Managing wombats

A review of current practice, issues and challenges to inform wombat management in the ACT.

Office of Nature Conservation

DRAFT Technical Report to the Conservator for Flora and Fauna

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Acknowledgement of Country

The City and Environment Directorate acknowledges the Ngunnawal people as traditional custodians of the ACT and recognise any other people or families with connection to the lands of the ACT and region.

We respect the Aboriginal and Torres Strait Islander people, particularly our Aboriginal and Torres Strait Islander staff, and their continuing culture and contribution they make to the Canberra region and the life of our city.

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ACT Government

Contents

Glossary

- ***City and Environment Directorate (CED) –*** ACT government department responsible for managing conservation estate and public land.
- ***Closed season*** – A defined period during which hunting or capturing was prohibited for listed species.
- ***Deterrent –*** Something that discourages or prevents someone from taking an action due to the perception of negative consequences.
- ***Dry sheep equivalent (DSE)*** – A unit of measure used to assess the nutritional needs of livestock and the carrying capacity of a farm. It equates to the amount of feed required daily by a two-year-old, 50 kg Merino wether.
- **Leaseholder** – A person or entity granted a Crown lease by the Territory, giving them the right to occupy and use land according to the terms and conditions of the lease.
- ***Noxious pest/pest*** – An animal, insect, or plant considered harmful to agriculture, the environment, or human health, and officially declared or classified as such under relevant legislation or regulations.
- ***Olfaction –*** The sense of smell.
- ***Open season –*** A specific period during which it is legally permissible to hunt, take, or possess certain wildlife species that are otherwise protected. An open season is officially declared by the relevant authority (e.g., the Minister responsible for wildlife or a delegated agency) and specifies:
    - The dates during which hunting or taking of wildlife is allowed.
    - The species to which it applies.
    - Any conditions or restrictions, such as location, bag limits, or methods of hunting.
- ***Pasture Protection Board*** – Local government bodies established under the *Pastures Protection Act 1934*. The 59 boards in NSW were responsible for managing grazing, controlling pests like rabbits and feral animals, and promoting sustainable land management.
- ***Protected species*** – Species protected by law that cannot be taken, harmed, or interfered with without appropriate authorisation.
- ***Reintroduction –*** The movement of wild animals into part of their former range from which they have been extirpated.
- ***Translocation –*** The deliberate movement of wild animals from one part of their range to another.

- ***Vermin*** – Species of animals not protected by law and often considered pests due to their negative impacts on agriculture, native species, or the environment.
    - Declared vermin can usually be destroyed or managed at any time, including outside of open seasons, unless other laws (such as firearms laws) apply.
    - The list of vermin is not fixed and can be updated by regulation or proclamation.

Executive summary

The ACT seeks to adopt a holistic and informed approach to wombat management, balancing species conservation with protection of landholder and industry assets. This document reviews relevant information to inform best-practice wombat management and to ensure populations persist in the ACT.

The scope encompasses cross-jurisdictional legislation, stakeholder views, management methods and monitoring approaches. The document also highlights current challenges within the ACT, including the complexities involved in balancing conservation with stakeholder needs.

As native marsupials wombats are integral to the region's ecosystem but present several management issues. These include wildlife-vehicle collisions and conflict with agricultural activities. Wombats may face challenges including urban expansion, habitat loss and the prevalence of sarcoptic mange.

Key findings from the review include:

- **Legislation and Policy**: Unlike other Australian jurisdictions, the ACT does not allow specific provisions for the control of wombats nor provide guidance on non-lethal conflict mitigation. This has led to frustration among leaseholders managing wombat-related damages.
- **Threats to Wombats**: Habitat loss and sarcoptic mange remain the primary threats. Management of sarcoptic mange is complex and is currently conducted by wildlife carers. There is no clear mechanism for the government to limit the application of mange treatments in areas where chemicals may have negative ecological consequences. There are currently no guidelines around the release of rehabilitated wombats, including identified release zones that are ecologically suitable.
- **Stakeholder Conflicts**: The ACT has diverse stakeholders who hold conflicting views on how wombats should be managed. Consultation with stakeholder groups on policy changes is a possible method for reducing tension and increasing stakeholder support. Working groups, such as the Wombat Mange and Monitoring Group, also provide forums for stakeholders to engage on topics relevant to their concerns and interests.
- **Public education**: Development of housing near areas of wombat activity can increase incidences of human-wildlife conflict. Providing informative material and engaging in public communication are strategies to increase awareness in the community.

- **Management Tools**: Fencing, burrow modifications, and deterrents are available to manage wombat damage, but are often resource-intensive and may yield inconsistent results. Many have not been trialled in the ACT and stakeholders may not be aware of the available options. Burrow modification interventions would require additional approvals, and there is currently no streamlined application process to make this available to landholders.
- **Research and collaboration**: The ACT partners with citizen scientists to collect data on wombats through the ACT Wombat Portal, NatureMapr, and WomSAT. Where possible, decision-making should be based on systematic surveys that are scientifically robust and fit for purpose. Leaseholders currently do not have a method of reporting wombat impacts on their property.

Recommendations include:

- Support non-lethal methods for wombat control by land managers to mitigate damage, which may include the provision of information, resources and training;
- Develop an appropriate mechanism to allow humane euthanasia of wombats on rural lands that are afflicted with severe mange, noting animal welfare considerations;
- Coordination between ONC ecologists and PCS Licensing and Compliance to clearly identify areas within the ACT, and possibly NSW, where rehabilitated wombats can be released. Selection of suitable sites can reduce the likelihood of overabundance and future human-wildlife conflict;
- Review procedures and licensing pathways for the deployment of Cydectin and other mange treatments to ensure appropriate placement that minimises negative impacts on aquatic systems;
- Over the longer term, explore and evaluate options to support holistic management of Bare-nosed Wombats in the ACT through an appropriate policy mechanism, including for example, a Controlled Native Species Management Plan under the *Nature Conservation Act 2014*.

1. Introduction

Wombats are iconic Australian marsupials, deeply embedded in the cultural heritage of First Nations Peoples and the national identity (Garvey et al., 2016). There are three extant species: the Bare-nosed Wombat (*Vombatus ursinus*), the Southern Hairy-nosed Wombat (*Lasiorhinus latifrons*), and the Northern Hairy-nosed Wombat (*Lasiorhinus krefftii*). Although once likely widespread, all three species have experienced significant declines and range contractions since European settlement (Aitken, 1971, Gordon et al., 1985, Buchan A and DC, 1998, Cooke, 1998, McIlroy, 2008). The clearing of land for agriculture and urban development, coupled with the introduction of European rabbits (*Oryctolagus cuniculus*), has had a profound impact on wombat populations (Aitken, 1971, Cooke, 1998). Rabbits provided competition for food and shelter (Cooke, 1998), and wombat warrens were often destroyed during rabbit control efforts (Triggs, 2009). Increasing conflict with livestock (Crossman et al., 1994) also contributed to population pressures. The Northern Hairy-nosed Wombat suffered the greatest decline, reduced to a single known population of approximately 30 individuals by 1982 (Gordon et al., 1985). It is now listed as endangered under the *Nature Conservation Act 1992*. In contrast, the Bare-nosed Wombat was declared vermin as early as 1906 in Victoria, and considered a pest in other states (Temby, 1998).

Historically wombats were widely regarded as pests, particularly because their burrowing behaviour damaged rabbit exclusion fencing (Aitken, 1971, Temby, 1998). This view contributed to sustained population control efforts and legislative measures in all jurisdictions to reduce their impact. The Australian Capital Territory (ACT) awarded early protection to Bare-nosed Wombats under the *Animals & Birds Protection Ordinance* 1918. Growing public concern over animal welfare, conservation, and sarcoptic mange has pressured other state governments to adopt more protective policies. Though wombats are now protected species in most states, they can be controlled under permit systems where they cause damage.

The management of wombats has become a highly contentious issue due to the complexities of trying to balance competing interests of stakeholder groups, including but not limited to local government, rural leaseholders, First Peoples and wildlife care groups. Conservation and wildlife care groups are concerned for the welfare of Bare-nosed Wombats and advocate for better protections. Agriculturalists want to manage the species to minimise the damage it can cause to infrastructure, stock and farm personnel. Given the diversity of stakeholder interests, reaching agreement on the best approach to wombat management is a persistent challenge.

This review highlights the legislative, ecological, and stakeholder challenges involved in balancing species conservation with human land use and infrastructure needs. It reviews past and current legislation across the Australian states and territories to inform the conservation and management of wombats in the ACT.

2. Legislation, policy and regulation

2.1 Policy and legislation

Following European settlement and the expansion of agriculture in Australia, all three wombat species have experienced conflicts with humans. Initially, conflicts arose because wombats caused damage to rabbit exclusion fencing and wombat burrows provided refuge for rabbits. As a result, wombats were commonly viewed as pests and were able to be lethally controlled under legislation in most states.

The range of all three species of wombat contracted significantly as a result of large-scale land clearance for agricultural and urban development, and the introduction of European rabbits (*Oryctolagus cuniculus*) (Aitken, 1971, Temby, 1998, Gordon et al., 1985, Buchan and Goldney, 1998, McIlroy, 2008, Cooke, 1998). Over time attitudes towards wombats and concern for their conservation increased and legislation changed to reflect this.

This section provides an overview of the legislative frameworks and policies related to wombat management across various Australian states and territories. These frameworks serve to inform the management approaches in the Australian Capital Territory (ACT) and offer potential insights into improving wombat conservation and management strategies.

2.1.1 Victoria

Legislative history

The Bare-nosed Wombat was declared vermin throughout the state of Victoria in 1906, under provisions of the *Vermin Destruction Act* 1890 (Seebeck 1988). In 1925, a bounty was placed on Bare-nosed Wombats under the *Vermin and Noxious Weed Act* 1922*,* with more than 60,000 bounties paid up until 1955. The bounty was subsequently suspended in 1966 and officially abolished in 1971. Bare-nosed Wombats remained a pest to many and from 1971 to 1986 government officials fumigated their burrows on Crown land.

In 1977, Bare-nosed Wombats were declared protected under the *Wildlife Act* 1975 in the region west of the Melbourne to Sydney railway line, where they occurred in low numbers. The vermin status of the species was maintained in eastern Victoria until 1984, when Bare-nosed Wombats were protected under the *Wildlife Act* 1975 across all Victoria. Lobbying by farmers led the species to be declared 'unprotected wildlife' in 193 parishes in eastern Victoria under the *Wildlife Act* 1975. The declaration of the species as 'unprotected wildlife' enabled the destruction of Bare-nosed Wombats by landholders, their families, and employees by means of fumigation, trapping or shooting on freehold or leasehold land, and within 1 km of such land on adjoining Crown land. In June 1997, the *Wildlife Act* 1975 was modified to enable destruction only on the occupier's property with a high-powered, centre-fire rifle of .222 calibre or larger.

Current legislation and process

In February 2020, an amendment to the *Wildlife Act* 1975 revoked the unregulated control of Bare-nosed Wombats across 193 parishes in eastern Victoria. It is now an offence to kill, take, control or harm Bare-nosed Wombats across the entire state of Victoria without authorisation. This includes activities such as destroying or disturbing their burrows. To destroy a wombat without a permit carries a penalty ranging from $8,261 to $39, 652 and/or six to twelve months in jail. On March 19, 2025 the Victorian Legislative Council voted to review the state's lethal control program for wombats and explore alternative control measures. The review was still underway at the time of writing and no formal legislative changes had been announced.

To destroy a wombat or their burrows landowners need to apply for an authority to control wildlife permit (ATCW) from the Department of Energy, Environment and Climate Action which can be done online, by post or email (Table 1). Applicants are required to demonstrate damage to their property, crops or pasture, impacts on biodiversity values, or risks to human health or safety. Applicants must also demonstrate that all other reasonable options have been considered. A wombat management methods factsheet outlines "non-lethal" management options for landholders. Forest and Wildlife Officers review applications and may require a property inspection. This process can take up to six weeks to complete.

Each ATCW specifies the species of wildlife that can be controlled and the method of control. Anyone shooting wildlife under the *Wildlife Act* 1975 must also comply with the Firearms Act 1996.

Table 1. The number of permits issued to control Bare-nosed Wombats and the number of animals to be harmed in Victoria over the last seven years

Year	Number of permits	Animals authorised to be culled
2023	222	1902
2022	226	1862
2021	207	1675
2020	273	1478
2019	268	3655
2018	252	3830
2017	270	3374

2.1.2 New South Wales

Legislative history

New South Wales was home to all three species of wombat until the last claimed sighting of Northern Hairy-nosed Wombats in 1909. Bare-nosed and Northern Hairy-nosed Wombats had partial protection under the *Native Animals Protection Act* 1903. Under this act both species were protected from destruction during the declared closed season from August to January each year. Bare-nosed Wombats lost these protections when they were not included on the list of protected species under the *Animals and Birds Protection* Act 1918. Bare-nosed Wombats regained legal protection under the subsequent *Fauna Protection* Act 1948. Landholders were required to obtain permits for wombat destruction, except in areas governed by Pasture Protection Boards. At this time, wombats were also regarded as a noxious pest by the Department of Agriculture under the *Pastures Protection Act* 1934. This created a conflict in areas where landholders were required to destroy wombats under the *Pastures Protection Act* 1934, but could be prosecuted for doing so under the *Fauna Protection Act* 1948.

In 1959 the National Parks and Wildlife Service and the Department of Agriculture reached a compromise, leaving Bare-nosed Wombats unprotected but no longer declared noxious. As a result, both species of wombat became fair game for sports shooters and landholders. In March 1973, Bare-nosed Wombats were awarded full protection with provision for destruction for damage control purposes by being removed from the First Schedule (list of unprotected animals) of the *Fauna Protection Act* 1948-67. The following *National Parks and Wildlife Act* 1974 provided full protection to Northern Hairy-nosed Wombats, which were classed as endangered. Bare-nosed Wombats were also given protection with a provision for damage control under a permit system.

Current legislation

Wombats are protected under the *NSW Biodiversity Conservation* Act 2016. It is an offence to harm a wombat unless a licence is obtained from the Department of Climate Change, Energy, the Environment and Water.

To obtain a licence landholders must demonstrate animals are a threat to human safety, damaging property and/or causing economic hardship. Where possible, the department seeks to resolve negative interactions using non-destructive methods and recommends non-lethal methods on their website. However, a licence to harm individual animals may be required to mitigate problems. To apply for a licence, landholders must contact their local National Parks and Wildlife Service (NPWS) office to discuss the nature and severity of the issue and any non-lethal measures that may resolve the problem. They can then download and fill in an application form and lodge it with their local NPWS. The National Parks and Wildlife Service may grant a licence to the owner or occupier of a property to cull wombats. Records of the number of animals harmed need to be kept on a record sheet provided and lodged with the NPWS office within 7 days of the licence expiry. All people operating under the licence must comply with the *Firearms* Act 1996 and the Code of Practice for the Humane Destruction of Wombats by Shooting in NSW. Harming wildlife without a permit may receive a maximum fine of $330,000 with an additional $33,000 for each animal harmed or two years in jail.

Within the last seven years a small number of permits have been issued (Table 2). The maximum number of Bare-nosed Wombats to be harmed on any one permit was 50 animals. More commonly permits range from 1 – 20 animals for issues including damage to crops, competition with stock, hazard for vehicles, damage to fencing, and causing erosion and disease.

Table 2. The number of permits issued to control Bare-nosed Wombats and the number of animals to be harmed in New South Wales over the last seven years.

Year	Permits issued	Number of wombats to be harmed
2023	34	187
2022	38	219
2021	26	138
2020	42	221
2019	76	501
2018	103	752
2017	40	193

2.1.3 Queensland

Legislative history

The Northern Hairy-nosed Wombat and Bare-nosed Wombat were protected in Queensland under the *Native Animals Protection Act* 1906. However, this and subsequent Acts provided provisions for damage control. By 1982, the Northern Hairy-nosed Wombat was restricted to a single population of approximately 30 animals (Gordon et al., 1985). The *Fauna Conservation Act* 1974-1989 provided permanent protection for the Northern Hairy-nosed Wombat with no provision for damage control. Northern Hairy-nosed Wombats were declared endangered under the *Nature Conservation Act* 1992. Bare-nosed Wombats remained protected with provision for damage control under a permit system.

Current legislation

Northern hairy-nosed and Bare-nosed Wombats are protected under the *Nature Conservation Act 1992,* though there are provisions to control Bare-nosed Wombats *for* damage mitigation purposes. A damage mitigation permit *is required to* take wildlife to minimise damage or loss of property (e.g. crops) or to protect human health and wellbeing. Damage mitigation permits may cover the removal and translocation of problem animals or lethal control.

To obtain a three-year permit to remove and relocate wildlife applicants must demonstrate the following:

- Certificate of completion of a training course concerning the keep, relocation, and safe handling of relevant wildlife.
- A current first aid certificate issued by an approved first aid provider.
- Referee reports from two suitably skilled and qualified persons.
- Statements outlining the ability to handle wildlife, including safety procedures to be applied when handling or moving wildlife and access to appropriate equipment.
- Statements outlining wildlife identification skills.
- A resume including details of qualifications provided with the application.

If an applicant does not have any experience, they are recommended to contact a local damage mitigation permit holder for guidance and possible endorsement under this permit type.

To obtain a permit to lethally control wildlife, applicants must demonstrate damages caused and the economic losses incurred, or any threats to human health (e.g. disease or injury risks). Two non-lethal damage mitigation measures to prevent or minimise damage need to have been attempted prior to application for lethal control. There are no specifications about suitable non-lethal methods to be used or the duration of use. A statement outlining the applicant's relevant knowledge and experience in correctly identifying the relevant species is required. Permits are issued for one-year unless the landholder has an approved property management plan, in which case permits can be issued for three years. The Department of Environment Science and Innovation offers a service to guide applicants through the assessment process. The service includes meeting with a departmental project manager to discuss the information needed for the application. Applicants can email a downloadable form to the permits and licensing department and may take up to 40 business days to process. Once a permit has been granted, permit holders are required to lodge a return of operations form every three months and within 10 days of the permit expiry detailing how many animals were taken under the permit. The maximum penalty for *controlling protected wildlife without a permit is* $15,480 (100 penalty units).

2.1.4 Tasmania

Legislative history

Bare-nosed Wombats were not protected in Tasmania until the passing of the *National Parks and Wildlife Act* 1970, which provided partial protection allowing for the declaration of an

open season. The Minister by order, could declare the dates and places on which the taking of any partially protected wildlife may start, stop, be prohibited or permitted and impose any conditions on the order. No open seasons were declared, and destruction for damage control purposes was undertaken by permit.

Current legislation

Bare-nosed Wombats are protected under the *Nature Conservation Act* 2002 with provision for damage control.

The Department of Natural Resources and Environment encourages people to use non-lethal management options for mitigating wombat damage and several factsheets can be found on their website for Living with Wombats. A property protection permit is needed to control protected wildlife, including Bare-nosed Wombats (Table 3). Permits can be applied for by landholders, managers or lessees of land to prevent the destruction of, or injury to any stock, crops and equipment or infrastructure used in crop and/or stock production. Applications must identify the damage caused, the method of control to be used and the number of animals they want to take. The Department of Natural Resources and Environment must be satisfied a financial loss is likely to occur if the crop, stock, equipment or infrastructure is not protected. Applications are assessed on a case-by-case basis, which may include a visit to the applicant's property. The local abundance of Bare-nosed Wombats, the impacts they may have on the property, and whether non-lethal measures will be effective at the site are considered when issuing permits.

The Department of Natural Resources and Environment Tasmania assesses population trends using annual spotlight monitoring of 190 10-km transects across the state. Issued permits specify the number of Bare-nosed Wombats that may be taken and a timeframe of up to 12 months Permit holders are required to maintain accurate records of animals destroyed and report them within 28 days of the permit expiry. Persons controlling wildlife without a permit or who do not comply with the terms of their permit can receive a penalty of up to $19,500 (100 penalty units).

Table 3. The number of permits issued to control Bare-nosed Wombats and the number of animals to be harmed in Tasmania from 2016 to 2022. N/A cells indicate a lack of data.

Year	Permits issued	Total quota issued	Wombats culled
2022	9	165	29
2021	6	N/A	17
2020	5	51	20
2019	4	N/A	107
2018	6	110	N/A
2017	22	160	N/A
2016	52	2171	N/A

2.1.5 Western Australia

Legislative history

Southern Hairy-nosed Wombats were not provided protection under early game acts in Western Australia. The *Game Act* 1912 provided protection to all "non harmful" native fauna, but it is unclear whether this extended to Southern Hairy-nosed Wombats. The *Fauna Protection Act* 1950 was the first to provide blanket protection to all native fauna in the state, including Southern Hairy-nosed Wombats. In 1975 it was re-named the *Wildlife Conservation Act* 1950 and included new provisions for damage control permits.

To prevent Southern Hairy-nosed Wombats from becoming an agricultural threat across the state, the Agricultural Protection Board declared them as vermin in areas of WA outside their known range. In 1973, the declaration was amended to include Southern Hairy-nosed Wombats as a pest species under the *Vermin Control Act* 1918-1970. When the *Vermin Control Act* was replaced by the *Agriculture and Related Resources Protection Act* 1976, the Southern Hairy-nosed Wombat was included as a category seven declared animal. As a category seven species, the Minister had the authority to recommend and approve a species management plan that included management by lethal control.

Current legislation

In 2019 the *Wildlife Conservation Act* 1950 was replaced by the *Biodiversity and Conservation Act* 2016 and the Biodiversity Conservation Regulations 2018. Under the Biodiversity Conservation Regulations 2018, there are provisions for controlling fauna that have been listed as managed species. Fauna may be listed as a managed species if they are determined to be impacting public safety or biosecurity or causing economic or ecological damage. The Southern Hairy-nosed Wombat is not currently listed as a managed species. There are no records of licence applications or grants for Southern Hairy-nosed Wombat control in Western Australia.

When fauna cause damage to agriculture, native animals may be declared pests under the *Biosecurity and Agriculture Management Act* 2007 (BAM Act). Under the BAM Act, every organism except a human being has a legal status assigned through a declaration made by the Minister. If the Minister has not made a declaration, the status automatically remains unlisted. BAM status determines whether a permit is required to import the organism into Western Australia. The Southern Hairy-nosed Wombat is listed as a Permitted species S11 (exempt) on the Western Australian organism list under the BAM Act. This means they are not a declared pest and can be imported into the state without a permit provided they satisfy import permits and can be kept without a permit.

2.1.6 South Australia

Legislative history

Wombats gained their first legal recognition under the *Animals Protection Act* 1912 on the schedule of unprotected animals. Partial protection was achieved under the provision of *Animals and Birds Protection Act* 1919 with the declaration of a closed season on wombats from July to December. During the closed season landholders were only permitted to cull wombats for damage control purposes. The Fauna Conservation Act 1964 provided full protection with a provision for controlling wombats for damage mitigation. Under the *National Parks & Wildlife* Act 1972, the Bare-nosed Wombat was listed as 'Vulnerable' with full protection. The Southern Hairy-nosed Wombat was permitted to be controlled for damage mitigation purposes.

Current legislation

The Bare-nosed Wombat and Southern Hairy-nosed Wombat are protected under the National Parks and Wildlife Act 1972 (NPW Act). It is an offence to catch, interfere with, harass, or kill both species without a permit. The Department for Environment and Water recommends

using non-lethal means for managing wombats prior to resorting to culling and has a "Living with Wombats" factsheet. The Department of Environment Water can issue destruction permits in circumstances where wombats cause damage or threaten human safety (*section 53.1c of the SA National Parks and Wildlife Act 1972*). Permit application forms are available online and can be emailed, posted or dropped off at the nearest regional office. Applications are considered by National Parks and Wildlife rangers on an individual basis. Consideration is given to whether non-lethal means may resolve the problem, the extent of the damage and threats to safety. There is a code of practice for the humane destruction of wombats which permit holders must abide by. The penalty for killing a wombat without a permit is a $2,500 fine or six months in prison.

An amendment was made to the National Parks and Wildlife Act in 2023 prohibiting the destruction, damage or disturbance of wombat burrows without a permit, with a maximum penalty of $5 000 or imprisonment for 12 months. Permits are not required if:

- you are the owner of the land where the burrow is located,
- you are authorised to destroy, damage or disturb the burrow by the owner of the land where the burrow is located; and
    - the burrow is located outside of a Wombat Burrow Protection Zone; and
    - the burrow is causing, or is likely to cause, damage to crops, stock, machinery or infrastructure (including tracks and built structures) or may constitute a safety risk or hazard to people.

If a burrow is located within a declared Wombat Burrow Protection Zone a person must not, without a permit, destroy, damage or disturb the burrow. No Wombat Burrow Protection Zones currently exist so a permit is not presently needed to destroy a wombat burrow. There is a protection for wombat burrows factsheet outlining the new changes.

2.1.7 Australian Capital Territory

Legislative history

Bare-nosed Wombats have been fully protected in the ACT since the *Animals & Birds Protection Ordinance* 1918. Successive Commonwealth ordinances and the *Nature Conservation Act* 1980 kept full protection in place.

Current legislation

As native animals under the *Nature Conservation Act 2014*, Bare-nosed Wombats remain protected. Killing a native animal is an offence under section 130 of the Act, which presently carries a maximum penalty of $16,000 and/or imprisonment of 1 year for an individual, or $81,000 for a corporation (higher if the species is specially protected). Under sections 128-129 of the Act, it is an offence to interfere with a nest (including burrow) of a native animal. These offences presently carry a range of penalties, up to (in a case involving a wombat) $16,000 and/or imprisonment of 1 year for an individual, or $81,000 for a corporation. A range of offences apply to damaging land in a reserve. The maximum penalty for the most serious of these offences is presently $400,000 and/or 7 years' imprisonment for an individual, or $2,025,000 for a corporation. Some activities, including nest destruction, may potentially be carried out under a licence issued by the Conservator of Flora and Fauna. It is the responsibility of the proponent to apply for a licence for any proposed activity that may otherwise be an offence under the Act. The ACT Parks and Conservation Service administers the Act and conservation officers are responsible for conducting compliance activities. These include public education, inspections and investigations to promote and support compliance.

In 2025, the ACT Government strengthened its regulatory framework for wildlife protection during development by introducing the Nature Conservation (Protection of Burrowing Animals During Development) Conservator Guidelines. These guidelines, issued by the ACT Conservator of Flora and Fauna, are a notifiable instrument under the *Nature Conservation Act 2014*, giving them legal force and requiring compliance from developers operating in areas with suitable habitat. The guidelines aim to minimise harm to native burrowing animals, such as Bare-nosed Wombats, by requiring site assessments, avoidance of active burrows, and consultation with the Conservator where disturbance is unavoidable.

2.1.8 Differences between the ACT and other jurisdictions on wombat control

Apart from the ACT, all jurisdictions currently have a specific provision under legislation to enable wombat control for the purpose of damage mitigation. Victoria is currently conducting a review of their lethal control policies for wombats, but this review is still in progress and there have been no legislative changes. Control is regulated by a permit system, and landholders are required to pursue alternative management methods in almost all states before seeking a culling permit.

Tasmania is the only state which considers trends in wombat populations when setting permit allocations. Understanding baseline population data is critical to assessing a program's efficacy and impacts. Controlling too few individuals can be ineffective at reducing damages, while removing too many can have negative conservation outcomes (Taggart et al. 2008).

Most states have an online permit application system or provide a form that can be submitted to the relevant department. Applications typically take 4-6 weeks to process, and landholders may be frustrated by these timeframes (Sparrow, 2011, Stott, 1998, Bunn, 2019). When landholders are faced with wombats burrowing under dams and other infrastructure, they feel prompt action is required to prevent further damage. Most states require the applicant to have tried 'non-lethal' damage mitigation strategies before applying for a permit, but guidance on 'non-lethal interventions' may not be provided. Further research into the efficacy and animal welfare considerations of common 'non-lethal interventions' is also required.

There has been a substantial reduction in the number of permits and the number of wombats permitted to be culled within the last decade across all states. This is in response to mounting public pressure on government agencies from conservationists and animal welfare advocates. As a result, landholders feel they are unable to reduce the damage caused by wombats on their property. For many farmers, the lengthy application process is not worth the time it takes to apply for a permit if they are only permitted to cull 10-25 wombats. As such some landholders act outside of permit systems and official government registers are considered an underestimate of the true numbers of wombats culled (St John and Saunders, 1989, Taggart et al., 2008).

3. Wombats in the ACT

3.1 Distribution and abundance

Prior to European settlement Bare-nosed Wombats were thought to have a continuous distribution across much of their range including the ACT. Following European settlement, the establishment of farming along with the introduction of rabbits is thought to have had a significant reduction on the distribution and abundance of all three species of wombats (Buchan A and DC, 1998, Cooke, 1998). Dingoes (*Canis familiaris dingo*) have been known to predate on wombats where the two species co-occur, but their effects on overall population numbers is unclear (Thorley and Old, 2020). Current occurrence records from the ACT Wildlife Atlas show Bare-nosed Wombats are widespread across the ACT, particularly along the

Murrumbidgee and Molonglo River (Figure 1). Wombats are also known to occur across Namadgi National Park (CED survey data).

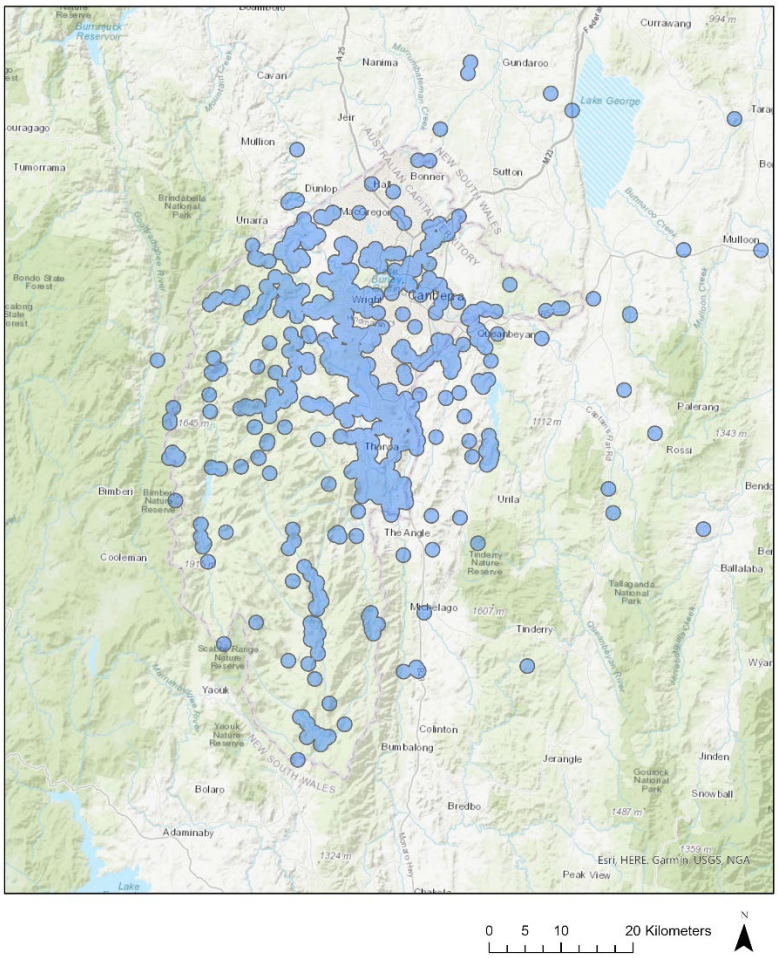

Figure 1. The known distribution of Bare-nosed Wombats (blue) in the Australian Capital Territory, taken from ACT Wildlife Atlas records, CED survey data and the ACT Wombat Mange Portal Map. This data collection system is designed to capture data within the ACT and is likely an underrepresentation of wombat distributions in NSW.

Abundance is likely to vary locally and regionally, depending on a range of factors, such as habitat type, soil type and climatic conditions. Competition from rabbits and kangaroos for food resources also limits Bare-nosed Wombat numbers in many areas (Tamura et al., 2021, Bird et al., 2012, Cooke, 1998).

There are currently no reliable estimates of abundance for Bare-nosed Wombats in the ACT. After an initial likely decline from habitat loss, following the expansion of agriculture and urbanisation, anecdotal reports from leaseholders suggest the distribution and abundance of Bare-nosed Wombats have increased over the last 10-20 years. Anecdotal evidence from park rangers also support an increase in distribution. Reports dating back to 1975 indicate Bare-nosed Wombats were not present on the Canberra plains or in Canberra Nature Park at the

time, though they were present in Tidbinbilla and Namadgi National Park. Rabbit control officers were known to target Bare-nosed Wombats because of the holes they made in rabbit proof fencing (Don Fletcher, pers. comm.; Higgins, 1991).

3.2 ACT Government stakeholder engagement

The Office of Nature Conservation (in CED) initiated a Wombat Working Group in 2021 to bring together stakeholders with interests in Bare-nosed Wombat management in the ACT to share knowledge and discuss management issues. The group consisted of wildlife carers, ACT Government, agriculturalists and researchers. The group met several times virtually, but lack of attendance meant that it was disbanded. A Wombat Mange Management Sub-group also commenced in 2021. The subgroup met quarterly until it was scaled back and eventually paused in 2024. For more information on relevant stakeholders in the ACT see Section 4.

3.3 Monitoring and management

The Office of Nature Conservation conducted line transect surveys across 13 sites to monitor wombat populations in the ACT, but these methods have now been judged insufficient to robustly estimate abundance. For more information on monitoring wombat populations see Section 6.8.

Mange is treated by wildlife care groups under a CED permit for use of moxidectin on public land in the ACT, with strict conditions of its use around waterways due to its toxicity to aquatic species. For more information on the prevalence and treatment of sarcoptic mange in the ACT see Section 5.2.1.

3.4 Rescue and rehabilitation

There are two wildlife rescue organisations within the ACT that care for and rehabilitate sick and injured Bare-nosed Wombats. Wombat Rescue is solely dedicated to Bare-nosed Wombats, and ACT Wildlife cares for all injured wildlife. Wombat Rescue operates under a licence to take, rehabilitate and release wildlife in the ACT issued under Section 273 of the *Nature Conservation Act 2014*. Both groups work closely with each other and NSW care groups to coordinate resources for the care of Bare-nosed Wombats.

Wombat Rescue reports responding to several call outs a day. In the last 6 months Wombat Rescue have taken 19 Bare-nosed Wombats into care. Records indicate up to 50 wombats are taken into care annually by Wombat Rescue and ACT Wildlife cares for 20-30. What most individuals take into care are pouch young orphaned as a result of road vehicle collisions. To a

lesser extent Bare-nosed Wombats with severe mange are taken into care for treatment, with carers preferring to treat mange in situ where possible.

Of the approximately 50-60 Bare-nosed Wombats taken into care each year fewer than 10 animals are released in the ACT. In 2024, 28 wombats from the ACT were taken into care and only five were released into the ACT. Animals that come into care from New South Wales must be released in NSW. Release sites are resource intensive to find. For wombats these may include a large enough area that is free from mange, away from roads, has available food and water, and a low density of resident wombats. ACT Wildlife procures empty burrows to release animals by evicting resident Bare-nosed Wombats with the use of one-way gates. Wombat Rescue creates artificial starter burrows to release animals by digging a 70 cm deep L -shaped tunnel in flat ground. They place a 45 cm diameter trench liner half pipe over the hole before filling it back in to make a tunnel. When creating tunnels on private land they use soft release techniques, fencing the burrow and providing supplemental food. Animals released into parks and reserves are not provided supplemental food or fenced burrows. Carers monitor released individuals for a few weeks using wildlife cameras, but released animals rarely stay in the release area.

More recently, there has been request from Wombat Rescue that ACT Government provide land for a pre-release wombat sanctuary or haven to prepare rehabilitated wombats for wild release. Areas would need to be designated and fenced for this purpose, and policy or guidelines developed around effective and safe release of wombats. The feasibility and need for a wombat sanctuary, and the role of the ACT Government in providing such a facility, is still in discussion.

4. Stakeholder consultation and interviews

This section lists the primary stakeholders invested in Bare-nosed Wombat management in the ACT, and their interests in this issue (Table 4). It is important to note this is not a comprehensive review of stakeholder opinions on Bare-nosed Wombat management in the ACT and only expresses the views and opinions of a small number of people from each stakeholder group. Views and opinions are likely to vary within stakeholder groups. A formal review of stakeholder views is recommended.

Table 4. Identified stakeholders within the ACT with an interest in Bare-nosed Wombat management

Group	Organisation/name	Role in relation to Bare-nosed Wombats
ACT Government	Office of the Conservator of Flora and Fauna, City and Environment Directorate	Acts on issues that affect the conservation matters covered in the *Nature Conservation Act 2014*, particularly protecting native plants and animals
	Office of Nature Conservation Policy, City and Environment Directorate	Updates policy and legislation under the *Nature Conservation Act 2014*
	Office of Nature Conservation, City and Environment Directorate	Undertake a range of nature conservation programs in the ACT, including research on local flora and fauna, preparing scientific advice on ecological and natural resource management, conducting ecological surveys, biodiversity monitoring
	City Services, City and Environment Directorate	Deliver a range of services, including shop and playground upgrades, road and path maintenance, domestic animal services, and the management of urban open spaces including tree planting and grass mowing that may be impacted by Bare-nosed Wombat behaviour
	ACT Natural Resource Management, City and Environment Directorate	Integrated management of ACT's natural resources, including biodiversity, sustainable agriculture and cultural history
	ACT Parks and Conservation Service, City and Environment Directorate	Land management of the conservation estate, vertebrate pest and weed control, and managing visitor experiences.
	Licensing and Compliance, City and Environment Directorate	Licensing and compliance under the *Nature Conservation Act 2014*
	Urban Wildlife, ACT Parks and Conservation Service, City and Environment Directorate	Manage the outcomes of human-wildlife conflict, including nuisance animals, vehicle strikes and sick and injured animals

Group	Organisation/name	Role in relation to Bare-nosed Wombats
	Veterinarians, City and Environment Directorate	Administering treatment and care of animals including wildlife within the ACT
Industry	Icon Water	Responsible for maintaining supply of water and sewage services in the ACT. These services may be impacted by Bare-nosed Wombat activity on occasion and require management
	Developers	Construction of new developments within the ACT in compliance with Conservator Guidelines for Burrowing Animals
Agriculturalists	Rural leaseholders	Land management and agricultural production which may be impacted by Bare-nosed Wombat behaviour
	ACT Rural Landholders Association	Advocacy for farmers and best practice farming within the ACT
Wildlife carers	Wombat Rescue	Caring for injured wombats and treating mange infected populations within the ACT. Advocate for wombat conservation and welfare
	ACT Wildlife	
Researchers	Prof Scott Carver	Conducting research on wombat ecology, biology and management
Ngunnawal	Dhawura-Ngunnawal Caring for Country Committee (DNCCC)	The representative body for ACT Government for traditional custodians of the Country in and around the ACT

4.1 Rural leaseholders

Rural leaseholders are frustrated by their current ability, or lack thereof, to manage Bare-nosed Wombats on their properties. Streambank erosion and reduced water quality as a result of wombat burrowing near waterways have been raised as a concern by landholders in correspondence with the ACT Government. Burrows and tunnels are becoming a big safety concern, with some paddocks described as 'Swiss cheese'. Staff and stock are frequently injured by falling into burrows (see section 9.2.1). Rabbits have become difficult to control, as they shelter in Bare-nosed Wombat burrows and cannot be treated. Landholders have

expressed interest in the development of an authorised control program like the kangaroo management program in the ACT.

The management of mange on private properties is a cause of concern for rural leaseholders. Some leaseholders have reported their dogs have contracted mange from the burrows of infected animals. This has resulted in expensive vet bills and distress to both dogs and their owners. Wildlife carers have also been caught trespassing on private property to treat mange. Landholders are concerned carers may be applying toxic chemicals without their knowledge. Furthermore, some leaseholders have experienced pressure from lobby groups in relation to kangaroo management and are apprehensive of similar dynamics with wombat carer groups.

Rural landholders within the ACT are frustrated by the current level of engagement with ACT Government on wombat management issues. Those involved in the Wombat Working Group have expressed concern that the group was heavily focused on conservation and mange treatment and did not adequately address the difficulties of managing wombats on rural properties. Their view is that rural landholders should be engaged directly to better understand the management issues they are facing, and to develop damage mitigation strategies to improve co-existence with wombats. Concerns about sick wombats on rural lands were raised. For these strategies to be successfully implemented, they must be accepted by landholders as feasible and effective options. Additionally, continuing discussions between researchers, ecologists and landholders on the ecological value of wombats may improve landholder tolerance of wombats and facilitate effective management (Schumann et al, 2012).

It is important to note, there are 381 farmers within the ACT and only three rural leaseholders were consulted in the writing of this review. The views presented here do not necessarily represent the views of all rural leaseholders within the ACT.

4.2 Wildlife carers

ACT Wildlife and Wombat Rescue are two groups rehabilitating Bare-nosed Wombats in the ACT. Wombat Rescue are often called out to assess the condition of injured or mange-affected animals by the ACT Parks and Conservation Service (PCS) and the public. Wombat Rescue has approximately 20 active members who respond to calls and their resources are strained. They are concerned about the level of awareness and training rangers have in assessing mange cases and determining if treatment or euthanasia is needed. While carers acknowledge assessing the severity of mange is subjective, they would like mange training courses to be mandatory for all rangers to attend. To address this issue in part, the ACT Chief Veterinary

Officer developed the 'Assessment of sarcoptic mange in wombats: A guide for rangers' as a decision sheet for PCS rangers assessing mange severity and the need for humane euthanasia. Additionally, carers are concerned about the lack of suitable release sites for rehabilitated animals in the ACT, leading to most releases occurring in NSW. Both care groups worry about post-release survival and are exploring GPS tracking to monitor outcomes.

Wombat Rescue leads efforts to treat mange across populations, while ACT Wildlife limits treatment to intended release areas (see section 9.3.1). Despite ongoing efforts, carers lack the resources to eliminate mange from populations and believe more needs to be done to control the disease. Wombat Rescue also notes that some leaseholders are reluctant to allow property access to wildlife carers to treat mange affected Bare-nosed Wombats, increasing tension between the stakeholder groups.

Urban development in the ACT is encroaching on Bare-nosed Wombat habitats, likely forcing them into river corridors and increasing population density (see section 9.3.2). While carers have positive relationships with some developers, they are concerned others neglect proper wombat management. Carers fear Bare-nosed Wombats are being pushed into narrow river corridors which will place a strain on resources and result in more aggressive territorial behaviour. They would like to see buffer zones placed around new developments to minimise impacts to Bare-nosed Wombats, but no context was provided.

4.3 Community

Bare-nosed Wombats frequently interact with areas used by the broader community. As urban sprawl encroaches on Bare-nosed Wombat habitat there will likely be increases in human-wombat interactions and potential conflicts in urban areas. The broader community was not consulted as part of this review, and their opinions remain unknown.

Many people who do not live with wombats on their properties are often unaware of the issues these animals can cause, which contributes to resistance toward their management. Increasing public education about Bare-nosed Wombat biology, ecology, and the challenges they present can improve acceptance of species management strategies (Reiter et al., 1999). Including educational material on wombat ecology, impacts and management options on the CED website could be a valuable resource for the community. This would be similar to the information that is currently provided for other managed species (e.g. kangaroos). By fostering understanding through a well-structured information campaign, communities can better

support responsible Bare-nosed Wombat conservation and reduce human-wombat conflicts across urban and rural settings.

4.4 Ngunnawal

Bare-nosed Wombats were widely used by First Nations people in many parts of southeast Australia. Much of the traditional knowledge has been disrupted due to the impacts of colonisation. Unfortunately, limited access to relevant contacts has constrained our ability to assess the importance of Bare-nosed Wombats to the Ngunnawal community at this stage. Reviving and incorporating First Nations perspectives into contemporary conservation efforts can help honour cultural importance and provide holistic approaches to managing Bare-nosed Wombat populations in the ACT.

4.5 Office of Nature Conservation (ONC)

The management of Bare-nosed Wombats is becoming an emerging and complex issue for ONC. ONC initiated a Wombat Working Group to work with stakeholders and better understand the complexities and conflicting viewpoints in this space, but reported they had trouble engaging leaseholders within the working group. The working group came to an end when there was no new information to guide decision-making. ONC faces pressure from wildlife groups to manage mange and has worked with researchers and wildlife carers to mitigate mange impacts. This includes the creation of the Wombat Mange and Monitoring Group, a subgroup of the Wombat Working Group focused on monitoring wombat populations and assessing mange. While there is a desire within ONC to effectively manage this species, a range of knowledge gaps and resource allocation has proven to be a significant hurdle.

Ecologists in ONC are also responsible for the monitoring and conservation of a range of threatened riparian and aquatic species in the ACT. There are concerns that mange treatments such as moxidectin are highly toxic to aquatic life, and the negative consequences this may have on threatened aquatic species.

4.6 ACT Parks and Conservation Service (PCS)

Rangers find it challenging to manage community frustrations surrounding wombat burrow management in ACT parks and reserves. Walking and cycling trails are often re-routed along sub-optimal routes due to the presence of Bare-nosed Wombat burrows. As conservation officers, rangers are permitted to interfere with wombat burrows where necessary and are required to adhere to the Conservator Guidelines for the Protection of Burrowing Animals.

Rangers would like support to manage burrows, particularly short starter burrows that are not used as a primary refuge.

Rangers have also raised concerns around streambank erosion and damage caused by wombats burrowing near waterways, particularly along the Murrumbidgee River.

4.7 ACT Natural Resource Management

The primary issues ACT Natural Resource Management (ACT NRM) encountered with Bare-nosed Wombat management were a result of conflicts with farmers. Anecdotally Bare-nosed Wombat numbers have increased in the last 15-20 years, and subsequently the number of conflicts has increased. Among landholders there is an appetite to declare Bare-nosed Wombats overabundant and allow lethal controls as a management tool. ACT NRM would be reluctant to implement lethal control as there are multiple knowledge gaps around current population levels and minimum viable populations. ACT NRM also highlighted the lack of resourcing for non-lethal options for managing conflict between landholders and Bare-nosed Wombats. Subsidising exclusion fencing in hotspot areas may be a feasible option for conflict resolution. One-way gates, another management option, may remove conflict in one area but relocate wombats and conflict to another area.

4.8 Icon Water

Bare-nosed Wombats have damaged Icon water essential services infrastructure (see section 9.2.1). Icon Water sought advice from ecologists on damage mitigation strategies but had difficulties finding skilled ecologists with capacity to assess the problem and implement recommendations. As a result, Icon Water now manages wombat damage independently based on online consultation with ecologists. They have adopted a variety of management strategies, but they require monitoring and management investments. Icon Water currently has sufficient resources to continue implementing their management program.

4.9 Licensing and Compliance

The Licensing and Compliance team is supportive of developing a CNSMP for wombats and indicated that this is preferable to issuing licenses for control. They recommended that if the ACT government was to permit lethal control of Bare-nosed Wombats it should be part of an evidence-based controlled native species management plan (CNSMP), similar to macropods. Additionally, the Licensing and Compliance team noted that a CNSMP should include clear guidelines around when control is appropriate, and the criteria that must be met for control to

occur. For example, the existing CNSMP for Eastern Grey Kangaroos clearly defines when control occurs, the number of animals to be removed, and benchmarks for shooter proficiency. A CNSMP for wombats should also be paired with a new code under the *Animal Welfare Act* that defines how wombats are to be controlled humanely. Currently there have been no formal complaints to the licencing department about Bare-nosed Wombats.

4.10 Office of the Conservator for Flora and Fauna

In recent years, wildlife carers have been concerned about the impacts of new development on Bare-nosed Wombats. In response, the Office of the Conservator for Flora and Fauna developed the Conservator Guidelines for the Protection of Burrowing Animals during development (Protection of Burrowing Animals During Development) Conservator Guidelines 2025 notified under the Legislation Act 2001). There are currently two licences issued to interfere with Bare-nosed Wombat burrows.

4.11 Scientists

The only scientist consulted during this review was Dr. Scott Carver, who specialises in researching wildlife disease ecology. Dr. Carver was a member of CED's Wombat Working Group and has worked with the ACT and Tasmanian governments on mange-related projects. He felt the Wombat Working Group effectively achieved its intended purpose. Similar to the Tasmanian wombat working group, the CED-led group came to a natural end when participants ran out of new information to bring to the table.

Dr. Carver has worked extensively with wildlife carers on mange treatment. He noted that within the stakeholder group there is disagreement over best practice treatment methods and determining when euthanasia is appropriate. He noted that conversations in this space can escalate quickly, and more research is necessary. A recent study by the Wombat Protection Society and associated researchers trialled increasing the dose of moxidectin from 20 ml to 100 ml to treat mange in wombats. Dr. Carver noted that this is a large increase in dosage, and studies gradually increasing the treatment dose to determine the lowest effective amount would be key to preventing excessive use of moxidectin.

Dr. Carver acknowledged leaseholders had conflicts with Bare-nosed Wombats and more research was necessary in this space, but it was outside his area of expertise.

4.12 Chief Veterinary Officer

The ACT Government Chief Veterinary Officer (CVO) was primarily concerned Bare-nosed Wombats treated for mange *in situ* are not getting the proper care they need. Ideally animals would be diagnosed by a qualified veterinarian prior to being given treatment, although the CVO did acknowledge that this was not possible when treating wild animals *in situ*. They raised concern that the indiscriminate application of moxidectin at all burrows within an area can lead to accidental overdosing of individual Bare-nosed Wombats. Conversely, some wombats may not receive a full dose if the chemical splashes as they are exiting a burrow or they move away from the treatment area. Healthy animals within the population will also unnecessarily receive treatments, which could lead to the development of chemical-resistant mites.

The drugs being used to treat Bare-nosed Wombats have the potential to cause harmful side effects in other species. Dogs that ingest moxidectin can experience neurotoxic effects and possible mortality. Faecal matter from treated animals contains traces of moxidectin, which can wash into waterways and affect aquatic systems. Responsible use of mange treatment drugs is critical to ensuring the negative impacts on ecological function are minimised.

4.13 Developers

The ACT population is projected to grow to 696,000 by 2050. Over the next few decades urban expansion is likely to further encroach on areas where Bare-nosed Wombats reside, resulting in management issues for urban developers. No developers were spoken to during this review. Consultation with developers is recommended to ensure urban expansion can be managed with minimal impacts on Bare-nosed Wombats.

5. Complexities of wombat management

The management of wombats is highly contentious, with challenges arising from the need to balance the competing interests of diverse stakeholder groups, including local government, leaseholders, First Nations, and wildlife care organisations (see Table 4). Conservation and wildlife care groups advocate for stronger protections for Bare-nosed Wombats, while agriculturalists and developers seek to manage the species to reduce damage to infrastructure, livestock, and personnel. This section seeks to bring together diverse stakeholder perspectives on a range of issues to highlight the complexities involved in reaching a management solution.

It is unlikely that all stakeholder groups will agree on a single approach to wombat management. However, participatory planning can improve communication and foster mutual understanding. Involving stakeholders in decision-making processes can lead to greater ownership of outcomes, enhance program credibility and transparency, and support the achievement of long-term goals (Hewitt and Messmer, 1997). Stakeholders are less likely to adopt or support management practices if they feel their opinions have not been taken into consideration and may take management actions into their own hands.

To date, there is no known research specifically examining the complexities of stakeholder relationships in wombat management. However, studies have explored landholder relationships with Southern Hairy-nosed Wombats (O'Brien, 2019, Sparrow, 2011, St John and Saunders, 1989, Stott, 1998) and Bare-nosed Wombats (Marks, 1998c). Additionally, the 5th IUCN World Parks Congress in 2004 brought together conservation experts to discuss human-wildlife conflict. Insights from this workshop, summarised by Madden (2004) provide a useful guiding resource for managing human-wildlife conflict.

5.1 Common causes of damage

5.1.1 Burrowing behaviour

Wombats are one of the largest burrowing herbivores in the world and create warren complexes that vary in complexity from single entrance burrows to a collection of interconnected burrows (warren). Burrows can vary in depth (0.4-2.8 m) and length (0.5-20 m), as such the spoil mound can be anywhere from 2.5-8 m^2 (Triggs, 2009, McIlroy, 1973). A Bare-nosed Wombat can use up to 11 burrows within their home range, though they typically favour the use of 1-2 burrows (Evans, 2008). Though their burrowing provides essential ecosystem services it often leads to conflicts with people. Bare-nosed Wombat burrows can undermine infrastructure such as roads, buildings, water tanks, fencing, dams which can result in substantial damage, financial costs and safety concerns.

One of the main points of contention for rural leaseholders with Bare-nosed Wombats on their properties in the ACT is the damage and occupational health and safety risks burrows can cause. This includes damage to fencing, dams, roads, buildings and erosion. Wombat damage to fencing can result in stock escaping from paddocks, posing a safety risk to both stock and people. Livestock may become injured or lost once they escape from the safety of a property resulting in financial losses to the rural leaseholders. Where properties adjoin parks and reserves there is a risk escaped stock may damage parks and reserves and incur fines for the

landholder. Furthermore, rural leaseholders have a legal responsibility to ensure their stock does not stray from their property and can be held liable for any damages if they escape. Fence damage can also allow access to properties from undesirable pest species such as pigs.

Rural leaseholders and Icon Water have reported issues with Bare-nosed Wombats burrowing into the sides of dams or reservoirs. This is not only a safety concern for people but also the Bare-nosed Wombat. If a dam wall breaks it has the potential to release large volumes of water, threatening farm water supplies and downstream properties. In addition, it could cause increased erosion and sediment washing into the Murrumbidgee River and other major waterways. This places a significant financial burden on the rural leaseholders who are responsible for appropriately maintaining their dams. Icon Water have been managing Bare-nosed Wombats burrowing around dams by using one-way gates to force animals to leave the burrow and filling the hole with cement once they have been evicted.

Icon Water, rural landholders and PCS rangers have reported safety concerns with Bare-nosed Wombats burrowing under roads and tracks and within paddocks. The weight of a vehicle driving over a tunnel can cause the tunnel to collapse, causing damage to vehicles and necessitating vehicle and road maintenance. For rural leaseholders, burrows pose a significant safety risk to people and stock. Landholders using quadbikes and buggies can incur significant injuries if their vehicle falls into a burrow, which can lead to lengthy recovery times and a loss of income. Rural leaseholders have reported vehicles falling in tunnels as frequently as once a month with estimated damages costing ~$1,000. This risk is increased in summer when grasses and other vegetation obscure burrow entrances. Landholders can also be liable for injuries to contractors and other staff working on their property, and landholders have been sued by injured contractors. Stock falling into wombat burrows can negatively affect animal welfare and lead to financial losses. One rural leaseholder has had to remove high value stock from a paddock with high levels of Bare-nosed Wombat activity. When wombat burrows limit accessibility of paddocks landholders may not be able to carry out other management tasks such as weed control. While burrow entrances can be mapped to reduce the risk, it would need to be updated regularly to account for new burrows. This is not feasible for rural landholders at a large scale.

Bare-nosed Wombats burrow under other infrastructure, such as buildings, water tanks and wastewater treatment drying beds. They can be removed with the use of one-way gates and burrows can be backfilled, but it is possible wombats will re-excavate the site. Rural leaseholders have tried using mesh to prevent re-excavation, but this treatment only lasts up

to six months. Icon Water use a range of methods to prevent Bare-nosed Wombats re-excavating under infrastructure including the installation of cement skirts, placement of large rocks or mesh skirting. This requires ongoing maintenance and monitoring to keep animals out of undesirable areas. Burrows can also harbour rabbits, which creates an added layer of complexity in rabbit control. If rabbits are found using Bare-nosed Wombat warrens, Icon Water install one-way gates to remove the wombat before fumigating the burrow.

5.1.2 Grazing competition and crop damage

Within the ACT there are 20,869 ha of agricultural land, the majority of which is stock grazing land, with a small amount of cropping. Though competition for food resources between wombats and livestock has been reported as an issue of concern in other states (O'Brien, 2019, Stott, 1998, Marks, 1998c), rural leaseholders in the ACT have not reported it as an issue. The density of wombats on properties can vary at local and regional scales and may influence reports of grazing competition. For example, within the Murraylands of South Australia, Southern Hairy-nosed Wombats have an estimated DSE (dry sheep equivalent) of 0.5, comparatively sheep have a 1.2 DSE. Dry sheep equivalent is a unit of measure used to assess the nutritional needs of livestock and assess the carrying capacity of a farm. It equates to the amount of feed required by a two-year-old 50 kg Merino wether per day. Landholders have had to reduce their stocking rate by 20%, to account for the impacts of growing Southern Hairy-nosed Wombat populations, threatening the viability of some farms. Due to the differing climatic conditions in the ACT Bare-nosed Wombats might not have a substantial grazing impact. However, only three rural leaseholders were consulted in the writing of this document. Further consultation with rural leaseholders is recommended to understand the extent of the problems they are facing within the ACT before ruling grazing competition or crop damage out as a potential cause of conflict.

5.1.3 Erosion

Along waterways wombat burrows are often perceived to increase erosion in creeks and gullies (O'Brien, 2019); however, the extent of damage has not been quantified. Past land clearance may have resulted in increased soil instability, facilitating wind and water erosion of creek lines over time. When Bare-nosed Wombats burrow into steep banks, they undercut and destabilise them, the effects of which are exacerbated in unstable soils where there is a lack of vegetation. Eroding soils are transferred into waterways with environmental implications for aquatic systems, including loss of fish habitat, aquatic barriers and increased nutrient loads.

Targeted monitoring in areas suffering from erosion is necessary to determine the extent and underlying cause of erosion and inform best practice management actions.

Rural leaseholders have used fencing to prevent stock from accessing creek lines and contributing to erosion risks. They are unable to prevent Bare-nosed Wombats from digging into creek banks and damaging the stock exclusion fencing. One rural leaseholder remediated the creek line of his property to reduce the erosion and subsequent damage to the surrounding aquatic environment with the help of ACT NRM and community groups (Figure 2). It took significant effort getting the necessary approvals on top of the time and costs of the

Figure 2. Top - the eroding creek line on a leaseholder's property prior to remediation works. Bottom - the creek line after remediation works.

work itself, totalling over $50,000. This work was undertaken as part of a grant program and would otherwise have been infeasible for the rural leaseholder. The rural leaseholder reported difficulty in dealing with 'red tape' associated with the project and would not have completed it without the help of the ACT NRM.

5.1.4 Land clearance for urban development

Recent expansion of urban development has caused concern among wildlife groups for wombats. Though Bare-nosed Wombats are a protected species they are not threatened and thus do not need to be considered when assessing a site for development approval. As such, developments have been planned, approved and construction commenced in areas where Bare-nosed Wombats occur without considering the impacts. Though it is an offence to kill or interfere with a Bare-nosed Wombat under the *Nature Conservation Act* 2014, burrows have reportedly been destroyed during earthworks by developers, potentially burying Bare-nosed Wombats alive (pers. Comm., wildlife carers 2024). Wildlife carers have reported increased numbers of call outs in areas where urban development has or is occurring. This has highlighted the need for a greater understanding of the impacts of development on Bare-nosed Wombats.

As a response to potential impacts from development on Bare-nosed Wombats and other burrowing animals, the Conservator of Flora and Fauna has developed Conservator Guidelines for Burrowing Animals. The purpose of the guidelines is to improve consideration of burrowing animals during development and provide direction to developers on best practice methods to minimise harm. The guidelines will apply to any new developments within the ACT. During planning stages, developers will need a suitably qualified ecologist to identify burrow and shelter sites, monitor them for activity and ensure they are vacant or avoid developing over them wherever practicable. Wombat Rescue and ICON Water have highlighted the difficulties of conducting appropriate assessments due to the lack of capacity among suitably skilled ecologists in the ACT. Wombat Rescue are often called by ecologists seeking advice on how to manage wombats (pers. Comm., Wombat Rescue 2024). Where avoidance of burrows is not possible developers can apply for a licence to destroy burrows and must follow the guidelines to ensure this is done with minimal disturbance to animals.

The guidelines don't take into consideration the potential for new developments to fragment and isolate populations, limiting dispersal and resulting in genetic differentiation over time. Prior to any new land use zoning, consideration should be given to whether wildlife populations will be disconnected resulting in small and isolated populations that over time could result in inbreeding. There is concern development is pushing Bare-nosed Wombats into narrow river corridors where increased densities could result in increased competition for resources and creating stressful conditions for animals. Without a more detailed understanding of the abundance of Bare-nosed Wombats and carrying capacity in the ACT it is

difficult to determine the impacts of increasing development and expansion. Furthermore, the carrying capacity of Bare-nosed Wombats is unknown and likely to vary from region to region based on habitat and resource availability.

If Bare-nosed Wombat densities are reaching a critical limit with food resources it can increase stress, competition and ultimately population declines. Increased stress and high Bare-nosed Wombat densities are often associated with increased mange prevalence (Sengupta, 2019). Areas closer to fresh water are also predicted to have the highest suitability for mange *(Ringwaldt et al., 2023).* Urban areas abutting river corridors where Bare-nosed Wombats occur could result in increased human-wombat interactions. Dispersing Bare-nosed Wombats may wander into urban areas where conflicts can occur (e.g. burrow damage) and be more susceptible to road vehicle collisions. There could also be increased interactions between wombats and pets, resulting in injuries to domestic dogs and wombats. Dogs have been known to enter burrows where they may contract mange, get stuck or become injured. Increased public education on the implications of living near Bare-nosed Wombats will be essential.

It is important to note no developers were consulted in the preparation of this report. Consultation with developers is recommended to improve Bare-nosed Wombat management in areas under development.

5.2 Conservation concerns

5.2.1 Mange

Sarcoptic mange is a skin condition caused by the *Sarcoptes scabiei* mite. Mange initially presents as skin reddening and hair thinning. As the disease progresses, visible signs of itching, alopecia and epidermal crusting appear (Pence and Ueckermann, 2002). Mange has strong animal welfare implications as affected individuals can suffer a slow and agonising death, usually through secondary infection, blindness and/or starvation (WHA, 2021). Prevention of mange in Australia is considered almost impossible, as all disease transmission pathways would need to be interrupted, including transmission from host species such as foxes (WHA, 2021).

Ideally mange should be diagnosed and treated by qualified veterinarians so the condition is correctly identified, and animals can receive appropriate treatment. This is not feasible for wildlife populations. Mange in wombats is typically diagnosed and treated by wildlife carers and volunteer groups with varied levels of training, experience and coordination. Diagnosing the disease in its early stages can be difficult without catching and examining animals. The

same symptoms can be caused by malnourishment from low quality feed, creating the potential for misdiagnosis (Fraser et al., 2018).

The distribution of mange and its impacts on wombat populations is poorly understood. Bare-nosed Wombat populations often persist in the presence of mange, and prevalence is usually ≤ 15% (Carver et al., 2021). During outbreaks, mange prevalence can rise to > 50%, with near 100% mortality of infected individuals (WHA, 2021). In some cases, mange outbreaks have resulted in > 90% decline in local Bare-nosed Wombat abundance (Skerratt 2005; Martin et al. 2018a). Research suggests population decline and range retraction can occur when mange prevalence is > 25% (Carver et al., 2023). Additional research is needed to understand which environmental variables may lead to mange outbreaks.

Increased rates of mange are often associated with high wombat densities and periods of drought or high stress (e.g. seasonal stress in winter) (Sengupta, 2019). Burrows are thought to be the predominant mode of sarcoptic mange transmission in wombats (Evans, 2008, Martin et al., 2019, Beeton et al., 2019). The humid and cool microclimate within wombat burrows provides favourable conditions to maximise mites off-host survival, particularly in cooler months (16.4 days in winter and 5.96 days in summer). Mites can survive in burrows longer than the minimum known frequency of wombat burrow switching 4- 10 days. Transmission is exacerbated by patterns of burrow use and sharing (Evans, 2008; Martin et al., 2019b).

Regulation of veterinary chemicals used to treat mange in Australia

The Australian Pesticides and Veterinary Medicines Authority (APVMA) is responsible for the regulation and control of agricultural and veterinary chemicals in Australia. Under legislation, the APVMA can evaluate, approve and register agricultural and veterinary chemicals, regulate supply, undertake compliance and issue permits for use. There are currently four active permits (valid in all states and territories of Australia) and three active permit holders approved for veterinary chemicals use for the treatment of mange in wombats.

The Wombat Protection Society holds two permits for the use of a Cydectin (active constituent Moxidectin). One permit allows for a dose 4 ml per kg of body weight with a maximum single dose of 100 ml on an adult wombat (>15 kg) with five days between doses and no more than five doses. The efficacy and toxicity associated with this dose rate has not been fully evaluated and users must observe wombats for any signs of toxicity. Any wombats that die after treatment must be reported to a veterinarian and a detailed postmortem carried out.

A second permit held for the use of Cydectin allows 0.8 ml dosage per kg of body weight with a maximum dose of 20 ml applied once weekly for 15 weeks. This permit is also held by Mange Management Incorporated. Cydectin can be delivered directly or by topical application using a pole and scoop to pour a dose onto the wombat's back, or indirectly by using a burrow flap that doses the wombat when passing underneath.

Intervet Australia holds a permit for use of Bravecto (active constituent Fluralaner) for mange treatment. The dose is 25 mg/kg with a maximum of three doses one month apart on wombats > 5 kg. Bravecto must be applied by topical application directly or by using a pole and scoop to pour a dose onto the wombat's back.

A condition of all these permits is that 'the product must only be used by persons who have appropriate experience in identifying mange infection and toxicity signs in wombats'. It is the permit holder's responsibility to ensure people operating under the permit are trained in the identification and treatment of mange in wombats. This is particularly relevant for care groups, where mange treatments may be administered by a range of volunteers. The permit holder must record any adverse experience associated with the use of the product and report them to the APVMA as soon as possible.

While there are no conditions on any of the APMVA permits with regards to Cydectin use near waterways, an environmental protection warning on the product states 'Moxidectin is extremely toxic to aquatic species. Do not contaminate dams, rivers, streams or other waterways with the chemical or used container." This statement applies to use of the product under all APVMA permits.

Applying moxidectin indiscriminately across all burrows in an area may lead to unintentional overdosing of individual wombats over time, either from inaccurate dosage or from wombats relocating to treated burrows. Some wombats may not receive a full dose if the chemical splashes as they are exiting a burrow or they move away from the treatment area. Healthy animals within the population will also unnecessarily receive treatments. This could lead to the development of mite resistance arising from inappropriate chemical concentrations being administered.

There is also a risk non-target animals are treated, as wombat burrows are known to be used by a range of other native species (Linley et al., 2024, Thornett et al., 2016) and the impacts of moxidectin on these species is unknown. The broadscale use of these chemicals can result in chemical residues within the environment which can have negative impacts on native fauna,

including invertebrates and aquatic species. Application with a pole and scoop though more time consuming can specifically target wombats with mange and promotes good chemical stewardship.

Some carers believe other products are safer or more effective and use a range of alternative treatments or supplementary products to relieve itching and treat secondary infection. Less invasive approaches include the one-off or repeated administration of a topical acaricide. However, topical treatments may not reach mites due to a failure to penetrate parakeratotic scale crust or be adequately absorbed systemically due to a thickened epidermis. Even among experienced careers there is wide disagreement about how best to treat mange (O'Sullivan, 2018).

Current treatment of mange in the ACT

In the ACT, Bare-nosed Wombats are primarily treated for mange by Wombat Rescue volunteers, and to a lesser extent ACT Wildlife carers. Volunteers operate under APVMA permits PER89982 and PER90837 issued under section 112 of the Agricultural and Veterinary Chemicals Code 1994. The first permit allows for the treatment of Bare-nosed Wombats with mange using up to 20 ml of Cydectin via burrow flap or pour on/pole and scoop application methods. The second permit allows for the treatment of Bare-nosed Wombats with Bravecto using pour on methods only. Volunteer groups must also apply for a licence under the *Nature Conservation Act 2014* to use a vehicle within a reserve.

In addition, Wombat Rescue has a TCCS permit for use of Cydectin on public lands to undertake population treatments, with strict conditions of its use around waterways due to its toxicity to aquatic species. Cydectin must not be used when there is a medium chance or greater (>40 %) of heavy rain (>10 mm) forecast and all treatments within 5-15 m of a permanent waterway must be removed within 24 hours in the catchment area. A treatment area cannot exceed 1km of river reach, can only be treated at the population level once annually and no more than 6 treatment areas can be treated annually along the Murrumbidgee and Molonglo Rivers. Population level treatment by burrow flap application must not be used within 15 m of permanent waterways but is permitted for treating a maximum of 5 individuals at any one time. Cydectin cannot be used within 5 m of the water's edge or within 5 m from the centre of drainage lines and intermittent gullies, including unnamed drainages at any time. No treatments are to be applied in the Cotter Catchment above Cotter Dam, Namadgi National Park or Tidbinbilla Nature Reserve. The location and

dosage details of all treatments, particularly those within 5-15 m of a permanent waterway, must be entered into a shared spatial layer once treatment has commenced.

Mange-affected Bare-nosed Wombats are treated both individually and at a population level. Population level treatments are conducted by Wombat Rescue and occur mainly in riparian areas along river corridors. Due to the substantial time it takes to install burrow flaps on every burrow, and permit restrictions, volunteers are only able to treat burrows along a 1 km stretch of the river at a time. Mange can be successfully eliminated in isolated areas, but where connected populations of Bare-nosed Wombats occur along river corridors, it is difficult to eradicate mange as infected individuals from outside the treatment zone can wander in following the course of treatment. Access of carer groups to rural lands at a broad scale is not supported by many rural landholders due in part to safety and security concerns, which means treatment of mangy wombats on rural leases is limited. This has welfare implications for animals severely affected by mange.

ACT Wildlife only administers mange treatments in areas where rehabilitated Bare-nosed Wombats are to be released if there has been isolated incidence of mange to maximise their chances of survival.

Wombat Rescue regularly responds to call outs to treat and rescue mangy Bare -nosed Wombats from concerned members of the public and ACT Parks and Conservation Service.

Mange distribution

To gain a better understanding of the distribution of mange in the ACT, CED have developed an online portal to enable the community to report sightings of mange-affected Bare-nosed Wombats. Sightings are also reported on WomSAT, an online application developed by researchers at the University of New South Wales. This data helps inform the national distribution and prevalence of mange in wombats. Users of WomSAT create an account and sightings must include a photo for verification. While applications of this nature enable capture of data across broad regions, reporting is typically skewed towards areas of high human activity and therefore may not accurately represent the presence/absence of mange (Figure 3).

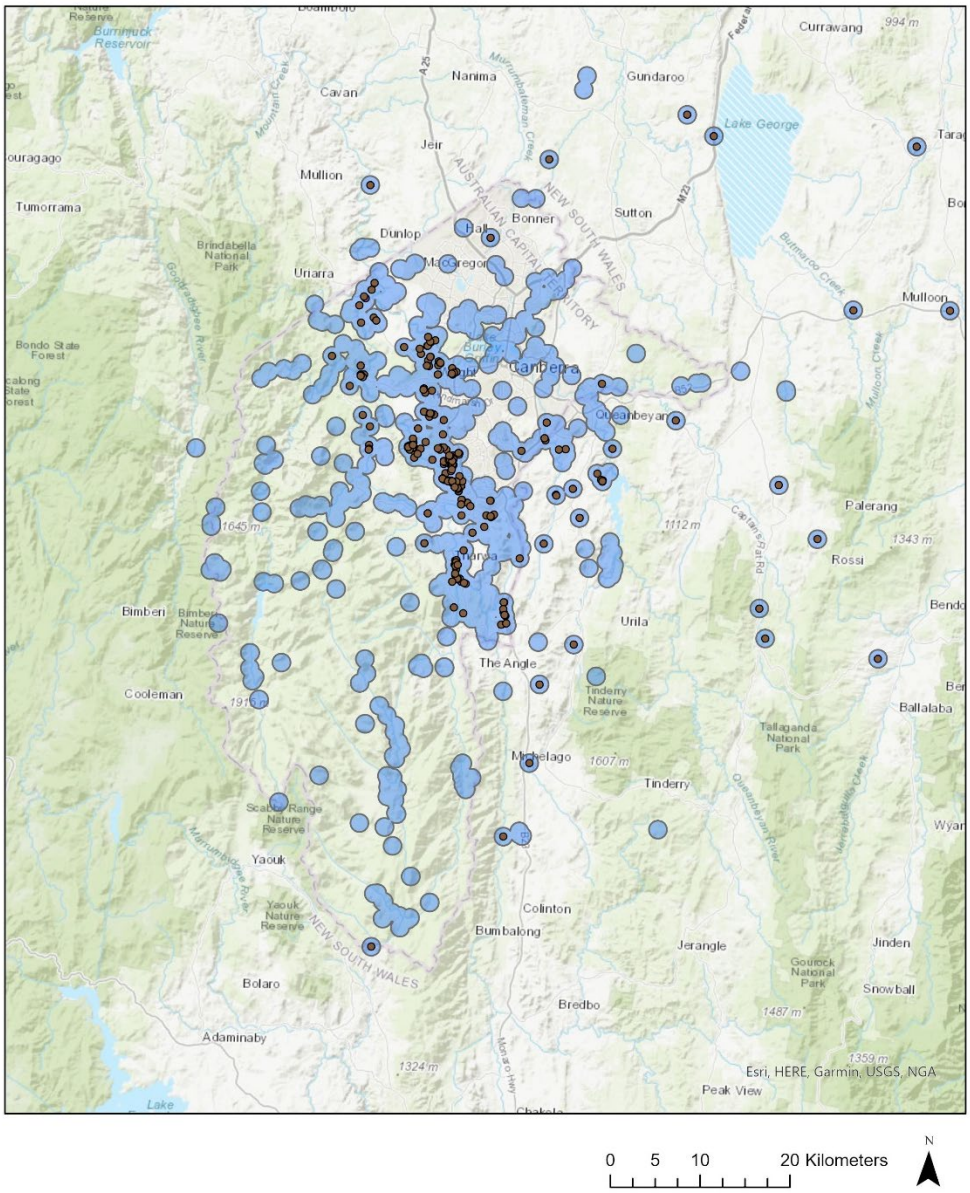

Figure 3. The known records of mange in Bare-nosed Wombats (red dots) in the ACT taken from CED survey data and ACT Wildlife Atlas wombat records and mange portal data.

Wombat Mange and Monitoring Group

To progress treatment of mange and improve monitoring of Bare-nosed Wombats in the ACT, CED convened the Wombat Mange and Monitoring Group (initiated March 2021). This group was formed as a subgroup of the Wombat Working Group. Members included two community wildlife care groups (Wombat Rescue and ACT Wildlife), Prof. Scott Carver of the University of Georgia USA (formerly of the University of Tasmania) and CED staff. The group took a collaborative approach to addressing mange and coordinates activities of the community and ACT Government. Previous activities of the Wombat Mange and Monitoring Group include:

- Trialling the use of Bravecto, as a potentially longer-lasting, more effective, and target-specific treatment for mange.
- Developing a collaborative monitoring program to provide data on wombat populations, distribution, and mange prevalence across the ACT.
- Support mange treatment in public reserves while minimising risks associated with using Cydectin near waterways.
- Undertake collaborative research on the impacts of mange treatment chemicals on aquatic ecosystems.
- Develop and promote a publicly accessible web-based communication portal to enable community members to report Bare-nosed Wombat sightings and incidences of mange.

5.2.2 Road vehicle collisions

Collisions with vehicles are a source of mortality or injury for Bare-nosed Wombats and a safety concern for people. Roadkill records reported in the WomSAT app between 2015-2019 are relatively low in the ACT in comparison to other states (Figure 4, Mayadunnage et al., 2024). WomSAT relies on citizen scientists to report sightings and thus data may not be representative of all road kills occurring in the ACT. Roadkill records are collected by the Urban Wildlife Team, and it is worth reviewing them to gain a better understanding of the frequency of collisions and identify hotspot areas where intervention may help to reduce collisions.

The frequency of vehicle collisions is likely to vary depending on traffic levels, vehicle speed, Bare-nosed Wombat population density, climate and season (Mayadunnage et al., 2024, Ramp et al., 2005). Bare-nosed Wombat road mortalities are higher in winter and early spring (Roger et al., 2011, Mayadunnage et al., 2024, Nguyen et al., 2022). This could be linked to seasonal changes in the activity periods of Bare-nosed Wombats or more cars being on the road at dawn and dusk due to shorter winter days. High Bare-nosed Wombat road mortalities have been linked to areas of dense forest cover and the greenest ground cover in areas where wombat burrows are present (Roger and Ramp, 2009).

Within the ACT, most Bare-nosed Wombats (approximately 50 a year) come into care because of injuries from road vehicle collisions or being orphaned due to a vehicle collision. The relatively small number of Bare-nosed Wombats taken into care does not represent the total number of wombats killed.

Wombats can cause substantial damage to vehicles, the cost of which is unknown. Analysis of 17,000 animal collision claims between 1 January – 31 December 2023 by Suncorp Group revealed the most common animals drivers collide with are kangaroos, wallabies, wombats, deer, dogs, cows and emus (AAMI, 2024). The average cost of an animal collision insurance claim is greater than $5,000 and 16% of vehicles were written off in claims that involved wildlife. The study revealed 76% of Australians believe kangaroos would cause the most damage to a car if involved in a collision, followed by wombats (16%).

Even if roadkill is not causing widespread declines of Bare-nosed Wombats, wildlife-vehicle collisions should be reduced where possible. Measures to reduce wildlife vehicle collisions include installing wildlife warning signs, installing underpasses or overpasses, and using deterrent devices (see section 10.5 for more information).

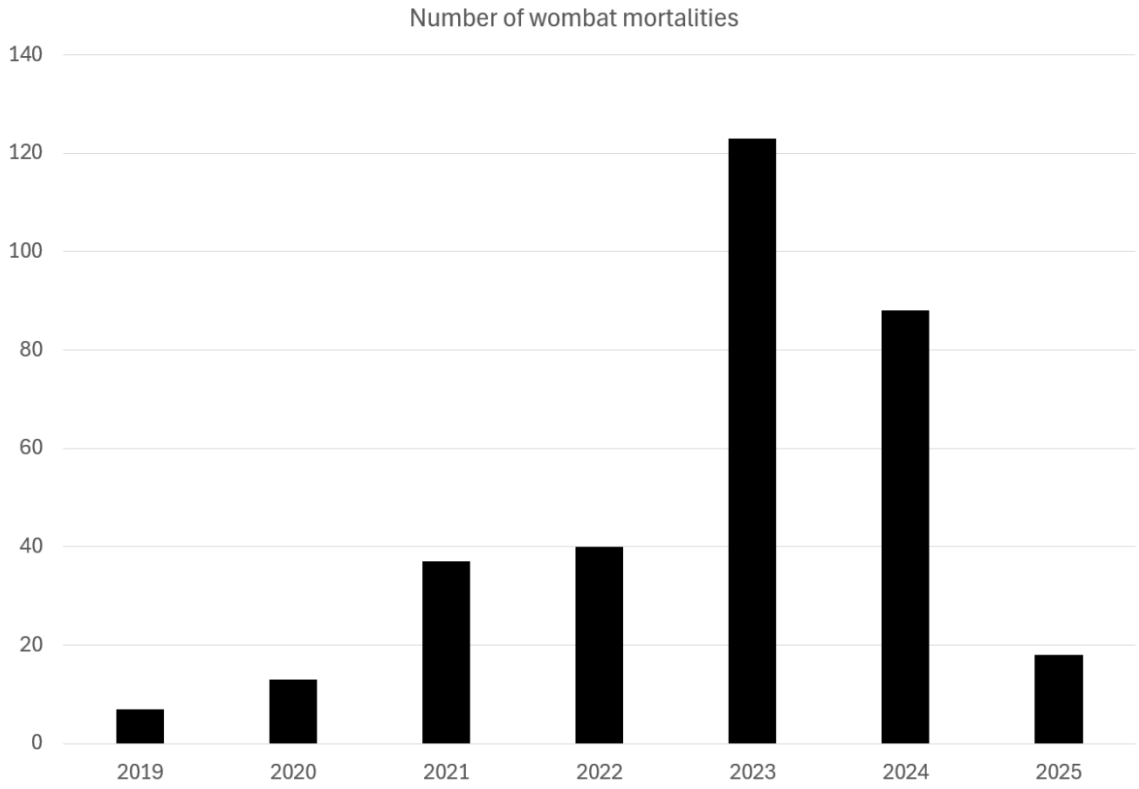

Figure 4. Temporal distribution of wombat roadkill records reported by the ACT Urban Wildlife Team between July 2019 and July 2025. For 2019, data is limited to July-December of that year; for 2025, data is limited to January-July of that year.

5.2.3 Habitat loss

The expansion of urban development has caused concern for the safety of Bare-nosed Wombats. The ACT is around 236,000 hectares, which is roughly 43.6 conservation estate, 10% highly modified urban land, and 15% highly modified rural and broadacre lands. The exact

division of land may be different as land zoned for urban areas may still be undeveloped or rezoned to another land use prior to development. Between 2006 and 2022, the ACT's urban area grew by 9% (2,760 ha). Most development has been in Gungahlin (Taylor, Throsby, Jacka and Moncrieff), West Belconnen (Ginninderry) and the Molonglo Valley (Whitlam and Denman Prospect). The increase in urban land has been driven by strong and sustained population growth over the last decade. The ACT population is projected to grow to 696,000 by 2050. The *ACT Planning Strategy* 2018 aims to accommodate this growth while limiting urban spread by setting a target of 70% of new housing being built within existing urban areas. The impact of urban expansion of Bare-nosed Wombat populations is poorly understood. Urban development is thought to be pushing Bare-nosed Wombats into river corridors where their densities are high, resulting in increased stress from resource competition and territoriality (pers. comm wildlife carers 2024). In contrast, reports from other stakeholder groups indicate the distribution and abundance of wombats is increasing. The distribution of Bare-nosed Wombats across different land use zones is unknown and worth investigating to properly understand the potential impacts of further development on populations.

6. Wombat management methods and options

Conflicts with wombats have traditionally been resolved using lethal controls, but there is increasing advocacy for the development of alternative 'non-lethal' management options. Creating policy around alternative 'non-lethal' management options are hindered by a lack of quantitative evidence on their effectiveness and humaneness. Management options perceived as non-lethal can have negative ecological or animal welfare impacts, sometimes resulting in death. For example, translocation often has low survival rates but is perceived as a non-lethal management option because it does not involve the direct killing of animals. The term 'non-lethal' has not been used to classify management options in this review.

Research into damage mitigation techniques has not yielded conclusive results or sustained long-term benefits (Barlow et al., 2010, Koehler AE, 1990, Mason, 1998). Given the nature of conflicts vary greatly, no single management technique will alleviate all conflicts. A variety of damage mitigation techniques are needed that can be tailored to the ecological, social, cultural and economic realities in which conflicts occur (Dubois et al., 2017). Land managers also require data on the distribution and abundance of wombats, as well as the type and extent of damage, to effectively implement a management strategy.

This section reviews current research on wombat management and damage mitigation strategies.

6.1 Fencing

Exclusion fencing is a popular tool for eliminating damage to high value resources. While it is perceived as non-lethal it can have negative impacts on target and non-target species by prohibiting natural movement patterns or inhibiting access to important resources. Prior to installing exclusion fencing, careful consideration needs to be given to the ecological impacts on excluding species from their habitat.

6.1.1 Foot netting

Excluding wombats from areas where they are causing damage such as to high value infrastructure or resources can help to reduce damages and increase landholder tolerance towards wombats. Several wombat exclusion fence designs have been trialled. Attaching foot netting to the bottom of fences has been found to temporarily reduce the number of holes dug in fencing by 35-63% for up to 3 weeks (Marks, 1998b). Borchard et al. (2009b) trialled using hinged joint wire (80 cm wide x 15 cm spacings) attached to the outside of existing fencing and flattened along the ground and secured with tent pegs every 1 m along a 100 m section of fence and silt fencing (770 mm wide) laid out in the same manner and secured every 30 cm. In both designs hinge wire foot netting was placed on the inside of the fence at wombat breach points. The foot netting trial resulted in a mean exclusion rate of 35% for a one month. In the absence of aversive stimuli wombats quickly learned to chew through the silt fence or dig under the wire netting.

6.1.2 Electric fencing

Electric fencing has been shown to exclude wombats from areas where their behaviour conflicts with human land use (Marks, 1998b; St John and Saunders, 1989). The electrification of the dog fence along the Nullarbor Plain in south east Australia has reduced damage to the fence caused by Southern Hairy-nosed Wombats, damage that allows Dingoes (*Canis familiaris dingo*) to pass through (St John and Saunders, 1989). On the outside of the dog fence, an additional two strands of wire 15 and 30 cm above the ground, positioned approximately 30 cm away on from the original dog fence were constructed. The fence is patrolled regularly by dog baiters who assess the fence for signs of damage. Most damage occurs from Southern Hairy-nosed Wombats inside the fence attempting to travel north. Electrifying the fence has prevented Southern Hairy-nosed Wombats from travelling north, resulting in them moving

south of the highway into crop land where they had not previously been, resulting in conflicts with wombats and crop farmers (Sparrow, 2011). Marks (1998a) found electric fencing produced variable results, for Bare-nosed Wombats with electric fencing reducing the number of holes by 0-92% over 13 weeks. Landholders who used electric fencing to exclude Southern Hairy-nosed Wombats from their properties reported it to be unsuccessful as the electrified strands were often shorted out by vegetation or debris and it was too time intensive to check (O'Brien, 2019). Electric fencing is costly and time consuming to maintain on a small scale. Landholder perceptions of success may not be influenced solely by damage reduction, but also by the time and costs associated with implementing and maintaining control measures.

The use of electric fencing to reduce wombat damage is best suited to protecting small areas with important assets inside wombat free areas. Electric fencing will require regular inspections to ensure the fence hasn't been damaged or shorted out and involves construction costs and ongoing costs to run.

6.2 Wombat gates

Swinging gates have been recommended to reduce fence damage by wombats in Australia (Breckwoldt, 1983, Triggs, 2009) which can allow stock to escape paddocks or other unwanted animals from entering crop fields. Wombats can make numerous breaches in fencing and the installation of gates at every breach point may be impractical. The placement of gates would depend on the density of wombats in the area and the number of access points being used. Gates should be installed at the most well–used breaches and exclusion netting can be used to 'train' wombats to use the gates. Anecdotal evidence suggests Bare-nosed Wombats will use gates placed up to 800 m apart without making new holes (Triggs, 2009). Breckwoldt (1983) recommends gates of a timber construction which is likely to require regular maintenance. Newer fence designs consist of heavy-duty weld mesh gates weighing at least 2-3kg if trying to exclude other animals such as wallabies (Statham and Statham, 2009, Driessen et al., 2020). If Bare-nosed Wombats could not see through gates they would dig a hole next to it rather than use it (Statham and Statham, 2009). Gates weighing between 4.5-16 kg have also been reported to be used by Bare-nosed Wombats (Coates, 2013). Borchard et al. (2009a) found Bare-nosed Wombats continued to breach the foot netting of fencing for the first few months while they learned to use the gates requiring ongoing repairs. Driessen et al. (2020) wired gates open for two weeks to allow Bare-nosed Wombats a habituation period but did not report on fence breaches throughout the study.

The decision to use wombat gates or a combination of gates and exclusion fencing will depend on the extent of the problem, the cost of the damage and the cost to purchase, erect and maintain the length of fence required. The installation of gates can be laborious and will likely require ongoing maintenance. The installation of gates in fencing may prevent damage to fencing but it does not prevent wombats from accessing areas where their behaviour may cause further damage on the property, thus not all property managers will readily accept the use of swinging gates or view it as a successful damage mitigation strategy (Borchard and Collins, 2001).

6.3 Mapping wombat burrows

There are a variety of methods for surveying and mapping the location of wombat burrows. While it is not a direct damage mitigation method it may prove useful for choosing the most appropriate management action for burrows in unfavourable locations. Mapping the locations of tunnels can help to prevent accidents such as vehicles or machinery falling down tunnels which can collapse under their weight, by avoiding driving over them. However, in areas with a high density of tunnels this may be unavoidable.

6.4 Burrow collapsing

As wombats are known to use multiple burrows within their home range, the opportunity exists to remove problem burrows through collapsing them, moderating their burrowing activity with minimal impact on the wombats. However, widespread burrow destruction is not recommended as it can lead to the displacement of wombats. It is also important to consider the impact of burrow collapsing on young at foot who may not be able to travel long distances. Historically burrow collapsing has been used following fumigation to prevent neighbouring Southern Hairy-nosed Wombats from recolonising the area, however, it was rarely successful as burrows were re-excavated (Marks, 1998a). Burrow collapsing in combination with other methods to exclude wombats from areas where they are causing damage may prove more effective.

The gradual collapsing of burrows over three days in combination with the use of deterrents has been trialled as a management option for Southern Hairy-nosed Wombats (Sparrow et al., 2016, O'Brien, 2018). This method involves collapsing the first 1-2 m of the tunnel on day one, followed by another several meters on day two. The tunnel is left open, providing a clear exit point for wombats. The disturbance of the burrow over the first two days is 93% effective in getting Southern Hairy-nosed Wombats to exit the burrow before ripping the tunnel on day

three (O'Brien, 2018). On day three the tunnel is carefully ripped with a backhoe, stopping every few meters to check the direction of the tunnel and look for signs of occupancy. If a wombat is still within the tunnel, it can be left for another day to see if they will leave. On one occasion a Southern Hairy-nosed Wombat failed to leave on the fourth day and had excavated a further 7 m of tunnel overnight despite the presence of alternate inactive burrows nearby (≤ 50m away). The failure of burrow disturbance to get the Southern Hairy-nosed Wombat to leave may reflect the importance of the burrow. Although Southern Hairy-nosed Wombats may use up to 10 different warrens within their home range, they usually use 1-2 warrens on most occasions to which they display high site fidelity (Shimmin *et al.* 2002; Finlayson *et al.* 2005).

Two studies trialled the effectiveness of dingo urine and faeces in deterring Southern Hairy-nosed Wombats from re-excavating collapsed tunnels and produced mixed results (O'Brien *et al.*; Sparrow *et al.* 2016). Sparrow et al. (2016) found untreated collapsed burrows on the Nullarbor plain in South Australia were recolonised within 75 days while those treated with dingo scents showed minimal activity. In contrast, O'Brien *et al.* found that in the Murraylands of South Australia deterrents didn't play a significant role in the time taken for recolonisation to occur. The differences in results between the two studies could be attributed to variances in the methods used or environmental factors such as predator densities at the sites or burrow availability and importance and warrants further investigation. Although burrow collapsing is considered non-lethal its impacts on evicted wombats has not been studied and warrants further investigation. Studying the impact of burrow collapsing on wombats may help to answer questions about the reasons for its success of failure. Burying steel mesh at the location of the collapsed burrow is untested but may prevent wombats from re-excavating.

Alternate methods could trap and relocate wombats or empty burrows using one-way gates placed in burrow entrances prior to collapse. Trapping is more time consuming and costly as traps need to be checked every morning and it requires careful planning and trained personnel to handle and relocate the wombat(s) but removing animals from the area may provide longer term relief from conflict. One-way gates can be installed and left in place until the burrow is empty, though regular assessment of the gate is recommended as wombats have been known to dig around or under them. Motion sensor cameras can be used to determine if a burrow is empty. Low-cost methods such as raking the soil to assess for footprints or the placing of sticks in a burrow entrance can be used to determine if a burrow is empty however, it is not always possible to determine if a wombat has gone into the burrow or exited.

The time and costs of burrow collapsing will vary on a case-by-case basis. Some burrows may be simple single entrance tunnels that take 1.5 hrs to rip while other more complex 5 entrance warrens that are 4 m deep can take up to 10 hours (O'Brien, 2018). Soil type and burrow depth will impact the time and costs associated with burrow destruction. Given the time and costs of collapsing burrows along with the low success rate it is not a viable long-term solution to wombat management, but it may prove useful in certain situations. Given Bare-nosed Wombats within the ACT breed year-round consideration needs to be given to the potential for there to be young at foot that may not be able to travel to the next nearest burrow or move through a wombat gate. Though these studies found burrow collapsing did not result in new burrows being dug in other locations it is always possible that it could transfer the conflict to a new location.

6.5 Deterrents

Designed to capitalise on an animal's mechanisms of threat detection, deterrents aim to discourage the use of human resources with aversive stimuli (Ramp et al., 2005, Apfelbach R, 2005, Schakner and Blumstein, 2013). A wide range of deterrents, such as chemical cues, novel objects, and painful stimuli are increasingly being marketed as non-lethal means of reducing human wildlife conflict (Breitenmoser et al., 2005). Although there are numerous studies on the use of deterrents, many devices have not been quantitatively field-tested, and their perceived effectiveness lies in testimonial and anecdotal reports. Controlled lab studies often do not translate to field situations, where numerous uncontrollable environmental factors can influence the way animals detect and respond to threats (Mason, 1998, Koehler AE, 1990, Barlow et al., 2010). Even where devices have been field tested, they often produce conflicting results.

Before deterrents are recommended to mitigate wombat damage, a better understanding of the factors influencing wombat threat perceptions and responses to them is needed. Further research is required to evaluate responses in different environmental conditions such as varying distance to cover, and with different methods of application and placement, to determine the optimal conditions for success. In addition, future studies should consider conducting trials in a closed system with known individuals or capturing and marking individuals prior to commencing trials for ease of identification so individual variation in responses can be taken into consideration.

6.5.1 Olfactory deterrents

Olfaction is known to play an important role in social communication in wombats (Taggart and Temple-Smith, 2008, Triggs, 2009), little is known about its role in threat perception. Anecdotally, fertilisers such as blood and bone, dog and human urine are thought to deter wombats (O'Brien, 2019).

Dingo urine and faeces has been trialled with mixed results. Field trials found no difference in Southern Hairy-nosed Wombat activity before and after placing a cup of blood and bone in burrow entrances (O'Brien et al., 2021). Captive Southern Hairy-nosed Wombats increased their exploratory behaviour in response to dingo faeces placed inside burrows, followed by increased use of burrows and concealed locations (Descovich et al., 2012). Sparrow et al. (2016) reported Southern Hairy-nosed Wombats showed greater avoidance and prolonged time to recolonisation of collapsed warrens treated with dingo odours than control warrens on the Nullarbor in South Australia. Conversely, the application of dog urine and dingo faeces had no significant impact on the time taken for Southern Hairy-nosed Wombats to recolonise collapsed warrens in the Murraylands of South Australia (O'Brien, 2018) or deter them from using burrows where dingo urine and faeces were placed at the entrance (O'Brien, 2019). No known research has been conducted on the effects of odour deterrents on Bare-nosed Wombats.

The differing results of these studies indicate Southern Hairy-nosed Wombat responses to predator odours may be context dependent, but disparities in experimental design and analyses make it difficult to determine which factors are influencing threat perceptions. Control–impact studies may lead to a misconception of the effectiveness of treatments as they don't consider differences in pre-existing activity levels at treatment sites (Koehler AE, 1990, Parsons and Bondrup, 1996, Rytwinski et al., 2016). Southern Hairy-nosed Wombats may have responded to blood and bone or dingo odours with increased hiding or reduced ranging behaviour in a manner that was not evident from the camera data, or it could have been perceived as a low risk. The use of a greater volume and repeated or more widespread application of deterrents may elicit greater avoidance responses. The application of odours inside burrows or in open areas further from the safety of a burrow may heighten risk perceptions, resulting in greater avoidance responses (Atkinson et al., 1994).

6.5.2 Visual deterrents

Anecdotal evidence suggested wombats are fearful of shiny objects and actively avoid them. Stationary CDs have been found to elicit avoidance responses in Southern Hairy-nosed Wombats, with a decrease in the number of visits to burrows following their application (O'Brien et al., 2021). Visual stimuli produced avoidance responses most likely due to an immediate fear response (neophobia) of an unknown object within their environment (Harris and Knowlton, 2001, Davidson-Nelson and Gehring, 2010, Bruggers et al., 1986). Wombats may respond more readily to visual cues as they are easily detected from further away than olfactory cues, which require closer investigation. Though these preliminary investigations are encouraging, habituation to visual stimuli is a major limiting factor to their long-term use, particularly when unaccompanied by negative reinforcement (Koehler AE, 1990, Gilsdorf et al., 2002). Habituation to CDs was not observed in Southern Hairy-nosed Wombats over the 5-night trial, however, it may occur over a longer time frame.

6.5.3 Virtual fencing

Virtual fencing is a term often used for placing deterrents along roadsides that are activated by approaching vehicle headlights. On activation the device emits a sound, flashing lights or both with the aim of scaring away any animals that may be adjacent to the roadside. Virtual fencing is not a physical barrier and allows animals to move through the landscape. Early trials in Tasmania reported a 50% reduction in roadkill over a three-years (Fox et al., 2018), but the trial had many design flaws and likely had little to no effect on possums, wallabies or wombats (Coulson and Bender, 2019). A study on the impacts of virtual fencing on wombats found a small reduction in the number of wombats killed after the virtual fence was installed (Stannard et al., 2021), however the study design was flawed and widely disputed (Coulson and Bender, 2022, Candy and Englefield). Similarly, other deterrent devices mounted to vehicles like the Shuroo have been found ineffective, as the noise the device makes cannot be heard over the vehicle noise from >50 m away (Bender and Coulson, 2022).

6.6 Translocation

Translocation is a widely used "non-lethal" human-wildlife conflict mitigation measure, but its effectiveness is disputed. The survival of translocated animals is often low, and the conflict may not be resolved or could be transferred to the release site (Bradley et al., 2005, Linnell et al., 1997). Translocation has been trialled on Southern Hairy-nosed Wombats to relieve conflicts with agriculturalists. Southern Hairy-nosed Wombats were translocated from areas of

conflict to a property where species numbers were low and lots of inactive burrows were available to release them into. Animals were fitted with GPS and/or VHS collars to monitor their survival and behaviour in comparison to resident animals. Though translocated Southern Hairy-nosed Wombats had high survival rates and exhibited release site fidelity conflicts were not resolved. Neighbouring Southern Hairy-nosed Wombats moving into vacated burrows at the source site within a matter of weeks. Landholders using culling as a control measure to reduce conflicts with Southern Hairy-nosed Wombats have reported similar results, with neighbouring animals recolonising vacated warrens (St John and Saunders, 1989). Translocation of a larger number of animals may provide longer relief from conflict. However, Southern Hairy-nosed Wombats evaded traps by remaining underground or digging under fencing, resulting in a low trap rate of 5.95%. Similarly, the trapping success of Bare-nosed Wombats was 7.9% and Northern Hairy-nosed Wombats as low as 1-2%, all species avoid capture by remaining underground for extended periods of time (McIlroy, 1977a; Alan Horsup, pers. comm 2018). Thus, large scale translocation could be labour intensive and cost prohibitive. Furthermore, the ongoing translocation of large numbers of Southern Hairy-nosed Wombats would over time lead to shortages of suitable conflict free release sites with low numbers of conspecifics in the species natural range. Translocation could be used as a tool to repopulate areas where numbers are known to have declined, however, it may result in further deaths if the cause of the decline has not been addressed.

Similarly, the critically endangered Northern Hairy-nosed Wombat has been successfully re-introduced into areas they were extirpated from by releasing them into starter burrows (Horsup, 2004). A study on the survival of rescued and rehabilitated Bare-nosed Wombats reported high survival (94.5%) of animals released onto a private property within the first 42 days following release and 77% survival after eight years (Saran et al., 2011). Survival was not found to be related to age, sex, provision of supplemental food, season or time spent in rehabilitation.

Despite its limitations, translocation may prove useful for removing a small number of individuals from areas of conflict, where alternative measures fail or are unsuitable. When used in combination with burrow collapsing or deterrent use it may yield more promising results in reducing conflict at the source site. Prior to carrying out a translocation careful planning is needed. Translocation plans should adhere to the Conservator Guidelines for the Translocation of Native Flora and Fauna in the ACT. . Important biological and ecological factors need to be taken into consideration, such as capture stress, disease transmission, habitat suitability, and competition with conspecifics. The availability of burrows at the release site is a key

consideration when it comes to translocating wombats, which would require up to date knowledge of wombat distribution and density. Follow up monitoring is imperative to ensure survival of translocated animals.

6.7 Culling

Historically, conflicts with wombats have been managed using lethal controls. In most states, there are provisions to cull wombats causing damage or threatening human safety under permit systems (see section 6.1). The lethal control of wombats has become a highly contentious and controversial issue in the last few decades, due to changing public attitudes towards its use and concerns about wombat conservation. Permits to destroy Bare-nosed Wombats have decreased greatly in Tasmania and other states where it is allowed in the last few years due to increasing public pressure. The impacts of culling on wombats populations are poorly understood (Tartowski and Stelmann, 1998, Taggart et al., 2008). If conducted at unsustainable levels it can result in range contractions and population isolation (Powell, 2006, Fuller et al., 1992, Woodroffe et al., 2005). In contrast, killing an insufficient number of animals can fail to reduce damage to an acceptable level (Hone, 2007). In some cases, the removal of animals from a population can encourage population growth and immigration, thereby increasing conflict (Treves et al., 2016). Culling can disrupt social structures that lead to fractured social groups and increases in conflicts (Wallach et al., 2009, Allen et al., 2015). Despite the limitations of culling, there may always be some situations in which it is the best intervention method (Warburton and Norton, 2009).

There is one known study examining the effects of culling on Southern Hairy-nosed Wombats. Changes in the number of active burrows were monitored in an area where culling occurred and an adjacent control zone where no culling took place. Over the two-year term of the study an estimated 12% of the population was culled per year. Despite this there was an estimated 30-40% increase in the number of Southern Hairy-nosed Wombats in the culled area, while in the unculled area there was an estimated 50-60% increase. The increase in Southern Hairy-nosed Wombat numbers over this time frame could have been a result of increased rainfall and recovery from the 1981-83 drought, the effects are unlikely to be the same on a stable or decreasing population (Tartowski and Stelmann, 1998).

Culling it is often preferred as a conflict reduction tool by landholders, as it is convenient, immediately shows results, satisfies their need for control, and is perceived as cost effective (Horton RR, 1997, Zinn et al., 1998, Treves and Naughton Treves, 2005).

Landholders surveyed in South Australia most widely used culling to reduce conflicts with Southern Hairy-nosed Wombats in South Australia and those who were financially dependent on their property or had experienced damage were more likely to cull wombats (O'Brien, 2019). Despite the widespread use of culling, only half of the landholders using it perceived it to be effective. A lack of data on wombat numbers makes it difficult for state agencies to set balanced culling quotas often resulting in ineffective conflict resolution (Taggart et al., 2008). Many landholders feel they are rarely permitted to cull enough wombats to mitigate damage with recolonisation of burrows being an ongoing problem (Stott, 1998, Taggart et al., 2008, St John and Saunders, 1989). Official government registers are considered an underestimate of the true numbers of wombats culled, as some landholders resort to culling outside the permit system (St John and Saunders, 1989, Taggart et al., 2008). The use of lethal controls needs to be carefully evaluated and managed based on scientific evidence, to ensure conflict reduction without threatening species conservation.

6.8 Wombat monitoring and research

There are significant knowledge gaps in our understanding of Bare-nosed Wombat populations in the ACT. Addressing these gaps will require dedicated monitoring and survey effort to collect fit-for-purpose datasets. This section examines a variety of survey options, and their costs and benefits.

6.8.1 Quantify the frequency and occurrence of wombat damage

Perceptions and tolerance of damage caused by wildlife are often shaped by financial dependence on crops or livestock and previous experiences (Naughton-Treves L, 2005, Van Tassell et al., 2000). Perceived damage can sometimes be disproportionate to actual damages (Dickman, 2010, Knight, 2000, Madden, 2004, Wigley and Garner, 1986). Quantifying the frequency and cost of Bare-nosed Wombat-related damage is crucial to distinguish between real and perceived impacts. This data can help identify high-conflict areas and guide wildlife managers in developing targeted management actions. In regions where damage is minimal or misattributed, educating stakeholders can be crucial to mitigating conflict. Conversely, where significant damage occurs, targeted management interventions to reduce damages may be necessary to alleviate its effects.

Accurately reporting the prevalence and costs of wombat damage from landholders and other relevant stakeholders will require a consistent approach to data collection. This will require

CED to develop a reporting tool for stakeholders to submit information such as: (1) the type of damage; (2) the location of the damage; (3) the financial costs associated with damage; and (4) negative safety outcomes associated with damage. Collecting a consistent set of data in each report will allow for comparison with wombat population data and other key population metrics. This tool will need to be managed by CED or another relevant team within the ACT Government.

6.8.2 Ecological surveys of wombats in the ACT

One of the critical aspects of species management is understanding population dynamics. Currently, Bare-nosed Wombat population monitoring in the ACT is limited, with few systematic surveys to track wombat numbers or distribution. Animal welfare and stakeholder concerns around the prevalence of mange also require systematic surveys that include areas with and without mange treatment applications. High-quality distribution and abundance data paired with standardised impact and mange assessments will provide land managers with the tools for effective management and conflict mitigation.

Current monitoring

CED has commenced a long-term monitoring program at eleven sites within the ACT. The purpose of these surveys is to detect changes in populations over time, and to collect data on mange prevalence and severity. Survey sites were selected based on known presence of Bare-nosed Wombats and ease of accessibility. Surveys are conducted twice annually in winter and consist of walking 1 km transects at a slow pace (45 mins), commencing 30 mins after sunset (Figure 5). Surveys are carried out in teams of at least two people for health and safety reasons. Surveyors use night vision binoculars to reduce disturbance of animals.

When a Bare-nosed Wombat is seen, the surveyor notes their location using a GPS, takes a compass bearing and estimates the distance to the animal. Wombats are given a body condition score (ranked 1-5, with 1 being poor and 5 being excellent) and a mange score using the categories described in Stannard et al. (2020). Observers also record a mange confidence score to reflect how confident the surveyor is in their assessment in the presence or absence of mange, noting that it can be difficult to assess from a distance. Weather variables including temperature, rainfall, wind speed, cloud cover and visibility of the moon are measured at the beginning of each transect. A further two sites in Namadgi National Park are surveyed annually using the same method as above, with the exception that surveys are undertaken from a vehicle.

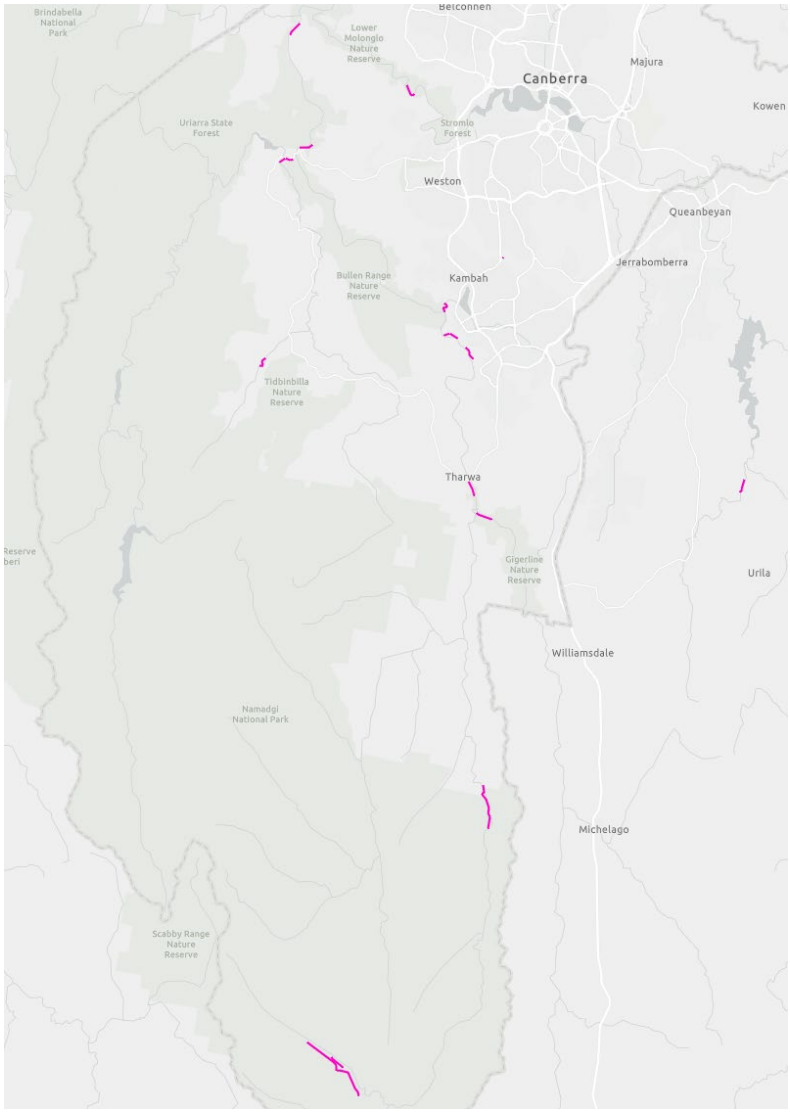

Figure 5. Locations (pink) of the line transect surveys conducted to detect changes in populations over time, and to collect data on mange prevalence and severity.

Bare-nosed Wombat records are also collected using applications such as NatureMapr and the Atlas of Living Australia. These are useful tools that enable public reporting of wombat sightings over large areas that would otherwise be infeasible for ecologists to survey. These incidental sightings are typically biased towards areas of high human activity (i.e., roads or trails) and there are caveats around their value in understanding a species distribution or abundance. Without standardised survey effort, it is difficult to determine whether areas with a lower number of records represent a true absence or a low survey effort. Species and signs of their presence, such as faeces, tracks and burrows, can also be misidentified or difficult to detect. Burrows also present a challenging proxy for wombat occupancy as burrows may remain in an area after an individual has moved on (Tartowski and Stelmann, 1998).

Gaps in current methodology

A comprehensive survey program to inform wombat management in the ACT requires data on (1) wombat density or relative activity across areas of suitable habitat; (2) prevalence of mange across existing wombat populations; and (3) the effect of mange treatments on the prevalence of mange. The current monitoring program captures relative activity data within the conservation estate but is not representative of all Bare-nosed Wombat habitat in the ACT. A more representative selection of sites would require survey transects to be located across conservation estate, rural lands, and other stakeholder areas (i.e., Icon Water). This would require approval from stakeholders for ecologists to access their land for surveys.

The current site selection does not consider whether sites have been actively or historically treated for mange. This makes it difficult to determine whether the abundance or current health of the local population is affected by these treatments. In future, monitoring sites should be evenly stratified into two groups: treated and untreated. Once these sites are selected, treatment conditions should remain consistent throughout the study period.

The current survey methodology as described above is subject to imperfect detection of both mange prevalence and individual wombats. Vegetation and uneven topography can make it difficult to detect individuals and assess mange severity. For more information on alternative survey methodologies that may be more suitable, refer to the section below.

The current monitoring program is conducted across 26 survey nights annually, with two staff or volunteer members required to conduct each survey. In the past this work has been done by CED ecologists and volunteers from Wombat Rescue. Expanding the survey scope to include transects on rural land and other stakeholder properties would increase the survey time required. For consistency and impartiality, this should be done by trained ecologists and not members of any stakeholder group.

Alternative monitoring methods for consideration

Due to the nocturnal and burrowing nature of Bare-nosed Wombats they are difficult to survey. Direct counting using spotlight surveys are labour intensive and not practical over large areas. Spotlight counts are not representative of population numbers as wombats may remain in their burrows and avoid being counted (McIlroy, 1977b).

Mark recapture studies, requiring individuals to be captured on more than one occasion, are challenging as Bare-nosed Wombats are difficult to capture. They can remain underground for

prolonged periods or dig around traps to avoid capture (McIlroy, 1977b, Skerratt et al., 2004). In these surveys, trapping only a portion of burrows can result in imprecise abundance estimates (Banks et al., 2003). Trapping every burrow across a large area is impractical due to the time and labour required.

The number of active burrows has successfully been linked to wombat abundances using mark-recapture methods (McIlroy, 1977a), burrow flap counters (Tiver, 1981) and remote cameras (Swinbourne et al., 2018). A combination of burrow activity levels and the number of active burrows is a relatively low-cost method and has been used to infer population abundances (St John and Saunders, 1989). Burrow activity can be estimated using burrow flap counters or remote cameras. Abundance estimates using these measures will allow land managers to track trends in population levels but will not provide an exact density.

Ground penetrating radar has been used successfully to map Southern Hairy-nosed Wombat burrows (Swinbourne* et al., 2015). It can be used to determine the length, depth and direction of wombat tunnels and help determine if a burrow is a main, secondary or starter burrow. There are various ground penetrating radar systems available, simple units can be hired for between $200-400 a day and can penetrate up to 8 m depth.

Drones have successfully been used to map wombat burrow locations in New South Wales grasslands (Old et al, 2019). In their study, Old et al. (2019) detected a similar number of burrows using desktop analysis of drone imagery and ground-based surveys. In aerial surveys observer errors can result in inaccurate counts, but standardising the results using a transect with a known number of burrows can help develop a correction factor for the dataset (Tiver, 1981). Recording video footage during aerial surveys can also allow for more accurate and repeatable scores of wombat warrens (McGregor and Wells, 1998). Drone surveys can be affected by vegetation, with reduced efficacy in dense vegetation where burrow entries are obscured (Old et al 2019; Taggart et al, 2008). These aerial surveys provide an alternative to manual searching for burrows and can be used to quickly assess range expansion in local wombat populations. Detecting decreases in distribution based on burrow surveys is more difficult, as warrens remain visible long after they have been vacated.

Integrating drones with thermal sensors has been used effectively to directly survey a range of terrestrial and arboreal species (Beaver et al, 2020; Howell et al, 2021; Witt et al, 2020). These methods have not yet been tested on wombats, but they may provide a suitable alternative to ground-based surveys. While thermal drone surveys may reduce labour inputs and reduced

detection abilities in dense vegetation, they are still subject to the pitfalls of direct count methodologies. Direct counting will still be subject to imperfect detection if individual wombats remain underground during the surveys.

6.8.3 Furthering research by partnering with scientists

There are lots of knowledge gaps that hinder the effective management of Bare-nosed Wombats in the ACT. While it is not necessarily the role of the ACT Government to conduct the research to fill these knowledge gaps, collaboration with scientists may help to overcome some of these knowledge gaps.

Collaboration between the ACT Government and researchers could help fill the knowledge gaps discussed above. Key research areas include developing a deeper understanding of complex stakeholder views and collecting more robust population-level data for wombats in the ACT. Additional topics could include further research into mange treatment and collaborating with landholders to develop effective damage mitigation strategies. Landholders currently lack reliable options for mitigating conflict with wombats. These options need to be well-tested, and the limitations and benefits of each need to be clearly understood.

7. Recommendations

The following steps are recommended to address key stakeholder concerns in a responsible and balanced manner:

- Support non-lethal methods for wombat control by land managers to mitigate damage, which may include the provision of information, resources and training;
- Develop an appropriate mechanism to allow humane euthanasia of wombats on rural lands that are afflicted with severe mange, noting animal welfare considerations;
- Coordination between ONC ecologists and PCS Licensing and Compliance to clearly identify areas within the ACT, and possibly NSW, where rehabilitated wombats can be released. Selection of suitable sites can reduce the likelihood of overabundance and future human-wildlife conflict;
- Review procedures and licensing pathways for the deployment of Cydectin and other mange treatments to ensure appropriate placement that minimises negative impacts on aquatic systems;
- Over the longer term, explore and evaluate options to support holistic management of Bare-nosed Wombats in the ACT through an appropriate policy mechanism, including

for example, a Controlled Native Species Management Plan under the *Nature Conservation Act 2014*.

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