# Threatened Species Assessment

## *Miniopterus orianae bassanii*
## Southern Bent-wing Bat

### Taxonomy

*Miniopterus schreibersii bassanii* Cardinal & Christidis, 2000

The Southern Bent-wing Bat *Miniopterus orianae bassanii* is currently recognised as a subspecies of the Common Bent-wing Bat *Miniopterus orianae*. This taxon was formerly called *M. schreibersii,* however genetic studies reveal that the Australian bats are distinct from the overseas *M. schreibersii* (Appleton et al. 2004). Recent authors have recognised the name *orianae* (Woinarski et al. 2014, Jackson and Groves 2015). The long-fingered bats *(Miniopterus* spp.) have recently been elevated to family status (Miniopteridae), splitting them from the Vespertilionidae (Miller-Butterworth et al. 2007; Van Den Bussche and Hoofer 2004). There are three subspecies of the Common Bent-wing Bat, which are morphologically similar, but differ genetically and form separate maternity colonies (Cardinal and Christidis 2000). The Southern Bent-wing Bat was described in 2000 based on genetic and skull morphological differences (Cardinal and Christidis 2000). Further genetic analysis suggests it may be reproductively isolated from the sympatric Eastern Bent-wing Bat *M. o. oceanensis* and warrant full species status (Reinhold et al. 2000; Wood and Appleton 2010). Further taxonomic investigations are currently underway (Sigit Wiantoro and Kyle Armstrong, pers. comm., 2019). The Southern Bent-wing Bat is the largest of the three subspecies, having a mean weight of 15.7 g and a mean forearm length of 47.6 mm (Churchill 2008). It is currently not possible to reliably distinguish the Southern Bent-wing Bat from the Eastern Bent-wing Bat using traditional field-based techniques.

### Current conservation status

Listed as Critically Endangered under the *Environment Protection and Biodiversity Conservation Act 1999*.

Listed as threatened under the *Flora and Fauna Guarantee Act 1988* as *Miniopterus schreibersii (*SAC 1992).

Categorised as Critically endangered in the 2013 Advisory list of threatened vertebrate fauna in Victoria (DSE 2013).

### Proposed conservation status

Critically Endangered in Victoria

Criterion B2ab(i,iii,v)

Southern Bent-wing Bats are known from only two maternity caves in Victoria where females congregate to give birth to their young. Declines in the number of mature adults have been recorded in recent decades and may be continuing.  It is classified as having only one location as one of the threats to the species (the introduction of White-nosed Syndrome which is currently killing millions of bats in the USA) could impact the whole Victorian population rapidly due to the regular movements of bats between caves.  A risk assessment has considered that it is 'highly likely/almost certain' to be introduced into Australia in the next 10 years, and it is 'likely' that bats will be exposed.  Southern Bent-wing Bats were considered the species in Australia most likely to be impacted.

### Species Information

#### Description and Life History

The Southern Bent-wing Bat is a medium-sized, insectivorous bat. It is an obligate cave-dweller, roosting in limestone caves, coastal sandstone caves and volcanic lava tubes. A large proportion of the population aggregates during late spring and summer at maternity caves (which characteristically have high temperature and humidity),

although there is also interchange between the maternity cave and non-breeding caves during this period. Individuals are more dispersed during in autumn, winter and early spring, roosting in smaller numbers in more caves across a wider area. Wetlands are favoured sites for foraging (Stratman 2005), and individual bats can fly 20-30 km to foraging sites from roost sites (Bourne 2010). Some individuals have been recorded flying 70 km between roosting caves during a night (Emmi van Harten, pers. comm.).

Females give birth to a single young from mid-November to January (DELWP 2018). Sexual maturity is reached at two years, and individuals may live for up to 22 years (Lumsden and Gray 2001).

There is limited information on the diet of the Southern Bent-wing Bat, however a recent study in the summer/autumn of 2019 (Kuhne 2019) found that the diet consisted predominantly of moths (Lepidoptera) with smaller quantities of Diptera, Hymenoptera, Neuroptera, Orthoptera and Trichoptera also taken at times. A total of 67 species of moths were identified, some of which are associated with agricultural landscapes.

### Generation Length

The generation length of Southern Bent-wing Bats is estimated to be 10 to 12 years. This is based on the Mammal Action Plan (Woinarski et al. 2014) which used maximum longevity of 22 years from Lumsden and Gray (2001), in combination with females not breeding until the second year of their life.

### Distribution

The Southern Bent-wing Bat occurs in south-west Victoria and south-east South Australia (Cardinal and Christidis 2000). As an obligate cave-dwelling subspecies, its distribution largely reflects the distribution of caves within this area. The most easterly sites confirmed by genetic analysis are at Lorne and Pomborneit (Cardinal and Christidis 2000), where it co-occurs with the closely related Eastern Bent-wing Bat (*M. o. oceanensis*). Genetic testing of individuals throughout eastern Victoria and southern NSW have not revealed any recent records of Southern Bent-wing Bats outside this range (B. Appleton, pers. comm.). Genetic sampling of Bent-wing Bats using disused mines in central Victoria revealed only Eastern Bent-wing Bats, suggesting that the distribution of the Southern Bent-wing Bat does not extend into central Victoria (Lumsden et al. 2012). Extensive banding studies were undertaken in the 1960s on bent-wing bats (Dwyer 1969), and there are several records of individuals moving between the Warrnambool/Naracoorte population and sites north-east of Melbourne and in south-east NSW within the range of the Eastern Bent-wing Bat (Dwyer 1969; Seebeck and Hamilton-Smith 1967). The longest movement recorded was of an adult male banded in 1963 in north-east NSW and recaptured in 1965 at a cave near Warrnambool, a distance of 1300 km (Dwyer 1969). As there are very few of these long-distance records compared to the number of recaptures within the normal range, it is assumed that these are not typical and represent vagrants, data recording errors or possibly human assisted movements. Accordingly, these records have not been included in this assessment.

### Habitat

The Southern Bent-wing Bat has two key habitat requirements: roost sites and foraging areas. All known roost sites are underground, predominantly in limestone caves but also in lava tunnels, coastal cliff rock crevices and man-made tunnels. Different caves are used within and between seasons, as the bats seek the appropriate microclimatic conditions.

There are only three maternity sites for the Southern Bent-wing Bat: one in South Australia at Naracoorte and two in Victoria. The main Victorian maternity site is near Warrnambool in western Victoria. In January 2015, a second Victorian maternity site was located near Portland in far southwestern Victoria. This cave had rarely been monitored at this time of the year and so it was not known if this site had been regularly used or was a recently formed maternity colony. Monitoring every January since 2015 has revealed it has been used as a birthing site each year, although by smaller numbers than at the Warrnambool maternity cave (Tony Mitchell, Amanda Bush, Lindy Lumsden, unpublished data). It is not currently known how much interchange there is between this and the other two maternity caves.

The numbers of individuals using the non-breeding sites are usually fewer than in maternity caves. Although some non-breeding sites may contain several thousand individuals, smaller numbers are more typical, and individuals may also roost singly. The total number of bats recorded during winter censuses is typically less than the number recorded over summer, which suggests that there are additional, unknown over-wintering sites.

Cave microclimate is an important factor in determining the use of caves by bats. Populations of Southern Bent-wing Bats are dependent on maternity caves that have specific structural characteristics that allow heat and humidity to build up, so as to facilitate the rapid development of the young. High temperatures (approx. 30 degrees C) and high humidity levels (>80% RH) have been recorded within the maternity cave at Naracoorte suggesting that the heat produced by the bats themselves increases the temperature by up to 10$^{o}$C (Baudinette et al. 1994). In contrast, during winter bats select cool cave temperatures that facilitate entry into torpor, where they lower their body temperature to reduce energy expenditure (Hall 1982).

Foraging habitat is also a critical habitat requirement, although there is limited, specific information on foraging requirements. The Southern Bent-wing Bat has a fast, direct flight pattern (Dwyer 1965). Individuals radio-tracked from the Naracoorte maternity site concentrated their foraging time along a forested ridgeline within 3-4 km of the cave (Grant 2004). Wetlands are also used extensively, with individuals recorded flying considerable distances to reach these foraging areas. Limited foraging occurred in open pastures and within Radiata Pine (Pinus radiata) plantations, likely due to the lower availability of insects in these habitats (Grant 2004). Foraging can also occur over vineyards (Bourne 2010). The Southern Bent-wing Bat can travel long distances from the roost site, with lactating females recorded repeatedly returning to areas 23 - 25 km from the Naracoorte maternity cave, with one male recorded foraging 35 km from the roost site (Grant 2004; Bourne 2010). More recent studies have shown individuals flying 70 km between roosting caves, sometimes on a nightly basis (Emmi van Harten, pers. comm.).

**Threats**

The following summary is based on information in the draft Recovery Plan (DELWP 2018).

A range of threats have been identified as potentially impacting on the status of the Southern Bent-wing Bat. However, there is little empirical evidence to clearly identify which are the main cause/s of the current decline.

Management of roosting caves has in some cases reduced the suitability of these sites for the Southern Bent-wing Bat, including due to guano mining in the 1800s and early 1900s (Hamilton-Smith 1998). Some caves on private land are used as rubbish dumps, while inappropriate land use activities have occurred above others. Weed growth around entrances can obstruct flight spaces, and sometimes result in caves becoming unusable.

Some of the caves used by the Southern Bent-wing Bat currently receive (or did in the past) significant levels of human visitation. Disturbance can have a significant, long-lasting impact (Bush et al. 2016). If the disturbance occurs from late autumn to early spring it can cause the bats to use up valuable fat reserves as they rouse out of torpor. Disturbance during summer in the maternity sites can cause pups to fall to the ground reducing the numbers of juveniles surviving.

Since European settlement, approximately 90% of the native vegetation within the distribution of the Southern Bent-wing Bat has been cleared (DEWHA 2009). As native forested vegetation and wetlands appear to be preferred foraging habitat, especially during the critical breeding period (Grant 2004; Stratman 2005), these past changes are likely to have significantly impacted this subspecies. Any recent or future changes to foraging habitat within the foraging range (e.g. within approximately 35 km) of important roosting sites could impact on food availability or diversity, and hence the long-term survival of bats using these areas. Such changes could include draining or modifying wetlands, altering riparian areas, clearing native vegetation, including paddock trees, or inappropriate fire regimes. The clearing of native vegetation for agriculture has been extensive in the region surrounding the Warrnambool maternity cave, with only small pockets of native vegetation remaining. Further destruction of the remaining habitats in these areas could be highly detrimental to the survival of the subspecies. In addition, the use of agricultural pesticides may severely reduce the abundance of prey species, especially moths and their larvae.

Studies at the maternity sites have revealed evidence of pesticide residues within bat guano and bats. Concentrations of DDT, DDD and DDE along with other residues were found in both juveniles and adults (Allinson et al. 2006; Mispagel et al. 2004). It is not known if these chemicals have contributed to the recent decline in numbers of the Southern Bent-wing Bat, but in the past DDT has been implicated in significant mortality rates in bats in the USA (Geluso et al. 1976). Sub-lethal exposure has been reported to increase metabolic rates. The resulting reduction of body weight and the inability of bats to store sufficient fat reserves for hibernation, may lead to reduced over-winter survival (Allinson et al. 2006). DDE may also act as an anti-androgen interfering with sexual development and subsequent fertility of male bats (Allinson et al. 2006).

Drought may impact on the reproductive success and adult survival of Southern Bent-wing Bats by reducing prey availability if critical wetland foraging sites dry up, especially in addition to changed hydrological patterns due to

agricultural intensification. The Naracoorte area suffered below average rainfall over the 2000s, with 2006 recording the lowest rainfall since records began in 1868 (Bourne and Hamilton-Smith 2007). The drought in conjunction with unusually low temperatures during the breeding season in November and December 2006 are believed to have been the cause of significant mortalities of pups. Large numbers of emaciated pups were observed and in excess of 500 dead pups were found on the floor of the cave. Similar patterns could have occurred in the past in Victoria. In addition, in the future, climate change is likely to result in more extremes and variability in climatic conditions, including a reduction in rainfall and greater likelihood of droughts. This has the potential to increasingly impact on the survival and breeding success of the Southern Bent-wing Bat, due to the reduction in prey availability, free water to drink, and humidity in roosting caves.

The extent to which disease may have caused the recent decline is unknown, however a comprehensive health assessment has just been undertaken (Holz et al. 2018a,b,c, 2019a,b). Although a wide range of viruses, fungi and parasites were recorded, there was significant cause of decline identified, although a lower immune function suggests the population is under environmental stress. In 2008, at Naracoorte there was a high mortality rate of pups, with some individuals having severe ulcerative lesions as well as malnutrition (Bourne 2010).

In North America, a newly-emerged disease is currently decimating populations of hibernating, cave-roosting bats. White-nose Syndrome (WNS) is caused by the fungus (*Pseudogymnoascus destructans*) which presents as a visually conspicuous white fungus growth on the face, ears or wings of bats (Puechmaille et al. 2010). Millions of bat deaths have been attributed to the fungus since 2006, with mortality rates approaching 100% in some caves (Puechmaille et al. 2010). This disease is rapidly spreading across the USA and has now also been recorded in Canada and Europe (Puechmaille et al. 2010). It has not yet been recorded in Australia (Holz et al. 2018b). However, were it to be inadvertently introduced, it could have equally devastating consequences for Australian cave-dwelling bat species. The fungus grows optimally at temperatures of between 5 and 10 degrees C, with an upper growth limit of approximately 20 degrees C (Blehert et al. 2008). Many of the non-breeding caves used by bats in the winter are, therefore, within the temperature range suitable for the fungus. A risk assessment concluded that the introduction of White-nosed Syndrome was 'almost certain/highly likely' over the next 10 years and that Southern Bent-wing Bat would be the subspecies most impacted (Holz et al. 2016). The prevalence of other potential disease-causing fungi is unknown.

Feral Cats (*Felis catus*) and Red Foxes *(Vulpes vulpes)* have been recorded preying on bats as they exit caves, sometimes taking significant numbers. For example, Dwyer (1966) reported the accumulated remains of 476 Eastern Bent-wing Bats taken by a fox at a cave in NSW over a two-year period, and feral cats have been recorded preying on bats as they exited a maternity cave of Eastern Bent-wing Bats in eastern Victoria. The impact of introduced predators on the Southern Bent-wing Bat is not known. Black Rats (*Rattus rattus*) also occur in the maternity caves and are likely to prey on pups.

The impact of the recent proliferation of wind farms within the range of Southern Bent-wing Bats is currently unclear, however, it is possible that any wind farm built close to a significant roosting site could have a major impact on that colony due to collisions with the turbine blades. International studies suggest there may be cumulative impacts of wind farms on migratory species in particular, with the impacts greater at particular times of the year and under certain weather conditions (Kunz et al. 2007). Mortalities of Southern Bent-wing Bats have been recorded at Victorian wind farms, however the impact at the population level is currently unknown.

Little is known of the impact of fire on bats, although severe bushfire has been shown to reduce the relative abundance of Eastern Bent-wing Bats (Jemison et al. 2012). Fire could impact roosting bats if smoke was drawn into caves. Fire could also impact foraging habitat, and prey availability and composition for bats. Large, high intensity fires within the foraging range of significant roosting sites could therefore reduce food availability for Southern Bent-wing Bats.

## IUCN Criteria

**Criterion A. Population size reduction.**
Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4

| | Critically Endangered | Endangered | Vulnerable |
|---|---|---|---|
| A1 | ≥ 90% | ≥ 70% | ≥ 50% |
| A2, A3, A4 | ≥ 80% | ≥ 50% | ≥ 30% |

A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.

A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.

A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [*(a) cannot be used for A3*]

A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

*based on any of the following:*

(a) direct observation [*except A3*]

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

## Evidence:

**Eligible under Criterion A2 as Vulnerable**

The population reduction over the next 30 to 36 years is estimated to be 25 to 35%, based on (b), (c) and (e) above.

The Southern Bent-wing Bat was nationally listed as Critically Endangered in 2007, largely due to the massive decline in numbers in the SA component of the population from 100,000-200,000 to 20,000 individuals, since the 1960s. There have also been declines within the Victorian range, although these may not have been as dramatic. In the 1960s, the maternity colony at Warrnambool was estimated to contain 10,000-20,000 individuals (Dwyer and Hamilton-Smith 1965). In the 2000s, numbers were estimated from exit counts at 10,000-15,000 individuals (Grant and Reardon 2004; Gray 2000). Video recorded exit counts taken each summer between 2000 and 2004 suggested a decline from 15,000 individuals to less than 10,000 individuals (C. Grant, pers. comm. 2010).

Recent estimates (2018 and 2019) using improved technologies (thermal imaging cameras and automated tracking software) have enabled more accurate counts of 15,000-18,000 individuals. It is most likely that this apparent increase in numbers is due to improvements in counting techniques rather than actual increases in population numbers due to the current technique detecting more of the individuals that are present. Recent attempts to replicate the manual counting method from the early 2000s resulted in less than a third of the count obtained on the same night using the current approach, suggesting there has been a real decline (i.e. the manual counting approach recorded approximately 6000 bats, while the thermal camera technique recorded approximately 18,000 individuals; Amanda Bush and Lindy Lumsden unpublished data). As a result, it is not possible to accurately estimate the extent of the recent decline, but a conservative decline of 30% has been used here. The total numbers were then adjusted to represent only the adult breeding females, as used in the assessment of current numbers.

**Eligible under Criterion A3 as Vulnerable**

The population reduction over the next 30 to 36 years is suspected to be 10 to 60% (midpoint 35%), based on (b), (c) and (e) above.

As outlined above, it is expected that there will be declines into the future due to a number of threats, most notably the potential introduction of White-nosed Syndrome (WNS) into Australia, and the frequency and severity of droughts. Habitat loss and degradation continues, such as wetland drainage, further reducing foraging habitat. The main Warrnambool maternity cave is in a very unstable cliff line and parts of it could collapse, even if managed sympathetically.

**Eligible under Criterion A4 as Vulnerable**

The population reduction over any 30 to 36 year period, including both past and future, is suspected to be 10 to 60% (midpoint 35%), based on (b), (c) and (e) above.

| Criterion B. Geographic range in the form of either B1 (extent of occurrence) and/or B2 (area of occupancy | | | |
|---|---|---|---|
| | Critically Endangered Very restricted | Endangered Restricted | Vulnerable Limited |
| B1. Extent of occurrence (EOO) | < 100 km² | < 5,000 km² | < 20,000 km² |
| B2. Area of occupancy (AOO) | < 10 km² | < 500 km² | < 2,000 km² |
| AND at least 2 of the following 3 conditions: | | | |
| (a) Severely fragmented OR Number of locations | = 1 | ≤ 5 | ≤ 10 |
| (b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals | | | |
| (c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals | | | |

## Evidence:

**Eligible under Criterion B1 as Vulnerable**

The Extent of Occurrence (EoO) across the taxon's range is estimated to be 12,000 or 14,000 km², based accepted, post-1970 records in the Victorian Biodiversity Atlas (VBA), using current understanding of the distribution of the taxon (using records from genetic analysis). The lower limit excludes records from the Otways, and further work is required to fully define the limits of the distribution.

It is estimated to have one or two locations, depending on the threat. If WNS was introduced this could impact all roost sites, as it could spread between caves rapidly (hence all of the Victorian range could be considered just one location), or if the cause of the decline was cave collapse it would only affect one of the two maternity sites (hence two locations).

It is estimated to have a continuing decline in (i), (iii) and (v) above, due to loss of wetlands and other foraging habitat, under drought conditions and climate change. There are predictions of population declines in the future due to habitat lost and the risk of the introduction of WNS, but it is unknown when WNS might be introduced - it might happen next year, or it might not happen for 30 years.

**Eligible under Criterion B2 as Critically Endangered**

The Area of Occupancy (AoO) across the taxon's range is estimated to be 8 km², based on 2 x 2 km grids derived from accepted, post-1970 records in the VBA. This figure relies on there being only two maternity cave roosts in

Victoria (i.e. the smallest area essential for survival of the taxa), and then using the 2x2 km grid cell approach. As above, it has one or two locations. It has a continuing decline in (i), (iii) and (v) above.

| Criterion C. Small Population size and decline | | | | |
|---|---|---|---|---|
| | | Critically Endangered | Endangered | Vulnerable |
| Number of mature individuals | | < 250 | < 2,500 | < 10,000 |
| AND at least one of C1 or C2 | | | | |
| C1 | An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future): | 25% in 3 years or 1 generation (whichever is longer) | 20% in 5 years or 2 generations (whichever is longer) | 10% in 10 years or 3 generations (whichever is longer) |
| C2 | An observed, estimated, projected or inferred continuing decline AND least 1 of the following 3 conditions: | | | |
| (a) | (i) Number of mature individuals in each subpopulation | ≤ 50 | ≤ 250 | ≤ 1,000 |
| | (ii) % of mature individuals in one subpopulation = | 90 – 100% | 95 – 100% | 100% |
| (b) Extreme fluctuations in the number of mature individuals | | | | |

## Evidence:

**Ineligible under Criterion C**

It is estimated that there are 12,000 to 14,500 mature individuals, which exceeds the thresholds for criterion C.

| Criterion D. Very small or restricted population | | | |
|---|---|---|---|
| | Critically Endangered | Endangered | Vulnerable |
| Number of mature individuals (observed or estimated) | <·50 | <·250 | <·1,000 |
| D2 Only applies to the VU category<br>Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time. | - | - | D2. Typically:<br>AoO <·20 km2 or number of locations ≤ 5 |

## Evidence:

**Eligible under Criterion D2 as Vulnerable**

The taxon is estimated to be very restricted.

**Criterion E (Quantitative Analysis) was not addressed as the taxon does not have a detailed Population Viability Analysis.**

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