clean, middle and edge ridges starting to develop. Teats pale/dark pink and becoming more visible. | Mating (Aug-Sep) |  |
| 3 | Pouch large, middle and edge ridges are fully developed, pouch is clean. Teats large, elongated and red/dark pink. | Pregnant (?) (Sep-Oct?) |  |
| 4 | Pouch young present, pouch fully developed. Teats large, elongated and red. | Pouch young (Sep-Oct) |  |
| 5 | Pouch fully developed, no pouch young, stain in pouch and around teats, lactating. Teats large, elongated and red. | Nest young (Nov-Dec?) |  |
| 6 | Pouch regressing after young are weaned, similar to Stage 2, possible stain around teats. | Regressing (Dec-Feb?) | |

**Camera Trapping**

| | | | | | |
|---|---|---|---|---|---|
| Site | | Observer | | | |
| Datum | | Long (E) | | Lat. (N) | |
| Date set | | Date retrieved | | Total camera nights | |

If set independent of a trap grid, fill out data sheet for (Tick):

☐ Local Site Information ☐ Recent fire and disturbance ☐ Vegetation Structure

| | | | | | |
|---|---|---|---|---|---|
| Camera make and model | | | | | |
| Camera code | | | | Lock Key | |
| Direction (Aspect°) | | Height (cm) | | Dist. to target (m) | |
| Angle to ground (°) | | Facing | ☐ Animal Trail ☐ Fence Gap ☐ Other | | |
| Camera Settings: | | | | | |
| | | | | | |
| Battery type | | Battery replacement date | | | |
| Card number | | Number of images | | | |
| Bait / Lure (provide full details) | | | | | |

| Comments / sketch / problems/site photo |
|---|
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| ☐ Lens cleaned (tick) |