

# Southern Bent-wing Bat National Recovery Team Annual Progress Report 2022

*'Coordinating national conservation of the Southern Bent-wing Bat'*



February 2023

Encompassing Progress Achieved up to November 2022

## Acknowledgements

The format of this progress report has been adapted from the *Recovery team annual progress report (draft)*, Commonwealth of Australia 2017.

Cover image: Cosmos Magazine, prepared with photograph by Lindy Lumsden.

## List of abbreviations

ARI	Arthur Rylah Institute for Environmental Research, DEECA
DAFF	Department of Agriculture, Fisheries and Forestry (Previously DAWE)
DEECA	Department of Energy, Environment and Climate Action, Victoria (Previously DELWP)
DELWP	Department of Environment, Land, Water and Planning, Victoria
DEW	Department of Environment and Water, South Australia
EPBC Act	Commonwealth Environment Protection and Biodiversity Act 1999
GHCMA	Glenelg Hopkins Catchment Management Authority
LCLB	Limestone Coast Landscape Board, South Australia
NGT	Nature Glenelg Trust
NPWS	National Parks and Wildlife Service, South Australia
PIT	Passive Integrated Transponders
SBWB	Southern Bent-wing Bat
SWIFFT	State Wide Integrated Flora and Fauna Teams, Victoria
WNS	White-nose Syndrome

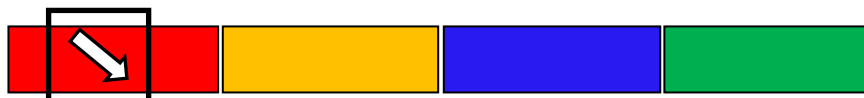
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# 1. SUMMARY ASSESSMENT OF PROGRESS

<b>EPBC Act Status</b>	Critically Endangered
<b>Recovery Plan</b>	DELWP 2020, available at: <a href="http://www.environment.gov.au/system/files/resources/8e34a419-3e71-4321-9a8b-45c25c4320bb/files/recovery-plan-southern-bent-wing-bat.pdf">http://www.environment.gov.au/system/files/resources/8e34a419-3e71-4321-9a8b-45c25c4320bb/files/recovery-plan-southern-bent-wing-bat.pdf</a>
<b>Recovery Team</b>	Southern Bent-wing Bat National Recovery Team Chair: Dr Lindy Lumsden <a href="mailto:Lindy.Lumsden@delwp.vic.gov.au">Lindy.Lumsden@delwp.vic.gov.au</a>
<b>Date of report</b>	February 2023. Encompassing progress up to November 2022.

## State/condition and conservation trajectory



**very poor**

**poor**

**good**

**very good**

**Confidence** Adequate. High-quality evidence and high level of consensus.

## Key highlights

- The Southern Bent-wing Bat was voted Australia's Mammal of the Year in the inaugural competition run by Cosmos Magazine, greatly raising the profile of the subspecies and resulting in numerous media opportunities for Recovery Team members.
- The Southern Bent-wing Bat has been listed as a priority species under the National 2022-2032 Threatened Species Action Plan.
- The Recovery Team has incorporated additional focus on undertaking on-ground management action in the past year.
- Several studies on Southern Bent-wing Bats have been published in 2022, furthering the Recovery Team's understanding of the subspecies' survival rates, seasonal movement patterns (van Harten et al. 2022a, 2022b) and diet (Kuhne et al. 2022), with research underway to address remaining key knowledge gaps.
- Recent publications and research have guided on-ground action and provided advice to planned developments to reduce impacts on Southern Bent-wing Bat populations.
- The Recovery Team has continued preparing for the potentially disastrous introduction of White-nose Syndrome to Australia and prepared guidelines for the largest Southern Bent-wing Bat maternity roost to reduce the risk of introduction and provide guidance in case the fungus arrives.
- Brochures to support surveillance and reporting of White-nose Syndrome and other diseases in Australian bats have been created and distributed to relevant groups.
- Zoos Victoria continue to fund the National Recovery Team Coordinator role, which remains integral to the functionality of the Recovery Team.
- The Recovery Team continues to be a highly enthusiastic, collaborative, inclusive and effective team for promoting the conservation of the Southern Bent-wing Bat.
- Ongoing implementation of the National Recovery Plan is needed to meet the long-term objective of ensuring that the Southern Bent-wing Bat can survive, flourish and retain its potential for evolutionary development in the wild.


## 2. IMPLEMENTING RECOVERY ACTIONS AND MEETING OBJECTIVES

Progress towards the implementation of recovery actions and objectives in the National Recovery Plan (DELWP 2020) is outlined in the table below. New activities and progress since the last annual report in November 2021 have been summarised; however, a brief outline of previous work has also been included where this provides context for the progress that has been made for each recovery action to-date. Note that the listed actions have been abbreviated in the table. Full descriptions of each action can be found in the National Recovery Plan.

Status of the actions and objectives have been summarised using a traffic light system as follows:


- **No/little progress** No/little progress has been made on this action and/or objective not achieved
- **Some progress** Some progress has been made on this action and/or objective partly achieved
- **Completed** This action has been completed and/or objective achieved

<b>Progress against the objectives, actions and management practices outlined in the Draft National Recovery Plan</b>		<b>Status</b>
<b>Objective 1.</b> Develop techniques to accurately estimate the population size at the maternity sites and undertake regular assessments of population numbers to thoroughly document population trends.		●
<u>Action 1.1</u> Develop techniques to estimate population numbers, survival rates & breeding success	<u>Prior to November 2021</u> Development and refinement of the use of thermal imagery and an automated counting application batTracker for estimating fly-out numbers in Victoria (Hield et al. 2019, Lumsden et al. 2020), infrared photography for counting numbers of pups (Lumsden et al. 2018) and counts of relative numbers of bats from infrared time lapse images. (This work is led by Amanda Bush and Lindy Lumsden at ARI). Development of N2, an automated counting system used to monitor the SBWB population at Bat Cave, Naracoorte. Ongoing testing of equipment and refinement of the software to obtain nightly population estimates. Passive monitoring of PIT-tagged SBWB at cave roosts, with confirmed minimal impacts of this marking technique for Southern Bent-wing Bats (van Harten et al. 2019, 2020). Testing of alternative PIT-tag antenna locations at Bat Cave (Naracoorte), confirming the current location of the antenna is most suitable. PIT-tag readers installed at Bat Cave and one nearby non-breeding site. Ultrasonography was trialled and succeeded at detecting pregnancies in SBWB using the Naracoorte maternity site. This method will be used to estimate breeding success at Naracoorte. This work is part of Nicola Bail's Masters	●




	<p>project (Nicola Bail, Thomas Prowse, Lindy Lumsden, Terry Reardon).</p> <p><u>Current reporting period</u></p> <p>Additional funding from Zoos Victoria has allowed for further refinement of the N2 automated counting software at Naracoorte. The system is functional but undergoing refinements to increase the accuracy of counts and fully automate the process. Equipment has been installed outside Bat Cave and nightly population counts since December 2021 have been produced. Funding from DEW has assisted with the heavy data storage burden produced by all-night fly-out footage (Terry Reardon, Dennis Matthews, Paul Clissold).</p>	
<p><u>Action 1.2</u> Assess population numbers &amp; trends</p>	<p><u>Prior to November 2021</u></p> <p>Population Viability Analysis undertaken in 2020 as part of the reassessment of the conservation status, predicted deeply concerning declining population trends over the next 36 years. This modelling provides a baseline which can be updated as new information becomes available.</p> <p>Population counts at the Warrnambool maternity site and nearby non-breeding sites have been regularly undertaken over the summer months for the past 5 years.</p> <p>Emmi van Harten's PhD thesis (van Harten 2020) has produced multiple publications detailing population dynamics of Southern Bent-wing Bats. Information on survival rates (van Harten et al. 2022a), seasonal movement patterns (van Harten et al. 2022b) and SBWB's use of the landscape are available (Emmi van Harten, Lindy Lumsden, Terry Reardon and Thomas Prowse).</p> <p><u>Current Reporting Period</u></p> <p>In the 2021/2022 breeding season, regular population assessments (funded by a DELWP Icon Species grant), were undertaken at the Warrnambool maternity site and nearby non-breeding sites with the flyout recordings currently being analysed to estimate numbers, with some preliminary data available (Lindy Lumsden, Amanda Bush, ARI).</p> <p>It was not possible to estimate numbers at the Portland maternity site for the 2021/22 breeding season due to storm conditions making access to the site unsafe.</p> <p>The Bat Cave population monitoring program (Terry Reardon, Dennis Matthews, Paul Clissold) is progressing incredibly well. Estimates of the size of the SBWB population Bat Cave have been made and documented each night since December 2021 (see section 3 for more details).</p> <p>A population count of the Warrnambool maternity site was taken in July 2022. More than 10,000 bats were estimated to be using this site in July, though accurate counts were not possible. This cave appears to be extremely important for SBWB throughout the year being used as a maternity</p>	

	roost and during winter (Lindy Lumsden, Amanda Bush, ARI).	
<b>Objective 2.</b> Determine the main cause/s of the recent decline in numbers of Southern Bent-wing Bats, and identify causal factors to enable targeted, rapid management responses to be implemented.		●
<u>Action 2.1</u> Risk assessment to prioritise threats & actions. Develop implementation plan	<p>A formal risk assessment has not been undertaken; however, a Specific Needs Assessment (SNA) for the Southern Bent-wing Bat is in progress, involving the majority of Recovery Team members and some external partners. This process will be highly beneficial for assisting with the prioritisation of management actions.</p> <p>As part of the SNA, the Recovery Team prioritised threats, selected potential management actions and compiled background information for species-specific management actions. This information informed the potential management action scenarios used in the subsequent stages of this assessment.</p> <p>Benefit estimation documentation was distributed and the participants predicted relative benefits using different scenarios, with the data submitted for analysis in October 2022. A workshop to share the results of independent benefit estimations and enable reassessments if required was held in November 2022.</p> <p>The team delegated cost estimation tasks relating to management actions to relevant members in September 2022. This is necessary for the cost estimation step of the assessment, which will follow.</p>	●
<u>Action 2.2</u> Monitor health (including risk of WNS)	<p><u>Prior to November 2021</u></p> <p>Peter Holz completed a health assessment of the Southern Bent-wing Bat for a PhD supervised by Jasmin Hufschmid and Lindy Lumsden (Holz 2018). SBWBs were screened for viruses, fungal pathogens, ectoparasites (Holz et al. 2018a, 2018b, 2018c) and blood parasites (Holz et al. 2019a). Pathology, haematology and morphology were also investigated (Holz et al. 2019b, 2020a, 2020b). No associations between the health of individuals and parasitic or infectious agents were found. Victorian SBWB had more herpesviruses, ectoparasites and blood parasites than South Australian bats, which may indicate chronic stress is impacting the immune system of this population (Holz 2018). SBWB were also screened for <i>Pseudogymnoascus destructans</i> (<i>Pd</i>), the fungus that causes WNS, with no evidence found in the population.</p> <p>The introduction of WNS to Australia was deemed 'highly likely' over the next decade and 'likely' that it would reach cave roosts (Holz et al. 2016, 2019c). Southern Bent-wing Bats have been deemed highly susceptible to <i>Pd</i>, as their roosts are within the optimal temperature range for the pathogen (Turbill and Wellbergin 2020).</p>	●



	<p>The Recovery Team has formed biosecurity and surveillance subgroups for development of guidelines and procedures to protect the Southern Bent-wing Bat from WNS and other diseases.</p> <p>Chris Turbill (Western Sydney University), Lindy Lumsden and Jasmin Hufschmid are leading an ARC Linkage Grant project investigating winter activity, immune responses and other WNS risk-factors in Australian cave-dwelling bats. A post-doc and two PhD students have been appointed.</p> <p>A WNS risk review is underway, coordinated by DAFF and with input from Recovery Team members. The review includes a rapid risk assessment, and is considering new information that has become available since the first Australian risk assessment was undertaken in 2016 (see Holz et al. 2016, Holz et al. 2019).</p> <p><u>Current reporting period</u></p> <p>Disease surveillance fact sheets have been developed for the general public, veterinarians and cavers/cave managers, to advise on what to look out for and how to report. These have been uploaded to the SWIFFT webpage (SWIFFT 2022). Fact sheets can be found at: <a href="https://www.swift.net.au/cb_pages/team_southern_bent-wing_bat_recovery_team.php">https://www.swift.net.au/cb_pages/team_southern_bent-wing_bat_recovery_team.php</a>.</p> <p>A draft biosecurity procedure for Naracoorte Caves prepared by the biosecurity subgroup has been circulated to the Recovery Team for any final comments from internal members. Wildlife Health Australia has asked a North American expert to review the draft procedure. The procedure has also been shared with the Australasian Cave and Karst Management Association Inc and Australian Speleology Federation's cave conservation network. These partners will provide feedback and comment on this document prior to finalisation.</p>	
<p><u>Action 2.3</u> Determine survival rates</p>	<p>van Harten et al. (2022a) have published an article on survival rates for Southern Bent-wing Bats at Naracoorte, based on an extensive PIT-tagging study. Winter survival was high for all age and sex classes. Survival rates were markedly lower in summer and autumn of 2016, which corresponded with severe drought in the region (Emmi van Harten, Lindy Lumsden, Terry Reardon, Thomas Prowse).</p> <p>Nicola Bail is using the 2016-2022 PIT-tag data to formulate current survival rates for SBWB in South Australia. 496 additional bats were PIT-tagged at Naracoorte in 2022 as part of Nicola's Masters project, and data is regularly being collected (co-investigators Thomas Prowse, Lindy Lumsden, Terry Reardon). An additional 500 bats are planned to be tagged in early 2023.</p> <p>Survival rates for Victorian populations are still needed.</p> <p>Survival rates for pre-volant juveniles are still needed.</p>	



<p><u>Action 2.4</u> Assess breeding success</p>	<p><u>Prior to November 2021</u></p> <p>Breeding success has been inferred from comparisons of pup counts with concurrent counts of the volant population. This has been possible only once at Bat Cave, in 2003. 54% of mature females were estimated to have reproduced that season.</p> <p>In 2020, 39% of adult females at the Warrnambool maternity site were estimated to have given birth, and 97% of adult females at the Portland maternity site.</p> <p>There are high uncertainties in these estimates.</p> <p>Nicola trialled the use of ultrasonography to diagnose pregnancy in a sample of the breeding population at Bat Cave. 263 female SBWB received ultrasounds in September and October of 2021, with 83.3% of this sample pregnant.</p> <p><u>Current reporting period</u></p> <p>Nicola Bail (co-contributors Thomas Prowse, Lindy Lumsden, Terry Reardon) pregnancy tested a sample of the Southern Bent-wing Bat population at Bat Cave in October 2022. Data collected will be used to estimate the reproductive output of Southern Bent-wing Bats at Naracoorte in the 2022/23 breeding season.</p> <p>Concurrent pup and adult population estimates were taken at the Warrnambool maternity site in the 2021/2022 breeding season; however, the young were born in a different chamber this year which made it harder to get clear photos (now 40 m above the cave floor rather than 25 m), and unfortunately it has not been possible to accurately estimate numbers (Lindy Lumsden and Amanda Bush).</p> <p>It was not possible to access the Portland maternity cave during the 2021/22 breeding season due to storms making access unsafe (Lindy Lumsden and Amanda Bush).</p>	
<p><u>Action 2.5</u> Determine maternity cave microclimatic conditions &amp; water use</p>	<p>Monitoring of in-cave temperature and humidity continues to be conducted at the Warrnambool and Naracoorte maternity sites and a range of non-breeding caves in use by SBWB in Victoria and South Australia.</p> <p>Microclimate monitoring at the Warrnambool site continues (ARI – Lindy Lumsden and Amanda Bush). This information will be used as a baseline to assess changes after the surface hole of one chamber will undergo modification.</p> <p>Due to the height of avens at the Warrnambool maternity site, no microclimatic data has been obtained from the specific areas in which the bats cluster; however, dataloggers are suspended through the surface holes into the chamber space near these avens.</p>	
<p><u>Action 2.6</u> Strategic survey of numbers, usage &amp; seasonal patterns</p>	<p>Population numbers continue to be monitored at four significant non-breeding sites in Victoria (Amanda Bush &amp; Lindy Lumsden, ARI).</p>	

<p>at non-breeding sites</p>	<p>Emmi van Harten, Lindy Lumsden, Terry Reardon and Thomas Prowse have now published findings on the seasonal population dynamics and movement patterns of SBWB in South Australia. Regular movements between maternity and non-breeding roosts are described. In addition, a previously undescribed movement was noted regarding adult females and juveniles; “These classes left the maternity cave in late summer, when juveniles became independent, and returned in early mid-autumn, later undertaking winter dispersal” (van Harten et al. 2022b).</p> <p>Nicola Bail, Terry Reardon, Rose Thompson and Dennis Matthews installed a PIT-tag reader at an additional non-breeding roost in South Australia in 2022. The data retrieved from this reader will increase the understanding of regular movements between roosts and use of non-breeding sites over the year.</p>	
<p><u>Action 2.7</u> Survey for additional unidentified roosts</p>	<p><u>Prior to November 2021</u></p> <p>As a precursor to wind farm construction in Victoria, extensive localised searches for roosting sites were conducted. No new roosts were found.</p> <p>Steve Bourne located a previously unknown non-breeding cave near Naracoorte.</p> <p><u>Current reporting period</u></p> <p>Three new caves were discovered in Western Victoria, within the range of SBWBs, with evidence of recent usage by bats at one site.</p> <p>A recent wind farm proposal triggered a number of landholders to contact VSA raising issues about caves and bats on their properties. VSA is currently investigating these sites.</p>	<p>●</p>
<p><u>Action 2.8</u> Determine foraging availability</p>	<p><u>Prior to November 2021</u></p> <p>Amanda Bush (University of Adelaide, ARI) undertook a GPS tracking study in Autumn over 2 years, by attaching GPS tags to 60 individuals from the Warrnambool population, with the aim of investigating foraging behaviour, habitat selection and movement distances and patterns. Transmitters were retrieved from 20 individuals. Analysis of GPS data revealed that bat locations were closer to trees than would be expected from random movement alone. This included both native and exotic paddock trees, and planted linear strips. Individuals foraged up to 85 km from their roosting caves. Bats moved between day roosts frequently, even daily, including between caves about 60 km apart.</p> <p>Kuhne (2020) conducted a study into the diet of SBWB, describing some of the species SBWB prey on. The abundance of these species in the landscape is not clear. See action 2.9</p> <p><u>Current reporting period</u></p>	<p>●</p>

	<p>Amanda Bush has obtained funding to undertake GPS tracking work in South Australia in 2023 to investigate how foraging patterns may vary in different landscapes with differing levels of remnant vegetation and wetlands available.</p> <p>A key knowledge gap is prey availability, and trends in insect numbers.</p>	
<p><u>Action 2.9</u> Investigate diet</p>	<p>A dietary study was undertaken using faecal samples from Victorian and South Australian roosts. DNA metabarcoding was used to identify likely prey species in guano. Samples were primarily comprised of Lepidoptera (moths), with many species associated with agricultural land detected. This work was completed for Johanna Kuhne's Honours thesis (co-investigators Thomas Prowse, Terry Reardon), with the results published in 2022 (Kuhne et al. 2022).</p> <p>Further information is required on seasonal dietary patterns, and prey availability compared to what is consumed.</p>	●
<p><u>Action 2.10</u> Investigate impact of pesticides</p>	<p>Holz (2018)'s investigation deemed pesticide levels unlikely to be directly contributing to the decline of SBWB, but there may be subclinical effects.</p> <p>No further progress has been made on this action in this reporting period.</p> <p>In addition to any direct impact on the bats themselves, pesticides may have indirect impact by significantly reducing the abundance of SBWB prey species. Further investigation is required.</p>	●
<p><u>Action 2.11</u> Investigate impact of wind farms</p>	<p><u>Prior to November 2021</u></p> <p>Dead SBWBs have been identified during post-construction wind farm monitoring in Victoria (Moloney, Lumsden and Smales, 2019).</p> <p>A wind farm subgroup was formed by the Recovery Team to provide advice on request, such as in response to the request from DAFF to review the draft Southern Bent-wing Bat Adaptive Management Plan for Mount Fyans Wind Farm.</p> <p><u>Current Reporting Period</u></p> <p>Amanda Bush's GPS tracking study will assist in assessing the susceptibility of SBWB to wind farm mortality by estimating the height Southern Bent-wing Bats fly at. Data collected in 2020 and 2021 are being analysed, and a drone is being used to calibrate the vertical accuracy of the GPS units.</p> <p>Survey guidelines for bats for informing wind farm assessments are being developed by DEECA. These documents have an emphasis SBWB.</p> <p>Pre-construction and post-construction mortality monitoring assessments continue to be undertaken by consultants in Victoria and assessed by DEECA and DAFF.</p>	●

	<p>Victoria's south-west renewable energy zone overlaps closely with the foraging range of SBWB.</p> <p>Portland offshore environment has also been announced as one of Australia's offshore energy zones and is proximal to one of three known maternity sites. Additional information is needed on the likely impact of offshore developments in this area will have on SBWBs.</p> <p>Proposals for wind farms continue to be developed within the range of SBWBs. With the increase in the number of proposed and operating wind farms in the range of SBWB, the cumulative impact of these developments needs to be considered.</p> <p>Wind turbines characteristics continue to evolve. Newer proposed turbines are typically higher, with longer blades, and set higher off the ground. These features may alter mortality risk to SBWB however this has yet to be quantified.</p> <p>Research conducted at a Portland wind farm identified further SBWB mortalities from turbine collisions and trialled the use of seasonal, nightly turbine curtailment during low-wind speeds (Bennett et al. 2022). During the targeted period, turbines commenced operation at wind speeds of 4.5 m/s (increased from the operational cut-in speed of 3 m/s) and were found to reduce overall bat mortality by 54%. Total annual energy generation loss was estimated at just 0.16% and revenue loss at 0.09%. The authors of this research state, 'This study demonstrates that curtailment is a valid method for reducing bat turbine collision in south-eastern Australia. Consideration should be given to curtailment as a means to reduce bat turbine impacts in Australia, particularly at sites with known endangered and threatened populations...' (Bennett et al. 2022). Low wind-speed curtailment is also known to be effective at significantly reducing insectivorous bat mortality internationally (e.g. Whitby et al. 2021).</p> <p>Further guidelines for wind farm operators to reduce the risk to SBWB, as well as other bats in this region, are required, as well as research into risk factors and effectiveness of mitigation actions.</p>	
<p><u>Action 2.12</u> Determine suitable cave-gate design</p>	<p>No work specific to SBWBs has been conducted.</p> <p>Research from New South Wales provides information on results of cave-gate design for other subterranean bat species (Gonsalves et al. 2021). Emergence activity and minimum colony size were 7–10 times greater with 'bat friendly' grating (horizontal bars with spacing &gt;125 mm) than other gating treatments; however, almost all activity was by Eastern Horseshoe Bats circling at gates which continued for many years and bent-wing bats (Eastern Bent-wing Bat and Little Bent-wing Bat) made little use of these sites. Alternatives need to be trialled for other species such as bent-wing bats.</p>	<p style="text-align: center;">●</p>

<p><u>Action 2.13</u> Feasibility of an artificial maternity cave</p>	<p>No progress has been made (not considered a high priority compared to other actions).</p>	<p>●</p>
<p><b>Objective 3.</b> Protect the maternity sites and other key non-breeding sites.</p>		<p>●</p>
<p><u>Action 3.1</u> Active management to protect maternity sites</p>	<p>The Warrnambool maternity cave continues to be actively managed specifically for conservation purposes. To monitor disturbance levels, Security cameras are in use to photograph trespassers at the site. Signs have been erected to deter visitation to the site, and landholders of neighbouring properties are helping to minimise disturbance. Stock have been removed from the block above the cave to reduce damage and promote growth of native plants. A management plan has been finalised for this site (Trust for Nature, Lindy Lumsden and Garry Peterson).</p> <p>Designs have been developed to replace existing logs covering one of the surface holes of the Warrnambool maternity site, which have been in place for over 20 years and are deteriorating. The aim of replacing these logs is to improve safety and improve microclimatic conditions with the aim of increasing breeding success. Planning is underway to undertake the work in autumn 2023 (Yvonne Ingeme, Lindy Lumsden, Amanda Bush, Garry Peterson).</p> <p>Trust for Nature controlled weeds (Apple of Sodom and Boxthorn) around pophole entrances above the Warrnambool maternity site and has commenced extensive revegetation works in the surrounding area.</p> <p>The maternity cave at Naracoorte continues to be managed for bat conservation and world heritage value, as part of the Naracoorte Caves National Park World Heritage Area, South Australia. Management is ongoing. Protective coverings were applied to fences surrounding the cave entrance over the 2022 weaning period, as in previous years. This serves to minimise the occurrence of lethal or injurious collisions of newly volant juveniles with the fence (Ingeme et al. 2018, Holz et al. 2019b).</p> <p>Aside from population monitoring, no active management is being undertaken at the Portland maternity cave. This cave is largely inaccessible to the public and additional management actions have not been deemed necessary.</p>	<p>●</p>
<p><u>Action 3.2</u> Management plans for key non-breeding sites</p>	<p>A cave audit subgroup was formed by the Recovery Team to audit known SBWB roost sites in both SA and Vic and determine management actions required for each cave.</p> <p>In Victoria, Amanda Bush and Lindy Lumsden (ARI) maintain relationships with landholders of key non-breeding sites and work with them to minimise disturbance of these sites and keep entrances clear of obstruction.</p>	<p>●</p>

	<p>In 2021, Naracoorte Caves National Park ceased tours of a section of Blanche Cave used by SBWB outside the maternity period.</p> <p>A management plan for a key non-breeding site in South Australia is being drafted. This plan will be used to guide management action at this site. This plan may be used as an example for development of management plans at other non-breeding sites following the cave audit. The plan has been circulated to the team for comment. Discussions were had with the owner of the property to ensure the management plan would align with their interests. The plan is now ready for revision, based on these discussions and the developments (below) regarding weed and vegetation control.</p> <p>Nature Glenelg Trust (Rose Thompson) submitted a successful application for funding from the Grassroots Grants program of the Limestone Coast Landscape Board to support a SA cave audit and the writing of management plans. Site visits commenced in November 2022.</p> <p>The Limestone Coast Landscape Board (Mark deJong, Michelle Sargent) have organised funding for management of weeds and grass at a significant South Australian non-breeding roost site by Burrandies Aboriginal Corporation. Fox trapping is also planned at this site. The first site visit will occur in late 2022.</p>	
<p><u>Action 3.3</u> Control introduced predators</p>	<p>Naracoorte Caves National Park continue monitoring and control of introduced pests, as required.</p> <p>Incidental monitoring of introduced predators has been undertaken during annual monitoring of Victorian breeding and non-breeding roosts.</p> <p>Fox trapping has been planned at a significant South Australian non-breeding roost site.</p>	●
<p><u>Action 3.4</u> Erect/maintain signs to limit cave access</p>	<p>'Do not disturb' signs have been mounted above and inside the Warrnambool maternity cave, and these signs have been maintained during the current reporting period (Trust for Nature, Lindy Lumsden and Garry Peterson).</p> <p>A 'Cave Closed' sign has been mounted in one of Victoria's significant non-breeding roosts.</p> <p>The disturbance subgroup is having ongoing discussion into additional signage requirements.</p> <p>Landholders at a non-breeding roost near Warrnambool have fenced the perimeter of the cave on their property to discourage unauthorised access. Communications between recovery team members (Amanda Bush) and landholders have been effective in this case.</p>	●
<p><u>Action 3.5</u> Provide information &amp; advice for council</p>	<p><u>Prior to November 2021</u></p> <p>DELWP provided advice to DJPR about a number of limestone quarries operating close to known SBWB roost sites.</p>	●



planning processes	<p>DELWP provided advice to a shire that was planning to develop a walking trail close to a SBWB roost site.</p> <p><u>Current reporting period</u></p> <p>DEECA is working closely with Councils regarding wind farm planning processes.</p>	
<u>Action 3.6</u> Provide information to state agencies for fire planning processes	<p>Prescribed burns at Naracoorte Caves National Park are planned in a way that ensures protection of the maternity cave.</p> <p>Advice was provided on specific proposed burns near roosting caves in the Lower Glenelg area (Garry Peterson, Amanda Bush, Lindy Lumsden, DELWP).</p> <p>DEECA have prescriptions specific to burn preparation works and conducting burns near caves and SBWB roost sites (Yvonne Ingeme, DEECA).</p>	●
<u>Action 3.7</u> Develop & promote a code of conduct for cave visits	<p>The disturbance subgroup of the Recovery Team to develop a code of conduct for cave visits, due to the high risk to SBWB disturbance poses.</p>	●
<b>Objective 4.</b> Protect and enhance foraging habitat around the maternity sites and key non-breeding sites.		●
<u>Action 4.1</u> Protect key areas of foraging habitat	<p>The Lower Limestone Coast Water Allocation Plan (LLC WAP) provides policy for protecting wetland and creek Groundwater Dependent Ecosystems (GDEs) from groundwater extraction. Many wetlands important as foraging habitat within the Naracoorte Ranges area are highly groundwater dependent.</p> <p>The 2019 Risk Assessment for the LLC WAP identified High Risks to GDEs in the Joanna Management area (which includes the Naracoorte Caves area and Mosquito Creek) from groundwater extraction. (Claire Harding, NPSW, DEW).</p> <p>Amanda Bush's PhD work will greatly improve the understanding of what defines 'key foraging habitat' for SBWB. This will allow for informed management and protection of key foraging areas. However, due to current technology limitations, this data only provides a small snapshot of habitat use over a short period of time and in one season of the year, and further studies are required.</p>	●
<u>Action 4.2</u> Restore & enhance foraging habitat	<p>Nature Glenelg Trust continues to restore Mount Burr Swamp, South Australia. Restoration of wetlands and revegetation of this area continues. This site is close to key SBWB non-breeding caves, and provides foraging habitat.</p> <p>Revegetation of land surrounding the Warrnambool maternity site is being undertaken, with the aim of providing additional foraging habitat. 2000 tube stock were planted in the 4 ha immediately surrounding the cave, and the adjacent 5 ha area was sown using direct seeding (1 kg of seed per ha). Local indigenous plants were selected based</p>	●



	<p>on Ecological Vegetation Classes. Weeds have also been controlled in this area (Trust for Nature). Detectors have been installed to monitor foraging activity over the newly revegetated areas along with control sites over paddocks and nearby older revegetation works for comparison. These will be monitored over time to evaluate the effectiveness of providing more foraging habitat through revegetation.</p>	
<p><b>Objective 5.</b> Clarify the taxonomic status, distribution and population structure of the Southern Bent-wing Bat.</p>		●
<p><u>Action 5.1</u> Clarify taxonomy</p>	<p>PhD student Sigit Wiantoro (University of Adelaide) undertook a full taxonomic review of Indo-Australian bent-wing bats.</p> <p>Ophelie Planckaert (University of Melbourne, PhD supervised by Lindy Lumsden) collected new genetic material that supports these findings (see below).</p> <p>This work is still being drafted for publication.</p>	●
<p><u>Action 5.2</u> Clarify extent of geographic range based on genetics</p>	<p><u>Prior to November 2021</u></p> <p>PhD student Ophelie Planckaert (University of Melbourne, supervised by Lindy Lumsden, Kyle Armstrong, Craig Nitschke and Patrick Baker) has obtained genetic samples from 368 <i>Miniopterus orianae</i> individuals. Samples were taken across the range of both the Eastern Bent-wing bat and Southern Bent-wing bat, and in the overlap zone.</p> <p><u>Current reporting period</u></p> <p>Genetic analysis has been undertaken by Ophelie Planckaert which has clarified the current geographic range of both subspecies, with the range of SBWB unchanged, but a shrinkage of the distribution of the EBWB in recent years.</p>	●
<p><u>Action 5.3</u> Develop field-ID tool to distinguish between Southern Bent-wing Bats &amp; Eastern Bent-wing Bats</p>	<p><u>Prior to November 2021</u></p> <p>Ophelie Planckaert is also investigating the efficacy of using full spectrum acoustic analysis to improve the accuracy of call identification (Planckaert et al. 2020). Echolocation calls have been recorded across the range of both Southern Bent-wing Bats and Eastern Bent-wing Bats.</p> <p><u>Current reporting period</u></p> <p>ARI AI Full Spectrum call analysis approach (now called BatLingo) has been developed and tested on bat species in NW Victoria. Calls from south-west Victoria are currently being incorporated to commence developing a key for that area, with the aim of improving accuracy of identifying SBWBs (Lindy Lumsden, Amanda Bush, ARI, Ophelie Planckaert Uni of Melbourne).</p>	●
<p><u>Action 5.4</u> Improve understanding of population</p>	<p>Ophelie Planckaert's genetics project is revealing interesting patterns on population structure and the differences between SBWB and EBWB.</p> <p>Recent research at Naracoorte (van Harten et al. 2022a) indicates a high proportion of individuals return to their natal</p>	●

structure for informing recovery	<p>cave for the maternity season. Research on seasonal movements has been published by Emmi van Harten, Lindy Lumsden, Terry Reardon and Thomas Prowse. This research suggests that SBWB follow the maternal guidance hypothesis, where mothers show their young non-breeding sites in the region (van Harten et al. 2022b).</p> <p>SBWB populations are centred on each of the three maternity caves (and associated non-breeding caves), appearing to form discrete or partially-discrete populations (Dwyer 1969, TSSC 2021). Both Amanda Bush and Emmi van Harten's work has shown that SBWBs regularly fly long distances, but the degree of interchange between maternity sites is not fully understood.</p> <p>Nicola Bail is investigating sex-specific differences in emergence behaviour. Analysis is ongoing but preliminary results are promising. Understanding differences in emergence behaviour between the sexes and throughout the reproductive period may indicate underlying social structure.</p>	
<b>Objective 6.</b> Compile and maintain databases to aid in the management of the subspecies.		●
<u>Action 6.1</u> Compile, maintain & assess information on roost sites	<p>The cave audit subgroup, led by Rose Thomson (NGT) is working to compile information and assess management requirements for SBWB roost sites. Visits to South Australian non-breeding roosts commenced in November 2022.</p> <p>Funding has been obtained to complete an audit of caves in the South Australian range of SBWB. This funding will allow for the creation of management plans for some non-breeding roosts and visits to these roosts to better understand current management requirements.</p>	●
<u>Action 6.2</u> Develop a project register	<p>The research priorities subgroup worked to collate research and monitoring actions in the Recovery Plan, and to then prioritise these actions based on their urgency and priority, with further detail on research actions still to be developed.</p> <p>A formal project register has not yet been developed.</p>	●
<b>Objective 7.</b> Establish a long-term monitoring program for the Southern Bent-wing Bat.		●
<u>Action 7.1</u> Design & implement monitoring program with an adaptive management framework	<p>Long-term monitoring of the Warrnambool and Portland maternity sites and nearby non-breeding sites continues (funded by Icon Species grants for the last two seasons). Population counts of adults and juveniles are regularly taken at the Warrnambool site, and at the Portland site where possible.</p> <p>Infra-red illuminators and an infra-red camera have been installed outside of Bat Cave, Naracoorte. The camera has been wired to a dedicated PC room, where video files are remotely processed every night. Through this system and the ongoing refinement of N2, an automated counting system, nightly fly-out counts are being generated for 2021</p>	●

	<p>and 2022 at Bat Cave. The ongoing refinement of this project and software are expected to lead to a fully automated process, where nightly population estimates of this significant maternity site will be generated (Terry Reardon, Paul Clissold, Dennis Matthews). Preliminary discussions have been conducted with TERN to investigate the possibility of TERN taking over the long-term population monitoring at Bat Cave.</p> <p>These programs can feed into an overarching long-term monitoring program within an adaptive management framework.</p>	
<b>Objective 8.</b> Facilitate and promote community interest, understanding and participation.		●
<u>Action 8.1</u> Develop & implement communication plan	<p>A communications subgroup was formed in 2022 and developed a communications strategy.</p> <p>This document provides agreed upon facts, key messages, sensitive information and more. This document will and has been used by team members doing public communications about SBWB.</p> <p>The inaugural Australian Mammal of the Year 2022 competition raised a lot of awareness for the Southern Bent-wing Bat. The SBWB was crowned Australian Mammal of the Year (AMOTY) following a campaign that lasted several weeks, generating lots of social media activity, articles, media interviews and features, that was led by the Recovery Team. The draft communications plan provided helpful guidance for preparing messaging.</p> <p>In the period June – October 2022, 16 radio interviews, 8 online news articles, 1 television segment and 3 print newspaper articles about the SBWB were released. Most resulted from interviews with members of the Recovery Team.</p> <p>The Recovery Team plans to produce information brochures for landowners of SBWB caves.</p>	●
<u>Action 8.2</u> Change perceptions of landholders about pesticide use	<p>The LCLB released a 'How to build a bat box' brochure with Naracoorte Men's Shed. The brochure includes information on the benefits of bats, and threats such as pesticides.</p> <p>LCLB provided funding to Mary Retallack of Ecovineyards to promote viticulture practices increasing habitat for bats. The Grassroots Grant funding will enable the program to expand in the Limestone Coast.</p> <p>A bat citizen science activity was held at Mount Burr Swamp in 2021, with promotion and discussion of the role of bats in the ecosystem. Landholders in the area were the target group of this activity but LCLB noted more effort is required to attract this demographic (Limestone Coast Landscape Board, NGT).</p>	●
<u>Action 8.3</u> Maintain & strengthen	<u>Prior to November 2021</u>	●

<p>relationships with community organisations</p>	<p>LCLB, Friends of Naracoorte Caves and NGT (Rose Thompson) delivered a community bat night in November 2020.</p> <p>Members of local caving groups are involved with the Recovery Team and subgroups.</p> <p>Naracoorte Caves National Park staff maintain a strong relationship with Friends of the Naracoorte Caves.</p> <p><u>Current reporting period</u></p> <p>Several team members attended and presented SBWB research at the 2022 Australasian Bat Society (ABS) conference in Brisbane.</p> <p>Members of the ABS were encouraged to vote for the SBWB as 'Mammal of the Year' by Recovery Team members in the Cosmos Magazine competition and seemingly took the information on board with excitement.</p> <p>Friends of the Naracoorte Caves are managing the funding of the Bat Cave Monitoring Program and collaborating with Terry Reardon, Dennis Matthews and Paul Clissold on this project.</p> <p>As outlined in Action 2.2, North American partners of WHA, the ASF and Australasian Cave and Karst Management Association Inc., are contributing to and involved with the finalisation of the WNS Procedure prepared by the Biosecurity subgroup.</p> <p>Bat nights were held at Naracoorte Caves National Park in April and November of 2022. LCLB, National Parks and Wildlife Service and staff from Naracoorte Caves organised the event, with Rose Thompson (NGT) and Nicola Bail (University of Adelaide, Zoos Victoria) as guest speakers.</p> <p>Rose Thompson spoke to students in the Young Environmental Leaders Program at their camp at Robe in November 2022 about bats of the south-east SA.</p> <p>Nicola Bail spoke about SBWB, recent research and the Recovery Team at 'MegaFest 2022', an event held at Naracoorte Caves National Park. Naracoorte Caves staff offered the Bat Observation Centre as a free activity on the day (normally payment is required).</p> <p>Naracoorte Caves staff held free Bat Observation Centre sessions with visitors after the SBWB was named Australian Mammal of the Year.</p> <p>Yvonne Ingeme gave a presentation to the Victorian Speleological Association on 'Bats you may encounter in Victorian caves' that included Southern Bent-wing Bats and raised threat issues such as the impact of human disturbance within roost sites.</p> <p>Yvonne also gave a SBWB presentation to Friends of Grampians Gariwerd in Halls Gap and a presentation on SBWB to the Hamilton Field Naturalists Club in Hamilton. These presentations were aimed at raising awareness of SBWBs and reducing threats to the species.</p>	
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	<p>Friends of Naracoorte Caves received and manage the funding for the upcoming GPS tracking project in South Australia in 2023 (Amanda Bush, University of Adelaide). This project includes an initial community presentation about the project (undertaken in November 2022) and a future one outlining the results of where the bats are foraging.</p>	
<p><u>Action 8.4</u> Increase community participation in revegetation of foraging habitat &amp; cave protection &amp; restoration</p>	<p>Restoration at Mount Burr Swamp Restoration Reserve (see 4.2).</p> <p>Yvonne Ingeme gave a presentation to the Hamilton Society for Growing Australian Plants that included recommendations for creating bat friendly gardens, to improve foraging habitat.</p>	●
<p><u>Action 8.5</u> Develop closer links with Indigenous groups</p>	<p>Gunditjamara (Gunditj Mirring Traditional Owners Aboriginal Corporation) is interested to receive major updates/correspondence from the Recovery Team. Emmi sent the corporation the 2020 and 2021 annual reports.</p> <p>As part of an exchange between DELWP and Eastern Maar (Eastern Maar Aboriginal Corporation), members of Eastern Maar had planned to visit the Warrnambool maternity site during summer monitoring; however, unfortunately these plans had to be cancelled due to poor conditions making cave access difficult. It is hoped that this can proceed in another monitoring period. Eastern Maar were also invited to attend Recovery Team meetings.</p> <p>In December 2021, Rose Thompson (NGT) attended a South-east Aboriginal Focus Group gathering and presented a talk about bats in the south-east, particularly the SBWB.</p> <p>Engagement with Boandik descendants has occurred and fostered through education activities at Mt Burr Swamp, South Australia.</p> <p>Burrandies Aboriginal Corporation has been contracted by the LCLB to manage weeds at a significant non-breeding site (Michelle Sargent, Limestone Coast Landscape Board).</p> <p>The local Aboriginal social enterprise Worn Gundidj provided the plants and seed for the revegetation works at the Warrnambool maternity site.</p>	●
<p><b>Objective 9.</b> Provide direction and guidance to the recovery of the Southern Bent-wing Bat and review the success of the Recovery Plan.</p>		●
<p><u>Action 9.1</u> Establish a Southern Bent-wing Bat Recovery Team</p>	<p>The National Recovery Team was formed in October 2019 including a variety of members from state and Commonwealth departments/agencies, non-government organisations, zoos, caving groups and species experts from various universities and research institutions. Team membership, subgroups and Terms of Reference were reviewed in September 2022. The Recovery Team is highly</p>	●

	<p>collaborative and inclusive of all organisations and individuals interested in the recovery of the SBWB.</p> <p>The Recovery Team has met regularly throughout this reporting period with well attended meetings in March, May, September and November of 2022, and members have attended additional meetings for the Specific Needs Assessment and subgroup meetings throughout the year.</p> <p>In September, Marty Gent joined the Recovery Team, representing Glenelg-Hopkins Catchment Management Authority. This addition will assist with the functionality of the team and cross border cooperation on landscape-wide projects, with the Limestone Coast Landscape Board already represented on the Recovery Team.</p>	
<u>Action 9.2</u> Conduct a mid-term review of the Recovery Plan	Not due for another year	●
<u>Action 9.3</u> Review implementation of the Recovery Plan & re-assess status of subspecies after five years	Not due for another 3 years.	●
<b>Management practices</b> (status not listed as these practices are ongoing)		
<p>Parks &amp; reserves with roosting caves: Closer monitoring of population numbers.</p> <p>Monitoring &amp; reducing impacts from human disturbance, predation by introduced predators &amp; encroachment by weeds</p>	<p>Naracoorte Caves National Park, South Australia, actively manages caves used by the SBWB in the Park. Ongoing management activity involves pest and weed control, maintenance of cave entrances, daily remote monitoring of SBWB roosting in Bat Cave (Thomas Shortt, NPWS). Staff at Naracoorte Caves National Park also provide on-site assistance and support for the Bat Cave Monitoring program.</p> <p>The Bat Cave Population Monitoring Program has been extremely successful at formulating current population size estimates. Population size at Bat Cave is known for many nights in 2022. The program is undergoing refinements to improve accuracy, reduce processing time and fully automate the process.</p> <p>Victorian caves continue to be monitored regularly as described above. Additional monitoring of the Warrnambool site occurred in winter and spring of 2022.</p> <p>A security camera was placed in the Warrnambool maternity site to monitor human disturbance. A group of four people were seen entering the cave in late January of 2022. No obvious signs of mass disturbance were noted but disturbance remains a concern, particularly in the maternity season.</p>	

	<p>Invasive plant species have been removed from the area surrounding the Warrnambool maternity site. These efforts are combined with revegetation work at the site.</p> <p>DELWP provide advice and recommended mitigation measures in relation to the proposed Great Ocean Road walking trail. Recommendations served to reduce human disturbance and reduce the risk of WNS for a non-breeding roost in close proximity to the proposed trail.</p> <p>DELWP provided advice in relation to the proposed Southern Grampian Volcanic Trail Master Plan. This plan proposes a walking trail in close proximity to a key non-breeding roost.</p>	
<p>Aim to prevent any further native vegetation removal in terrestrial or wetland environments throughout the SBWB range. Develop decision-making tools (e.g. overlays) to help government &amp; land managers to identify important areas</p>	<p>Recovery Team members had input into the Victorian species Habitat Distribution Model for Southern Bent-wing Bats in 2020, highlighting key areas of roosting and foraging habitat (Yvonne Ingeme, Lindy Lumsden &amp; Amanda Bush).</p>	
<p>Planned burning should be undertaken in such a way as to minimise impact on foraging habitat</p>	<p>Prescribed burns are planned within the Naracoorte Caves National Park for Autumn 2023. The environmental assessments for these burns will consider risks to key foraging habitat for the SBWB (Thomas Shortt, Naracoorte Caves/NPWS).</p>	
<p>Aim to increase the amount of foraging habitat in the vicinity of key roost sites</p>	<p>The area surrounding the Warrnambool maternity site is being revegetated, along with Mt Burr Swamp.</p> <p>See Action 4.2 for details.</p>	
<p>Strictly enforce restrictions on items capable of carrying the fungus that causes WNS</p>	<p>Additional directions regarding WNS and equipment have been added to scientific and recreational caving permits issued at Naracoorte Caves National Park. Postcode data (Australia) and country of origin (international) are collected when visitors purchase cave entry tickets at the National Park. As recorded at Action 2.2, a biosecurity procedure has also been drafted for Naracoorte Caves NP.</p> <p>The Australian Speleological Federation is maintaining a strong position on WNS and decontamination protocols amongst cavers in Australia.</p>	



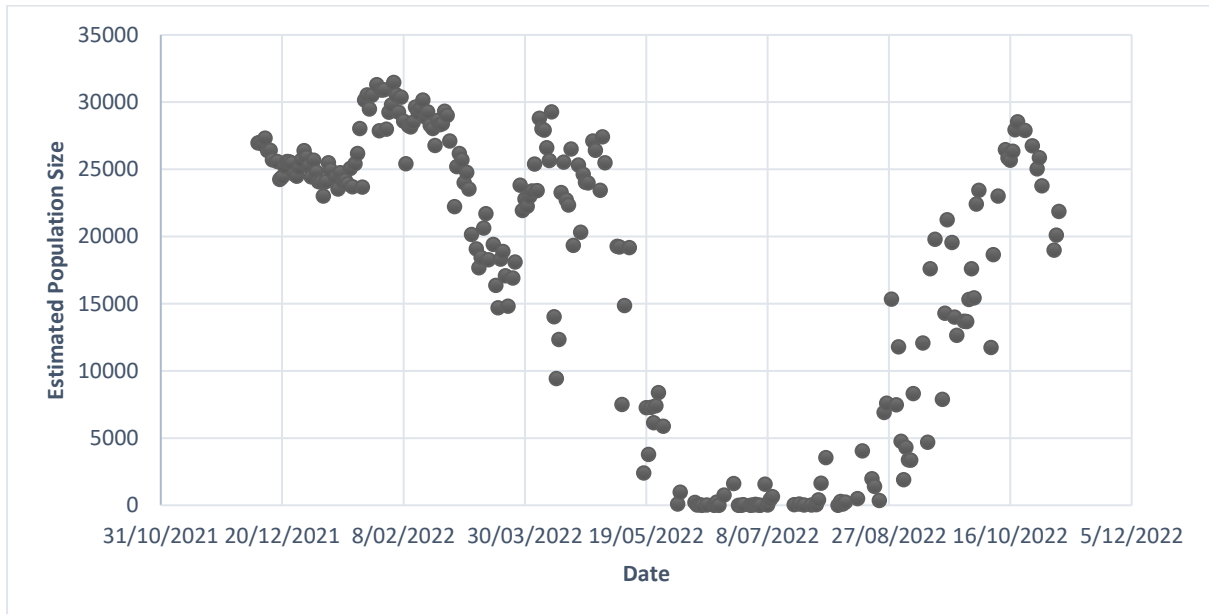
	<p>Salleh et al. (2021) found that awareness of decontamination protocols amongst cavers was not strongly correlated to adherence to these protocols. Further efforts at education and targeted biosecurity activities may be necessary to prevent the introduction of the fungus causing White-nose Syndrome.</p> <p>A presentation on WNS was given at the ABS conference in Brisbane 2022 to raise further awareness of the disease, emphasising the threat to Australian bats and the importance of keeping it out of Australia (Yvonne Ingeme and Keren Cox-Witton).</p>	
Liaison with Indigenous groups over the management of caves with cultural heritage values	<p>No progress has been made this reporting period.</p> <p>The ongoing South Australian cave audit will hopefully allow for further progress on this action.</p>	
Avoid & minimise the impact of wind farms on any key areas used by the SBWB (defined using a risk-based approach). Mitigation actions, rigorous pre- & post- construction monitoring, sharing of mortality data required for any wind farms built in key areas or migration routes	<p>In Victoria, DEECA continue to have input into planning processes around wind farms to ensure rigorous assessments and monitoring.</p> <p>DEECA prepared and presented detailed submissions at the public Willatook Wind Farm panel hearing on potential SBWB impacts associated with the wind farm development and recommended mitigation measures to minimise impacts, including buffering habitat features and implementing turbine curtailment.</p> <p>See Action 2.11.</p>	

### 3. TRACKING CHANGES IN THE STATE/ CONDITION AND CONSERVATION TRAJECTORY

<b>Summary state in 2021</b>	
Abundance	<p>In the 2020/21 breeding season, there were between 28,800 and 35,200 individuals estimated to be roosting at Bat Cave (December 2020). This estimate includes first-year individuals who are not yet reproductively mature, but not new-born pups.</p> <p>In 2020/21 the Warrnambool population (based on the Warrnambool maternity site and surrounding non-breeding sites), ranged between 17,233 and 18,299 adults early in the breeding season. Once the young had started flying, the total adult and young of the year counts range from 22,391 to 23,545. These figures are based on a 95% confidence interval from the automated counting process.</p> <p>Counts of the Portland population (the Portland maternity site and nearby non-breeding sites) are not available for 2021. However, in 2020, there were estimated to be 1000-1500 individuals, including non-reproducing individuals.</p> <p>It should be noted that the automated counting programs used to estimate population size, batTracker (Victoria) and N2 (South Australia), are continuing to be refined. Victorian population estimates are currently being re-evaluated and may be amended in coming years. Increasing knowledge of these animals and populations is informing refinements to batTracker and N2. Old counts will be re-processed to ensure consistent methodology and the highest possible accuracy in population estimates.</p>
Distribution	<p>The Southern Bent-wing Bat has a restricted distributed (19,452 km<sup>2</sup>) from south-eastern South Australia (around Robe, Naracoorte and Port MacDonnell) to south-western Victoria (east to Lorne and Pomborneit). There are two major maternity sites with long histories of occupation: Bat Cave, which lies within the Naracoorte Caves National Park in South Australia and a sea cliff cave near Warrnambool in Victoria. A third, smaller maternity site near Portland, Victoria was discovered in 2015 and accounted for about 3% of the entire breeding population in 2020.</p>
Threats	<p>A range of threats have been identified as potentially impacting on the Southern Bent-wing Bat; however, the main cause(s) of the severe decline in numbers and the mechanisms of that decline are unclear. Identified known and/or potential threats include damage or destruction of roost sites, clearing and modification of foraging habitat, disease (including the risk of WNS), climate change (including increased impact of drought), human visitation/disturbance at caves, introduced predators, inappropriate fencing, collisions with turbines at wind farms, fire, and accumulation of pesticides or other toxins.</p>
<b>Current known state</b>	
Abundance	<p><u>Bat Cave</u></p> <p>In the 2021/22 breeding season, the highest count of first year individuals and adults (during the weaning period in February 2022) was 27,900 – 34,100 individuals. This estimate includes pups born in the 2021/22 season, but some pups may not have started flying by the date</p>

	<p>of this estimate, so this may be an underestimate.</p> <p>At the beginning of the 2022/23 season (October 2022), the peak number of adults at Bat Cave was estimated to be 25,200 – 30,800 individuals, including reproductively inactive first year individuals, but not new-born pups.</p> <p>See Figure 1 for population estimates in the reporting period from the N2 nightly counts, and Figures 2-4 for examples of how the N2 system works.</p> <p><u>Victorian Populations</u></p> <p>Population counts from the 2021/22 breeding season are still being analysed from the recordings of the flyouts, but preliminary data from one night in December 2021 suggests a total figure of approximately 19,000 (adults and first year animals), and from two nights in February 2022 approximately 24,000 individuals were counted (which included newly flying young of the year). However, counts from the other sampling nights during this season are required before overall numbers for the season are finalised.</p> <p>The most recent population estimates available for the Portland population is that of the 2020/2021 count, detailed above.</p>
Distribution	There has been no change in the distribution since the previous reporting period
Threats	Threats remain the same as in the previous reporting period.
<b>What is the current state/condition and conservation trajectory?</b>	
<p><u>Population Trends at Maternity Sites</u></p> <p><b>Bat Cave</b></p> <p>The number of individuals recorded at Bat Cave in the 2021/22 season (27,900 – 34,100, noting that this may be an underestimate) was similar to those recorded in the 2020/21 season (28,800 – 35,200).</p> <p>As there is likely to be some annual variation in population size further years of consistent sampling is required before it is possible to determine the long-term trajectory of the population. The new counting system at Bat Cave, N2, which currently has nightly population estimates from December 2021 to November 2022 (see Figure 1) provides the unique opportunity to obtain detailed information on fluctuations in numbers within and between years.</p> <p><b>Warrnambool</b></p> <p>Based on preliminary analysis the estimates for 2021/22 were broadly similar to those in 2020/21, however further analysis of last year’s recordings, and longer periods of sampling are required before it is possible to assess population trends. In addition, due to refinements to batTracker to improve count accuracy, the counts from recent years have not been analysed identically. The reanalysis of earlier recordings will contribute to determining population trends at this site in the future.</p> <p><b>Portland</b></p> <p>Due to the location of the site and the inability to access this site in some years, there is currently insufficient information to determine any trends in this population.</p>	

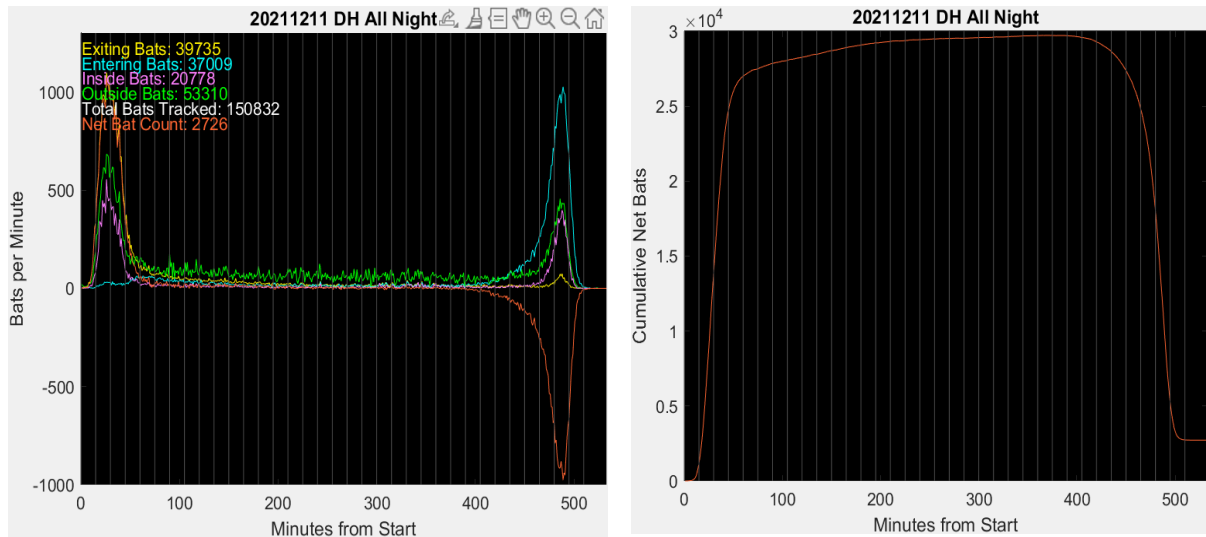
## Population Monitoring at Bat Cave



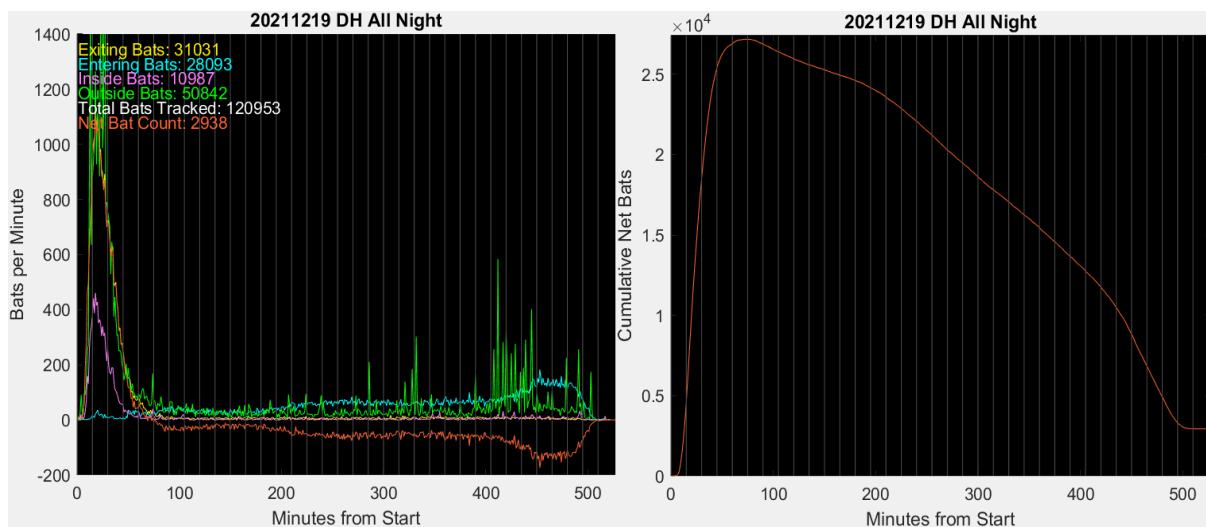
**Figure 1: Population estimates at Bat Cave, Naracoorte from December 2021 to November 2022.** There is slight uncertainty in these estimates ( $\pm 10\%$ ) that is not represented in this figure. This monitoring program is still in development and investigation is ongoing into the level of accuracy in estimates.

## Bat Cave Long Term Monitoring Project Outputs

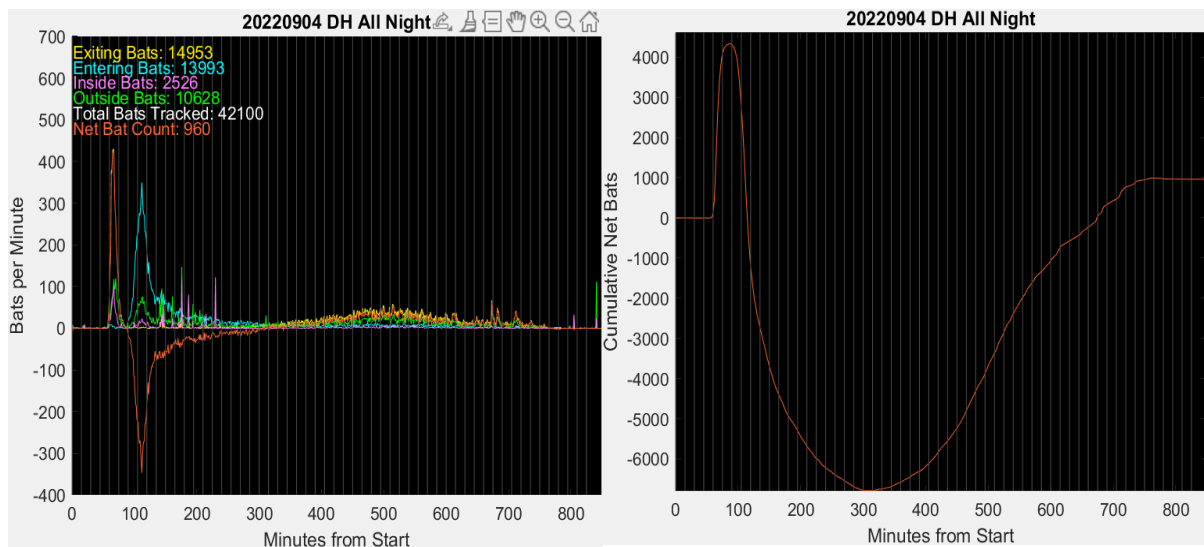
Below are a series of plots generated by N2, the software written to monitor the population size at Bat Cave. The plots on the left start at the beginning of the flyout and show a tally of bats detected per minute throughout the night for: bats exiting the cave (in yellow), bats entering the cave (in blue) and the net count of bats outside the roost (in red). The image on the right shows a cumulative count of the number of bats outside of Bat Cave throughout the night. This series of figures shows the variability in Southern Bent-wing Bat emergence between nights.



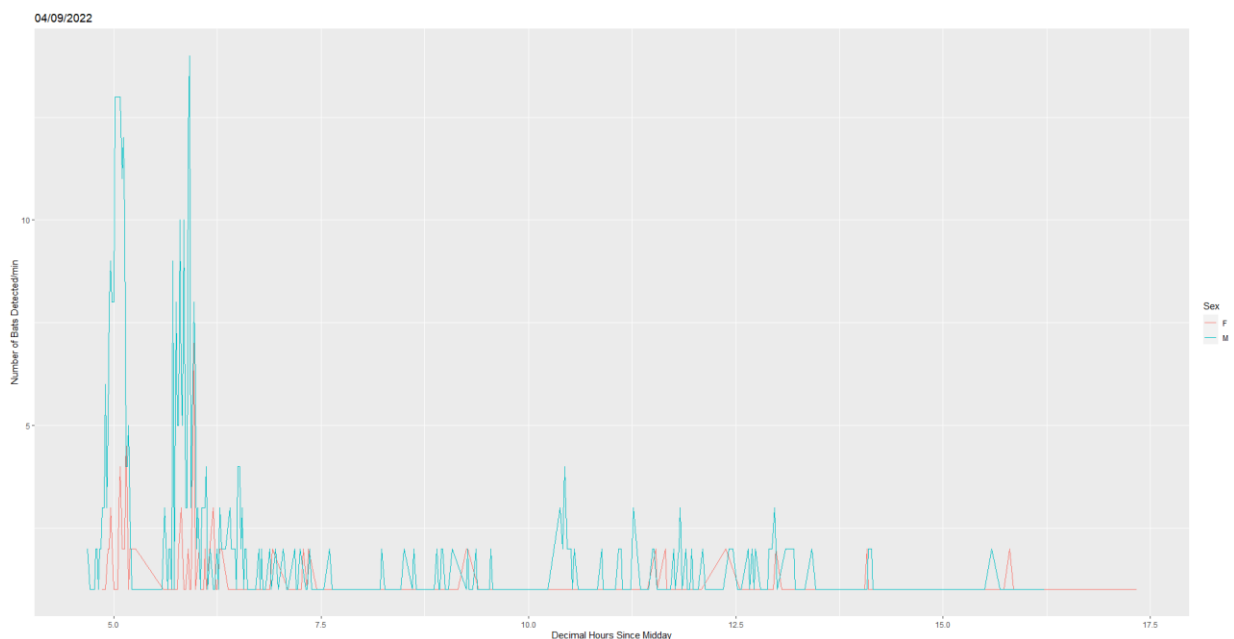
**Figure 2: Fly-out pattern at Bat Cave on a warm night (11/12/2021).** Note that peaks associated with both the emergence and return of bats are steep, and few bats return throughout the night. This graph is typical of flyout behaviour on warm nights. The total count for this night was approximately 29,700 bats.



**Figure 3: Fly-out pattern at Bat Cave on a cool night (19/12/2021).** Note that while the fly-out is steep, bats continually return throughout the night. This is typical of fly-out behaviour observed on cool nights. Approximately 27,200 bats were estimated to be roosting at Bat Cave on this night.



**Figure 4a: Novel emergence behaviour noted in September of 2022 (04/09/2022).** Note the small peak during flyout, represented as the green peak on the far left of the plot. Following emergence, a mass fly-in occurs, represented as the blue peak on this plot. This is likely indicative of bats returning from a nearby non-breeding roost following flyout, then entering the maternity cave. The cumulative count (right) shows that more bats entered the cave than the number that left in the initial flyout. Approximately 4,300 bats were estimated to be roosting at Bat Cave this night.



**Figure 4b: PIT-tag data can be used to investigate novel patterns observed in N2.** The above graph shows the number of bats detected on the in-cave PIT-tag reader on the night of 04/09/2022, when the 2-peak pattern in Figure 4a was noted. Most bats detected on the in-cave PIT-tag reader on this date ( $n = 351$ ) were male (blue) ( $n = 250$ ), with fewer females (red). Note that this graph starts just before 1700, and Figure 4a starts at 1700.

## Summary

The Southern Bent-wing Bat was listed as Critically Endangered nationally under the EPBC Act in 2007. This listing was based on a severe decline in population numbers and the small number of maternity roosts. A reassessment of the conservation status was undertaken in 2021. A Population Viability Analyses (PVA) developed by the Recovery Team as part of this reassessment predicted an 84% to 97% reduction in population size from 2020-2056, and as a result the status of Critically Endangered was retained (TSSC 2021).

In recent years extensive efforts have gone into new approaches for estimating population numbers and significant progress has been made in obtaining accurate estimates. However, as the systems are still being refined, and as there maybe yearly fluctuations in population numbers due to seasonal conditions, several more years of consistent monitoring will be required before population trends can be assessed.

A number of assumptions were required in the Recovery Team's PVA and this model will be refined as new information becomes available. Recent research is helping to fill key knowledge gaps and is greatly increasing the understanding of the subspecies. For example, preliminary findings from Nicola Bail's work, and high variation in fecundity estimates from concurrent pup and adult counts, infer that there may be high variation in reproductive success between years. van Harten et al. (2022a) found lower survival rates of adult females during and following the weaning period, which may reduce the potential reproductive output of this population, as well as the survival of dependent young.

White-nose Syndrome and drought both remain significant threats to this subspecies, and the introduction of WNS to Australia is considered 'highly likely' (Holz et al. 2016, 2019c). The Recovery Team is working hard to reduce the risk of WNS introduction into Southern Bent-wing Bat roosts, and Australia more broadly.

There is evidence of high variation in breeding success, lower survival of breeding females, as well as two significant, largely uncontrollable threats, and no evidence of population growth at any maternity roost. For these reasons, the state of the population remains very poor, and the PVA analysis suggests the population numbers are likely to be still declining.



## 4. SUPPORTING INFORMATION

### Recovery Team Report

In the past 12 months, the Southern Bent-wing Bat National Recovery Team has had four on-line meetings to discuss progress and issues relating to the recovery of the Southern Bent-wing Bat. Several subgroups are continuing to actively work on specific tasks, guided by the Recovery Plan, and identified by the Recovery Team.

Funding of the coordinator position has been extended by Zoos Victoria, allowing for the position to continue. After an immense amount of work and invaluable contribution to both the Recovery Team and the conservation of the Southern Bent-wing Bat, Emmi van Harten resigned from the coordinator role, but remains an active member of the Recovery Team. Nicola Bail took over the coordinator position in September 2022.

Considerable effort by the Recovery Team has gone into the Specific Needs Assessment for Southern Bent-wing Bats, and the results of this assessment will be highly beneficial for prioritising management actions to conserve the species.

A communications strategy for the Southern Bent-wing Bat was developed by the Recovery Team. This document was incredibly useful for members of the Recovery Team when preparing for interviews and other media opportunities relating to the Southern Bent-wing Bat.

The Southern Bent-wing Bat was awarded the inaugural 'Australian Mammal of the Year' in a voting campaign run by Cosmos Magazine. Recovery Team members and partners campaigned strongly on social media, within community groups and in private social circles to persuade voters. The success of this nomination and award has greatly increased public awareness of the subspecies and resulted in a number of radio interviews, television segments, online articles and newspaper articles about the Southern Bent-wing Bat and the Recovery Team.

An emphasis has been placed on on-ground management action to conserve the Southern Bent-wing Bat. Revegetation efforts, control of introduced species and the development of management plans for non-breeding roosts have been undertaken in 2022. The Recovery Team recognises the need for prompt on-ground management actions and this will be prioritised in the next reporting period. The Specific Needs Assessment will play an important role in this process.

The Southern Bent-wing Bat was listed as a priority species under the National Threatened Species Action Plan in 2022 (DCCEEW 2022). This listing, in conjunction with the Specific Needs Assessment and increased community support, should significantly assist in the implementation of the National Recovery Plan, by further enabling grants to be sought to implement on-ground actions.

The Southern Bent-wing Bat Recovery Team continues to invite new members and review the Terms of Reference to ensure that all relevant parties can contribute to the conservation of the Southern Bent-wing Bat. The Recovery Team is highly collaborative, with a diverse range of specialists, managers and stakeholders active in the team. The collaborative nature of the team has greatly assisted in securing funding for research and undertaking on-ground management.

### **Future course of action**

The National Recovery Team recommends ongoing implementation of the National Recovery Plan. The pending completion of the Specific Needs Assessment will be useful for prioritising management actions for the recovery of Southern Bent-wing Bat, and identifying additional required actions.

Active management of all maternity sites should continue to focus on the conservation of the SBWB. Management plans for significant non-breeding caves should continue to be developed to enhance the protection of these sites and the bats roosting in them, as well as promoting good relationships with landholders.

Long-term monitoring of population numbers at the maternity caves and key non-breeding caves should continue indefinitely. The regular monitoring at the two largest maternity caves should continue to enable accurate assessments and long-term trends. Discussions are ongoing regarding the storage of data from the automated counting system at Bat Cave, Naracoorte. The process may be fully automated and run by an external organisation in future, instead of relying on the work of volunteers. This will secure the longevity of the project and reduce the workload for volunteers.

There is now a dataset containing the nightly movements between several cave roosts of ~3400 SBWB from 2016-2022 for the SA population. PIT-tagging will be extended into 2023 and ideally analyses will continue with existing data to learn as much as possible about SBWB from these data.

Further investigations will be undertaken to understand the foraging range and foraging habitat requirements of SBWB in both Vic and SA.

Although much has been learnt in recent years about the biology of the SBWB, there remain some key knowledge gaps. These will be clearly articulated and prioritised to encourage more studies to be undertaken.

The impact of wind farms on SBWB warrants further investigation. With a high number of wind farm proposals near SBWB roosts and in foraging areas, the impact of wind farms on SBWB survival rates needs to be investigated, the effectiveness of potential mitigation actions evaluated, and mitigations implemented.

Communication efforts and outreach should continue in the next reporting period to foster public appreciation for the species.

Biosecurity and disease surveillance efforts should continue, with the aim of keeping WNS out of Australia for as long as possible. Public education efforts should continue, particularly in areas where recreational caving is popular.

Continued funding of the coordinator role is recommended, as it greatly assists the team in scheduling and completing and reporting on actions in a timely manner.

The Specific Needs Assessment will assist in the prioritisation of on-ground actions aimed at halting declines and recovering populations, and the development of new or more detailed actions where needed. But the next step, implementing these actions in a timely manner, will be dependent on the availability of funding, and the Recovery Team will continue to actively seek the required funding.

Given the poor trajectory of this subspecies and the predicted high likelihood of extinction in the next 50 years, on-ground actions need to be completed as soon as feasibly possible. These will be most effective if they incorporate an evaluation of the effectiveness of the actions, so that there can continue to be 'learning while doing', along with targeted research to address specific key knowledge gaps.

## Information sources

### Recovery Plan

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### Conservation Advice

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## Appendix 1: Conservation assessment criteria





### State/condition and prospects for long term survival in the wild

*How do you rate the state/condition of the species or ecological community and its prospects for long term survival of the in the wild, based on current information? If there are limited data available, it may be appropriate to make a qualitative assessment based on expert assessment.*

State/condition grades	Criteria
 Very good	The species appears to have <b>very good</b> prospects for long term survival in the wild, based on an evaluation of the parameters outlined in section 4, such as abundance, distribution, habitat condition or the impact of threats.
 Good	The species appears to have <b>good</b> prospects for long term survival in the wild, based on an evaluation of the parameters outlined in section 4, such as abundance, distribution, habitat condition or the impact of threats.
 Poor	The species appears to have <b>poor</b> prospects for long term survival in the wild, based on an evaluation of the parameters outlined in section 4, such as abundance, distribution, habitat condition or the impact of threats.
 Very poor	The species appears to have <b>very poor</b> prospects for long term survival in the wild, based on an evaluation of the parameters outlined in section 4, such as abundance, distribution, habitat condition or the impact of threats.

### Conservation trajectory

*What is the conservation trajectory of the species or ecological community in terms of whether it is improving, deteriorating, or stable? If possible refer to the ['national listing criteria for species and ecological communities'](#) and make a determination of the conservation trajectory using at least one criteria.*

Recent trend	Criteria (for example)
 Improving	Increase in population numbers or the geographic distribution of the species or ecological community
 Deteriorating	Decrease in population numbers or the geographic distribution of the species or ecological community.
 Stable	Population numbers or the geographic distribution of the species or ecological community are stable.
 Unclear	There is insufficient information to make an estimate of the conservation trajectory of the species or ecological community.

### Level of confidence

*What is your level of confidence in these estimates based on the available evidence and the consensus of experts?*

- Evidence and consensus too low to make an assessment    
  Limited evidence or limited consensus    
  Adequate high-quality evidence and high consensus