

National Report: Australia's Response to Sarcoptic Mange in Wombats

Current Picture
Concerns and Needs
Proposed Plan of Action

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Introduction

About this Report

Overview

Written primarily for the mange community, this report provides a plain-language snapshot of the status of Australia's response to sarcoptic mange in wombats and proposes a plan for future work.

There are three parts:

- Part 1. The current picture — a summary of policy, treatment practices, research and innovation
- Part 2. Review of stakeholder concerns, needs and ideas
- Part 3. Proposed plan of action.

There is no intent to expand the reader's understanding of mange itself. For a comprehensive easy-to-read synopsis, see Wildlife Health Australia's [Fact Sheet: Sarcoptic Mange in Australian Wildlife](#).

Background

The genesis of this report was an encounter with a mange-afflicted wombat named Winston on Boxing Day 2015. Further impetus came from several observations over the following year:

- A lack of verifiable data to support claims of mange prevalence, but no apparent moves to establish monitoring on a national scale.
- No obvious avenue for unifying the diverse responses to mange and no point of contact to initiate action on gaps and persistent hurdles.
- No clarity about safe and effective Cydectin[®] dosage in spite of repeated calls over many years from researchers and wildlife carers for a clinical trial.
- Wide-spread exhaustion and frustration among many people who want to do their best for sick wombats but have little confidence in whether their efforts are helping or harming.

Objectives

- To be a catalyst for establishing national coordination of the response to mange in wombats
- To give all stakeholders a common understanding of the status of mange work in Australia as a starting point for defining future work
- To propose a plan that will lead directly to action on the most important issues and help move past some stubborn sticking points
- To provide a hopeful and realistic vision to everyone, particularly the many people who feel disheartened.

Audience

This report was originally written for the mange community — anyone involved in treatment, research, policy, education and advocacy relating to mange in wombats. It may also be of interest to people and organisations with a broader interest in Australian wildlife welfare and conservation.

Scope

This report focusses solely on Australia's response to mange in the two species of wombat known to succumb to it — *Vombatus ursinus*¹ (bare-nosed wombat) and *Lasiorchinus latifrons* (southern hairy-nosed wombat) — and their combined home ranges covering ACT, NSW, SA, TAS and VIC.

There is also a sizeable population of *Lasiorchinus latifrons* in WA but there are no known cases of mange in that State.² The third species of wombat, *Lasiorchinus krefftii* (northern hairy-nosed wombat), remains unaffected by mange.

Terminology note: *Vombatus ursinus* is known by three different common names, the most well-known being "bare-nosed" and "common". While various groups favour different names, this report uses "bare-nosed" except in direct quotations and references.

Method

- Data collection from 78 contributors via 44 long-form interviews, 6 conversations, 22 online survey responses, 6 written submissions and a selective literature review. Contributors include government environment departments, researchers, academics, veterinarians, wildlife groups/carers, peak bodies and landowners; all listed in [Appendix A](#).
This consultation process collected extensive input and gave people in all sectors the opportunity to be heard.
- Qualitative data analysis of all inputs as described in [Part 2](#).
- Preview of the discussion draft by Dr Scott Carver, Dr Clare Death, Katja Gutwein, Dr Pam Whiteley and Dr Rupert Woods followed by review and comment by all contributors.

Authorship

I am independent, self-funded and have no affiliations or motives beyond hoping to help the people who help the wombats. My professional sphere is IT and project management with postgraduate study in environmental and geospatial science. I have extensive non-profit experience in everything from domestic animal welfare to aged care, including two years' volunteer involvement with mange.

Acknowledgements

I started this project in partnership with another volunteer, Katja Gutwein, in mid-2017. After initial planning and shared interviewing, Katja departed in November 2017 to assume joint leadership of Mange Management Inc in Victoria when founders Jenny and Reg Mattingley stepped down. I'm very grateful to Katja for her early work and to the many people who have given significant time and thought to their contributions.

¹ Encompassing all three sub-species: *Vombatus ursinus hirsutus* common (bare-nosed) wombat (mainland); *Vombatus ursinus tasmaniensis* common (bare-nosed) wombat (Tasmania) and *Vombatus ursinus ursinus* common (bare-nosed) wombat (Bass Strait).

² Personal communication, Dr Michael Swinbourne, University of Adelaide. A paper on the southern hairy-nosed wombat in WA by Swinbourne et al is currently under review for future publication.

Executive Summary

The Current Picture

Sarcoptic mange in wombats is a voracious infestation by the mite *Sarcoptes scabiei* that, unless treated, progresses until the animal is so severely compromised that it dies with immense suffering. Mange can spread rapidly through populations, particularly those of high density.

It affects all three sub-species of *Vombatus ursinus* (bare-nosed wombat) and *Lasiorhinus latifrons* (southern hairy-nosed wombat) whose combined home ranges cover ACT, NSW, SA, TAS, VIC and WA.

Mange is addressed by a range of committed volunteers and professionals but with no leadership or coordination of their efforts. Mange-affected wild wombats are treated by volunteer wildlife groups/carers with the support of veterinarians and landowners. Research is conducted by several academics who take a particular interest in the subject.

Key Findings

Analysis of stakeholder inputs to this report found a number of key needs and concerns:

- The need for a coordinated approach to managing mange across all regions
- The need for credible data about wombat populations and mange prevalence
- The need for a greater understanding of mange and better treatment options
- Concern about the efficacy of the current treatment regimen and difficulties executing it
- Concern about a lack of clear information and a strong sense of “*I just don’t know what to do*”.

These needs and concerns represent fundamental hurdles to responding to mange effectively, but there is currently no framework to address them. In short, sarcoptic mange appears to fall between the cracks of Australia’s wildlife management system.

Priority Actions

- Establish national coordination of the response to mange and prepare a plan of action.
- Determine whether any management strategy should focus solely on wombats or address mange on a multi-species basis.
- Establish national surveillance of wombat populations and the prevalence of mange.
- Draft a comprehensive research agenda — a prioritised list of the most pressing research needs — and actively promote that agenda in the scientific and philanthropic communities.
- Assess mange treatments and application methods in current use and, as appropriate, initiate further study to determine their safety, efficacy and optimal dose range. Start with topically applied Cydectin[®] as this is the only APVMA-approved treatment.
- Determine whether any other threats to wombats require greater focus than they currently receive — for example, road deaths, toxoplasmosis, habitat loss, climate change.

Next Steps

Given the overwhelmingly positive response to the discussion draft of this report — and in the absence of any specific body to assess and implement the report’s recommendations — the author will liaise with a range of stakeholders in November 2018 to determine the best way forward.

Mange: Why Does It Matter?

Why should Australia take notice of sarcoptic mange in wombats and direct resources to it?
Why does it matter?

It's a matter of welfare — mange inflicts a slow and painful death

The latest research suggests that the sarcoptic mange mite was introduced to the wombats' habitat by humans who brought mite-carrying species to Australia — and by that measure alone, if not for reasons of compassion, we may consider that humans bear some responsibility for putting right what humans have put wrong.

It may be a matter of wombat conservation — but nobody knows for sure

- There is no data on wombat populations in many regions.
- The spread and long-term impact of mange is not well understood.
- The resilience of affected populations is variable and not well understood.
- The capacity of other pathogens to do harm could be greater in mange-weakened populations.
- The only wombat species unaffected to date, the northern hairy-nose, is critically endangered and could be further threatened if it were to succumb to mange.

Without the warning that evidential data can provide, might Australia discover too late that mange is a bigger problem than anyone thought possible?

It's a matter for others too, not just wombats

Mange affects many domestic and wild animals globally.

In Australia, mange has been reported in domestic dogs and foxes and in several native species — but nobody can predict how mange will impact them in future or how many more native species may be affected. Knowledge gained through researching and treating mange in wombats has the potential to help in the broader context.

On all of these counts, some combination of human compassion, human responsibility and the precautionary principle points to the importance of this work — and, in particular, to adequate surveillance to ensure that Australia becomes and remains aware of the impact of sarcoptic mange.

Part 1. The Current Picture

The Status of Wombats — Protection | Conservation

	Common Wombat Mainland <i>Vombatus ursinus hirsutus</i>	Common Wombat (Tasmania) <i>Vombatus ursinus tasmaniensis</i>	Common Wombat (Bass Strait) <i>Vombatus ursinus ursinus</i>	Southern Hairy- nosed Wombat <i>Lasiorninus latifrons</i>
INTERNATIONAL Status – IUCN Red List				
IUCN Red List Status	Least concern ¹			Near threatened ¹
NATIONAL Status – Australia’s EPBC Act Threatened Species List				
EPBC Act Listing Status			Vulnerable As of July 2018, this status is under review as it may no longer meet EPBC criteria	
STATE Status — Protection and/or Conservation				
ACT	Protected ²			
NSW	Protected ³			Endangered ³
SA	Protected ⁴ (and classed as “Rare”)			Protected ⁴
VIC	Protected ⁵ except for 193 parishes in eastern Victoria where wombats are unprotected and may be controlled without authorisation on land used for rural production.			
TAS		Protected ⁶	Protected ⁶	

Grey cells are the equivalent of "not applicable" — i.e. not the home range of the species

1. IUCN. (2012). IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. iv + 32pp.
2. ACT Nature Conservation Act 2014
3. NSW Biodiversity Conservation Act 2016
4. SA National Parks and Wildlife Act 1972
5. VIC Wildlife Act 1975
6. TAS Nature Conservation Act 2002

The Status of Mange — Notifiable Disease | Key Threatening Process

Sarcoptic mange is neither a notifiable disease nor a key threatening process (KTP) nationally or in any State or Territory (henceforth referred to as jurisdictions).

As noted under [Innovations and Initiatives](#), an EPBC Key Threatening Process nomination for the impact of sarcoptic mange on *Lasiorninus spp.* is in the early stages of the assessment process.

How Is Australia Responding to Mange?

Australia's response to mange in wombats is largely led by volunteer wildlife groups/carers who advocate on behalf of wombats and run treatment programs, often supported by veterinarians and land owners, and by individual university researchers who pursue their interest in the issue. Some of these parties communicate with each other but none of them holds responsibility for setting the course and coordinating the wide range of activities that comprise a full response.

While commendable work is being done in many pockets, the combined lack of coordination, paucity of data on wombat populations and mange prevalence, and divergent approaches in different jurisdictions result in a piece-meal response.

Governments

The federal government plays no role in coordinating mange efforts.

Tasmania is the only jurisdictional government with a specific focus on mange. In response to the effect of mange in Narawntapu National Park (NP) and the ensuing public outcry, the government established the Wombat Mange Working Group in 2016 to assess the status of the State's wombat populations, assess the distribution and severity of mange across the State, and provide advice to the community about treating wombats. This working group includes biologists, veterinarians and other members from government and the University of Tasmania.

Government Perspectives

There is unanimous agreement among jurisdictional government environment departments — and among all participants in this report — that mange is an animal welfare issue.

Whether it's also a conservation issue is less clear. There are isolated incidents of local population declines and anecdotal reports of areas that once teemed with wombats but no longer do. However, little is known about the resilience of affected populations, and any long-term impact is unknown in the absence of population and prevalence data.

The following statements of jurisdictional government perspectives on mange were written and/or edited and approved by the named Department with no further editing by the author.

ACT – Environment, Planning and Sustainable Development Directorate (EPSDD)

"EPSDD considers mange in wombats to be an animal welfare issue. It is also a potential conservation issue given that mange is known to have caused localised declines in other jurisdictions, but there is currently no evidence or perception of a threat to population levels in ACT. Whether mange is a long-term threat to the species is unknown without data.

The biggest wildlife issues in the ACT include balancing different community attitudes to the large population of kangaroos, invasive species (weeds), loss and fragmentation of habitat due to urban development and recovery programs for about 30 threatened species."

NSW – Office of Environment and Heritage (OEH)

"Mange is seen principally as a welfare issue. OEH doesn't know whether it's a conservation issue or a long-term threat to the viability of wombat species in NSW. This will depend on what's learned about the extent of the problem, the resiliency of populations, whether treatment-and-release of individuals is effective or treatment needs to occur at the local population level, etc.

The most pressing problem is loss of habitat for all species, with the rarest species (those that are listed as threatened species) having the highest priority. The challenge with all conservation agencies is where best to put resources to have the greatest impact. Wombat mange is definitely an emerging issue and so on the spectrum but not in the red zone as one of the highest priorities as common wombats aren't classed as threatened, just protected."

SA – Department of Environment and Water (DEW)

“It’s a mix of both welfare and conservation. Mange can have significant negative affect on the health of wombats, and the welfare of those animals affected is a concern. With the loss of habitat in many of their core areas, mange certainly provides an additional pressure to conservation, and particularly to some small populations if there is an outbreak.

Mange is not currently a major threat to the long-term survival of the southern hairy-nosed wombat (SHNW). Loss of habitat — especially native grasslands — is the most critical threat as well as climate change, plant/weed toxicity and drought.

There are numerous welfare and wildlife conservation issues under consideration and active management through the Department, from managing abundant species such as long-nosed fur seals and little corellas, to trying to conserve species under imminent threat such as orange-bellied parrots and emu wrens. Mange does not appear to be as prevalent in SHNWs as in bare-nosed (common) wombats (BNWs) because the parts of SA they inhabit are drier than east coast environments so the mites cannot survive as long off-host. Researchers who catch and observe SHNWs report that it is rare to find one affected by mange. However, the consequences of mange can be devastating for those individuals that are affected by it.”

TAS – Department of Primary Industries, Parks, Water and Environment (DPIPWE)

“Mange is viewed as a localised conservation issue in region/s of decline; more broadly as an animal welfare issue for affected individuals.

As in any State, Tasmania has a range of pressing wildlife issues, including a range of threatened and endangered species and wildlife disease issues (including Devil Facial Tumour Disease, beak and feather disease, sarcoptic mange). Even though common wombats are not listed as a threatened species in Tasmania (except the Flinders Island subspecies listed on EPBC due to limited distribution), they are clearly a priority for the Government, amongst other priorities.

The current data on wombat population trends and mange prevalence does not support the view that mange is a threat to the long term survival of wombats in Tasmania. DPIPWE however recognises that mange has been attributed to be the cause of a significant decline at Narawntapu National Park and acknowledges that the disease can cause localised declines.”

VIC – Department of Environment, Land, Water and Planning (DELWP)

“DELWP considers mange in wombats to be an animal welfare issue. DELWP is aware that mange is prevalent based on anecdotal reports from wildlife organisations and carers, but without scientific data (population levels and the impact of mange on populations), there’s insufficient information to class it as a conservation issue or a long-term threat to the species in Victoria.

DELWP is constrained by limited resources and competing priorities, and as such must prioritise funding towards areas where it is most needed and/or will have the most effective outcome. Examples of current competing priorities include kangaroo impacts in peri-urban and rural areas, koala conservation and management in areas where they are over-abundant or their welfare is impacted, and strategies and procedures for more effective management of deer and feral cats to protect biodiversity and threatened species.”

Government Activity

Jurisdictional governments provided the following information about their initiatives relating to mange in wombats. Activities specific to population monitoring are described below under [Population and Prevalence](#).

Jurisdiction	Published Information About Mange	Other Mange-related Initiatives
ACT-EPsDD	<ul style="list-style-type: none"> No published information about mange 	<ul style="list-style-type: none"> In 2017 the ACT Environment Grants Program provided \$19,830 to community group ACT Wildlife to run a mange treatment trial at Tharwa. ACT is generally very supportive of those who want to help wombats in their own area.
SA-DEW	<ul style="list-style-type: none"> No published information about mange 	<ul style="list-style-type: none"> DEW publishes information on strategies that farmers can use to reduce the impact of wombats on their land with the aim of reducing conflicts and enabling wombats to remain in their territory. DEW regional staff provides in-kind support for researchers.
NSW-OEH	<ul style="list-style-type: none"> The OEH website provides information on the citizen science mange treatment program conducted at Bents Basin. Information is also provided in the Code of Practice for Injured, Sick and Orphaned Wombats (August 2015) 	
TAS-DPIPWE	<ul style="list-style-type: none"> DPIPWE's website provides extensive information on wombats and mange including a printable information sheet and poster as well as data showing population trends and the prevalence of mange in Tasmania. 	<ul style="list-style-type: none"> In 2016 DPIPWE established the Wombat Working Group to assess the status of wombat populations and the distribution and severity of mange across the state, and to provide advice to the community on treating mange in wombats. In 2017 DPIPWE provided \$100K of government funding for UTAS research into new treatments, for new mange-prevalence surveys and for small grants to treatment groups. DPIPWE also collaborates on publishing scientific peer-reviewed papers on wombats and is currently drafting a discussion paper on the state-wide approach to managing mange in wombats in Tasmania.
VIC-DELWP	<ul style="list-style-type: none"> There is very little published information at present but DELWP is in discussions with Mange Management Inc on how best to improve public awareness of the problem and how the public can help (e.g. advice on the DELWP website). 	<ul style="list-style-type: none"> Subject to resourcing and other priorities, DELWP is interested in understanding more about the health of Victoria's wombat populations, the severity of mange in the population and the effectiveness of its treatment.

Peak Bodies

Wildlife Health Australia (WHA) and the Australasian branch of the Wildlife Disease Association (WDA-A) play important roles in wildlife disease in Australia but neither is responsible for the hands-on management or coordination of specific ongoing threats to wildlife.

WHA's focus is on wildlife health issues that have the potential to impact primary production or human health, but current efforts are working towards expanding the organisation's scope to include diseases impacting on biodiversity.

Researchers

Researchers pursue projects based on personal interest and the availability of postgraduate students and funding. Dr Lee Skerratt conducted substantial research in the 1990s and early 2000s. Over the past 4 to 5 years there has been renewed interest and a growth in mange-related research but there is also a long list of subjects that researchers would pursue given more resources. Funding primarily comes from government grants, private grants and donations. Some academics speak of doing this work without being paid for it.

Wildlife Groups/Carers

Volunteer wildlife groups/carers run mange treatment programs or treat mange in the course of their general wildlife rehabilitation work. Many are also active in advocacy and community education. Carers may belong to organised wildlife groups, run independent sanctuaries or act as individuals, and they often encourage local landowners to assist with treatment. These volunteers are generally self-funded, primarily living on donations of money and supplies, small grants and merchandise sales.

Veterinarians

While there are not many veterinarians with extensive experience treating wombats, those who are able often provide health assessments, treatment support and euthanasia services, frequently free of charge or at reduced cost.

The Public

Public awareness of mange in wombats varies markedly between regions. In Tasmania, awareness is very high due to the high-profile decline of the wombat population in Narawntapu National Park in 2015. In other jurisdictions, mange in wombats remains unknown to much of the wider community, particularly in urban areas.

Members of the public sometimes get involved in hands-on treatment of mange, particularly on their own property, and usually in conjunction with a wildlife group or carer.

Population and Prevalence

Data on wombat populations and the prevalence of mange is essential to understanding its impacts. There is currently no national surveillance program specific to sarcoptic mange in wombats or any other species. This represents a significant knowledge gap. The lack of data means that Australia is unaware of wombat population numbers, population trends, and the proportion of wombats affected by mange nationally.

National Databases

- Wildlife Health Australia's Wildlife Health Information System (eWHIS)**
 Wildlife Health Australia (WHA) is the peak body for wildlife health in Australia and its objectives include monitoring wildlife diseases. WHA's database, eWHIS, accepts data from many sources, primarily government agencies, zoos, sanctuaries and universities. While new cases of mange in wombats would not be entered into eWHIS, a case of sarcoptic mange discovered in a species not previously known to be affected by *Sarcoptes scabiei* would be of interest to WHA and eWHIS.
- WomSAT**
 WomSAT was developed at the Western Sydney University (WSU) to map mange and other wombat threats across Australia. It stores wombat sightings, burrow locations, mange status and road deaths. Data can be entered by anyone via the WomSAT app or computer interface. Of the 16 contributors who provided input about WomSAT to this report, only two people report entering data regularly into WomSAT; four use it on an ad hoc basis and ten never use it. Further work is required to understand WomSAT's potential role in monitoring populations.
- Atlas of Living Australia (ALA)**
 Hosted by the CSIRO, the ALA is a national biodiversity database providing free online access for users to enter and retrieve biodiversity data. In addition to storing data records and images, ALA's DigiVol facility enables volunteers to view and tag images uploaded from wildlife cameras. Further work is required to understand any potential use of ALA and DigiVol in monitoring wombat populations.

State- and Territory-based Monitoring

While Tasmania is the only jurisdiction that regularly monitors wombat populations and mange prevalence, all jurisdictions have some form of wildlife monitoring and/or sources of related data, as summarised below.

Jurisdiction	Surveys of Wombat Abundance and/or Mange Prevalence	Other Potential Sources of Data
ACT	<ul style="list-style-type: none"> There are no government surveys of wombats or mange prevalence. 	<ul style="list-style-type: none"> ACT records the number of wombats required to be euthanised due to vehicle collisions.
NSW	<ul style="list-style-type: none"> There are no government surveys of wombats or mange prevalence. OEH has expressed interest in establishing surveys but has concerns about costs, methods and analytical approach. Julie Old, WSU, conducts surveys at Mudgee, Wolgan Valley and Merriwa by walking transects just after dusk. There is not yet enough data to see trends. 	<ul style="list-style-type: none"> NSW BioNet is a repository for biodiversity data products managed by OEH. It contains variable-quality data that can be entered by anyone. WildCount (OEH) is a 10-year fauna monitoring program that started in 2012. The program uses motion-sensitive digital cameras in 200 sites across 146 parks and reserves in eastern NSW and enables analysis of

		<p>trends in occurrence of animals at these sites to understand if animals are in decline, increasing or stable. So far, the data indicates an abundance of BNWs east of the Divide but there has been no analysis or modelling and no assessment of mange prevalence.</p> <ul style="list-style-type: none"> • Wildlife Rehabilitation data: All wildlife rehabilitation groups provide annual returns to OEH about animals rescued. It may be possible to analyse this data in future to ascertain the number of mange-infected wombats that are treated and their outcomes. • The WIRES wildlife rescue organisation database contains wombat rehabilitation records.
SA	<ul style="list-style-type: none"> • There are currently no State-wide government surveys but these have been done in the past. • University of Adelaide researchers are currently conducting population surveys throughout South Australia using satellite imaging and ground-truthing (to be published in late 2018). They are also working on population fluctuations and how best to estimate populations (modelling). 	<ul style="list-style-type: none"> • DEW issues permits for wildlife research and maintains a database of publications. • David Taggart, University of Adelaide, has also done work on the prevalence of mange using spatial data from veterinarians (to be published in 2018 or later).
TAS	<ul style="list-style-type: none"> • Tasmania has a 30-year history of annual mammal surveys including counts of wombats along >132 10km transects in eastern, northern and central Tasmania, where mange occurs. • Since 2017, twice-yearly surveys (summer and winter) of mange prevalence have been conducted at key locations across the State using observational counts and cameras. Results are available on DPIPWE's website. 	<ul style="list-style-type: none"> • Natural Values Atlas: contains >1500 wombat records from Tasmania. • DPIPWE's Tasmania Roadkill app was launched in 2018 and collects data on a range of species including mammals and birds. Wombats are frequently reported.
VIC	<ul style="list-style-type: none"> • Victoria does not currently monitor wombat populations. DELWP has expressed interest in population monitoring but also has concerns about costs and competing priorities. 	<ul style="list-style-type: none"> • Victorian Biodiversity Atlas (DELWP): contains ad hoc data. • Mange Management Inc. has a database of over 1000 wombat mange cases.

Informal Monitoring

While many parties — primarily wildlife carers — observe wombats and take notes about the mange cases they treat, they generally use their own systems, often paper notes. Some transcribe their results into Word, Excel or a private database but there is no evidence of consistent data collection, standard data format or collation of statistics. Further work is required to determine whether existing informal data kept by wildlife carers, veterinarians, sanctuaries and others may be of any value in understanding population and prevalence.

Treatment

Treatment of mange in free-living wombats is carried out primarily by volunteer wildlife groups and carers who proactively administer, deliver and pay for treatment programs themselves.

- In most cases, carers provide *individual treatment* to wombats observed to have mange.
- Where a large number of wombats in one area display symptoms, a *population treatment* may be conducted. This involves attempting to treat and monitor all wombats/burrows within a given area which is labour-intensive, time-consuming and costly.

A number of formal population treatments have been run in the past three years including the Bents Basin population treatment, a collaboration between OEH and the University of Sydney, and the Narawntapu National Park population treatment conducted by UTAS researchers.

- Some carers also administer monthly maintenance treatments in the same way that many people administer monthly flea treatment to a domestic dog or cat.

Treatment Programs

Some wildlife groups/carers focus on running mange treatment programs while others provide general wildlife care to all species. These volunteers are typically self-funded and rely on donations, small grants and/or merchandise sales to supplement their own contributions. Limited grant funding has recently been made available by the ACT and Tasmanian governments. Basic supplies include the treatment product (e.g. Cydectin[®], ~\$500/5L) and motion-sensor cameras (at least \$125 per camera for very basic models).

Some veterinarians support wildlife carers by providing health checks and euthanasia free of charge or at reduced cost where possible.

Land owners who report sightings of sick wombats on or near their own property may choose to deliver treatment themselves, usually with advice and supplies from the volunteer groups.

(The initial brief for this report included providing a directory of mange treatment groups and programs. This is important but would be better accomplished as a separate exercise. At the same time, it would be helpful to investigate the best approach for sharing information among groups.)

Approved Treatment

The only treatment approved by the APVMA for use on wombats is *Cydectin[®] Pour-on for Cattle & Red Deer* (active ingredient moxidectin 5g/L) administered using the 16-week treatment regimen outlined in APVMA permit PER82844 — 1ml/10kg body weight weekly for 8 weeks, then fortnightly for 8 weeks. Topical application is delivered either by the volunteer who uses a pole-and-scoop to pour a dose onto the wombat's back, or via a burrow flap that enables the wombat to 'self-medicate' when passing under the flap.

Products other than Cydectin[®] are to be used only as prescribed by a veterinarian.

The majority of respondents (29 of 41; 71%) report using Cydectin[®] while others continue to use treatments they had been using for years prior to the introduction of the APVMA permit. Carers who use Cydectin[®] believe the permitted dose is too low, but there is no consensus about the optimal dose range and there are no formal studies on the subject. These concerns are detailed in [Carer Concerns about Treatment](#) on page 21.

Other Treatments in Use

Some carers believe that other products are safer or more effective than Cydectin[®] and they report using a range of treatment alternatives. Carers also use supplementary products to relieve itching and treat secondary infection. Products used by participants in this study include:

Treatments reported in current use for mange (active ingredient & number of reports in parentheses)	Products reported in current use to treat symptoms and secondary infection
<ul style="list-style-type: none"> Ivomec[®], Genesis[®] (ivermectin), pour-on and injectable (<10 respondents) Revolution[®] (selamectin), pour-on (~5) Sulphur and Oil (<5) Advocate[®] (moxidectin and imidacloprid) (<5) Advantage Plus[®] (imidacloprid) (<5) 	<ul style="list-style-type: none"> Antibiotics (injected) Cetrigen[®] Antibacterial Wound Spray Chloromide[®] Antiseptic Pump Spray Oils — olive, vegetable, coconut, pawpaw, baby, tea-tree — used to suffocate mites, soften scabs, flush out maggots, and sooth/condition the skin Iodine Malaseb[®] to sooth itching Human skin antiseptic products Cattle pinkeye spray Pony pellets as supplementary food Vitamins.

Monitoring and Record-keeping

Carers and researchers consistently report that monitoring wombats under treatment is extremely challenging due to their nature and behaviour (nocturnal, burrowing).

Twenty people provided input on their methods of identifying wombats, noting burrow locations and recording treatment outcomes. Tools used by participants in this study include:

Observing Wombats	Marking Wombats	Locating Burrows	Recording Observations
<ul style="list-style-type: none"> Visual sighting Spotlighting Digital cameras Motion-sensor/night-vision cameras 	<ul style="list-style-type: none"> Food colouring Non-toxic black poster paint Stock marker Microchips 	<ul style="list-style-type: none"> Pink flagging tape tied to nearby tree Avenza[®] software and antenna to record and locate GPS coordinates 	<ul style="list-style-type: none"> Paper notes Computer spreadsheet or database software

Used only by scientific researchers: Thermal imaging cameras, GPS collars, VHF collars, Radio frequency ear tags.

Academic Research

This section provides a summary of work in progress and the findings of recent research. These lists are not exhaustive but provide a representative picture of the work being pursued by many of the most active researchers in this area.

Current Research

Wombats

Topic	Researcher	Institution	Time-frame
Genetic diversity of wombats across Australia (samples from TAS, SA, VIC, NSW)	Alynn Martin	UTAS	Expects to publish in 2018
SHNW population fluctuations and how best to estimate populations (modelling)	Michael Swinbourne	UofA	Expects to publish late 2018
Population trends of wombats in Tasmania	Rosemary Gales	DPIPWE	Ongoing
Investigating immune system diversity (MHC markers)	Julie Old	WSU	In progress
Population genetics	Scott Carver	UTAS	2018/19
Sequencing wombat genome	Scott Carver	UTAS	2019

Mites

Genetics of mange mites from animals across Australia	Scott Carver	UTAS	In progress
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Mange

Nutrition studies to see if nutrition plays a role in susceptibility to mange	Julie Old	WSU	In progress
Investigating the role of stress in mange	Julie Old	WSU	In progress
Understanding physiological effects of mange in wombats	Scott Carver	UTAS	Martin et al. 2018. Royal Society Open Science
Immune responses from wombats to mange	Scott Carver	UTAS	2019
Modelling of disease transmission (wombat to wombat)	Scott Carver	UTAS	2018/19
Assessment of current diagnostic methods for mange in wombats	Tamieka Fraser	UTAS	2018
Prevalence of mange in wombats in Tasmania and the factors associated with increased mange in some individuals and some populations	Rosemary Gales	DPIPWE	Ongoing

Treatment

Developing new longer-lasting treatment for mange in wombats (funded by DPIPWE grant)	Scott Carver	UTAS	Trials to continue through 2019
Developing a slow-release form of moxidectin using nanotechnology	Ravi Shukla	RMIT	Feasibility stage
Existing methods of population disease control	Scott Carver	UTAS	In progress
Design and development of a purpose-built quarantine hospital burrow for treating mange	Marcus Foth	QUT	Design stage

Related Topics

How sociality & dispersal influence success of rehabilitated bare-nosed wombats released into free-living populations	Georgeanna Story	ANU	Expects to publish end-2020 subject to funding
The impact of roads on the bare-nosed wombat, from the individual to the population	Georgeanna Story	ANU	Expects to publish end-2020 subject to funding
Assessment of wombat road deaths in Tasmania via Roadkill Tasmania app	Rosemary Gales	DPIPWE	Commenced 2018
Efficacy of wombat gates	Michael Driessen	DPIPWE	Pilot study complete

Recent Findings (2015 to present)

Wombats

Wombats do not emerge from their burrows when overnight temperature is 25°C or higher (based on 100,000+ wombat records, Cumberland Plain Woodland). Not yet published. Greater Sydney Local Land Services. (2018)	P. Ridgeway et al.
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Mites

Mange mite originated in Europe (more work required).	Scott Carver/ Tamieka Fraser
PCR (polymerase chain reaction) can detect mite presence even when skin scraping microscopy results are negative.	Scott Carver/ Tamieka Fraser

Mange

The animals can't cope with the energetic pressure of disease. Food supplementation may be a mitigating factor, and is a possible research direction.	Alynn Martin
Mange causes substantial behavioural and thermal changes in wombats.	Scott Carver/ Kellie Lovell
A mange outbreak can cause substantial declines in numbers.	Scott Carver
Transmission is consistent with burrow sharing.	Scott Carver
The presence of mange does not drive declines in all populations. Mange is widespread in Tasmania, generally at low prevalence, and overall the State-wide population is increasing.	Rosemary Gales

Treatment

A longer-lasting treatment is needed.	Alynn Martin
Black non-toxic poster paint, administered by a second bottle lid in the burrow flap, lasted 10 days to 2 weeks and proved to be the best marking product to enable treated wombats to be identified in camera images.	Bents Basin- <i>preliminary findings</i> ¹
Development of a multi-dose dispenser would considerably improve treatment of juveniles, and of multiple animals per burrow, and potentially lead to the need for fewer treatments and make treatment less labour intensive.	Bents Basin- <i>preliminary findings</i> ¹

Treatment (continued)

<p>Preliminary data analysis suggests that the treatment trial of a relatively isolated population was effective in dramatically reducing the number of animals with signs of mange but required significant manpower. Findings:</p> <ol style="list-style-type: none"> 1. All burrows must be treated whether active, inactive or minor. 2. Regular searches for new or previously overlooked burrows are essential. 3. Camera monitoring is essential to detect burrow flap avoidance & guide adjustment (using a few cameras re-positioned over time) 4. Supervision by wildlife professionals of well-trained personnel is essential. 5. Treating burrows on challenging terrain can be dangerous work so OH&S and legal/liability implications relating to volunteers must be considered. 	<p>Bents Basin- <i>preliminary findings</i>¹</p>
<p>1. These findings are preliminary but in the public domain from the document <i>Outcomes and lessons learnt from the pilot sarcoptic mange treatment program of common wombats Vombatus ursinus at Bents Basin State Conservation Area</i> (2015) Leary et al.</p>	

Related Topics

<p>Description of first reports of sarcoptic mange outbreaks in free-ranging koalas in VIC and SA between 2008 and 2015. Conclusion that increased surveillance will be necessary to monitor the effect of mange on koalas, with considerations for methods of control and management, and effects on wildlife welfare. (2016)</p>	<p>Speight et al.</p>
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Real-world Application of Recent Findings

<p>Tasmanian Wombat Working Group established with DPIPWE. (2016)</p>	<p>DPIPWE Wombat Working Group</p>
<p>Increased public awareness and community engagement including extensive information on wombats and mange available on the DPIPWE website.</p>	<p>DPIPWE Wombat Working Group</p>
<p>Substantial conservation changes at government level in Tasmania including assessing state-wide population levels of wombats.</p>	<p>DPIPWE Wombat Working Group</p>

Innovations and Initiatives

New Longer Lasting Treatment

A longer-lasting topical treatment for mange in wombats that can be widely used.	Trials to continue through 2019	Scott Carver, UTAS
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Red Healer Wombat Mange Treatment and Spray Applicator

<http://bayviewbushbabies.org.au/mange.html>

A plant-based remedy to control sarcoptic mange in the bare-nosed wombat. The spray applicator is a stand-alone unit.	Preliminary trials have been very promising and will continue through 2018	Bayview Bush Babies TAS in conjunction with Red Healer Natural Canine and Equine Products NSW
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CritterKleen Natural Treatment for Mange

A plant-based natural treatment reputed to work on mange by suffocating mites, lifting scabs and reconditioning the skin to allow hair follicles to emerge. The developer asserts that the product treats all kinds of skin conditions and pests in humans and wild and domestic animals.	Under development; pre-trial	Addy Jones, Farma Culture, Flinders Island TAS
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Slow-Release Form of Moxidectin using Nano-technology

A slow-release nano-delivery form of moxidectin that would result in lower doses having greater effect by persisting longer in the wombat's system.	Feasibility stage	Ravi Shukla, RMIT University, Melbourne
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MarsTrack™ Automated Burrow Applicator

An automated burrow-mounted treatment device to significantly reduce the time and effort required for in-field Cydectin treatment. Further information: Alex Griffiths, alexgriffiths@griffithscomponents.com	Trial in progress and expected to be complete by end-2018	Collaboration: Griffiths Components P/L; Latrobe University; federal government grant
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Quarantine Hospital Burrow

https://eprints.qut.edu.au/113724/1/SOS-wkshp_v3mf.pdf

Project to develop, and ultimately widely deploy, a new treatment approach using a purpose-built quarantine hospital burrow with removable roof panels.	Design stage	Collaboration: Marcus Foth, QUT Sleepy Burrows Wombat Sanctuary, NSW
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WIRES Online Course for Mange Treatment

A new online training course for WIRES members, with a view to national availability.	Expected to be ready by end-2018.	Kristie Harris, WIRES, NSW
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The Wombat Protection Society of Australia's "Mange Hub"

A re-name and re-launch of the WPSA's mange group to raise the profile of mange with the mission of "promoting and progressing prevention and treatment of mange".	Re-launched in 2017	Wombat Protection Society of Australia (WPSA)
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EPBC Key Threatening Process Nomination

An EPBC Key Threatening Process nomination for the impact of sarcoptic mange on <i>Lasiorhinus spp.</i> was submitted in March 2018	Early stage of the assessment process	Evan Quartermain Humane Society International, Sydney
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Kelso Sanctuary Proposal

Project to purchase land in Kelso and preserve it as conservation land — a place for wild wombats to live freely and be treated. Educational display also planned.	Fund-raising stage	Wombat Rescue Tasmania
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Part 2. Concerns, Needs, Ideas

The backbone of this report is the information collected from a wide range of people who actively work with wombats and sarcoptic mange, or have a strong link to it.

The ultimate goal of collecting and analysing these inputs is to elevate the response to mange for the animals and for the people involved. Understanding the difficulties — and ascertaining what all sectors believe is needed to respond more effectively and efficiently — is useful when planning an approach that addresses all aspects of the response. This section informs the plan proposed in [Part 3](#).

Contributors

The people who contributed their experience and opinions are a mixture of professionals and volunteers from the full range of sectors listed below — in total, 78 contributions via 44 long-form interviews, 6 conversations, 22 responses to an eight-question online survey and 6 written submissions. All contributors are listed in [Appendix A](#).

Their input represents a large volume of information. This report aims to provide a useful summary without excessive detail — but that detail is easy to access for future use.

Contributors from ACT, NSW, SA, TAS and VIC include:

- 43 wildlife carers
- 15 university researchers/academics/ veterinarians
- 9 representatives from 5 jurisdictional government environment departments
- 6 land owners
- 3 business owners (product innovators)
- 2 peak bodies.

Qualitative Data Analysis

The salient points from all inputs were classified using the categories below, enabling sorting and collation of data and identification of themes. This approach enables us to identify the most common concerns and needs across the board and within particular groups. So, for example, we can look at the five top concerns of the entire group; or the most frequently reported needs of carers compared to government or university researchers.

CONCERNS | NEEDS | IDEAS

- 01-Overall Approach to the Issue (strategy)
- 02-Knowledge Base & Research
- 03-Training & Guidelines
- 04-Communication & Information-sharing
- 05-Identifying Mange & Assessing Cases
- 06-Treatment Methods
- 07-Executing Treatment
- 08-Monitoring Treatment & Outcomes
- 09-Record-keeping
- 10-Attitudes & Relationships
- 11-Resources
- 12-Public Education & Awareness
- 13-Inaccurate or Misleading Messaging
- 14-"I just don't know the right thing to do"
- 15-Other Threats

TOPICS

- Welfare or conservation issue?
- Population and data sources
- Current treatment practices
- Current academic research
- Required research topics
- Treatment innovations
- Monitoring techniques
- WomSAT usage
- Treat vs Euthanise?
- Free-living vs In Care?
- Population vs Individual Treatment?

Concerns

All Contributors

Based on input from 78 contributions in total — 43 wildlife carers; 15 university researchers/academics/veterinarians; 5 governments (9 people); 3 business owners/innovators; 6 landowners and 2 peak bodies.

Discussion

The largest group of people who play a role in mange in wombats is the cohort of volunteer wildlife carers. This is evident in the ratio of carers interviewed compared to other roles and is reflected in the results below.

The most frequently reported concerns were (1) difficulties executing (delivering) mange treatment in the wild; (2) concerns about the efficacy and risks of the current treatment regimen; (3) shortage of time and funds; (4) uncertainty about whether treatment efforts are helping or prolonging suffering; and (5) a degree of discord or disconnect between groups or sectors.

	Category of Concern (number of responses in brackets)	Top Concerns within the Category
1	07-Executing Treatment (61)	Difficulty finding and identifying individual wombats to treat for the full regimen and/or to monitor outcomes. Treatment too time-consuming. Difficulty finding burrows.
2	06-Treatment Methods (30)	Risks of current treatments (potential resistance; concerns about safety and long-term effects). Efficacy of current treatment (lack of evidence; dosing too low; inappropriate one-size-fits-all burrow-flap approach).
3	11-Resources (23)	Lack of time; Lack of money.
4	14-“I just don’t know the right thing to do” (19)	“Am I doing the right thing or prolonging suffering?”
5	10-Attitudes & Relationships (18)	Friction between groups who disagree on best treatment. Feeling of disconnect from government.
6	03-Training & Guidelines (14)	Lack of clear consistent treatment guidelines and training.
7	15-Other Threats (13)	Road deaths, culling, other health conditions, habitat loss, climate change, drought.
8	01-Overall Approach to the Issue (strategy) (11)	Current approach is ineffective — fragmented, small-scale, state based. Feelings that the system is broken. A degree of disappointment in government track record on animals and a hope that governments will be more proactive regarding mange.
9	08-Monitoring Treatment & Outcomes (10)	Difficult (impossible) and time-consuming to monitor outcomes.
10	13-Inaccurate or Misleading Messaging (7)	Concerns about blanket statements or inaccurate advice that may result in extended suffering on the one hand or unnecessary euthanasia on the other — e.g. “every wombat with mange can be treated”, “all adults with mange should be euthanised”, “it’s better to try than not try”.

Carer Concerns about Treatment

Four issues arise repeatedly when speaking to people who treat mange:

- Cydectin® dose
- Treat or euthanise?
- Free-living or in care?
- Individual or population treatment?

Cydectin® Dose

Carers who follow the APVMA-approved Cydectin® treatment regimen believe the permitted dose is too low and strongly believe it should be increased. Their justification includes the following points:

- The Cydectin® dose approved for wombats is the recommended maintenance dose for cattle and red deer. This is not necessarily appropriate for other species, especially a species as severely affected by mange as the wombat.
- It is unlikely that the full dose will penetrate the wombat's coat and reach the skin because of the thick hair and build-up of dirt from burrowing activity. In addition, a portion of the dose is often lost to shake-off or run-off — and absorption of the diminished dose into the wombat's system is likely to be inhibited by the animal's thick dermis and mange-compromised condition.
- Several carers cite examples of faster resolution of visible and behavioural symptoms when using higher doses delivered in fewer applications.

There is broad agreement on the need for a higher dose but, given the lack of coordination of the mange response, there is nobody to take charge and address this issue. Carers' concern for the wombats they're treating is in tension with their desire to adhere to the APVMA permit — and this makes the dosing decision very difficult.

Treat or Euthanise?

People who treat wombats assess mange severity differently depending on their degree of experience and the availability of documented guidelines; and they have varying levels of confidence in the current treatment regimen. These factors affect their decision to treat or euthanase.

- One third of the 42 respondents to this topic (14 people) treat in all cases, no matter how severe. Some acknowledge that this decision depends on the carer's experience, physical ability and access to treatment options such as injectable antibiotics.
- Two-thirds (28 people) treat unless the wombat is too compromised to recover — but "too compromised" is subject to varying definitions.

Even when a decision to treat or euthanise has been made, it isn't always easy to implement. Carers often have difficulty delivering the full course of treatment and at times have difficulty arranging for immediate euthanasia.

Free-living or In Care?

There is broad agreement that it's acceptable to provide mange treatment to joeys and juveniles who are raised in care but there are distinctly different views on the decision to treat adults in the wild versus taking them into care. Of the 40 respondents who spoke directly to this issue:

- 7 people (18%) have personal experience of successfully keeping wombats in care and treating them for mange. This group is convinced that adults can be kept in care successfully providing that the capture process, enclosure facilities and care are all appropriate and of a high standard. They also believe that the true cause of death in captivity experienced by others may be the presence of co-existing health issues that would have resulted in death anyway.
- 3 people gave examples of others (not the 7 noted above) who have kept and treated wombats successfully.
- The majority of respondents (30 people, 75%) believe that treating in the wild is the only, or at least preferable, approach. Key reasons reported are: (a) bad experience with deaths in care, either personal or hearsay; (b) the belief that captivity causes stress that leads to death directly or indirectly; (c) post-treatment release can be difficult because wombats removed from their environment lose territory and because release to a new location can be problematic.

Individual or Population Treatment?

Of the 17 respondents who expressed a clear view, 95% believe that both approaches are valid depending on the situation.

The most common feedback is that population treatment (i.e. attempting to treat all wombats/burrows in an area as opposed to targeting individual cases) is appropriate when many wombats in one area have mange and/or the goal is to clear an area of mange. People also agree that population treatments require an enormous commitment of people, time and funds.

Needs

All Contributors

The top reported needs are (1) national coordination; (2) new long-lasting treatment methods; (3) more research to understand the problem (wombats, mites and mange); (4) improved record-keeping of treatment outcomes; and (5) greater public awareness and education.

	Category of Need (number of responses in brackets)	Top Needs within the Category
1	01- Overall Approach to the Issue – National Coordination (44)	Work towards a nationally coordinated approach. Current efforts are fragmented.
2	02- Knowledge Base & Research – New Treatment Methods (39)	Long-lasting effective treatments; preferably a one-off treatment.
3	02-Knowledge Base & Research – Wombats/Mites/Mange (31)	Research why wombats (as a species) are so susceptible to mange — and why some individuals appear to be more susceptible than others. Research wombat behaviour as we still don't know a lot about them. Does increased population density result in mange?
4	09-Record-keeping (30)	Interested in a standard national recording tool and/or app so that everyone is collecting the same data.
5	12-Public Education & Awareness (28)	Need community and landowner education and awareness. Awareness is key – it's very important to educate policy-makers and the public at the national level.
6	02-Knowledge Base & Research – Population & Prevalence data (18)	Better understanding of wombat population & distribution of mange; ideally long-term repeated surveys of same areas.
7	06-Treatment Methods – Current Methods (17)	Would eventually like to see all treatment methods trialled but start with optimal dosing of Cydectin®. Need best-practice treatment.
8	03-Training & Guidelines (17)	A set of published treatment standards so carers are on the same page Also, published standards for enclosures and release methods.
9	04-Communication & Information-sharing (16)	Better communication; cross-sharing of information and experience among the groups. Need all information in one easy-to-access spot. This information may need to be area-specific due to local variations in animals and environments.
10	11-Resources (14)	Funding is an issue — e.g. volunteers struggling to pay for Cydectin®. Funding and manpower are issues. With more personnel we could do more research.
11	10-Attitudes & Relationships (14)	Need to work together not against each other. Need open-mindedness to new solutions.
12	08-Monitoring Treatment and Outcomes (11)	Need better monitoring and recording of treatment outcomes.
13	01-Overall Approach to the Issue – National Agenda/Federal Government (10)	Would like to see mange on the national agenda and acknowledged by the federal government.

By Group

Based on input from 42 interviews — 5 with government environment departments; 14 with university researchers/academics/veterinarians; 23 with wildlife carers.

Discussion

It's worth looking at the sub-set of data collected via long-form interviews as this method of data collection provides the greatest degree of detail.

The first Ranking column shows reported needs across all 42 interviews, and the additional Ranking columns show how those needs were ranked by sub-groups.

The top-ranked needs are common to all groups as highlighted by the shaded area. This suggests broad agreement on the most important issues to address.

Category of Need (number of responses in brackets)	All Ranking 42 interviews	Carer Ranking 23 interviews	University Researcher/ Vet Ranking 14 interviews	Gov't Ranking 5 interviews
Figures in brackets — e.g. (39) — are the number of responses, so 1 (39) means ranked #1 with 39 responses.				
02- Knowledge Base & Research – New Treatment Methods (39)	1 (39)	2 (24)	2 (10)	1 (5)
01- Overall Approach to the Issue – National Coordination (37)	2 (37)	1 (26)	3 (9)	2 (2)
02-Knowledge Base & Research – Wombats/Mites/Mange (31)	3 (31)	5 (16)	1 (13)	2 (2)
09-Record-keeping (29)	4 (29)	4 (21)	4 (8)	—
12-Public Education & Awareness (28)	5 (28)	3 (23)	6 (4)	3 (1)
02-Knowledge Base & Research – Population & Prevalence data (18)	6 (18)	9 (10)	5 (6)	2 (2)
06-Treatment Methods – Current Methods (17)	7 (17) ¹	8 (12)	6 (4)	3 (1)
03-Training & Guidelines (17)	7 (17) ¹	7 (13)	7 (3)	3 (1)
04-Communication & Information-sharing (16)	8 (16)	6 (15)	9 (1)	—
10-Attitudes & Relationships (14)	9 (14)	9 (10)	7 (3)	3 (1)
11-Resources (11)	10 (11)	10 (9)	8 (2)	—
01-Overall Approach to the Issue – National Agenda/Federal Government (10)	11 (10)	12 (6)	6 (4)	—
08-Monitoring Treatment and Outcomes (10)	11 (10)	10 (9)	9 (1)	—
05-Identifying Mange and Assessing Cases (8)	12 (8)	11 (7)	9 (1)	—
07-Executing Treatment (5)	13 (5)	13 (5)	—	—
15-Other Threats (4)	14 (4)	14 (3)	—	3 (1)

¹ Where different items have the same number of responses, they're given the same ranking. For example, there were 17 responses for both 06-Treatment Methods-Current Methods and 03-Training & Guidelines, so both are ranked 7th.

Research Directions

Academic papers and articles generally make recommendations for further research based on their findings so it's worth looking at what they say.

Wildlife Health Australia's [Fact Sheet: Sarcoptic Mange in Australian Wildlife](#)³ provides a summary of areas requiring further study as follows:

- Modes and degree of transmission between and within species
- Evolutionary history of the mange mite in Australia
- Physical and behavioural impacts of mange on hosts
- Understanding dynamics of impacts of mange at the population level
- Understanding the environmental factors that exacerbate impacts of mange on host populations
- Understanding of the host immunological response to mange
- Distribution and monitoring of mange presence and prevalence within Australian mammal populations
- Clinical pathology associated with mange in the host
- Efficacy of treatment options at the population scale.

Research on Treatment Methods

Current treatment methods appear to rely on anecdotal evidence more than science. Given the growing number of volunteers treating mange in the field, their level of concern about the efficacy and risks of current treatments, and the fact that new treatments are not expected immediately, it would be worthwhile for researchers and carers to jointly assess the need for further study. Clinical trials require time, money and usually university supervision, but if the need is agreed, a search for supervisors, candidates and funding could yield results.

The following recommendations from just two papers — Death et al (2011) and Rowe (2016) — echo calls for greater certainty, and provide a starting point for a more thorough literature review and assessment of current treatment practices.

- Further studies should compare the pharmacokinetic parameters of oral, injectable, topical, short-acting and long-acting formulations of macrocyclic lactones in the wombat and utilize clinical trials to determine the effectiveness of various treatment protocols⁴
- For future use of topical moxidectin, investigating an effective dose rate for wombats may yield better results than using the suggested dose rates for cattle and red deer.⁵
- Undertake clinical and field trials to investigate the efficacy of the 12-dose topical moxidectin treatment protocol.⁵ (*Note: This reference to a 12-dose protocol refers to a regimen in use prior to publication of the 16-dose regimen documented in the APVMA permit – Ed.*)
- Undertake long-term studies to determine whether wombats treated to the point of sub-clinical infection re-develop clinical signs of mange following the termination of treatments, and determine under what circumstances wombats with complete elimination of infection become re-infected from their environment.⁵
- Determine the pharmacokinetic parameters and plasma drug deposition profile of topical moxidectin in wombats.⁵

³ Last updated May 2017; content provision and revision credited primarily to Scott Carver, Alynn Martin and Lee Skerratt)

⁴ Death, CE, Taggart, DA, Williams, DB, Milne, R, Schultz, DJ, Holyoake, C, Warren, KS (2011) Pharmacokinetics of Moxidectin in the southern hairy-nosed wombat (*Lasiorninus latifrons*). *Journal of Wildlife Diseases* 47, 643-649.

⁵ Rowe M, BSc Faculty of Veterinary and Agricultural Sciences The University of Melbourne, (2016) An Analysis of the Treatment of Sarcoptic Mange in Wombats Using Macrocyclic Lactones with Suggestions for Future Research, 1-5. (unpublished)

Challenges and Needs Reported by Governments

In the absence of direct dialogue between the community and those in jurisdictional government environment departments, it may be helpful to note the particular challenges and needs that these departments face when addressing mange in wombats.

Each point is shown exactly as provided by the contributing government departments. Some topics were raised by multiple governments in which case they appear multiple times in the list.

Challenges

- Competing priorities, finite resources — i.e. lack of time and money.
- We have to consider best use of resources so, for example, rather than saving one individual, those resources might be better directed to a population effort.
- Lack of data. If there were more data about the issue (extent of problem and effect on viability of species), then it may potentially have higher priority.
- Cross-jurisdictional issues make it difficult to know the right action to take — e.g. the differing opinions on individual vs population treatments.
- Lack of long-term solution. The current Cydectin[®] treatment regimen is resource-intensive with only short-term results.
- Differing opinions about how best to use Cydectin[®], partly because wildlife carers are looking for larger dosing than the APVMA permit allows.
- The challenges are considerable — lack of an effective long-term treatment for wild wombats; locating/capturing/treating wild animals; monitoring health status and reinfection rates of populations; restoring habitat to improve overall health of populations. In combination, these challenges make long-term solutions extremely difficult and expensive, and could potentially have impacts on the welfare of the wombats being treated and monitored.

Needs

- A consistent national approach across all affected states/territories.
- Something like this report is needed — a coming-together of all parties for an honest, unemotional discussion to look at what's happening and how best to address it.
- More information — a better understanding of distribution/prevalence of mange and resilience of populations, and better understanding of the vectors.
- Determining the size of the problem in our State — i.e. how big is the impact of mange on populations?
- Applied research including efforts to better understand the factors that result in some populations and some individuals being more impacted by mange than others.
- Investigations into the effectiveness of current methods to treat mange-affected individuals.
- Development of treatment options that are feasible for dispensing to wild wombats and are effective at the population level.
- More research into long-term solutions that confer long-lasting protection.
- Better treatment — which would have the added benefit of removing concerns about the public providing proper treatment (administering the full treatment regime) and potential development of resistance to the current anti-parasitic treatment.
- Research into longer-lasting treatment so that a one-off treatment could be effective.
- Research into ridding wombat burrows of mites.
- Addressing and improving resource availability for wombats — for example, how do we get/restore more native grasslands — to ensure wombat health is good in general; wombats that are malnourished will suffer more from the impacts of mange.
- Respectful cooperation and collaboration across sectors.
- Public education so that actions and decisions are based on facts.

Ideas

This list provides a summary of contributors' ideas that are not covered elsewhere in the report. These ideas are presented here so that all stakeholders can see the range of ideas on the minds of others and so that these ideas can be assessed for potential merit and further investigation.

IMPORTANT: Some of these ideas have already been ruled out by research and/or experience. Seeing them here highlights the persistence of misconceptions or attempts to reinvent the wheel — and this underlines the need to communicate accurate up-to-date information to the entire mange community.

01-Overall Approach to the Issue (strategy)

- Look into the Key Threatening Disease process for mange.
- Push for a CRC (Cooperative Research Centre) for mange, chlamydia and other diseases that are threatening Australian wildlife.
- Can scientists tell us the tipping point for a population collapse? If, for example, mange prevalence is below 15%, but possibly over 5- 8%, is that a sign that the species is threatened?
- We need nothing short of a paid body to oversee a national framework and response.

02-Knowledge Base & Research

- Investigate why mange is prevalent in some areas but not others.
- Investigate how mites could be eliminated from the environment before they spread to wombats and other wildlife.
- Conduct an in-field mite search — perhaps soil sample testing in areas where a mangy wombat has been reported to search for presence of mite load. Would like to see an entomologist looking into using soil samples to test for mites as a test for mange presence or risk.
- Investigate the use of trained sniffer dogs to detect burrows where wombats with mange reside.
- It's essential to get to the root causes of native animal disease and decline — and then address those root causes — rather than focussing only on treating the symptoms.
- Mange in wombats is probably an immune response / stress from environmental issues like habitat loss and toxic sprays (chemical influence). Conduct a post-mortem study on wombats with mange including a tissue scan to check for an overload of chemicals.
- Investigate the potential threat to wombats and to other native species of poisoning their habitat with toxic chemicals like RoundUp (glyphosate) to kill all vegetation and 1080 (sodium fluoroacetate) to get rid of browsing wild animals prior to replanting for pulpwood plantations. Eating glyphosate dramatically kills gut bacteria making humans and animals susceptible to chronic diseases. Investigate the hypothesis that chemicals have weakened the immune system of Tasmanian marsupials and subjected them to serious diseases — and examine whether sarcoptic mange occurrence coincides with areas treated with glyphosate.
- Need a better understanding of the influence of stress factors versus the wombat's susceptibility to mange. (Anecdotal evidence suggests foxes, dogs, humans, fighting for territory and drought etc all contribute to a wombat being more susceptible to mange).
- Given the many indications that stress is a pre-cursor to mange — possibly induced by habitat loss or degradation including scarcity of suitable food — should funds be directed to habitat protection/restoration instead of, or in conjunction with, treatment methods?
- Give priority to research on climate change and habitat-loss leading to the loss of nutritional value in the wombats' food sources. (Research has found that climate-change-induced reduction of nutrition and moisture in gum leaves is having a big impact on koalas, resulting in their need to drink more water).
- Investigate why some wombats don't get mange even when exposed or intentionally infested (as demonstrated by some individuals in Lee Skerratt's original research). Investigate why some populations do not appear to succumb to mange — e.g. *Lasiiorhinus krefftii*; *Lasiiorhinus latifrons* in WA.

05-Identifying Mange & Assessing Cases

- Can observations that the landscape is in poor condition (barren; poor nutritional value for wombats) serve as advanced warning that mange is likely to occur so surveillance is worthwhile?
- Use the goodwill of the community (bushwalkers/cyclists) to report mange cases.

06-Treatment Methods

- Different areas and climates create different conditions and therefore possibly require different treatment approaches.
- Would like to see someone (perhaps a group of bio-chemical veterinarians) focus on a custom drug formulated specifically for wombats ... possibly moxidectin combined with something else because moxidectin doesn't stop the breeding cycle but other products do and could be more effective.
- Is a powder treatment available? That would be easier to apply in some instances.
- Given that it's possible to subcutaneously implant domestic animals with hormones and other treatments, is similar slow-release implant technology possible for the treatment of mange?
- Is it possible to use technology that combines an external tracking device (providing data otherwise not available) with a continuous release mange treatment to break the mite life cycle?
- Investigate whether/how burrows could be treated.
- Investigate the use of sulphur around burrows to kill mites as a preventative measure.
- Use multi-dose dispensers to improve treatment of juveniles (who follow their mother and therefore miss out on treatment because the mother gets the single dose) and of multiple animals per burrow.
- Diatomaceous earth is used to kill mites in other species (e.g. birds). Look into its potential use for wombats and also investigate whether it's a factor in why the NHN (northern hairy-nosed wombat) doesn't get mange or why mites may not be present in their habitat.
- Investigate the potential use of oral pellets (e.g. Eraquell® Pellets Palatable Wormer for Horses) as an application method of ivermectin.

07-Executing Treatment

- The appropriate disposal of mange-infested carcasses is essential.
- Look into the under-recognised issue of off-target treatment. In our work, 58% of at-burrow activity was from non-wombat species and it's likely that a good proportion actually entered the burrows and got treated. We have many direct observations of this but it's difficult to quantify.
- Is there any type of tracking device that could be attached and used to locate 'my' wombat for treatment?

04-Communication & Information-sharing

- A closed facebook group to share knowledge.
- An online forum would be helpful.

12-Public Education & Awareness

- Farmers need to be made aware that they create problems for their stock by not treating wombats and vice versa. Good farmers treat both their stock and wombats, and subsequently report seeing fewer wombats with mange. Old-style farmers not liking wombats intentionally shoot healthy ones and leave manged wombats to infest others.

Part 3. Proposed Plan

The Plan

This plan proposes a way to start moving towards a more coordinated approach to mange.

Funding for wildlife is tight so it's important to target the greatest needs. That said, the plan should consider all aspects of a complete response *before* prioritising tasks or discounting them based on time and cost constraints. The perception that a task will be too time-consuming or too expensive can lead to a pivotal piece of work being discarded too soon.

Note: This is a high-level outline that necessarily omits detail. A large quantity of well-considered information was submitted during the data collection phase, and that detailed information will be made available.

1. Framework and Strategy	The Plan
<ul style="list-style-type: none"> Establish national coordination of the response to mange. Determine who will coordinate. Define the scope of the response (i.e. mange in wombats? mange in all native fauna? wombat welfare and conservation in general?) Prepare a written plan using this proposal as a starting point. Set milestones in order to monitor the implementation and assessment of initiatives — e.g. goals for 2018 year-end and then targets for 1 year, 3 years and 5 years. 	
2. Knowledge Base & Research	Research Population and Prevalence
<ul style="list-style-type: none"> Draft a comprehensive <i>research agenda</i> covering all areas requiring investigation and promote it to potential research supervisor/candidate and funders. Wombat behaviour: territory, social interaction, use of burrows Mange: transmission, progression, susceptibility of the species and of individuals Other threats to wombats: road deaths, climate change, habitat loss, disease, culling New treatments: longer-lasting Existing treatments: efficacy and safety of Cydectin[®] dosing; other treatments in use. Establish appropriate surveillance to monitor populations and the incidence/impact of mange Specify the data needed to monitor wombat distribution and abundance, population trends, mange prevalence. Consider existing data sources. Establish surveillance as required, ideally aiming for long-term repeated surveys of the same areas. 	
3. Intervention	Prevent Treat Monitor Record
<ul style="list-style-type: none"> Address in-field treatment challenges The particular challenges of the species and the treatment regimen merit attention with a view to improving treatment outcomes and making the work easier for volunteers. Examine the current Cydectin[®] treatment regimen in light of carers' concerns While this step also fits under the research umbrella, it's important to note here that the wide-spread concerns of volunteers and the lack of research combine to indicate the need for joint review (by researchers and carers) of the safety, efficacy and optimal dosing of topical moxidectin, subject to confirming the current expectation that Cydectin[®] will still have a role in treatment once new products become available. Also conduct a review of documented cases that appear to demonstrate better results from 	

<p>using variations of the approved regimen and determine how to assess their safety and efficacy.</p> <ul style="list-style-type: none"> Assess other treatments in current use that are described by carers as highly effective. Determine whether any of these products and methods merit further study. Consider establishing national standards for recording treatment details and outcomes. In the short term look at providing a standard record-keeping template so that all carers are collecting the same data in the same format to facilitate analysis of outcomes. In the longer term consider a standard reporting tool/app. 	
4. Working Together	Communication & Information-sharing Attitudes & Relationships
<ul style="list-style-type: none"> Publish a directory of all interested stakeholders to aid communication. Agree on the best avenue for information sharing. Online forum? Website? Newsletter? Increase interaction between researchers and wildlife carers to elevate the quality and accuracy of information available to the entire mange community. This includes seeking expertise from each other, sharing findings with each other and providing curated, timely information to the entire mange community. Work to soften the disconnect between some groups and between some sectors. Encourage collaboration and cooperation in the name of wombat welfare and conservation. Help all parties see that there are multiple valid perspectives. Continue to engage with jurisdictional government environment departments Determine what's possible and affordable so that departments can put requirements on the agenda for future budgeting where possible. 	
5. Resources	Information (training/guidelines) Time, Money, Energy, Supplies
<ul style="list-style-type: none"> Establish a central repository of curated information or some way of making accurate, up-to-date information readily available to all stakeholders. Adopt national guidelines for identifying and assessing mange in order to help carers with the decision to treat or euthanise. Carers need clear guidelines to help with the treat-or-euthanise decision (perhaps using DPIPW's 2018 <i>Mange Treatment Protocols and Euthanasia Guidance</i> as a starting point). All stakeholders need an agreed understanding of what it means to be "too compromised to treat", including clarity about whether the resolution of visible and behavioural symptoms is a reliable indicator of full recovery. Provide best-practice treatment standards and guidelines to lift the standard of care and help ease the "<i>I just don't know what to do</i>" dilemma. Carers need a clear understanding of treatment protocols and the implication of improper or incomplete treatment. It's important to understand that that if they wish to treat, they must do it properly — and if they cannot do so, euthanasia may be more appropriate and humane, subject to proper assessment against guidelines. Prepare a funding plan This includes, but isn't limited to, preparing a business case to take to government ministers and potential funders to make them aware of the issue and to seek their support. Include an outline of the problem, an overview of the solution/plan and specific requests. Contributors of time and money are more likely to support projects that clearly demonstrate how their inputs will contribute to the overall plan. 	

6. Public Education and Messaging

- Prepare a public awareness plan
Educate a public that, in many areas, is completely unaware of mange in wombats and other wildlife. Address inaccurate and misleading messaging in the public domain and within wildlife care circles.

Next Steps

The author will liaise with stakeholders in November 2018 to determine the best way forward.

Concluding Remarks

People describe the issue of sarcoptic mange in wombats differently depending on their vantage point and lens. To some, it's a wicked problem that's rapidly driving the species towards extinction. To others, it's a non-event or a sad-but-true part of the natural cycle of life.

It's not surprising that the problem is perceived differently across such a wide range of terrain, weather patterns, habitat modification and human interaction — so these divergent views are probably fair descriptions of what people actually see in front of them.

To accurately understand how mange is impacting wombats across their entire range, we need to apply clear thinking and scientific rigour — and that means obtaining credible data for indicators such as population distribution, mange prevalence, resilience and treatment outcomes. (On a personal note, I believe it's also helpful to stay genuinely curious, at least initially, about why other people have different views. They may not be wrong; they may be facing a different view of the situation or have novel ideas worth a second look).

The plan proposed in this report suggests an approach for working together across jurisdictional boundaries to systematically identify and acquire the data and knowledge needed to better-understand the problem and respond appropriately.

Although Australia currently has no national framework for responding to the threat that mange poses to the welfare and conservation of wombats, the overwhelmingly positive response to the discussion draft of this report suggests that the mange community is more than ready to take the initiative and establish a new model for getting this work done.

“Let's get organised and stop the guesswork”

Report contributor, February 2018

Appendix A. Contributors

Interviewees

Wildlife Groups/Carers/Sanctuaries

Alder	David	WPSA	NSW
Bisset	Dianna	Rocklily Wombats	NSW
Butcher	Lindy	ACT Wildlife	ACT
Cox	Amanda	WPSA	NSW
Creighton	John	Wombat Care Bundanoon	NSW
Faulkner	Lauren	Wombat Rescue Tasmania	TAS
Fulton	Jacqui	Landowner	VIC
Goldsworthy	Belinda	Wildlife carer/advocate	NSW
Gutwein	Katja	Mange Management Inc.	VIC
Harris	Kristie	Head Office, WIRES	NSW
Harvey-Bird	Marcia	Bayview Bush Babies	TAS
Holme	Roz	Cedar Creek Wombat Sanctuary	NSW
Irons	Greg	Bonorong Sanctuary	TAS
Lett	Vickii	WIRES	NSW
Mattingley	Jenny	Mange Management Inc.	VIC
Mayne	Bea	Wombat Rescue Tasmania	TAS
Rettig	Kim	Wombat Rescue Tasmania	TAS
Riviere	Renae	State Manager—Tasmania, Conservation Volunteers Australia	TAS
Smith	Narelle	Wildlife carer	VIC
Stepan	Donna	Sleepy Burrows Wombat Sanctuary	NSW
Stevens	Brigitte	Wombat Awareness Organisation	SA
Wynan	Marie	WPSA	NSW

Peak Body Representatives

Rodger	Oma		Tasmanian Wildlife Rehabilitation Council	TAS
Woods	Rupert	Dr	CEO, Wildlife Health Australia	National

Government Representatives

Driessen	Michael	Dr	Senior Zoologist, Biodiversity Monitoring Section, Natural Values Conservation Branch, DPIPWE	TAS
Evans	Murray	Dr	Senior Ecologist, Parks and Conservation Service, EPSDD	ACT
Gales	Rosemary	Dr	Section Head, Biodiversity Monitoring Section, Natural Values Conservation Branch, DPIPWE	TAS
Greengrass	Kirsty		Manager, Biodiversity Policy and Regulation, Biodiversity Division, DELWP	VIC
Hickingbotham	Emma		Senior Project Officer, Biodiversity Policy and Regulation, Biodiversity Division, DELWP	VIC
Kelly	Deborah	Dr	Manager, Animal Welfare, DEW	SA
Lovell	Kellie		Project Officer, Policy and Conservation Advice Branch, DPIPWE	TAS
Stathis	Peter		Manager, Biodiversity and Wildlife, Conservation Section, Park Programs, National Parks and Wildlife Service, OEH	NSW

Researchers/Academics/Veterinarians

Beveridge	Ian	Dr	Retired Professor of Veterinary Parasitology, Faculty of Veterinary and Agricultural Sciences, University of Melbourne	VIC
Carver	Scott	Dr	Lecturer, Wildlife Ecology, School of Biological Sciences, University of Tasmania	TAS
Death	Clare	Dr	Principal Veterinary Officer, Livestock Quality Assurance, Chief Veterinary Officer's Unit, Biosecurity and Agriculture Services, DEDJTR	VIC
Foth	Marcus	Dr	Professor of Urban Informatics, QUT Design Lab, Queensland University of Technology, Brisbane	QLD
Fraser	Tamieka		PhD candidate, University of Tasmania	TAS
Martin	Alynn		PhD candidate, University of Tasmania	TAS
Old	Julie	Dr	Associate Professor, Natural Science (SoSH), Western Sydney University	NSW
Phalen	David	Dr	Wildlife Health and Conservation, Faculty of Veterinary Science, The University of Sydney	NSW
Ridgeway	Peter		Senior Land Services Officer (Biodiversity), Greater Sydney Local Land Services	NSW
Rowe	Madeleine	Dr	Veterinarian in private practice	VIC
Story	Georgeanna		PhD candidate, Australian National University	ACT
Taggart	David	Dr	Affiliate Conservation Research Fellow, Unit Ecology and Environmental Science, University of Adelaide	SA
Whiteley	Pam	Dr	Wildlife Health Surveillance Victoria Coordinator, Faculty of Veterinary and Agricultural Sciences, The University of Melbourne	VIC
Wicker	Leanne	Dr	Senior Veterinarian, Life Sciences, Healesville Sanctuary	VIC

Business Owners/Product Innovators

Anderson	Peter		Red Healer Natural Canine and Equine Products	NSW
Griffiths	Alex		Griffiths Components Pty Ltd	VIC
Jones	Addy		Farma Culture Pty Ltd	TAS

Online Survey Respondents

Bown	Simon	Landowner	VIC
Frew	June	WPSA member - Carer	NSW
Fulton ¹	Jacqui	Landowner	VIC
Goldsworthy ¹	Belinda	Wombat Carer/Advocate	NSW
Hobbs	Anita	Wildlife Rescue South Coast - Mange Treatment	NSW
Horton	Samantha	Landowner	NSW
Walsh	Amy	Carer	VIC
Woods	Adam	Regional Manager , Conservation Volunteers Australia	NSW
11 Carers ²		Carers — NSW x 5, TAS x 1, VIC x 5	Various
2 Landowners ²		Landowner — NSW x 1, VIC x 1	Various
1 Advocate ²		Advocate x 1	VIC

¹ Also participated in interview; ²Survey respondent names only published where express permission received.

Written Submissions

Boyden	Michael		Wombat Rescue Tasmania (WRT) member / retired forester	TAS
Marks	Clive	Dr	Director, Nocturnal Wildlife Research Pty Ltd (Asia-Pacific)	
Mercer-King	James		Managing Mange in the Mullion	NSW
Vermaak	Yolandi		Wildlife carer/rescuer and manages Wombat Rescue ACT/NSW	ACT/NSW
WS01			WIRES-Carer	NSW
WS02			WIRES-Carer	NSW

Advised/Aware

Peters	Andrew	Dr	Wildlife Diseases Association - Australasian Section	National
Boronyak	Louise		Research Principal, UTS	NSW
Crocetti	Susan		Wildlife Team Leader, Biodiversity and Wildlife Unit , NSW National Parks and Wildlife Service, OEH	NSW
Dewar	Elise		DPIPWE	TAS
Hatton	Louise		Wildlife Project Officer, Biodiversity and Wildlife Unit, Conservation Branch, Park Programs, NSW National Parks and Wildlife Service, OEH	NSW
Hawes	Mark	Dr	Veterinary Pathologist, Agriculture Victoria Research, DEDJTR and Wildlife Health Australia State Co-ordinator Vic	VIC
Henry	Naomi			
Hufschmid	Jasmin	Dr	Senior Lecturer in Wildlife Health, Pathobiology Section, Melbourne Veterinary School, Faculty of Veterinary and Agricultural Sciences, The University of Melbourne	VIC
Mutton	Amy		Zoologist, Species and Communities Program Biodiversity and Conservation Science, Department of Biodiversity, Conservation and Attractions	WA
Quartermain	Evan		Head of Programs, Humane Society International	NSW
Pelton	Grant		Acting Executive Group Director, Parks and Regions, DEW	SA
Pennock	Corin		ACT Wildlife (treatment program)	ACT
Ralph	Glenda		Southern Cross Wildlife Care	NSW
Ralph	Howard	Dr	Southern Cross Wildlife Care	NSW
Rose	Karrie	Dr	Pathologist Veterinary Registrar, Taronga Conservation Society	NSW
Shukla	Ravi	Dr	Senior Lecturer Biosciences and Co-Leader Ian Potter Nano Biosensing Facility, NanoBiotechnology Research Laboratory (NBRL), Centre for Advanced Materials & Industrial Chemistry, School of Science, RMIT University	VIC
Skerratt	Lee	Dr	Senior Research Fellow, Team Leader and Associate Dean of Research, One Health Research Group Veterinary Sciences James Cook University	QLD
Sparrow	Elisa	Dr	District Ecologist, Fleurieu Willunga Basin, DEW	SA
Swinbourne	Michael	Dr	Environment Institute, University of Adelaide	SA