Threatened Species Recovery Hub

National Environmental Science Programme

Guidelines for the treatment of Australian wildlife with sarcoptic mange

Part 1 - Treatment guidelines

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Cover image: Wombat with mange. Image: Scott Carver/UTAS

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Executive summary

Sarcoptic mange, caused by the mite *Sarcoptes scabiei*, is an emerging infectious disease that affects domestic and wild species globally. It was likely introduced to Australia via European settlement. In addition to affecting a number of our domestic species, it also affects multiple native Australian mammals. Mange has serious animal welfare impacts. It is chronically debilitating, causing significant morbidity and mortality, and is considered to be the most significant disease threat to wild wombats. Left untreated, mange can inflict immense suffering, frequently leading to death. Conservation impacts are poorly understood but mange is known to have caused the decline and possible local extinction of some bare-nosed wombat populations in southeastern Australia. Documented cases in other mammals include koalas and bandicoots, species already under multiple threats.

Significant time and resources are expended by wildlife veterinarians and volunteers in treating wildlife, particularly wombats, with sarcoptic mange. There is a compelling need and strong desire for guidance around treatment regimens and for research that would lead to improved treatment outcomes.

About this document

This document was developed as a sub-project of the National Environmental Science Program funded Threatened Species Recovery Hub (Project 1.4.4), carried out by the University of Melbourne in collaboration with the University of Tasmania in 2021.

This document consists of two separate sections **Part 1) Treatment guidelines** including a summary mange treatment information sheet (Section 10, also published separately) and recommendations for future research around treatment (Section 9), underpinned by **Part 2) a Literature review** (separate sister document) of current knowledge and treatment methods.

Each part targets different audiences. The treatment guidelines are for stakeholders who are directly involved in managing and delivering treatment (veterinarians; wildlife carers, treaters and rehabilitators; wildlife managers and policy makers). The recommendations are for those trying to coordinate the overall response to mange so that innovation and expenditure are directed to the right places. The literature review is for anyone seeking a snapshot of existing research-based and anecdotal knowledge.

The treatment guidelines in this document should be viewed as a starting point for a second phase of research and stakeholder collaboration to progress the content and application of mange treatment guidelines in Australian wildlife.

About the project

Aims

- To collate all of the literature on mange infection and treatment in Australian wildlife into a single document in order to understand and share the current state of scientific knowledge.
- To draft national treatment guidelines in order to improve on-ground decision-making.
- To highlight knowledge gaps and recommend required research in order to improve treatment outcomes and future versions of the guidelines.
- To expand the dialogue among parties involved in wildlife mange treatment in Australia.

The literature review underpins the treatment guidelines. Our approach was to draft the guidelines based on the literature, and supplement them with targeted interviews with veterinary experts and anecdotal information from limited stakeholder feedback. **Further consultation is required.**

Context

The context for this work is the growing community expectation of appropriate treatment of mange-affected wildlife, due to the significant welfare implications and uncertainty about conservation impacts. The **risks of inaction are substantial**, including continued uncertainty about the conservation implications of sarcoptic mange in Australian wildlife and the ongoing animal welfare impacts, both of which fuel dissatisfaction among the community of people attempting to treat this condition.

Treatment of mange by volunteers has developed in an ad-hoc fashion, partly due to the long-term lack of research and communication, and partly due to the **absence of leadership to coordinate action** efficiently and effectively across multiple jurisdictions and stakeholder groups.

Application

The application of this research lies primarily in making all relevant mange treatment information available in one document, which will be of substantial benefit to those involved in treating wildlife affected by sarcoptic mange and to those attempting to take the next best steps to conduct research and respond to mange more effectively.

The treatment guidelines can be provided to veterinarians and wildlife volunteers by veterinary businesses, wildlife organisations and government agencies to improve knowledge of sarcoptic mange infection and treatment, thus helping to improve animal welfare and treatment outcomes.

Key findings

The key findings identified from our review of the published and unpublished literature, combined with stakeholder input, are as follows –

Treatment-specific findings based on the literature's limited evidence-base demonstrate that:

- Treatment of mange involves initial decision-making around disease severity and the likelihood of successful treatment, which relies on experienced personnel to assess animal welfare, and the availability of veterinarians and land managers.
- There is a need for consistent national mange severity assessment criteria.
- The complexities of treatment in free-ranging wildlife present significant ongoing challenges.
- Currently approved doses of various acaricides (e.g. moxidectin) have been shown to be effective if treatment courses are sufficiently long and animals are reliably treated, however this can be difficult to achieve in free-ranging wildlife.
- Where possible (i.e. captive or clinical environments), injectable acaricides should be used, especially in animals that have mange-affected skin.
- New treatments (e.g. fluralaner) are showing promising results in multiple species but require the direct supervision of a registered veterinarian until available under permit.
- Supportive treatment can greatly improve the welfare of the individual and the likelihood of successful treatment.
- Volunteer treatment of mange in free-ranging wildlife has developed in an ad-hoc fashion, partly due to the lack of research and clear communication, with significant differences in treatment practicalities and outcomes in captive versus free-ranging animals.
- There is considerable uncertainty as to what constitutes best-practice treatment in free-ranging wildlife. There remains a great deal of work to do before we will understand the best treatments for sarcoptic mange in Australian wildlife in different contexts.
- Knowledge gained through field treatment by wildlife volunteers is not captured. Some members of the wombat volunteer community identify as the custodians of a large body of information that requires investigation and validation to progress understanding of mange treatment in free-ranging wombats. There is dissatisfaction that field treatment experience is not always endorsed as an evidence-base for selection of an appropriate moxidectin dose.

Other key findings that are integral to understanding the impacts of mange and determining how to target treatment effectively include:

- There is **minimal understanding of the prevalence and distribution of mange** across Australia, prompting the need for adequate monitoring.
- **There is no nationally coordinated approach to progressing research on this topic**. Most treatment-related university research is now one to two decades old, and prior recommendations for further work have not been actioned or funded. While research in a controlled setting has shown relatively predictable outcomes, effective treatment of wild populations is more complex and there is very little published information in this space.

Implications

The key findings have implications for policy-makers and funders. The knowledge gaps that have been highlighted, and the associated recommendations in section 9, can be used to direct funding and support towards essential research into treatment and the establishment of a national framework for responding to mange.

Next steps

The creation of a research plan for this important issue will be a vital next step in improving the health, welfare and conservation of Australian wildlife affected by sarcoptic mange. Building on the recommendations detailed in section 9, the research plan should address the following key areas of work:

- Experimental pharmacokinetic research into optimal drug dose and delivery
- Resourcing mange treatment and decision-making in the field in various contexts
- Determining how treatment should best be managed at a national, state and local level
- Investigating how to best manage individuals and monitor success, using technology.

This research plan should seek ways to combine the knowledge gained through field treatment by wildlife volunteers with the more traditional research approach in order to reveal optimal treatment strategies and align treatment advice.

Our treatment-specific findings are embodied in the treatment guidelines and have implications for current and future treatment standards. The guidelines are an important first step in sharing information about mange. They **will need to be updated to reflect best practice as knowledge expands** through further research and through collaboration with volunteers who treat mange in the field. This will require someone to take ownership of the guidelines.

Making a health assessment of a sedated wombat. Image: Scott Carver/UTAS

Part 1 - Treatment guidelines

The detailed information in this section is summarised in a **Summary Mange Treatment Information Sheet** in Section 10 (p. 19-20).

1. Introduction

Sarcoptic mange has likely been introduced to Australia multiple times since European settlement (Fraser et al., 2019) and has likely been in wombat populations for >100 years (Skerratt et al., 1998). Accordingly, outbreaks have generally progressed without intervention. Owing to the history of the disease caused by this parasite in Australia, mange is generally considered to have little effect on the long-term viability of host populations, even though short-term mortality may appear devastating (Pence and Ueckermann, 2002, Martin et al., 2018a, WHA 2021a). In Australia, there is unanimous agreement among jurisdictional government environment departments that mange is an animal welfare issue, but whether it is also a large-scale or local-scale conservation issue is often less clear (O'Sullivan 2018).

The impacts of mange on wildlife populations are rarely measured and the net effect of a mange epizootic can have consequences in remnant or fragmented populations (Pence and Ueckermann, 2002, Martin et al., 2018a). For example, recent research by Carver et al. (2021) showed generally increasing wombat populations in Tasmania despite widespread occurrence of mange across the state, except in one area where a large outbreak had driven a local population decline (Martin et al., 2018a). Other research has also shown that wombat populations can exist in multiple statuses with mange, including stable persistence, population decline and disease free (Beeton et al., 2019). The animal welfare implications of sarcoptic mange are significant, and there is growing community expectation of effective and coordinated management of this emerging disease in Australian wildlife.

In response, these guidelines have been developed as a sub-project of the National Environmental Science Program funded Threatened Species Recovery Hub. The document is designed to assist wildlife researchers, wildlife veterinarians, wildlife volunteers (treaters, rehabilitators and carers), and government conservation managers to make decisions around treating sarcoptic mange in captive and free-living situations. The information in this document is based on current research and veterinary knowledge, and incorporates elements of field experience while identifying knowledge gaps and research needs.

2. Diagnosis - confirmation of mite presence

Confirmation of the diagnosis of sarcoptic mange should be attempted in combination with assessment of clinical signs (i.e., patterns of alopecia and skin lesions) prior to treatment (Campbell-Ward, 2019). This is to **rule out differential diagnoses that may mimic mild to moderate sarcoptic mange** (e.g., wounds, follicular atrophy, hypersensitivity reactions, bacterial, fungal and other parasitic infections and dermatoses) (Campbell-Ward, 2019). While the logistics of this (including obtaining the required permissions to intervene with wildlife) is more difficult in free-ranging wildlife and should only be carried out by experienced personnel, it is recommended as best practice.

Definitive diagnosis involves capture, handling and sampling of an individual (+/- sedation as deemed necessary by a veterinarian), and confirmation via examination of skin scrapings by light microscopy, or skin biopsy/histopathology (Campbell-Ward, 2019). Polymerase chain reaction (PCR) assays on skin scrapings is useful for detecting low intensity *S. scabiei* infestations (Fraser et al., 2018), therefore if microscopy is not available or mites are not seen on microscopy but are suspected, molecular diagnostics should be explored. While the cost of 'in-house' veterinary clinic diagnosis via skin scraping is not high, any need for more significant expenditure on sedation or external laboratory diagnostics would also influence this decision.

In the absence of formal diagnostics, pre-treatment assessment should be carried out by someone with expertise in the visual assessment of sarcoptic mange. While severe skin crusting in wombats is pathognomonic for (i.e. only ever associated with) sarcoptic mange, alopecia (hair loss), excoriation (deep scratches/skin loss) and skin scaling can be caused by other conditions. For example, hair loss and superficial scabbing in wombats may occur as a result of fighting or dog attack wounds, so it is necessary to look specifically for signs of keratotic crust development (DPIPWE 2020). Along with skin lesions, moderate to severe sarcoptic mange may sometimes have a distinctive smell due to secondary bacterial infections (Campbell-Ward, 2019).

3. To treat or not to treat?

The decision around whether to treat or euthanise a mange-affected animal revolves around **1) mange severity 2) body condition/general health, and 3) capacity to treat appropriately**. This is a welfare decision for each individual, assessing the costs and benefits. Severely affected animals are less likely to recover following treatment when compared to animals with mild to moderate mange (Rowe et al 2019). Deciding whether to embark upon treatment in free-living individuals and populations involves further considerations outlined in Section 2.4, for example, the resourcing available and the likelihood of success and recurrence. The capacity to treat appropriately in the field also involves consideration of off-target effects such as environmental contamination by medications (especially if used at high doses), the creation of resistant parasites, and disturbance of host-parasite relationships (Moroni et al., 2020). Moxidectin and fluralaner can both be toxic to aquatic life and both should therefore not be used very close to waterways (Lumaret et al., 2012, MSD, 2018).

3.1 Scoring systems for description of mange severity

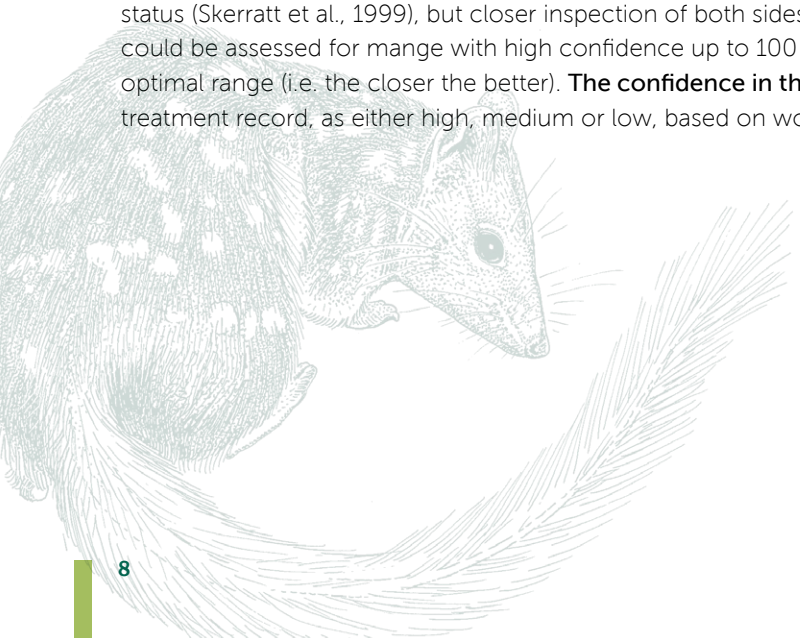
It is important to aim for national consistency in how mange severity is assessed and described. Scoring of mange severity should include a detailed assessment of the animal, by direct observation and/or from photographs, so that the decision about whether to proceed with treatment is well informed and the response to treatment can be recorded objectively over time. At minimum in all species, the severity of the disease should be classified into three categories as **mild (small areas of the body affected), moderate (more advanced lesions covering less than 50% of the body) or severe (greater than 50% of the total body surface area affected by advanced lesions)** (Pence and Ueckermann, 2002).

Specifically in relation to wombats, there have been several different methods used in the Australian literature to describe mange severity, which are all variations on the approach taken by Skerratt (2004b) where wombat body surface was divided into 13 sections in order to quantify the extent of sarcoptic mange (Skerratt et al., 2004, Borchard et al., 2012). Simpson et al (2016) modified this slightly to assess 14 skin segments, the method also used by Martin et al (2019). DPIPWE has simplified this method into two options for:

i. **field monitoring** by researchers and wildlife treaters (DPIPWE 2018)
ii. **the general public**, as described in their Mange Treatment Protocols and Euthanasia Guidance (2020) (DPIPWE 2020).

(i) For field monitoring purposes, each wombat observed directly or on a camera image should be given a mange severity score ranging from 0 to 5 for at least one of **four body segments on one or both side/s of the body: the rear flank, side, front flank and head** (DPIPWE 2018). The skin of each segment is examined for signs of **erythema** (skin reddening), **parakeratosis** (skin thickening) and **alopecia** (hair loss), where a score of 0 reflects a healthy skin segment with no signs of mange and 5 refers to a segment that is > 60% (i.e. over half) affected by any of these signs of mange (DPIPWE 2020; see Figure 1 below). Scoring multiple segments makes assessing response to treatment more sensitive. The back and rump of the wombats are not scored as these areas are prone to skin aberrations that are typically not the result of mange (DPIPWE 2020). The overall severity score for individual wombats is the highest score recorded from any one section of the body. **(ii) For the general public**, it is recommended that the minimum field assessment consist of scoring **all the skin of one or both flanks/sides** from 0 to 5, where 0 = healthy, 1 = likely healthy, 2 = early mange (< 10% of skin of flank affected), 3 = moderate mange (10–40% of skin of flank affected), 4 = severe mange (40–60% of skin of flank affected) and 5 = late stage mange (60–100% of skin of flank affected) (DPIPWE 2020; see **Table 1 and Figure 2**).

Clinical signs are usually symmetrical so viewing one side of the wombat is generally enough to assess its mange status (Skerratt et al., 1999), but closer inspection of both sides is preferable. DPIPWE (2018) found that most wombats could be assessed for mange with high confidence up to 100 m away from the observer, with 0–50 m being the optimal range (i.e. the closer the better). **The confidence in the mange score should also be recorded** as part of the treatment record, as either high, medium or low, based on wombat observability and movement (DPIPWE 2020).



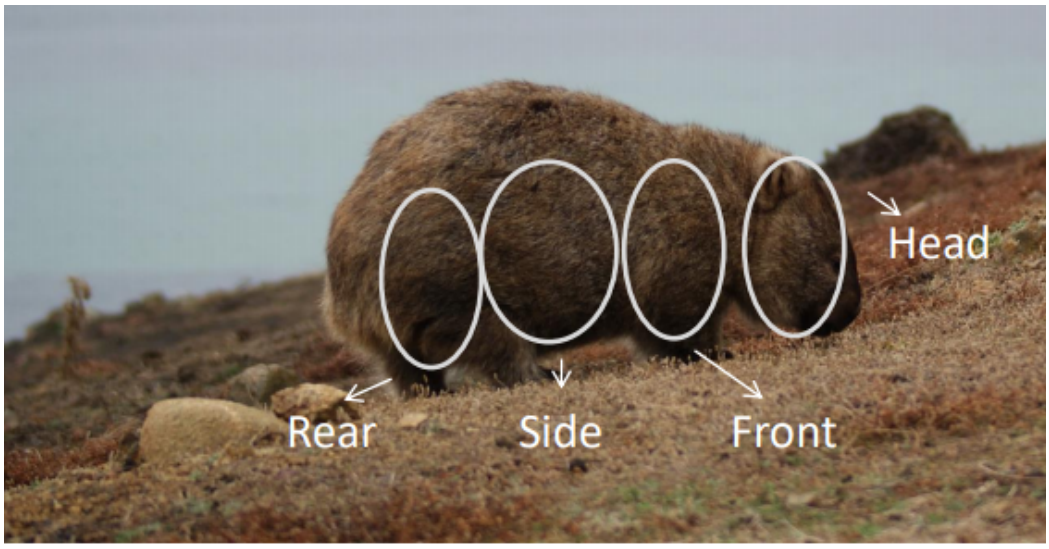


Figure 1. *'Monitoring' mange severity score for researchers and wombat treaters - A score ranging from 0 to 5 should be given for each of four body segments on one or both side/s of the body: the rear flank, side, front flank and head (DPIPWE 2018).*

Table 1: *Wombat mange severity field assessment scoring system for the general public used by the Tasmanian Department of Primary Industries, Parks, Water and Environment (modified from DPIPWE 2020).*

Mange Score	Hair Loss, skin crusts or redness	Mange Severity Status
0	No sign of mange observed	Healthy
1	Possible hair thinning/skin reddening	Likely healthy
2	Less than 10% of side/segment affected by mange	Early mange
3	10–40% of side/segment affected by mange	Moderate mange
4	40–60% of side/segment affected by mange	Severe mange
5	60–100% of side/segment affected by mange	Late stage mange

Figure 2: *'Field assessment' mange severity score for members of the public - A score ranging from 0 to 5 should be given for one or both side/s of the body (DPIPWE 2020).*

3.2 Body condition and general health

Individuals should be given a species-appropriate body condition score, which for wombats consists of gauging body condition as 'very poor', 'poor', 'good' or 'very good' (Simpson et al., 2016). These definitions reflect the level of protrusion of the ribs, pelvic bones, and shoulder girdle, with animals in 'very poor' condition having all of these elements showing, and animals in 'very good' condition having none showing, due to fat cover (Simpson et al., 2016). Assessment of the quality of the wombat fur may also form part of the condition assessment (Simpson et al., 2016).

In addition to clinical signs of mange and body condition, **the behaviour of the animal should also be assessed as a reflection of its general health**; animals that are so weak that they are easily approached, unable to see, unwilling to move, or behaving abnormally (e.g., foraging earlier in the day than might reasonably be expected for healthy individuals of nocturnal species), may be more severely impacted by mange (Simpson et al., 2016, Martin, 2018a). Those assessing wildlife body condition and health in the field require experience and knowledge of normal variation for the relevant species; for example, body condition may be difficult to assess visually with confidence due to the coat. A veterinary assessment will also allow for an overall assessment of the animal's health, including presence of secondary infections, hydration and metabolic compromise (NSW DPIE 2021). A wombat with severe mange that is also emaciated should be assumed to be more sensitive to the effects of medication.

Table 2: *Wombat body condition scoring system used by Simpson et al. (2016).*

	Very poor	Poor	Good	Very good
Level of protrusion of ribs, pelvic bones & shoulder girdle	All showing	Most (majority) showing	Some (minority) showing	None showing

3.3 Consideration of practicality of treatment and likelihood of success

Some species may be amenable to treatment in an appropriate captive environment (e.g., koalas, female brushtail possums, bandicoots, juvenile wombats) whereas others are generally not (e.g., adult wombats; some wildlife clinics do not treat male brushtail possums as they do not feel they can be released into their previous territory after more than 10 days in care).

Wombats showing signs of mange can be treated given appropriate circumstances, but treatment of severe to late stage mange requires serious consideration (see below). **Wherever possible, mange-affected adult wombats should be treated in the wild**, as bringing them into captivity will cause stress associated with capture, handling and confinement (DPIPWE, 2020). This stress in a severely mange-affected wombat has been reported to be immediately life threatening by wildlife carers who have experienced wombat deaths under these circumstances (O'Sullivan, 2018, DPIPWE, 2020), although there are some rehabilitators with the facilities and expertise to undertake this and more severe cases of mange may require this style of more intensive management. In addition, carers report that wombats removed from their environment lose their home range, which creates difficulty when trying to release back to the same location (O'Sullivan, 2018), therefore consideration must be given to the likelihood of success of treatment versus the welfare risk of displacement upon return to the wild.

Effective treatment is dependent on the availability of infrastructure and personnel to deliver a full course of the recommended treatment (DPIPWE, 2020). A major cause of treatment failure is when the full course of treatment is not achieved (DPIPWE, 2020). **Topical treatments need to be delivered onto a non-scabby/crusted (relatively normal) area of skin** (DPIPWE, 2020) at the interval, and for the duration of time, directed by a veterinarian or an APVMA minor use permit.

Wild animals should not be actively dosed in a preventative fashion for mange if they are not displaying signs of infection, **unless they are part of a population-level treatment attempt**, due to the possibility of adverse drug reactions, the creation of resistant parasites and disturbance of non-target host-parasite relationships (WHA 2021a).

3.4 Euthanasia

The species with the most developed decision-making processes around whether to treat or not are the wombat, but the same principles would apply for other species such as koalas, possums, wallabies and bandicoots. The presence of an animal that is severely affected by mange should prompt exploration into the extent of the problem locally. If euthanasia is required, a species appropriate method must be used that produces a rapid loss of consciousness immediately followed by death. Ideally euthanasia should be carried out by a veterinarian, but where this is not possible general considerations including those of health and safety can be found in the **'Standard Operating Procedure for euthanasia under field conditions'** (Sharp, 2016).

Wombats affected by mange are unlikely to recover without treatment (Skerratt 1998, Skerratt et al 1999), owing to the inability to control the mite infestation, which grows exponentially until the animal dies from the effects of the parasite burden (Skerratt, 2001). Therefore, for welfare reasons these animals should either be treated or euthanased as per above. Deciding to treat a wombat affected by severe to late-stage mange involves careful consideration, as **it is important not to prolong the suffering of an animal that is in pain and in an extremely poor state of health if treatment is unlikely to be successful**. There may be other complicating factors (e.g., secondary infections, both internal and external) that are not visible and treatable in the field. Severe to late-stage mange category animals require more intensive treatment (for example, provision of pain relief and antibiotics in addition to standard acaricide doses) or, if this is not possible, euthanasia on animal welfare grounds (DPIPWE, 2020). If a lactating female requires euthanasia there may be **dependent young** that need to be taken into care, and they may also require treatment (under the direction of a veterinarian).

As a guide, **euthanasia of a wombat is acceptable and should be considered if** one or more of the following signs are present (DPIPWE, 2020):

- The animal is extremely thin or emaciated
- Infected, foul-smelling wounds and/or flystrike
- Severe facial crusting leading to apparent blindness, difficulty breathing or eating
- 50% or more of the side of the animal is subject to hair loss and thick crusts.

If the wombat has the clinical signs above and is **so weak that it can be approached close enough to enable handling/capture**, it is likely the infestation has progressed very far. At this stage intensive management as described above is required for humane treatment, and if this is not possible it is therefore often recommended to euthanise to avoid prolonged suffering (DPIPWE, 2020; Mange Management, 2021, mangemanagement.org.au). Wombats in this state of health would be in considerable pain and discomfort and unable to maintain their body temperature or eat enough to maintain their body condition (Martin et al., 2018b).

Advice around appropriate euthanasia methods in wombats can be found in the 'Guidelines for the intial treatment and care of rescued wombats' (OEH, 2018). In addition to the welfare benefit, the removal of severely affected animals prevents them being an ongoing source of infection for the population (Skerratt et al., 2004). To reduce spread of mange, **bodies of wombats that die or are euthanised due to mange should be disposed of** by deep burial, incineration, or through a veterinary clinic that is willing to accept them for disposal in a sealed plastic bag. Body disposal can be logistically difficult and consideration of how wildlife authorities or others may provide assistance is warranted.

4. Regulatory requirements to enable treatment

Using registered veterinary chemicals to treat wildlife with mange generally **falls under both state/territory and national legislation**, as native animals are protected. Treatment of a protected animal by a non-veterinarian is generally not allowed without government permission, especially on crown land, and carrying out such an activity without a permit may therefore be variably considered a "harm" or "offence". The care of sick, injured and orphaned wildlife must be carried out by an experienced, authorised wildlife shelter or foster carer, wildlife rehabilitation organisation, and/or veterinarian, and each state/territory has different laws around the management and release of rehabilitated wildlife. Any wildlife illness or injury that requires prescription medication requires the involvement of a veterinarian or an Australian Pesticides and Veterinary Medicines Authority (APVMA) permit. Since use of veterinary chemicals such as Cydectin® or Bravecto® constitutes off-label use in wildlife (i.e. unregistered for the dose or species of interest), their use falls under the federal *Agricultural and Veterinary Chemicals Code Act 1994* (DPIPWE 2020). Veterinarians may dispense medication for off-label use to treat wildlife under their direct supervision (NB. The degree of supervision is at the discretion of the veterinarian and may or may not involve the ability for non-veterinarians to administer medication). Any individual or organisation other than a registered veterinarian must obtain permission to use these medications in any way other than that described on the label.

For landowners to treat mange-affected wildlife on their property (either for animal welfare reasons, as part of a broader population treatment program, or to reduce disease transmission cycles between wild and domestic animals), the permissions vary with the form of treatment and also by jurisdiction. In NSW, in-situ treatment of mange-affected free-ranging wombats requires a biodiversity conservation licence, which can involve a landowner being a member of a licensed wildlife rehabilitation organisation. Similarly in Victoria, all persons other than qualified veterinarians require authorisation under the *Wildlife Act 1975* to treat sick or injured wildlife, and this authorisation is provided to wildlife rehabilitators under their licence. South Australian legislation does not require a specific permit if the animal in question is on private property, as long as there is land holder permission and the animal is not directly captured/interfered with/taken into captivity. This is similar for treatment of wombats on private land in Tasmania, where a state-based permit is required for the pole-and-scoop drug application method but not for treatment via burrow flaps. In all these scenarios, however, veterinary prescription or a national APVMA permit is also required to use veterinary chemicals.

In accordance with the legislative framework described above, two permits are generally required in all Australian locations for non-veterinarians who are not under direct veterinary supervision to use veterinary chemicals on wildlife:

1. A state-based permit to allow treatment of a wild animal **and/or** landowner permission; **plus**
2. A permit from the APVMA under the national *Agricultural and Veterinary Chemicals Code Act 1994* for off-label use of a registered veterinary chemical (individuals who are members of a permitted organisation may be covered by that permit and therefore not require their own).

The required processes in each jurisdiction must be confirmed by the user and should be explored via the links below:

- ACT - https://www.environment.act.gov.au/parks-conservation/plants-and-animals/licensing-of-plants-and-animals
- NSW - https://www.environment.nsw.gov.au/topics/animals-and-plants/native-animals/rehabilitating-native-animals/wildlife-rehabilitation-licences
- SA - https://www.environment.sa.gov.au/licences-and-permits/wildlife-permits/permit-types/rescue-rehab-native-animals or email: dewfaunapermitsunit@sa.gov.au
- TAS - https://dpipwe.tas.gov.au/wildlife-management/fauna-of-tasmania/mammals/possums-kangaroos-and-wombats/wombat/wombat-mange
- VIC - https://www.vic.gov.au/wildlife-rehabilitation-shelters-and-foster-carers
- WA - https://www.dpaw.wa.gov.au/plants-and-animals/licences-and-authorities?showall=&start=4

In 2020, the Wombat Protection Society of Australia LTD (WPSA) and Mange Management Victoria were both granted permits by the APVMA for the use of Cydectin® Pour-On for Cattle and Red Deer and other registered products containing 5 g/L moxidectin (hereafter referred to as Cydectin®) to control mange in wombats. These permits are in force until June and December 2023, respectively. The WPSA was also granted a permit in 2021 to use higher doses of moxidectin, which is only in force for 12 months until 31 August 2022. All wombat mange treaters must receive written authorisation from a permit holder before using moxidectin (Cydectin®), unless they are working under direct veterinary supervision. Under these permits, all use must be recorded, including recording of any adverse events. The product must be used in the manner specified on the permit label and only by individuals who have been trained in classifying the stages of mange infection and observation of toxicity signs. In NSW, training is available and necessary for people who wish to use Cydectin® to treat mange under a WIRES APVMA sub-permit (https://www.wires.org.au/training/wombat-mange-course), and WPSA also provide training for those who apply for a sub-permit from them.
The WPSA and Mange Management APVMA permits can be found here:
2020 - https://permits.apvma.gov.au/PER89982.PDF
2020 - http://permits.apvma.gov.au/PER89040.PDF
2021 - https://permits.apvma.gov.au/PER90094.PDF

Workplace Health and Safety

It is important to practice **safe use of chemicals**. Specifically, the two most relevant products (Cydectin® and Bravecto®) are registered poisons and the Safety Data Sheets recommend wearing gloves and eye protection when handling the products, and to avoid release into the environment (MSD, 2018, Virbac, 2019).

5. Treatment recommendations

5.1 Acaracides

Captive/in-care wildlife

While historically following Skerratt (2001) it was recommended that treatment of sarcoptic mange for wombats in captivity should involve two acaricides, one systemic and one topical, this is no longer thought to be necessary. While topical treatment may be used to improve the comfort or recovery of an animal with mange (e.g., Malaseb® shampoo to soften crusts, soothe wounds and provide topical antimicrobial activity) it does not need to be an acaricidal product if one is being used systemically. Many of the previously recommended topical acaricidal products (e.g., amitraz or malathion) are potentially toxic and increasingly difficult to obtain (Curtis, 2004).

The recently updated veterinary textbook used by wildlife and zoo professionals in Australia, *Current Therapy in Medicine of Australian Mammals*, recommends repeated treatment with an avermectin (e.g., ivermectin or moxidectin) weekly until after clinical signs resolve (Bryant and Reiss, 2008). These drugs affect the nervous system of invertebrate parasites and result in them becoming paralysed and dying (Lumaret et al., 2012). Veterinarians treating mange in wildlife generally use **injectable avermectin products (e.g., subcutaneous ivermectin or moxidectin) off-label at recommended livestock doses e.g., 0.2–0.4 mg/kg, weekly over several months** and are satisfied with the efficacy of this dose in mild to moderate mange cases (multiple sources, 2021, pers. com., see Appendix B and Part 2 - Literature review). The use of injectable products likely increases the chance of treatment success due to more reliable achievement of required systemic drug levels. Therefore, if possible, it is recommended to use these injectable products as above, if the animal can be safely and humanely restrained or is to be maintained in captivity (which requires appropriate permits, expertise and equipment). Some veterinarians also report success in adult wombats with repeated treatments of the 2020 APVMA permit topical moxidectin dose (0.8 mL/kg, up to a maximum of 20 mL/wombat; A. Lowe, J. Weller, 2021, pers. com.). It is important to maintain the weekly doses in order to kill larvae as dormant eggs hatch over time, and sometimes in a captive setting it is more practical for weekly treatment to be continued with a topical avermectin (e.g. selamectin/Revolution® at dog/cat dose rates) after initial efficacy has been demonstrated by injectable products.

Free-ranging wombats

The 2020 APVMA minor-use permit approved treatment regimen of 0.8 ml/kg bodyweight (**8 ml/10 kg**) topical Cydectin® (5 g/L moxidectin) to **a maximum of 20 ml/wombat, weekly for 15 weeks**, is recommended for treatment of free-ranging wombats with mange (see APVMA PER89040 and PER89982). This dose has been increased compared to the previous permit from 2017 (APVMA PER828444), but is lower than the dose on 2021 WPSA permit (APVMA PER90094). Volunteers treating wombats in the field report that weekly treatment for 15 weeks is generally difficult to achieve. Successful treatment at this dose over this timeframe has been demonstrated when performing broader treatment of all local burrows using medicated burrow flaps, as opposed to relying on the pole-and-scoop method that requires individual animal re-sightings and close approach. Some volunteers indicate they treat initially using the pole-and-scoop method to ensure delivery of a full, regular dose if a wombat allows close approach, and then swap to use of burrow flaps for follow up treatment as the wombat improves and becomes less likely to be seen and/or allow approach. It is essential to understand and follow all APVMA permit conditions.

Every effort to identify individuals must be taken to ensure they are only receiving a once weekly treatment; this can be by using mange patterns, scars, fur colour or any other identifying feature. Adding food dye or other non-toxic marking products to the Cydectin® is recommended to identify whether an individual has been treated recently (DPIPWE 2020). As per the permit conditions, DO NOT continue treatment in wombats which show toxicity (lack of muscle control when walking, decreased responsiveness, incoordination, drowsiness, laying down and lack of motivation to get up, salivation). Stop treatment immediately or reduce the dose in consultation with a veterinarian. Wombats that die after treatment must be reported to a veterinarian immediately

Further formal research, including structured and robust collation of existing anecdotal evidence, should demonstrate no detrimental animal health and welfare effects if higher doses are to be used. Topical formulations of antiparasitic drugs are already registered for use at relatively higher doses than the injectable products to compensate for the likelihood that not all topically delivered medications will contact the skin and be absorbed. Dependent young of affected wildlife should also be treated under veterinary advice using the dose approved by the 2020 APVMA permit; higher doses in juveniles are more likely to result in toxicity, plus they also receive moxidectin through the milk if their mother is treated (Campbell et al., 2017). A challenge for the future is to find a way to incorporate knowledge gained through field treatment by wildlife volunteers with the more traditional research approach, to reveal the safest and most effective treatment strategies in different contexts.

New treatments

A one-off/single dose of topical Bravecto® at dog dose rates (25 mg/kg bodyweight) may be effective against mild to moderate mange in Australian wildlife, following trials in a small number of BNWs (Wilkinson et al., 2021) and anecdotal evidence from wildlife veterinarians treating common brushtail possums and BNWs. Some wombat carers have indicated they have not had success in all cases treated with Bravecto® and others have reported needing to use it monthly for several treatments to cure mange. A suitable product for diluting Bravecto® into a larger volume to enable its use as a 'pour-on' in the field is 5 ml of 'Orange Power Sticky Spot & Goo Dissolver', in which Bravecto® stays suspended for 24–48 hours, with the mixture penetrating well through fur (Wilkinson et al., 2021).

Treatment of wildlife using this protocol is only possible under the direct supervision of a veterinary surgeon, as the product is not yet approved for off-label use via an APVMA permit. The applied dose is for large dogs (20–40 kg) so therefore a 20 kg wombat is likely to be getting enough even if it only gets half (i.e. if some is spilled in application). It is not recommended to use other pharmaceutical agents e.g., Cydectin® as a vehicle for Bravecto®, as the combined safety of these products is unknown. Additionally, it is important not to over-dilute, as this can lead to delivering a non-therapeutic dose. While a single dose of Bravecto® is more costly, treatment costs have been shown to be competitive with Cydectin®, and predicted treatment effort substantially lower (Wilkinson et al., 2021), especially when compared to the use of high dose Cydectin® for multiple treatments. While promising, it is too early to suggest that a one-off treatment will generally be successful in all cases or species and further research is required.

5.2 Supportive treatment

While it may only be possible in animals brought into a captive environment and treated under direct veterinary supervision, supportive care is positively associated with the success of mange treatment in various wildlife species (Rowe et al., 2019). The treatment of wildlife in care should also follow best practice guidelines such as those published by Agriculture Victoria (AgVic, 2000) or the NSW Department of Planning, Industry and Environment (OEH, 2018).

In addition to the use of weekly acaricides, *Current Therapy in Medicine of Australian Mammals* recommends **removal of crusts, pain relief, fluid therapy, and antibiotics** if secondary infections are present (Campbell-Ward, 2019). **Veterinary oversight is recommended and is required for prescription of antibiotics and pain relief**, and to determine appropriate fluid therapy rates. For mange-affected wombats in care, in addition to medical treatment, particular attention should be paid to the thermal environment and nutrition (Campbell-Ward, 2019). Skerratt et al (1999) described bacterial infections and associated inflammation in various internal organs (lung, liver, kidney, heart, gastrointestinal tract and lymph nodes) in 10 bare-nosed wombats (*Vombatus ursinus*; BNW) with severe mange necropsied in Victoria. The extent of these changes supports the need for antibiotic treatment if wombats with severe mange are to be treated (Skerratt et al., 1999). Recommended analgesic and antibiotic doses, treatment frequency and treatment duration details for native Australian mammals can be found in Vogelnest and Woods (2019). For example, wombats can be treated with amoxicillin-clavulanic acid using the same treatment regime for deep pyoderma (skin infection/pus in the skin) as is recommended in dogs, until two weeks after resolution of clinical signs (AVPG 2021). Pain relief may be given in the form of opioid analgesics (e.g. buprenorphine) or non-steroidal anti-inflammatories (e.g. carprofen), and in wombats these are also both used at dog dose rates (Bodley, 2019).

The wombat volunteer community advocates for supportive treatment if a wombat can be approached and has open wounds as a result of skin fissures or scabs being scratched off (Mange Management, 2021). In the summer, when flies are prevalent, Chloromide® spray (Troy) is an antiseptic which may help the wound to heal and prevent wounds becoming flyblown (Mange Management, 2021). Other topical products that may assist in a similar way are Cetrigen® and Flints Lotion® (Mange Management, 2021; WPSA, 2020) in addition to antibiotic powders and sprays, some of which require veterinary prescription.

Combining treatment efforts with high calorie food supplementation, in captive and free-ranging scenarios, has been suggested as a possible way to more efficiently combat mange infection in wild and domestic animals (Martin et al., 2018b), although this is yet to be tested in Australia and consideration of the digestive health of wildlife is also important. Feeding of wildlife is not normally encouraged, and consideration must be given to the spread of noxious weeds if supplementary feeding is proposed in a field context, so advice should be sought from the relevant agriculture and environment departments. Guidelines for post bushfire feeding of wildlife provide a useful starting point (e.g. WHA 2021a, WHA 2021b). As oxidative stress has been demonstrated as an effect of sarcoptic mange in buffalo (Dimri et al 2008), supplementation with antioxidants (e.g., Zinc and Vitamin E) may be of assistance in treatment, especially if supplementary food is being considered. It may also be of benefit in free-ranging scenarios to provide fresh water for mange-affected wildlife (WPSA, 2020).

6 Captive individual versus free-ranging population treatment considerations

Captive treatment may often be more appropriate in smaller species (e.g., possums or koalas) and younger animals, as they can be more easily maintained in captivity (with the appropriate permissions) and retreatment efforts would otherwise be very resource intensive in the field. Within Australia, there has been increasing interest by the public and focus groups in options for treatment of mange in free-living wombats (WHA, 2021a).

There are important differences between treating individual wombats and populations, making the latter a more challenging endeavor. A pragmatic assessment of whether disease control can be achieved, and intervention therefore justified, should always be made (Moroni et al., 2020). Consideration should include local land-use, topography, geology, flora and fauna, weather conditions and climate, as well information about the affected wildlife population density and dynamics, and any prior knowledge of mange in the area. The long-term and population-level efficacy of field-based treatments is unclear at present (Campbell-Ward, 2019, Rowe et al., 2019) and eradication is unlikely unless there is a concerted and sustained treatment effort across the landscape (Martin et al., 2019). However, **two successful programs have been identified using the current 2020 APVMA approved topical Cydectin® dose of up to 20 ml/ wombat maximum, weekly for 15 weeks** (Leary et al 2017; Lowe & Vermaak, pers. com. 2021). Efficacy of such field-based treatment programs of mange in free-ranging wombats is influenced by dose, dose frequency, severity of disease at the individual and population level, and the resources available for population monitoring, coverage of burrows, and repeated treatment over the required geographic area (Campbell-Ward, 2019, Martin et al., 2019). With increased community participation and lack of expertise, there is risk of unintentional failure to execute protocols effectively (WHA, 2021a). The main risks include 1) accidental overdosing of individual wombats, under-dosing of individual wombats, missed or repeat treatments, and 2) off-target effects of widespread use of acaricides (WHA, 2021a). Continuous treatment regimes are discouraged, as prolonged exposure of the mite to treatment may result in mite resistance (Curtis, 2004).

Delivery success of treatment is the greatest limitation to population-scale pathogen eradication. Evidence suggests that if a population-level treatment attempt of mange in wombats does not have treatment available at all burrows in an area (both active and inactive), wombats will start to use previously inactive burrows because burrow flaps are a disincentive to entry (Leary et al., 2017, Martin et al., 2019). If wombats avoid burrows with treatment flaps, they will not be treated on a regular basis and the treatment program is unlikely to succeed. Some wombats require up to five days to get accustomed to the presence of the treatment flaps at the entrance of their burrows, and others may damage the treatment flaps (Old et al., 2018). For successful treatment in an area with large numbers of wombats, regular monitoring of the treated burrows and affected wombats is needed and thorough treatment procedures should be followed and recorded (Old et al., 2018, Martin et al., 2019). Leary et al (2017) reported that the number of "known" burrows more than doubled over the duration of their study at Bents Basin, as they continued to actively search for and treat them.

A southern brown bandicoot with mange. Image: Yasmin Hunter

7. Biosecurity considerations

7.1 Zoonosis risk

Direct contact with live and dead mange-affected ringtail possums (Domrow, 1992), koalas (Barker, 1974), foxes (McCarthy, 1960), and wombats (Skerratt and Beveridge, 1999) has led to mange infection in humans in Australia. This may appear as pruritic, erythematous vesicular papules on the skin, which may or may not require treatment. Dead animals with mange may pose a greater risk of transmission because the mites may be seeking a new host, stimulated by the temperature differential between a carcass and a living host (Skerratt and Beveridge, 1999).

Personal hygiene and protective equipment

Infection risk can be minimised by personal hygiene practices (such as wearing gloves and protective clothing and washing hands after handling animals), wearing permethrin impregnated clothing, and use of personal insect repellent (Hulst, 2019). The National Wildlife Biosecurity Guidelines contain practical advice and should be referred to (www.wildlifehealthaustralia.com.au/Portals/0/Documents/ProgramProjects/National_Wildlife_Biosecurity_Guidelines.PDF).

7.2 Field biosecurity - equipment use between individuals

In addition to the zoonotic risk, it is important to consider the possible transmission of mange between animals of the same and different species, and to animals from equipment used to handle mange-affected animals. In a practical sense, this means it is necessary to disinfect the hands or change gloves between handling of animals, and to use clean equipment on each animal.

Cross-host transmission of *S. scabiei* has previously been reported in Australia (e.g., wombat to koala (Barker, 1974); fox to dingo, and dingo to dog (McCarthy, 1960)); see Escobar et al. (2021) for broader information on cross-species transmission of *S. scabiei*. The observation of shared genetic sequences between *S. scabiei* infecting several Australian marsupial species and dogs with mange and humans with scabies also shows that cross-host transmission among marsupials and other hosts is very likely (Skerratt, 2002, Fraser et al., 2017). This highlights the need for additional precautions in the management of mange between different species of Australian wildlife and a renewed emphasis on infection control practices for stakeholders involved in their care (Fraser et al., 2017).

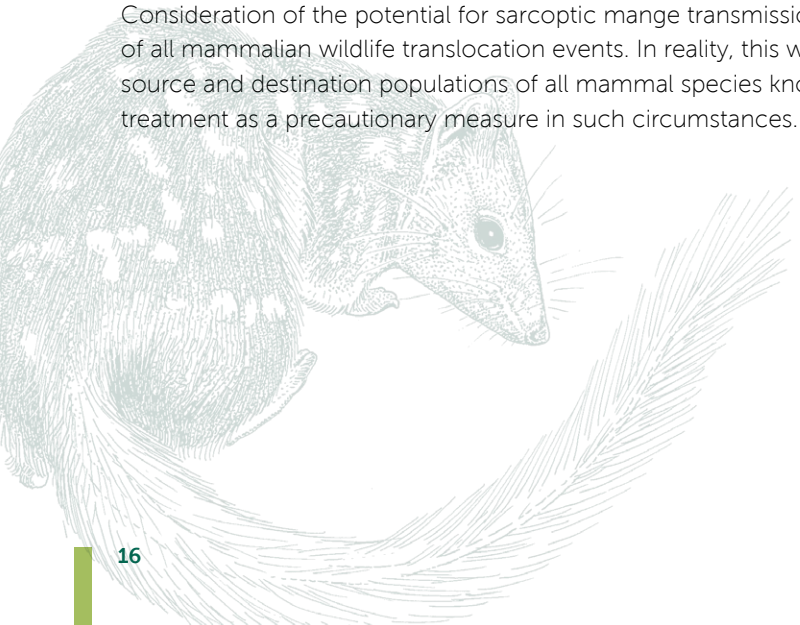
When designing treatment protocols, it is important to treat all in-contact animals, and ensure humans follow sound biosecurity protocols to avoid becoming a source of infection (Rowe et al., 2019). Any equipment that is used to handle mange-affected animals (e.g., cloth bags used for wombat joeys being treated for mange) can be decontaminated by machine-washing in hot water and drying using the hot cycle or by dry-cleaning (CDC 2021); at minimum using hot water washing and sun drying until completely dry (WHA, 2018). Cages or crates used to transport animals should be washed with hot water and detergent and allowed to dry completely before re-use.

The NSW Department of Planning, Industy and Environment 'Guidelines for the intial treatment and care of rescued wombats' (2021) includes recommendations such as:

- Rescued wombats with mange must be kept under strict quarantine throughout their rehabilitation and appropriate personal protective equipment should be used to prevent transmission of mange to the handler
- Hygiene and enclosure-cleaning protocols must be adequate to prevent transmission of mange between animals in care and to people.

7.3 Considerations for wildlife translocations

Consideration of the potential for sarcoptic mange transmission should occur during the disease risk assessment phase of all mammalian wildlife translocation events. In reality, this would involve assessment of the mange status in both the source and destination populations of all mammal species known to be susceptible. It may also involve prophylactic treatment as a precautionary measure in such circumstances.



8. Suggested data collection templates

It is essential that all treatment of wildlife using veterinary chemicals is recorded. This may occur using a paper-based system or a spreadsheet or database. The minimum data requirements for each case should be: location, species, age or age-class (juvenile/adult), sex, any individually identifying features, date of treatment, drug name and strength, dose and frequency of drug used (for wombats, number of burrow flaps deployed in treating an area rather than an individual), and outcome of treatment.

Datasheets for standard reporting of treatment and outcome are attached (see **Appendix C**):

- Example data sheet 1: **Treatment of individual wombats**
- Example data sheet 2: **Treatment of an area using burrow flaps**

9. Research needs and recommendations – mange treatment

These recommendations focus on the key influential uncertainties affecting treatment success in individuals such as: what treatment regime to use, how should treatment best be managed at a national, state and local level, and how can treatment be improved? The recommendations below revolve around treatment and management of individuals (not controlling mange at a population level). This list is not designed to be an exhaustive or detailed list of research questions, but provides an indication of priority areas. Broader research needs and knowledge gaps related to wildlife mange in general, and management of mange in populations, can be found in Section 4 (Knowledge gaps) of the **Literature Review** (Part 2 of this document).

- **Establish best treatment regimens for mange in individuals of various species under various conditions**, including:
  - Clinical trials to determine the pharmacokinetics, safety, efficacy and optimal dose of various acaricides using various administration routes (e.g. understand dermal absorption rates).
  - Treatment success relative to mange severity.
  - Understanding variability in treatment efficacy and outcomes.
  - Understanding drug toxicity and related issues such as passage of acaricidal drugs through the milk to the young.
  - Consideration of alternatives to clinical trials, bearing in mind the complexities of time, personnel, funding and access to wild or captive study animals.
  - Consideration of, and ongoing research into, new treatments and the benefits of supportive care.
- **Resource mange treatment and decision making in the field in various contexts**, including:
  - Streamlining complex logistical issues such as access to treatments, permits, diagnosis etc.
  - Practical methods to minimise the difficulties of topical drug application in the field.
  - Increasing understanding of the long-term efficacy of treatment and what constitutes successful treatment.
  - Increasing understanding of the incidence of re-infection.
- **Determine how treatment should best be managed at a national, state and local level**, for example:
  - Assess the appetite for and practicality of developing a coordinated approach to managing treatment of mange across regions.
  - Assess the appetite for and practicality of creating a central point of contact to steer and initiate treatment and research.
  - Develop a comprehensive, prioritised list of the most pressing research needs.
  - Investigate communication and the presentation of accurate information.
  - Integrate field-based knowledge with more traditional research approaches.
- **Investigate how treatment of individuals can be improved through better data collection and monitoring**, including:
  - Development of templates for consistent, standard data collection, and collation and analysis of data among those treating sarcoptic mange cases.
  - Investigate new methods/technology (e.g. electronic dosers) for delivering and monitoring treatment effectiveness/outcomes in individuals and across burrows.
  - Investigate data requirements of models to inform improvements in targeted treatment regimes.
  - Identification of the most scalable treatment approaches/methods for use in populations.

10. Summary mange treatment information sheet

1. Diagnosis - confirmation of mite presence *(for supporting content see p.7)*	• Prior to treatment, **confirmation of the diagnosis of sarcoptic mange should be attempted**, in combination with assessment of clinical signs. • Only veterinarians or experienced personnel with required permits should take samples (e.g. skin scraping) for diagnosis. • While definitive diagnosis can be more difficult in free-ranging wildlife, it is recommended as best practice. • In the absence of formal diagnostics, someone with **expertise in the visual assessment of sarcoptic mange** should carry out pre-treatment assessment.
2. Mange scoring *(see p.7-10)*	• The decision around whether to treat or euthanise a mange-affected animal revolves around 1) mange severity 2) body condition/general health, and 3) capacity to treat appropriately. • This is a **welfare decision** for each individual, assessing the costs and benefits. Severely affected animals are less likely to recover following treatment when compared to animals with mild to moderate mange. • Those assessing wildlife body condition and health in the field require experience and knowledge of normal variation for the relevant species. • At minimum, **mange severity** should be classified as: mild (less than 10% of body surface affected), moderate (more advanced lesions covering less than 50% of the body) or severe (greater than 50% of body surface affected by advanced lesions). • Individuals should be given a species-appropriate **body condition** score, which for wombats can be 'very poor', 'poor', 'good' or 'very good'. • In addition to clinical signs of mange and body condition, the **behaviour** of the animal should also be assessed as a reflection of its general health. • **Effective treatment** is dependent on the availability of facilities and personnel to deliver a full course of the recommended treatment.
3. Euthanasia *(see p.11)*	• Deciding to treat wildlife affected by severe to late-stage mange involves careful consideration; it is **important not to prolong the suffering** of an animal in pain and an extremely poor state of health if recovery is unlikely. • There may be other complicating factors (e.g., secondary infections, both internal and external) that are not visible and treatable in the field. • If euthanasia is required, a species appropriate method must be used that produces a rapid loss of consciousness immediately followed by death. • If a lactating female requires euthanasia there may be dependent young that need to be taken into care, and they may also require treatment. • The presence of an animal that is severely affected by mange should prompt exploration into the extent of the problem locally. As a guide, euthanasia is acceptable and should be considered (and ideally carried out by a veterinarian) if one or more of the following signs are present: • The animal is extremely thin or emaciated • Infected, foul-smelling wounds and/or flystrike • Severe facial crusting leading to apparent blindness, difficulty breathing/eating • 50% or more of the side of the animal is subject to hair loss and thick crusts.

4. Regulatory requirements *(see p. 11-12)*	• Using registered veterinary chemicals to treat wildlife with mange generally **falls under both state/territory and national legislation**. • Treatment of a protected animal by a non-veterinarian is generally not allowed without government permission, especially on crown land. • Landowner permission is always required to treat on private land, and in some jurisdictions landowners themselves must be members of licensed wildlife organisations in order to treat wildlife on their property. • Any wildlife illness or injury that requires prescription medication (e.g. sedatives, antibiotics, pain relief) requires the involvement of a veterinarian. • Use of veterinary chemicals such as Cydectin® or Bravecto® constitutes off-label use and requires veterinary prescription or an APVMA permit. • Veterinarians may dispense medication for off-label use to treat wildlife under their direct supervision (NB. The degree of supervision is at the discretion of the veterinarian and may or may not involve the ability for non-vets to treat).
5. Treatment *(see p.13-15)*	Acaricides • Some species or individuals may be amenable to treatment in an appropriate captive environment (e.g. possums, bandicoots, koalas). Wherever possible, mange-affected wombats should be treated in the wild, particularly adults. • In captive wildlife under veterinary supervision, **injectable ivermectin or moxidectin should be prescribed off-label at recommended livestock doses i.e., 0.2–0.4 mg/kg subcutaneously, weekly over 2-4 months** until negative skin scrapings are obtained. • For treatment of free-ranging wombats with mange, the 2020 APVMA minor-use permit approved treatment regimen is recommended i.e. 0.8 ml/kg bodyweight **(8 ml/10 kg) topical Cydectin®** (5 g/L moxidectin) to **a maximum of 20 ml/wombat, weekly for 15 weeks.** • A one-off/**single dose of topical Bravecto® at dog dose rates (25 mg/kg bodyweight)** is likely to be effective against mild to moderate mange in Australian wildlife, following trials in a small number of wombats and anecdotal evidence of success when used in possums and koalas. Treatment of wildlife using this protocol is only possible under the direct supervision of a veterinary surgeon, as the product is not yet approved for off-label use via an APVMA permit. • Topical treatments need to be **delivered onto a non-scabby/crusted area of skin** (i.e. relatively normal skin). Supportive treatment • Supportive care is positively associated with the success of mange treatment in various wildlife species. In addition to the use of weekly acaricides, **removal of crusts, pain relief, fluid therapy, and antibiotics** (if secondary infections are present) are recommended for animals in care. **Topical sprays** (e.g. Cetrigen®) may provide some antibacterial action and assist with wound healing in free-ranging animals. • **Veterinary oversight is recommended and is required for prescription** of antibiotics and pain relief, and to determine appropriate fluid therapy rates. • For mange-affected wombats in care, in addition to medical treatment, particular attention should be paid to the thermal environment and nutrition. • Supplementary feed and water may sometimes be appropriate and helpful.

6. Free-ranging population treatment considerations *(see p.15)*	Delivery success of treatment is the greatest limitation to population-scale pathogen eradication. Population-level treatment of mange in wombats **requires treatment to be available at all burrows in the area (active and inactive)**; otherwise wombats will start to use previously inactive burrows and may avoid treatment because burrow flaps are a disincentive to entry. For successful population-level treatment in wombats, **regular monitoring of the treated burrows and affected wombats** is needed, and thorough treatment procedures should be followed and recorded.
7. Biosecurity (see p.16)	**Zoonotic risk:** Direct contact with live and dead mange-affected wildlife has led to **mange infection in humans** in Australia. Dead animals with mange may pose a greater risk of transmission because the mites are seeking a new host. Infection risk can be minimised by personal hygiene practices (i.e. wearing gloves and protective clothing and washing hands), wearing permethrin impregnated clothing, and use of personal insect repellent. **Transmission between animals:** It is also important to consider the possible transmission of mange between animals of the same and different species, and to animals from equipment used to handle mange-affected animals.
8. Data collection (see p. 17, 24, 25)	It is essential that **all treatment of wildlife using veterinary chemicals is recorded**. This may occur in a paper-based system, spreadsheet or database. The **minimum data requirements** for each case should be: location, species, age or age-class (juvenile/adult), sex, any individually identifying features, date of treatment, drug name and strength, dose and frequency of drug used (for wombats, number of burrow flaps deployed in treating an area rather than an individual), and outcome of treatment.

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A Koala suffering mange on its face. Image: Pam Whiteley

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Links

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https://www.nespthreatenedspecies.edu.au/publications-and-tools/guidelines-on-how-to-treat-australian-wildlife-with-sarcoptic-mange

https://www.nationalparks.nsw.gov.au/things-to-do/volunteer-activities/bents-basin-wombat-program

https://rocklilywombats.com/pages/how-to-treat-mange

Appendix A. Wildlife veterinarians, academics and government stakeholders consulted during drafting

Organisation	Name	Position/role
The University of Sydney Veterinary School	David Phalen	Professor Wildlife Health and Conservation; and Veterinarian
Western Sydney University, School of Science	Julie Old	Researcher - Biologist, Zoologist & WomSAT Director
Taronga Wildlife Hospital, Sydney	Larry Vogelnest	Veterinarian
Taronga Zoo - Western Plains, Dubbo	Michelle Campbell-Ward Benn Bryant	Veterinarian Veterinarian
ZoosSA, Adelaide Zoo	David McLelland	Veterinarian
Bonorong Sanctuary, Tasmania	Alex Kreiss	Veterinarian
Australia Zoo, Queensland	Samantha Young	Veterinarian
National Zoo, ACT	Jayne Weller	Veterinarian
Department of Conservation, Biodiversity and Attractions, Western Australia	Simone Vitali	Senior Project Officer (Wildlife Health); and Veterinarian
ACT Parks and Conservation Service	Arianne Lowe (in collaboration with Yolandi Vermaak – Wildlife Rescue)	Veterinarian, Threatened Species Program, Tidbinbilla Nature Reserve
ZoosVic, Australian Wildlife Health Centre, Healesville Sanctuary	Chloe Steventon	Veterinarian
New South Wales National Parks and Wildlife Service	Aditi Sriram	Project Officer
New South Wales National Parks and Wildlife Service	Tanya Leary	Senior Ecologist, Conservation Branch
Department of Primary Industries, Parks, Water and Environment, Tasmania	Rosemary Gales	Section Head, Natural Values Science Section, Natural Values Conservation Branch
Adelaide Koala and Wildlife Centre	Natasha May	Head Veterinary Nurse

Appendix B. Suggested data recording templates – from DPIPWE (2020)

- Example data sheet 1: **Treatment of individual wombats**

- Example data sheet 2: **Treatment of an area using burrow flaps**

Examples of data sheets to record cydectin treatment

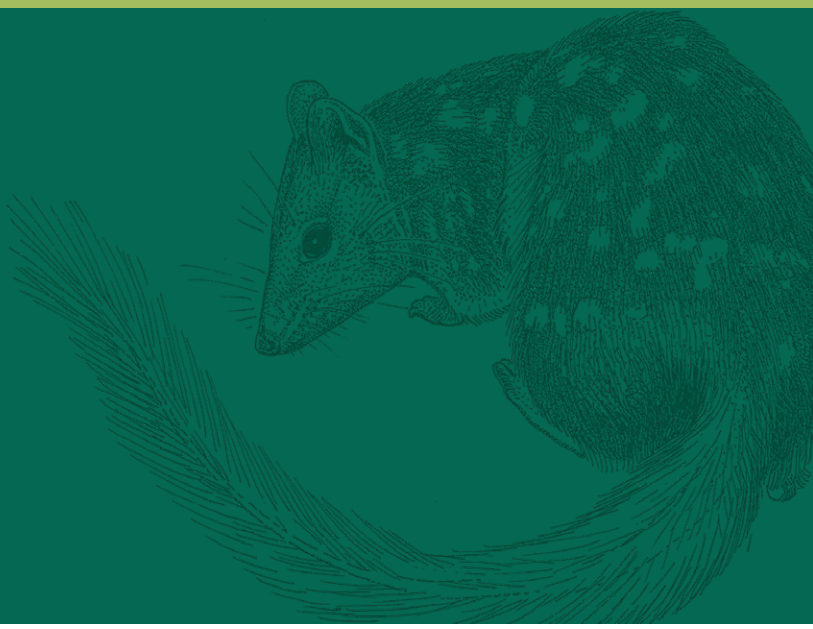
Example 1: Treatment of Individual Wombats (these may be modified to suit individual circumstances but the same types of information should be recorded)

Wombat ID/Description:					
Location where treatment is occurring (name of location and grid reference if possible):					
Date of treatment	moxidectin (Cydectin) dose (mL)	Mange severity score	Body condition	Name of person treating	Notes
Post-treatment observations (where possible)					
Date of obs.		Mange severity score	Body condition	Name of observer	Notes
Document whether treatment was completed or not and the possible/actual fate of wombat:					

Example 2: Treatment of an area using burrow flaps

Location where treatment is occurring (name of town/suburb and grid reference if possible):				
Number of burrow flaps deployed:			Estimated area (ha) flaps deployed over:	
Estimated number of wombats:				
Number of wombats observed with mange and their mange severity scores				
Date of treatment	moxidectin (Cydectin) dose (mL)	Flap number or numbers	Name of person treating	Notes
Post-treatment observations				
Estimated number of wombats:				
Number of wombats observed with mange and their mange severity scores:				

Further information:
http://www.nespthreatenedspecies.edu.au



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