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AUSTRALIAN VETERINARY EMERGENCY PLAN

AUSVETPLAN

Operational manual

Wild animal response strategy

Version 5.0

AUSVETPLAN is a series of technical response plans that describe the proposed Australian approach to an emergency animal disease incident. The documents provide guidance based on sound analysis, linking policy, strategies, implementation, coordination and emergency-management plans.

National Biosecurity Committee

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EMERGENCY ANIMAL DISEASE HOTLINE: 1800 675 888

The Emergency Animal Disease Hotline is a toll-free telephone number that connects callers to the relevant state or territory officer to report concerns about any potential emergency disease situation. Anyone suspecting an emergency disease outbreak should use this number to get immediate advice and assistance.

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1 Introduction

1.1 This manual

1.1.1 Purpose

This manual sets out the overall framework for the management strategies and control procedures for wild animals during an emergency animal disease (EAD) incident in Australia.

1.1.2 Scope

This manual is aimed at both government officers and other personnel involved in wild animal management and who may be called on to assist during an EAD response.

For government personnel, the manual provides a summary of the structures in place for the management of wild animals in Australia. It also links to key wild animal policies and procedures that provide more in-depth information on wild animal populations, management and control strategies, key roles and relevant industry organisations.

For personnel involved in wild animal management, this manual provides information and guidelines on responsibilities during an EAD incident, as required by the relevant government authorities, and strategies that may be adopted to improve both preparedness for, and the ability to handle, a suspected EAD.

This manual does not deal in detail with rodents and does not recommend widespread destruction of wild birds.

1.1.3 Defining what is a wild animal

Several definitions are important to this manual.

A wild animal is considered:

An animal that is found in the natural environment and does not live under human supervision and control. The species may be native to Australia or an introduced species. An introduced species may be a feral or invasive species.

Captive wildlife is considered:

An animal from a species that is found in the natural environment and has not undergone selective breeding, but the individual is kept by humans under supervision and control.

A domestic animal is considered:

An animal that has been tamed and kept by humans to serve a purpose, especially a member of those species that have, through selective breeding, become notably different from their wild ancestors. Domestic animals are only those animals actively kept under management plans that are being referred to.

1.1.4 Development

This manual has been produced in accordance with the procedures described in the **AUSVETPLAN Overview**, and in consultation with Australian national, state and territory governments; the relevant livestock industries; nongovernment agencies; and public health authorities, where relevant.

In this manual, text placed in square brackets [xxx] indicates that that aspect of the manual remains unresolved or is under development; such text is not part of the official manual. The issues will be worked on by experts and relevant text included at a future date.

1.2 Value of wild animals

When an outbreak of disease threatens a population of wild animals, there may be losses that go beyond those that occur with domestic animals. It is important to consider the multifaceted value of wild animals before designing a control program. On balance, feral animals are regarded as pests because of their role in disease transmission (exotic and endemic diseases), destruction of native habitat and agricultural land, predation of other animals, and competition for resources. However, it is possible they have attained a value through people's ability to profit from their abundance or due to their enduring presence in the environment.

Wild animals may have value in various ways:

- cultural — Aboriginal and Torres Strait Islander communities have a strong connection with native species
- economic — feral goats have provided alternative income for farmers battling drought, and kangaroo harvesting is a source of income in many rural communities
- nutritional — wild animals may be a source of food for pets or for human consumption
- iconic — some species may be iconic to Australia or certain regions; for example, the cassowary in Far North Queensland
- biodiversity — loss of threatened or endangered wildlife may compromise ecological communities
- social and community value — Australians value wildlife in their everyday environment
- wildlife tourism — some tourists visit particular communities specifically to see a native species
- recreational hunting — hunting provides recreation for numerous Australians; for example, feral species and in some states waterfowl.

1.3 Challenges in responding to a wildlife disease outbreak

Responding to a disease outbreak in free-ranging wildlife has considerable challenges (WHA 2020).

The elusiveness of wild animals makes detection of disease in populations or individuals more difficult than in domestic animals. Wild animals are often remote or difficult to find, and this hampers the ability to conduct surveillance and report on disease, and then to understand disease and infection and develop baseline health information. Diagnostic tests may also not be available, accurate or validated at the time to detect certain diseases in wild populations.

In addition to access challenges, safety issues are inherent in approaching or handling large, dangerous or venomous wildlife.

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The elusiveness of wild animals also impacts the ability of responders to manage disease. Techniques that work for domestic animals may be ineffective in wildlife because of differences in behaviour or avoidance of changes in the local environment, such as strange foods and smells. Techniques used with domestic animals may be unsuitable for use with wildlife because of difficulties in locating and capturing enough wild animals, and the potential for stress, injury and mortality of wildlife from handling. Management of disease is also limited by gaps in the knowledge of epidemiology, disease (or host) ecology and host–pathogen interactions.

Managing sick or dying animals and making decisions about the survival of individual animals can be mentally and emotionally taxing for the people involved, and distressing or confronting for the public. Responders must make sure they look after their own wellbeing, which might include taking regular breaks, finding supportive people to discuss concerns with, and other aids for mental, physical and emotional wellbeing. Wildlife disease managers should take these factors into consideration when responding to disease outbreaks.

1.4 Other documentation

This manual should be read and implemented in conjunction with:

- other AUSVETPLAN documents, including response strategies, operational and management manuals and any relevant guidance and resource documents (the complete series of manuals is available on the Animal Health Australia website¹)
- relevant nationally agreed standard operating procedures (NASOPs).² These procedures complement AUSVETPLAN and describe in detail specific actions to be undertaken during a response to an incident. NASOPs have been developed for use by jurisdictions during responses to EAD incidents and emergencies
- relevant jurisdictional or industry policies, response plans, standard operating procedures and work instructions
- relevant Commonwealth and jurisdictional legislation and legal agreements (such as the Emergency Animal Disease Response Agreement — EADRA³), where applicable.

¹ <https://animalhealthaustralia.com.au/ausvetplan>

² <https://animalhealthaustralia.com.au/nationally-agreed-standard-operating-procedures/>

³ <https://animalhealthaustralia.com.au/eadra/>

2 General principles

2.1 Who is involved

People involved in an emergency animal disease (EAD) response have different emergency management backgrounds and experiences, and are likely to come from various agencies such as:

- Commonwealth and state and territory chief veterinary officers
- Animal Health Australia
- Wildlife Health Australia
- National Biosecurity Committee
 - Environment and Invasives Committee
 - Animal Health Committee
 - National Biosecurity Communication and Engagement Network
- National Biosecurity Response Team
- Commonwealth, state and territory agriculture/environment departments.

Responders from nongovernment organisations will be heavily involved with implementing the EAD response plan as they work closely with those in contact with potentially infected animals. These groups may include:

- peak livestock industry bodies
- RSPCA and other animal welfare groups
- wild animal managers
- keepers of domestic and captive animals.

EAD responders may seek advice from experienced wildlife veterinarians (especially those with experience with the relevant wildlife species) and the environmental protection authority to improve risk and welfare management. In addition, ecologists, wildlife biologists, public health advisers, land managers, local and state government representatives and other stakeholders may need to be consulted when preparing biosecurity plans. Wildlife disease ecologists and wildlife epidemiologists often have much to contribute about population level risks and management. Due to the nature of EADs, as far as practical, participants at all levels should record and report on activities to allow appropriate evaluation and learnings for the future.

2.2 Legislation, regulations and guidelines

Legislation for the purpose of controlling EADs has been enacted at national and state levels. The national legislation is primarily concerned with preventing the introduction and establishment of disease or things that may carry disease. Statutory provisions exist in all states and territories for the control and eradication of disease in animals. These provide for controls over animal movement, treatment, vaccination, decontamination, slaughter, disposal, and compensation. Wide powers are conferred on government inspectors, including the power to enter premises, order stock musters, test animals, and order the destruction of animals and animal products that are suspected of being infected or contaminated.

Some state and territory legislation may impinge on certain activities directed at controlling wild animals during an EAD outbreak. Types of control activities vary between states but may include:

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- legislation designed to protect endangered flora and fauna, and sites of importance to Aboriginal and Torres Strait Islander communities
- legislation requiring landholders to suppress or destroy (or both) various species of wild animals that pose a threat to agricultural production and the environment
- animal welfare legislation, including that for managing animal health
- legislation covering animal and environmental biosecurity
- legislation covering the use of firearms and aircraft
- legislation covering agricultural and veterinary chemicals, dangerous goods and environment protection where it deals with the use of vertebrate pest poisons and baits
- workplace health and safety legislation
- other conservation legislation.

It is essential that the appropriate national, state and territory legislation be recognised, understood and adhered to when implementing any of the procedures outlined in this manual. Appendix 1 lists legislation by state and territory.

Agreements are also in place to manage EAD responses across multiple jurisdictions and between government and industry. These include the National Environmental Biosecurity Response Agreement (NEBRA) (DAFF 2022) and the Emergency Animal Disease Response Agreement (EADRA) (AHA 2022). NEBRA was signed by Australian, state and territory governments to establish the national arrangements for responding to an outbreak of an exotic emergency environmental pest or disease of national significance where there are predominantly public benefits. EADRA is a contractual arrangement that brings together the Australian, state and territory governments and livestock industry groups to facilitate the rapid responses to, and the control and eradication or containment of, emergency animal diseases.

Animal welfare is an important consideration when controlling wild animals. Codes of practice (CoPs) and standard operating procedures (SOPs) have been developed at a national level as well as within most states and territories for each of the key pest animal species, providing information on best-practice management, control strategies, species biology and impact, and the humaneness of current control methods (Sharp & Saunders 2005, 2011; Centre for Invasive Species Solutions⁴). These documents may not contain the most recently approved management methods such as the used of more humane poisons such as para-aminopropiophenone (PAPP) used against foxes and feral cats and NaNO₂ (Hoggone bait) used against feral pigs. It is recommended that consultation with local government personnel be undertaken for the most recent information. CoPs and SOPs, where available, have high technical detail and reflect the relevant legislation/regulations in place for that jurisdiction.

The *Guide to the care and use of Australian native mammals in research and teaching* (NHMRC 2014) provides information that be useful when managing native species in an EAD response. This guide includes different aspects of care such as capture and handling, sedation, disease control, sample collection and humane killing for a wide range of native species.

Wildlife Health Australia has developed *National wildlife biosecurity guidelines* (WHA 2018), which documents best-practice biosecurity measures for those working with Australian wildlife, and *National guidelines for management of disease in free-ranging Australian wildlife* (WHA 2020) which outlines the science of wildlife disease management and describes what options might be available to manage wildlife diseases in an Australian context.

⁴ <https://pestsmart.org.au/?s=COPs>

2.3 The wildlife–livestock interface

The wildlife–livestock interface is defined as the physical space in which wild and domestic species (as well as humans) overlap in range, and potentially interact (Hassell et al 2017). These areas of overlap between compartments (wildlife, livestock, human) provide opportunities for horizontal disease transfer between host species and can be hot spots for pathogen transmission, maintenance, and emergence. Ecological and epidemiological connections are dynamic and new interfaces and pathways continuously occur.

The livestock compartment only appeared after human domestication of animals. Recent anthropogenic changes in urban areas, farming, food systems and natural ecosystems have led to increased interaction between human, domestic and wild animal populations, leading to the spread of diseases like avian influenza, African swine fever and COVID-19.

Disease spread and patterns of transmission at the wildlife–livestock interface are largely because of the increase in human population and demand for protein and other commodities. This has led to habitat destruction, bringing livestock closer to wild populations. Additional risk factors that add complexity and allow for very rapid and wide spread of disease include global movement of large numbers of people (eg tourism, refugees, and international workforce), legal and illegal trade in animals and their products, illegal introduction of feral animals (eg pigs) close to human populations (often for hunting), increasing complexity of live-animal markets, and the impacts of climate change. The rapid rate of change in the planet and its ecosystems suggests that there will be future exponential growth of interactions at the wildlife–livestock interface, both within Australia and globally (Vercauteren et al 2021).

The wildlife–livestock interface is the integration of ecological, agricultural and human systems and its problems require many and diverse disciplines to provide solutions.

Limited data are available about the spread of EADs from domestic animals to wildlife and from wildlife to domestic animals in Australia. However, there are many examples of EAD transfer in other parts of the world, and these should be used as a guide if no data from Australia are available.

2.4 Biosecurity and zoonoses

EADs have the potential to cause serious impacts on wildlife individuals, populations and ecosystems. The types of biosecurity practices used to manage EADs and zoonoses in domestic animals can be applied to the wildlife context to protect against the transmission of EADs between wildlife, domestic animals, and humans. Appropriate personal hygiene, use of personal protective equipment (PPE), cleaning and disinfection of vehicles and equipment and movement restrictions should be used to ensure fomites do not transfer infection from domestic and captive animals to wildlife, or vice versa.

Australian wildlife may not have natural defence mechanisms against invasive pathogens now present in Australia (eg sarcoptic mange) because of a lack of evolutionary exposure. Similarly, they can be expected to lack defences against many EADs that are exotic to Australia. However, wildlife can also act as reservoirs of EADs (eg Hendra virus, avian influenza) and zoonotic diseases (eg bat lyssavirus) that can be dangerous to domestic animals and humans.

Factors to consider when assessing the zoonotic risk include the type of contact, the taxonomic group of wildlife and the specific health profile of the individual animal. When handling sick or stressed wild animals, consider the possibility that even if the EAD is not zoonotic the animals may still present a zoonotic risk, due to other pathogens they may carry. Zoonotic risk can be reduced through personal hygiene, use of PPE, handling techniques and vaccination where available.

3 Decision-making factors

This section describes the factors that should be considered when deciding what action, if any, will be taken against wild animals. These factors are to be assessed in conjunction with Section 3.7 (the decision-making key). They will aid selection of the techniques or combination of techniques to be used for surveying, sampling, containing, and reducing or vaccinating wild animal populations. They are grouped under five headings:

- epidemiological
- ecological
- economic
- resources and logistics
- social, political and cultural.

Some factors are relevant to more than one area and therefore appear under more than one heading.

3.1 Epidemiological

3.1.1 Epidemiological importance of wild animals

The epidemiological importance of wild animals relates to:

- their potential role in spreading the disease to other animals (wild and domestic)
- their potential role in spreading the disease to people
- the persistence of the disease in wild animal populations after its elimination from domestic animals
- their potential role as subclinical carriers of some diseases.

The aim of disease control in wild animals is to reduce the number of susceptible animals to below the density necessary to maintain the disease in the wild (the threshold density). Strategies for disease control concentrate on reducing the rate of infection, including by treating or reducing the number of infected individuals, and preventing contact with susceptible individuals by vaccinating, creating barriers between wild and domestic populations and/or reducing overall population density. Knowledge of the life history of a disease is essential for selecting the most appropriate technique for its control.

3.1.2 Transmission of the disease

Disease transmission across populations (horizontal transmission) can be either through direct contact (physical or with infected discharges) or indirect contact via the environment (eg a vector or fomite). For some diseases, transmission can occur between generations (vertical transmission). The rate of transfer is likely dependent on the epidemiology of the disease, the density of the wildlife vector, the density of the domestic animals (although dog rabies is not density-dependent) and the extent of the interface.

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Agent, host, and environmental factors interrelate in a variety of complex ways to produce disease. Implementation of measures to prevent disease transmission requires consideration of all three components and their interactions. For example:

- host susceptibility and behaviour
- agent infectivity and stability
- ambient environmental conditions
- population density
- seasonal variations
- presence of vectors.

Methods of disease control rely on management of one or more of these factors.

3.1.3 Choice of control method

The disease control methods used and the extent to which the number of susceptible animals must be reduced (the threshold density) depend on the disease, susceptible species present, animal welfare and the epidemiological situation. Prevention of disease transfer from wildlife to domestic animals generally involves vaccination of domestic animals and/or wildlife where available and techniques for minimising contact between domestic animals and wildlife which can include implementing animal-free buffer areas, reducing the density of domestic animals or reducing the density of wildlife. The appropriate techniques, or combination of techniques, will depend on the nature and type of emergency animal disease (EAD). Other factors, such as conservation status, may also influence the choice of control strategy for wildlife species. As with all management actions, using a combination of management techniques increases the effectiveness of the management intervention.

For example, with rabies lyssavirus (exotic), vaccination of susceptible wild animals may be a more effective option than population reduction, especially if the disease appears to have been in the population for a considerable period.

The requirement or ability to remove carcasses from the environment could influence the choice of control method, as well as the decision to control wild animals or not. For more information on carcasses, see Section 10 of this manual and the **AUSVETPLAN operational manual *Disposal***.

3.2 Ecological

3.2.1 Location of outbreak

The topography, remoteness or level of urbanisation, ease of access, vegetation density and the spatial extent of the outbreak will affect all operations, especially containment.

3.2.2 Seasons and weather

The season and/or weather patterns will affect wild animal distribution and movement patterns across the landscape, social behaviour, intra- and inter-specific contact rates, and food and water requirements. These may also impact the transmissibility of the EAD. Season and prevailing weather conditions will also affect ease of access to the habitat for management actions and may limit the management techniques practicable.

3.2.3 Initial density of susceptible species

The higher the density of susceptible animals and the greater the rate of interaction between individuals within the population, the more likely disease is to spread. The density, dispersal and social behaviour of susceptible species influences the management techniques that can be used. This information is often unknown for wild animals, or estimates are of low accuracy.

3.2.4 Reduction of density to minimise disease transmission

Reducing the density of susceptible species, hosts and/or vectors may reduce disease transmission by lowering circulation of pathogen in the wild, though some diseases like dog-mediated rabies is not density dependent and has a low reproductive rate of transmission. This may be achieved using lethal or nonlethal methods (see Section 6). The practicalities of this will depend on a variety of factors including the management techniques that are available for the target species, the resources available to implement those techniques, the potential welfare implications of those control measures on nontarget species, and the other factors listed in this section. For example, it may not be possible to reduce feral pig populations to a predetermined or desired density in many habitats. Achieving target reductions to desired pig densities has proven difficult in full-scale simulated EAD exercises in Australia (Gentle et al 2022, Choquenot et al 1996).

3.2.5 Other susceptible species present in the same area

If two or more wild species are susceptible, management actions should be implemented against all species simultaneously if at all practicable. However, it is important not to use techniques that reduce each other's effectiveness. If this is not possible, it may be necessary to stagger the management techniques using the most effective technique first. Conversely, it may be necessary to prioritise management against the most susceptible species or species most likely to transmit the EAD to other species initially and then against the remaining species once the density of susceptible animals in the first species is reduced to an acceptable level.

3.2.6 Likely movements of susceptible animals

Movement and activity patterns of wild animals are likely to be altered by operations to survey, control or contain them. Similarly, compensatory breeding or increased immigration from surrounding areas can occur if the populations are reduced. The likelihood of dispersal of wild animals will influence decisions about what management actions must be taken, the techniques to use, and the spatial scale at which wild animal management must be implemented.

3.3 Economic

Wild animals may have economic value to one or more groups of people. They may:

- be sources of meat for human and pet consumption
- provide live animals for export
- provide tourism opportunities
- have cultural significance
- provide sport (eg shooting).

For example, there are export markets for kangaroo, horse and camel meat. There may be economic impacts if disease is present, or believed to be present, in the wild population that is harvested for these markets.

The cost and effect of wild animals on the local, regional and national economies should be taken into account when considering control and containment operations. An awareness of the costs of alternative operations, including inaction, will assist in the decision-making process.

3.4 Resources and logistics

Approaches to disease management in wild animals should be considered for their efficiency, effectiveness and feasibility. There can be many logistical challenges to undertaking disease management in wildlife. The objectives of the management program must be clearly articulated to determine the approach and the resources required. The availability of human and material resources to undertake the operation must be considered. A strategic risk assessment and analysis of the available options, including consultation with environmental authorities, may help to guide management decisions.

The availability and number of technical personnel (species experts, wildlife biologists) and operational resources (eg vertebrate pest control officers) could influence the scale and type of operation. If resources are limited, there may need to be compromises in the intensity, methods of control and/or the area covered. The relative capabilities and estimated costs of different survey, control and containment techniques will influence which methods are chosen. The impact of control measures, such as oral baiting against a target species, might need to be measured against the potential impact on nontarget species. There may be human resource limitations — for example, limited experience in culling animals, trapping animals, restraining examining, sampling live animals, undertaking postmortems and so on.

The ability to locate and dispose of carcasses is also resource dependent. This could influence the decisions on whether to control wild animals and on control methods (see Section 7 of this manual and the **AUSVETPLAN operational manual *Disposal***).

3.5 Social, political and cultural

Public opinion

The decision to control wild animals, and the choice of control technique and carcass disposal could be influenced by public opinion. There may be public concerns about animal welfare if there are visible signs of disease in wild animals. Communication strategies will be key to the success of the implementation of a response.

The likelihood of litigation, and the legal powers or licences required for control officers may influence the choice of strategies and techniques.

Public safety

Concern for human and domestic animal safety could influence the decision to use certain control or capture methods, especially in an urban area.

Work health and safety of operational staff

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The choice of technique should consider the health and safety of operational staff. Maintaining health and safety of employees, other workers (e.g. contractors) and other people in the workplace is a legal requirement.

Control techniques must be chosen to eliminate risks to health and safety, or if this is not reasonably practicable, risks must be minimised as far as is reasonably practicable.

Social amenity

Disease in wild animals may have an impact on social amenity. For example, people may not want to picnic in parks if wild birds have a zoonotic disease.

Government policy and legislation

The current state, territory and national policies and legislation on issues such as EADs, wild or feral animals, and rural assistance will influence the scale and type of operation.

The sociopolitical acceptability of various disease management and control methods will be influenced by public opinion, sentiment voiced in the media, social licence and relevant government policy. Clear communication consistent with available data and knowledge of disease management and control methods is key to managing misinformation.

Cultural issues

Issues of cultural sensitivity may influence decisions on whether, and how, to control disease in wild animals. These may include issues of the cultural importance of certain species to Indigenous groups.

Dogs are important in the dreaming and in some communities are 'totem' and represent ancestors. Therefore, any policy that requires culling of free-roaming dogs may be opposed by these communities and may lead to distrust and dog movements.

3.6 Emergency animal diseases of concern

Table 3.1 Emergency animal diseases of concern and susceptible species.

Disease ^a	Primary species affected Other susceptible species	Transmission
African horse sickness	Equine species Dogs and dingoes (via eating meat of viraemic animals)	Mainly spread by biting midges — <i>Culicoides imicola</i> is the principal vector.
African swine fever	Pigs	Spread by contact with infected live pigs, carcasses, pig products and fomites. Arthropod vectors such as biting flies can cause mechanical spread and some soft tick species can serve as a reservoir.
Anthrax (zoonotic)	Most warm-blooded animals	Spread by ingestion of bacterial spores released from infected carcasses. Spores can remain viable for many years in soil.

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Aujeszky's disease	Pigs Horses, cattle, sheep, goats, dogs, cats, mink, foxes, deer, rabbits, mice and rats (sporadic cases)	Spread by contact with infected live pigs and ingestion of infected offal and, to a lesser extent, meat.
Australian bat lyssavirus (zoonotic)	Bats Humans (including fatalities) Horses (spillover host) Susceptibility of other species is unknown	Spread by bite or contact with saliva of infected bat. All four species of Australian flying fox and one species of insectivorous bat are thought to be the primary reservoirs.
Avian influenza (zoonotic)	Avian species A wide variety of mammals (infected naturally and experimentally)	Spread by contact with infected birds and their excretions — virus is shed in faeces and from respiratory tract. Wild waterfowl are an important reservoir.
Bluetongue	Ruminants Carnivores (from contaminated vaccines and eating infected meat)	Arbovirus is spread by a limited number of <i>Culicoides</i> midge species. Cattle are amplifying hosts and competent <i>Culicoides</i> species feed mainly on cattle.
Bovine brucellosis (zoonotic)	Cattle Most species of livestock as well as dogs, cats and humans (not significant in the spread to cattle)	Spread by contact with reproductive products or fluids of infected animals, and by ingestion of contaminated feed or water.
Bovine spongiform encephalopathy (zoonotic)	Cattle Other bovines, felines, goats, pigs, primates and humans (natural infection) Sheep (experimental infection)	Spread by ingestion of feeds contaminated with risk material from an infected animal. CNS tissues are considered the highest risk material and the infectious agent is the abnormal isoform of a prion protein.
Chronic wasting disease	Cervids (deer family) Zoonotic potential a concern but no current evidence	Spread by ingestion of contaminated body materials. No evidence of zoonotic transmission but increasing concerns.
Classical scrapie	Sheep and goats Experimental infection demonstrated in several species of laboratory and wild animals	Ingestion of contaminated material is the main route of infection. The scrapie prion is shed via saliva, urine, skin, faeces, milk and parturient materials. CNS tissues and some peripheral tissues of affected animals are potentially infectious.
Classical swine fever	Pigs	Spread by contact with infected live pigs, carcasses and pig products.

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		<p>Highest concentrations of virus are secreted in oral fluid.</p> <p>Movement of pigs is considered the most important factor.</p>
Contagious bovine pleuropneumonia	<p>Cattle and buffalo</p> <p>Small ruminants and camels are unaffected</p>	<p>Spread by contact with infected animals leading to inhalation of airborne bacteria.</p>
Contagious equine metritis	Equine species	<p>This is a sexually transmitted bacterium.</p> <p>Can also be spread by contact with infected discharges and via contaminated fomites.</p>
Equine influenza	<p>Horses and other equines</p> <p>Dogs (do not appear to play a role in spread)</p>	<p>Virus is shed in droplets by coughing horses and spread through contact with infected animals and contaminated fomites.</p> <p>Movement of infected horses and transfer via equipment, people and clothing facilitates spread between locations.</p>
Foot-and-mouth disease	<p>Ungulates (cloven hoofed)</p> <p>Many other species (but not implicated in the spread)</p> <p>Macropods and other Australian mammals (experimental infection involving large doses of virus)</p>	<p>Inhalation and ingestion are the main routes of infection. Virus is excreted in expired air, secretions and excretions, and from ruptured vesicles.</p> <p>Animal products are an important source of infection, with feeding of prohibited pig feed (swill feeding) of pigs implicated in many outbreaks.</p> <p>Readily spread via fomites such as equipment, vehicles, people and clothing.</p>
Infectious bursal disease	<p>Chickens, turkeys, waterfowl, game birds</p> <p>Some other bird species (antibodies detected)</p>	<p>Virus is excreted in faeces and contaminates water, feed, and litter.</p> <p>Commonly spread through movement of poultry products, and fomites.</p>
Japanese encephalitis (zoonotic)	<p>Waterbirds and pigs are the most significant amplifying hosts.</p> <p>Many species (evidence, but few show clinical signs — most commonly equids, pigs and humans)</p>	<p>Virus is transmitted by bites from infected mosquito vectors.</p> <p>Believed to be maintained in mosquito–waterbird or mosquito–waterbird–pig cycles.</p> <p>Vector-free transmission between pigs has been demonstrated but thought to play a lesser role in outbreaks.</p>
Lumpy skin disease	Cattle, buffalo and camels	<p>Thought to be mechanical spread by insects such as flies, mosquitoes and</p>

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		<p><i>Culicoides</i>. Can also be spread via fomites.</p> <p>Skin lesions contain the infective virus, and it is also shed in nasal, lachrymal and pharyngeal secretions as well as in blood, milk and semen.</p>
<p>Newcastle disease (zoonotic potential)</p>	<p>Poultry — chickens most susceptible to disease</p> <p>Most bird species (can be infected but clinical signs are not always apparent; ducks and geese can serve as reservoirs)</p>	<p>Spread by inhalation of virus-laden expired air, and by ingestion of water or feed contaminated with virus from nasal secretions or faeces.</p> <p>Movement of live birds is an important factor in spread between locations and spread is also possible by fomites.</p>
<p>Nipah virus (zoonotic)</p>	<p>Fruit bats — subclinical reservoir hosts</p> <p>Pigs, horses and humans (significant clinical disease)</p> <p>Cats and dogs (disease and seroconversion noted)</p> <p>Broad range of mammals (experimental infection)</p>	<p>Spread by ingestion of food sources contaminated by fruit bat secretions, and by contact with infected individuals showing clinical disease.</p>
<p>Peste des petits ruminants</p>	<p>Primarily goats and sheep (Camels and antelope may be infected)</p> <p>Deer (not implicated in spread)</p> <p>Cattle and pigs (can be subclinically infected but do not transmit the virus)</p>	<p>Primarily acquired via inhalation of virus shed through sneezing and coughing.</p> <p>Infected animals also shed virus through all secretions and excretions, though the virus has poor survival outside of the host.</p>
<p>Porcine reproductive and respiratory syndrome</p>	<p>Pigs</p>	<p>Spread by pig-to-pig transmission of virus shed in secretions and excretions.</p> <p>Infective virus can be present in animal products so feeding of prohibited pig feed (swill feeding) can cause spread.</p>
<p>Rabies (zoonotic)</p>	<p>All mammals</p>	<p>Spread by contamination of fresh wounds (skin or mucous membranes) by saliva from an infected animal. Usually via bites but can be through scratching or licking open skin.</p> <p>Respiratory and oral transmission are considered possible but uncommon.</p>
<p>Rift Valley fever (zoonotic)</p>	<p>Cattle, sheep, goats, and humans are the main species</p>	<p>Biological transmission by arthropod vectors is the most</p>

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	affected but has a wide range of vertebrate hosts	important means of spread. Mechanical transmission by insects is also probable. Infection also occurs via contact with carcasses, blood and viscera of freshly slaughtered infected animals.
Rinderpest (eradicated)	Cattle and buffalo Many other cloven-hoofed wild animals (but less susceptible and not important in spread)	Spread by contact with secretions and excretions from infected animals, with infection normally via the respiratory tract. Ingestion of contaminated meat may be a source of infection for pigs who could transmit it back to cattle.
Screw-worm fly (zoonotic)	All warm-blooded animals	Flies lay eggs in wounds or orifices of live animals. Female flies may disperse widely in search of hosts. Rapid spread could result from movement of infested animals or contaminated soil/waste.
Sheep pox and goat pox	Goats and sheep	Spread by contact with infected animals, usually via inhalation of aerosols from nasal secretions and saliva of infected animals. Movement of infected animals spreads the virus to new areas.
Surra	Horses, donkeys, camels, dogs, cats. Cattle, alpacas, llamas and buffalo (mild or subclinical) Other species (occasional mild disease) Wild dogs, dingoes and feral pigs (potential hosts)	Protozoan haemoparasite transmitted mechanically by biting flies. Tabanids are the most important vectors. <i>Trypanosoma evansi</i> is a fragile organism that does not survive long in the environment.
Swine vesicular disease	Pigs Cattle and sheep (evidence of virus present if housed with infected pigs; no clinical disease)	Spread by direct contact between pigs. Virus is shed in vesicular fluid and other secretions/excretions. Infection is through damaged epithelia, usually the skin of the feet.
Transmissible gastroenteritis	Pigs Dogs, cats, and foxes (seroconversion observed but no clinical disease)	Coronavirus spread by the faecal-oral route. Flies may play a role in mechanical spread in piggeries, and starlings are implicated in spread between herds in the USA.
Vesicular exanthema	Pigs	Disease in pigs associated with feeding them food scraps containing marine animal product. Virus is

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		closely related to a family of viruses isolated from marine animals.
Vesicular stomatitis (zoonotic)	Cattle, equids and pigs Sheep, goats and camelids Wide range of other animals (serological evidence of infection only)	Enters through mucosa or skin via contaminated secretions of infected animals. Can be spread mechanically by insects, on fomites and in contaminated feed or water.

CNS = central nervous system

a Refer to disease-specific response strategies at <https://animalhealthaustralia.com.au/ausvetplan>.

Emerging diseases in wildlife

In addition to this list of recognised EADs, it is important to consider the potential for new and emerging diseases in wildlife.

3.7 Decision-making key

The decision-making tool shown in Section 3.7.1 is a guide to the strategic planning needed for decision making for a response to an EAD when wild animals may be implicated or pose a risk of disease transmission. The tool should be used only after consultation between relevant personnel and should not be adopted by individuals. Subsequently, an advisory group of animal health and wildlife/vertebrate pest technical experts may use it to guide decision making on operations involving wild animal species.

There are four parts to the process, each with its own timescale:

- risk assessment — immediate to short term
- surveillance — short to medium term
- operational decisions — medium to long term
- evaluation — long term.

The checklist is not definitive; rather, it is a logical sequence that should be followed to its conclusion. There are various grey areas. Many of the operations and decisions may be concurrent, and they are often not mutually exclusive (eg population survey and disease sampling).

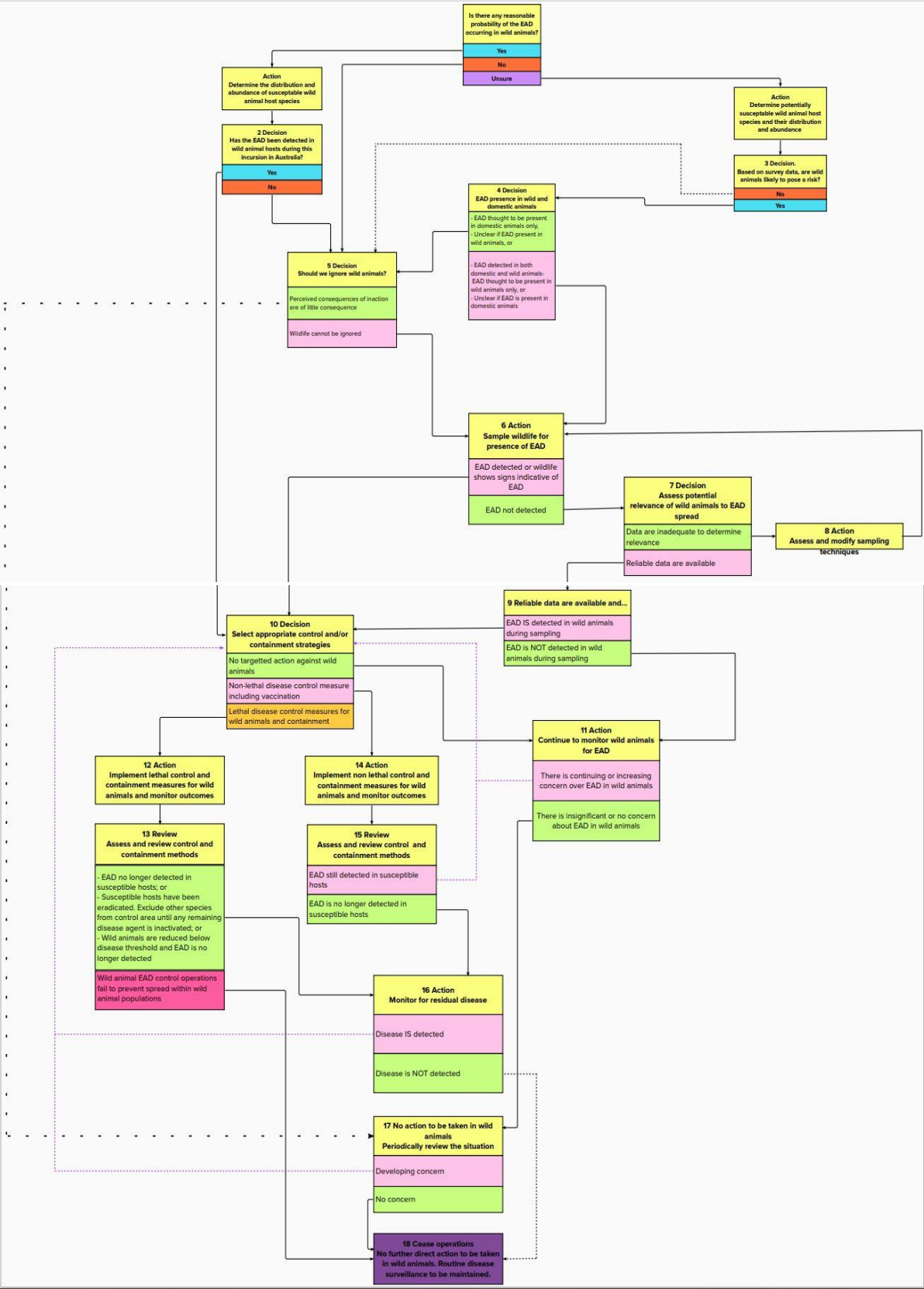


Figure 3.1 Decision-making tool

4 Ecological and biological Information

These sections provide guidelines only. When planning operations, always consult people with appropriate local knowledge and technical expertise. When implementing wild animal procedures, always consider animal welfare, occupational health and safety practices, the safe use of chemicals, the possibility of environmental contamination, effects on nontarget animals, the presence of threatened species and communities and the views of Indigenous groups, landholders and other stakeholders. In the planning stage, consider how information collected within each of these sections is to be managed, stored, interpreted, and relayed to personnel in the local control centre. The preparation of regular formal situation reports is integral to this process.

4.1 Ecology and biology

This section provides information on the ecological factors that affect the likelihood that a wild animal species will contract, maintain or spread disease (or all three). Factors influencing if an animal becomes infected and shows signs of the disease are complex and have implications on control methodology.

Several ecological factors affect the transmission, rate of spread and maintenance of disease within a population:

- **Population distribution and density:** This affects contact rates between susceptible and infective animals when transmission is density dependent. Disease transmission is facilitated at higher densities, and the distribution of wildlife (eg isolated versus continuous) can determine the area over which a disease is likely to occur. Clustering of infected animals will need to be considered.
- **Habitat requirements and availability:** Animals generally have specific habitat requirements, and availability of habitats will vary with animal density, including those of competing or sympatric species. Rugged terrain may also hinder operations to control spread.
- **Social organisation:** Group sizes and dominance hierarchies, and changes to social organisation at specific times of the year (eg breeding), may affect contact rates and disease transmission. Territorial versus nonterritorial behaviour can also influence disease dynamics.
- **Reproductive status and seasonality:** Breeding and other seasonal behaviours (eg dispersal in response to food shortages or migration behaviour) will lead to variability in contact rates and can affect the home range size and the population density of hosts.
- **Age structure of population:** Disease dynamics differ between populations with uniform age distributions and those with a high turnover rate. For example, diseases with a long latent period might be detected only in older animals, and age structure can affect the population's immune status and hence susceptibility to the disease and survivorship.
- **Home range size:** This can determine the area over which a disease can potentially spread. Home range size and density can also influence the conduct and effectiveness of control programs. In general, the larger the animal, the larger the home range, and the lower the productivity of the landscape, the larger the home range.
- **Movements and distances travelled:** There may be sex, seasonal and group effects. Some species (eg foxes) undergo yearly periods of dispersal, during which they can travel long distances in a short time. Generally, it is the young males of the population that will disperse the furthest but, in some species, adults might disperse instead of immatures. There can be

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large variations in the rate of movement and distances travelled by individuals within populations at any time of the year.

- **Barriers to dispersal:** Some natural or artificial barriers will restrict movements of animals and hence the rate and direction of disease spread. These barriers can cause disease spread to be unidirectional or to change direction. These barriers can also be used as geographical boundaries during control operations. Existing barriers may be useful in helping to limit movement of animals, or to physically separate one group of animals from another during control activities.
- **Response to disturbance:** In some cases, the imposition of control operations, human activities, weather events and natural disasters could cause animals to disperse from localised areas, or become harder to detect, especially if the animals become more secretive in response.
- **Interactions between wildlife species and domestic animals (eg at watering points):** Watering points are focal points for animal activity and interactions, especially in areas of low rainfall and during drought. Identifying the locations of watering points can assist with planning management actions. Similarly, restricting access to some watering points (by capping bores or fencing them off, etc) can force animals to concentrate around remaining water sources, limiting the area over which management actions must be taken.

Local wildlife/vertebrate pest technical experts, species experts or wildlife biologists and ecologists should be consulted to obtain current and local information on the ecology of susceptible wild animal species.

There is little global experience of how novel or exotic diseases, especially those that impact mammals, may affect marsupials in wild settings. Experimental studies of Australian marsupial species have been undertaken in laboratory conditions, but the knowledge gained from these experiments may not replicate outcomes in the natural setting (eg foot-and-mouth disease (FMD)).

There is enormous variation in the distribution, density and habits of wild animals between and within regions in Australia. Wild animals in Australia are generally difficult to manage. The success of control operations may also be hampered by the ability of some species to avoid detection; relocate to inaccessible areas under the pressure of control or hunting; rapidly repopulate areas that have been subject to control operations; and breed year-round where water, food and other necessary resources are abundant.

4.2 Summaries of important ecological factors for wild animal species

Further information, including distribution maps, for some of the wild animal species in this section can be found at the website pestsmart.org.au (hosted by the Centre for Invasive Species Solutions).

4.2.1 Bats (Chiroptera)

Bats have received significant attention in recent years because of their role in the ecology of emerging diseases such as Hendra virus, Menangle virus and Australian bat lyssavirus in Australia, and SARS, Ebola and Nipah viruses overseas (Cox-Witton 2019). Bat immunology is of interest because of bats' ability to coexist with some viruses without clinical disease (Baker et al 2013).

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Bats belong to the order Chiroptera, which has been traditionally divided into two suborders, Megachiroptera ('megabats') and Microchiroptera ('microbats'). The megabats are fruit, blossom or nectar feeders, and include larger bats, such as flying foxes and fruit bats, and several small blossom bats. The four largest species in Australia are flying foxes and belong to the genus *Pteropus*. The Australian range of flying foxes extends from temperate eastern and coastal Australia into the eastern tropics, around the tropical northern coastline, and south as far as the subtropical west coast. The geographical range of flying foxes has been expanding in Australia, due in part to climate change and anthropogenic environmental changes. The most widespread flying fox species — the little red flying fox — can be found in camps that include more than 100,000 individuals, a factor that could readily facilitate the transmission of disease agents (Plowright et al 2008). Flying foxes perform important ecosystem services as long-distance pollinators and seed dispersers for forest trees and plants (Fujita & Tuttle 1991).

Bat populations in Australia are subject to threatening processes, including habitat loss and fragmentation from deforestation and landscape modification, and climate change (Westcott et al 2015). The spectacled flying fox, the grey-headed flying fox and eight microbat species are listed as nationally threatened. Increased urbanisation brings flying foxes into closer contact with people and domestic animals (Plowright et al 2011).

Microbats are small bats; in Australia they are all insectivorous, with one species being carnivorous as well. They are found in many parts of Australia, from the cold southern regions to the arid inland and the tropical north. Most southern species are insect eaters that roost in tree hollows or under bark, usually near water. Most insect-feeding bats in tropical Australia live in caves or old mines. They may be communal or solitary. During colder months, the bent-winged bat has been known to migrate several hundred kilometres to warmer areas. During temperate winters, microbats can enter torpor or hibernation. They are nocturnal and some species are beneficial to agriculture through the control of insect pests (Churchill 2008).

The role that native Australian bats might play in an emergency animal disease (EAD) outbreak is undefined and would depend in part on the pathogen in question. The great mobility of bats gives them the potential to transmit viruses over large distances. Overseas, bats are responsible for rabies infection spillovers in terrestrial mammals outside endemic areas, but the disease does not appear to become established in these populations.

Key factors — bats

Several factors increase the risk of bats maintaining, transmitting and dispersing diseases:

- Bats have a long lifespan (most bats live for about 10 years, but some may live up to 25 years).
- The colonial habits of many bat species provide a highly efficient arena for the transmission of viruses from bat to bat and into the environment.
- Flying foxes are under increasing ecological pressure, which may cause them to move into new areas, overlap with the ranges of other species of flying fox and alter behaviours, which may change their susceptibility to carrying and shedding pathogens.
- Predators — including feral, domestic and native (eg foxes, cats and dogs) — may be susceptible to infection when interacting with or feeding on an infected bat.
- Flying foxes are highly mobile species capable of travelling long distances (Welbergen et al 2020).

Other factors

- Most of the 22 genera of Australian bats also occur in Papua New Guinea and Asia.

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- Bats play a very important role in regulating insect populations, in plant pollination and in seed dispersal.
- Bats have a significant cultural role for both Indigenous and non-Indigenous people of Australia.
- Attempts to 'move on' flying fox colonies are not recommended — they are generally unsuccessful and may have undesirable consequences.
- Eradication of bats is not desirable or feasible. Habitat destruction in confined locations should be planned with bat ecologists and should not occur when bat colonies have young pups.
- In all disease situations, unrealistic expectations of wild animal control or depopulation operations must be avoided.
- Some bat species are listed under state or territory, or federal legislation as threatened; this must be considered in management plans.

4.2.2 Buffalo (*Bubalus bubalis*)

Water buffaloes were imported into northern areas of Australia from Southeast Asia in the 19th century and were widespread across northern Australian wetlands. The brucellosis and tuberculosis eradication campaign, which occurred in the 1980s and early 1990s, drastically reduced their distribution and density (Robinson & Whitehead 2003). However, as remnant populations went largely unchecked (Petty et al 2007) and the farming of redomesticated herds has become popular over the past decade, population numbers of feral buffalo are on the increase (Jesser et al 2016).

Key factors — buffalo

Several factors increase the risk of buffalo maintaining, transmitting and dispersing diseases:

- The distribution of feral buffalo overlaps that of domestic cattle and other feral animals.
- Feral buffalo occur along the Northern Territory coast, placing them at risk of contact with unauthorised boat landings. Feral buffalo can occur as far south as Katherine and Mataranka region as well as in very small groups in Western Australia and Queensland close to the Northern Territory border.
- Feral buffalo can breed year-round if food and water are abundant.
- Their wallowing habits are likely to increase the probability of disease transmission to other species that drink from or share the wallows, especially pigs. Wallows also create environments that favour insect breeding, which are important in vector-borne diseases.
- In the wet season, bulls and cows (up to 500 animals) congregate for breeding, which may increase the probability of disease transmission.
- Under stress, a group may leave its home range and move into another group's home range.
- Control operations may alter the behaviour of surviving buffalo (eg feeding at night and retreating to cover during the day, and possibly hiding from aircraft), making it difficult to locate residual animals.

Several factors reduce the risk of buffalo maintaining, transmitting and dispersing diseases:

- The distribution of feral buffalo is generally limited, being confined to the 'Top End' of the Northern Territory; however, they have been seen in the Gulf of Carpentaria and near Kununurra.
- Feral buffalo do not tend to move great distances, and they have stable, relatively small home ranges (200–1000 ha).

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- Their dispersal is restricted by the availability of permanent fresh water to wallow in and drink.
- The Judas animal method (see Section 6.3.4) has been highly successful in locating residual buffalo.

4.2.3 Camels (*Camelus dromedarius*)

One-humped camels were first introduced into Australia in the 1840s to assist in the exploration of inland Australia. The current distribution of feral camels covers much of arid Australia; however, densities vary across this range. Camels tend to live in remote areas, with large population numbers centred in the Simpson and Great Sandy deserts (Saalfeld and Edwards 2008). As camel numbers and range have both expanded, camels have encroached more into remote communities, mainly in search of water during the hotter months (Saalfeld and Edwards 2008). An extensive camel management program was implemented in 2009 to reduce camel abundance in Central Australia. Some 160,000 camels were removed, predominantly through aerial shooting. However, camel abundance has increased since the conclusion of that program.

Key factors — camels

Several factors increase the risk of camels maintaining, transmitting and dispersing diseases:

- During periods of drought, large numbers of feral camels (up to 500 animals) congregate near watering points, where they have been observed to interact with domestic livestock.
- Camels can travel great distances (50–70 km per day and up to 5500 km per year).
- They compromise the security of farmed animals (eg cattle) by damaging fences.

Several factors reduce the risk of camels maintaining, transmitting and dispersing diseases:

- Generally, feral camel populations have relatively low densities; however, in some areas of the Simpson Desert, they may have higher densities.
- The dog fence provides a significant deterrent to the movement of camels into what is probably highly suitable habitat.
- Camels inhabit very remote areas, away from human settlements (although this can make any control operation(s) more difficult).

4.2.4 Cats (*Felis catus*)

The domestic cat and the feral cat are the same species. RSPCA (2018) defines feral and domestic cats as follows:

- *Feral cat*. A cat that is unowned, unsocialised, has no reliance on humans and reproduces in the wild
- *Domestic cat*. A cat that has some dependence on humans (direct or indirect); these include owned, semi-owned and unowned cats.

Feral cats are distributed Australia-wide in most terrestrial habitats. They are a highly adaptable species, and few environmental factors limit their distribution in Australia (Dickman 1996). Cats are implicated in several zoonotic diseases (Robertson 2008), of which rabies is of most concern. Although no unique rabies variants are associated with cats, they are the principal source of infection for humans in some countries (Bunn 1991). In the United States, feral cats were found to have no greater impact on transmissible diseases than free-roaming pet cats (Nutter et al 2004). Cats are the definitive

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host for *Toxoplasma gondii* and some *Sarcocystis* spp. Feral cats constitute a real risk as a sylvatic reservoir from which domestic animals, especially sheep, can become infected (Legge et al 2020).

A national feral cat action plan is being prepared for the management of feral cats in Australia.

Key factors — cats

Several factors increase the risk of cats maintaining, transmitting and dispersing diseases:

- Feral cats are widely distributed across all of Australia and many offshore islands.
- They are highly cryptic and difficult to detect.
- They are highly adaptable and can survive and reproduce in nearly any habitat.
- The density of feral and domestic cats is often highest where they are associated with humans (eg domestic cats at rubbish disposal sites).
- Cats have a high potential rate of increase (feral cats in south-eastern mainland Australia have, on average, two litters per year), so maintaining low population densities will be expensive and require ongoing efforts.
- There are currently limited control tools available for management of feral cats at a landscape scale. These include Felixer 1080 cartridges and Eradicat® (currently Western Australia only). Curiosity® cat bait has been approved for aerial baiting use by the Australian Pesticides and Veterinary Medicines Authority (APVMA) nationally. (Please check state regulations for use in specific states.) Most other techniques are labour intensive and suitable for only small areas.
- Although the home range of a feral cat tends to be stable, movements and dispersal may contribute to disease spread. Movements include
 - moving out to find prey and sometimes living commensally with people
 - exploratory or migratory movements
 - movement away from the natal home range (settling some 4–8 km away) by young males before breeding (other immature males may move in to take their place).
- Home ranges of male feral cats overlap home ranges of several female cats. Female home ranges can overlap in areas of high environmental productivity.
- Some controls may increase feral cat abundance rather than reduce it as it allows dispersing feral cats access to home ranges that would normally be defended by resident cats (Lazenby et al 2015).
- Surveillance and control operations may be difficult because:
 - density estimates of cats are often difficult to obtain and may be inaccurate because of the nocturnal and elusive nature of feral cats
 - feral cats are difficult to trap and to target for baiting programs
 - feral cats' variable behaviour and home ranges generally invalidate extrapolations from one area to another, and necessitate careful planning for specific areas (landscape productivity is a key factor in home range size)
 - they are usually very trap shy
 - they have a distinct preference for live prey, so baiting must take place when they are food stressed (eg in winter months)
 - baits must be surface laid, because cats will not detect and excavate buried baits (this makes nontarget bait take a significant concern)
 - there is continuous distribution in most areas
 - there is rapid re-invasion of an area following intensive control operations.

Several factors reduce the risk of cats maintaining, transmitting and dispersing diseases:

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- Restricting the movements of domestic cats would reduce the likelihood of their contact with wild animals.
- Feral cats are mostly solitary animals when there are limited food resources.
- Feral cats tend not to move great distances — they have stable, relatively small home ranges.

4.2.5 Cattle (*Bos genera*)

Feral European cattle (*Bos taurus*), zebu cattle (*Bos indicus*) and their hybrids have formed wild populations. These are largely limited to northern Australia, where they live in many rugged and remote areas where it is difficult to muster. Feral cattle often live in areas where domestic animals have been allowed to free range (Strahan 1995). These cattle do not remain wild for long.

Key factors — cattle

Several factors increase the risk of cattle maintaining, transmitting and dispersing diseases:

- Feral cattle share the same pathogens as domestic cattle and may interact with domestic stock.
- They are usually located in inaccessible terrain, and access can be made more difficult by seasonal climatic conditions.
- There are many insect vectors in tropical areas where feral cattle are often located.
- Apart from bulls, they are gregarious and tend to run in groups (10–30 animals in northern Australia).
- They have a wary and skittish temperament.

Several factors reduce the risk of cattle maintaining, transmitting and dispersing diseases:

- Due to their economic value, feral cattle populations once found are usually exploited rather than allowed to remain.
- They are neither widespread nor abundant, and are largely limited to northern Australia.

Domesticated banteng cattle (*Bos javanicus*) were introduced to the Cobourg Peninsula in the Northern Territory in the 19th century and have formed a persistent feral population. Recent sightings suggest they are expanding further east across northern Arnhem Land. They are considered an endangered species on the International Union for Conservation of Nature (IUCN) Red list.

4.2.6 Deer (*Cervidae*)

There are six main species of feral or wild deer in Australia: chital (*Axis axis*), sambar (*Cervus unicolor*), rusa (*Cervus timorensis*), hog (*Axis porcinus*), red (*Cervus elaphus*) and fallow (*Dama dama*).

Some species are found in small, fragmented colonies in isolated areas. Individually and collectively, the distribution of these species is much more restricted than those of the other feral herbivores, but in recent years their range and numbers have been increasing (Moriarty 2004). Deer almost doubled their range across Australia in the 20 years to 2021 and have yet to reach the limit of their distribution.¹¹

Some species such as sambar deer, in the highlands of Victoria, can be seasonally widespread and abundant. Red and fallow deer can be widespread over parts of the southeast region of South Australia. Deer also have a high natural rate of increase of between 35 and 50% per year and a herd of 30 can grow to 500 in 10 years. In Tasmania, hunting and culling limits population growth to approximately 11% annually and abundance doubles every 7 years (Cunningham et al 2021).

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The draft National Feral Deer Action Plan outlines the management of deer in Australia.⁵

Key factors — deer

Several factors increase the risk of deer maintaining, transmitting and dispersing diseases:

- Feral deer are gregarious (except for sambar and hog deer); some species can form large groups of up to 100 animals. This can increase the probability of disease spread and may mean that deer could have a role in an EAD outbreak.
- Deer travel long distances and show cryptic behaviour.
- The distribution of deer is significantly expanding across Australia.
- Their ability to become nocturnal in response to human disturbance makes control more difficult.
- They often live in rugged, inaccessible terrain, which makes aerial and ground shooting difficult.
- Deer have no natural predators other than man and, to a lesser extent, dingoes and wild dogs.
- Deer are regulated as game animals in some states rather than as a pest species.
- Deer regularly interact with domestic stock such as cattle.

Several factors reduce the risk of deer maintaining, transmitting and dispersing diseases:

- The distribution of some species of feral deer is limited to small, localised populations. In these cases, deer are unlikely to play an important role in an EAD outbreak (note that this does not apply to all species).
- Sambar and hog deer are solitary or live in small groups.

4.2.7 Wild dogs (*Canis familiaris*)

The taxonomic status of wild dogs is the subject of much contention. However, they can be separated into three groups: the dingo, the wild domestic dog, and the hybrid of these two. They can be found throughout Australia. A higher proportion of dingoes compared to hybrids is found in Western Australia and Central Australia, with hybrids being more common in the south-eastern states (Stephens et al 2015). Wild dogs, along with stray urban dogs, may play a role in the spread of canine rabies. Dingoes are now listed as threatened in Victorian legislation and in the Northern Territory. However, they, along with all wild dogs, are listed as a pest species in every mainland state.

The National Wild Dog Action Plan outlines the management of wild dogs in Australia.⁶ Most mainland states also have wild dog action plans.

Key factors — dogs

Several factors increase the risk of wild dogs maintaining, transmitting and dispersing diseases, especially canine rabies:

- Wild dogs are widespread. Of extra concern are populations that are in contact with domestic stock and with humans in remote communities, towns and cities (due to their use of peri-urban areas).
- Urban stray dogs on the outskirts of towns also visit the surrounding bush and countryside; these animals, along with peri-urban wild dogs, could provide a link between urban and wild animals.

⁵ <https://feraldeerplan.org.au>

⁶ <https://wilddogplan.org.au>

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- Wild dogs have a potentially high rate of increase because they can breed at all times of the year in cooler temperate climates (eg the eastern highlands) and produce up to two litters of 4–5 pups per year.
- They form packs or groups, which increases the risk of disease transmission between the animals within the group.
- Wild dogs regularly attack domestic stock (sheep, goats, cattle), which increases the risk of disease transmission between wild dogs and domestic stock.
- Dingoes disperse when food availability is limited, potentially spreading disease over large areas. This may also occur with other wild dogs.
- There is the potential for rapid re-invasion of an area by wild dogs following intensive population control activities.

Several factors reduce the risk of wild dogs maintaining, transmitting and dispersing diseases:

- High temperatures and lack of water or prey in many parts of Australia restrict the breeding and distribution of wild dogs.
- Dingoes in packs have relatively stable territorial boundaries, so protection of areas using animal-free buffer areas is a viable option (dingoes rarely make forays out of their territory or range).
- The presence of natural (eg escarpments) and constructed (eg dingo fencing) barriers limits dispersal of wild dogs.
- There are many existing trapping, shooting and baiting programs in localised areas to protect at-risk livestock production.

4.2.8 Donkeys (*Equus asinus*)

Donkeys were imported into Australia in the 19th century. They were especially useful in the northern regions of Western Australia and the Northern Territory, where they replaced horses, which are prone to *Indigofera* spp. toxicity. Feral donkeys occur predominantly in arid or semiarid areas in northern Western Australia, the Northern Territory and northern South Australia, and in isolated pockets of Queensland and New South Wales (Woolnough et al 2005).

Key factors — donkeys

Several factors increase the risk of donkeys maintaining, transmitting and dispersing diseases:

- Feral donkeys are widely distributed over pastoral districts in the Northern Territory and Western Australia, and in scattered locations in South Australia and Queensland, where they are an agricultural and environmental pest.
- Feral donkeys are also found in National Parks (Kakadu, Gregory National Park, Dampier Peninsula).
- They have a relatively high reproductive potential, regardless of food availability, although survival of foals is greatly reduced when food is limited.
- They can survive dry periods better than other ungulates, tolerating exposure to high temperatures and the absence of surface water.
- They are not territorial but have a social nature and will associate with stock. They have a habit of congregating in large groups of up to 500 animals around residual waterholes during the dry season.

Several factors reduce the risk of donkeys maintaining, transmitting and dispersing diseases:

- Feral donkeys are widely distributed but tend to be found only in remote locations.

- The use of the Judas animal technique (see Section 6.3.4) is very successful in locating residual animals.

4.2.9 Foxes (*Vulpes vulpes*)

Foxes have become widely established across most of the Australian mainland, except for the wet tropics, and have made some incursions into Tasmania (Saunders et al 2006, Saunders & McLeod 2007). Their distribution appears to be limited in some, but not all, areas by the presence of dingoes and the absence of rabbits (Saunders et al 1995). Their northernmost limits tend not to be continuous and change with seasonal conditions, although some northerly movements are becoming permanent (Edwards et al 2004).

Key factors — foxes

Several factors increase the risk of foxes maintaining, transmitting and dispersing disease:

- Foxes are widely distributed throughout the southern half of Australia.
- Their high densities in urban habitats bring them into contact with humans and domestic animals.
- They form family groups where food and other resources are abundant, which favours disease transmission.
- Subadult foxes, especially males, disperse between late summer and the onset of breeding in winter, with two distinct phases of movement: a sudden, quick movement involving straight-line travel, followed by slower, less directed movements that persist until new territories are established.
- Foxes can disperse over long distances (up to 300 km for adult males).
- Foxes are scavengers and hunters, and therefore are susceptible to infection through feeding on dead infected animals.
- Surveillance and control operations may be difficult because
 - density estimates of foxes are often difficult to obtain and may be inaccurate, due to the nocturnal and elusive nature of the fox and cyclic changes in fox density
 - foxes' variable behaviour and home ranges invalidate extrapolations from one area to another, and necessitate careful planning for specific areas
 - there is continuous distribution in most areas
 - there is rapid re-invasion of an area following intensive control operations
 - bait shyness may occur in populations in areas that are regularly baited.

At least one factor reduces the risk of foxes maintaining, transmitting and dispersing diseases:

- Although fox densities are higher in urban areas, the home ranges of urban foxes are smaller than those in rural areas.

4.2.10 Goats (*Capra hircus*)

Rangeland goats occur across Australia and on many offshore islands. They occur in all states and territories but are most prevalent in the semiarid pastoral areas of Queensland, New South Wales, South Australia and Western Australia. Goats prefer hilly or scrubby areas for protection; however, their numbers are limited by food availability, water availability, predation, and disease, either alone or in combination (Parkes et al 1996). Rangeland goats are often used to supplement income of farmers in arid and semiarid zones during periods of drought.

Key factors — goats

Several factors increase the risk of goats maintaining, transmitting and dispersing diseases:

- Rangeland goats breed year-round where food and water are abundant.
- The large size of their groups (up to 1000 animals observed) increases the probability of disease spread.
- Their large home ranges (up to 400 km² for males and 200 km² for females) and ability to move large distances (up to 30 km in 6 weeks in arid areas) mean that control areas for rangeland goats must be large.
- Rangeland goats move readily through most stock fences, making containment difficult.
- They often intermingle with sheep while grazing and at water, which facilitates disease spread between the species.
- Control and containment of disease may be difficult, as control operations may cause goats to become wary and move to inaccessible areas.
- The enormous variation in rangeland goat densities, both between and within regions, further compounds difficulties of survey and control operations.
- Many arid and semiarid zone land managers see rangeland goats as a valuable resource, which may limit control activities.
- Rangeland goats often gather in large numbers around watering points, especially at times of low rainfall, which increases the risk of disease transmission.

Several factors reduce the risk of goats maintaining, transmitting and dispersing diseases:

- Populations of rangeland goats can be quickly reduced by a concerted mustering effort.
- Dispersal is limited by access to water, and by interaction with dingoes, dogs and humans.
- The Judas goat method (see Section 6.3.4) has been effective for locating and removing recalcitrant goats.
- Water point traps in areas of low rainfall are an effective way of removing goats.

4.2.11 Horses (*Equus caballus*)

Feral horses are widely distributed in arid and semi-arid parts of the Northern Territory, Queensland, South Australia, and the northern rangelands of Western Australia. Feral horses are also present in wetlands of NT, all the way up to Cape York as well as on offshore islands such as Goulburn, Badu and Moa Islands. There are isolated populations in rugged areas in New South Wales and Victoria, with occasional incursions into the Australian Capital Territory (Dobbie et al 1993, Dawson et al 2006).

Key factors — horses

Several factors increase the risk of horses maintaining, transmitting and dispersing diseases:

- Feral horses are widely distributed, especially in northern Australia, and their habitat overlaps with cattle habitat.
- They live in overlapping home ranges, in harems or bachelor groups, and congregate in large cross-social groups of up to 100 animals to share food and water resources, which increases the probability of disease spread.
- They move large distances (up to 50 km from water to feed) and hence can spread disease over large areas.
- They use hilly country to escape capture, which may hamper control operations; residual animals can become wary after being shot at during control operations and may be difficult to remove.

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- Social licence for control activities will be difficult to obtain.
- There is a legislated ban on aerial culling of horses in New South Wales at the time of this review.
- There is potential for interaction between feral and domestic horses in Kosciuszko National Park due to high feral horse numbers and recreation use of the park by horse owners.

Several factors reduce the risk of horses maintaining, transmitting and dispersing diseases:

- Feral horses tend not to be found where domestic horses are kept (except as above).
- They have a low reproductive capacity, and mares generally have only one foal every 2 years.
- They do not disperse under control pressure, and their distribution is limited by access to permanent water.
- In drier areas, control operations can be centred on waterholes with a high degree of success.

4.2.12 Pigs (*Sus scrofa*)

Feral pigs are distributed across approximately 45% of Australia's land mass. In inland and seasonally dry areas of Australia, feral pigs are restricted to the vicinity of watercourses and associated floodplains. Populations, however, are still spreading in the more forest-covered parts of eastern and south-western Australia, where access to daily water and shelter is not limited (Choquenot et al 1996). The recent detection of African swine fever (ASF) in Timor-Leste and Papua New Guinea, and FMD in Indonesia is of great concern, as these diseases may enter the feral pig population in northern Australia and remain undetected until well established.

The National Feral Pig Action Plan outlines the management of this species in Australia.⁷

Key factors — pigs

Several factors increase the risk of pigs maintaining, transmitting and dispersing diseases:

- Feral pigs are distributed over many habitats, including agricultural areas, where they mix with domestic and other feral animals.
- They are scavengers, feeding on refuse and carcasses.
- They have a potentially high rate of population growth where food, water and shelter are abundant (producing two weaned litters every 12–15 months, with an average of 5–6 piglets per litter), which means that efforts to reduce and maintain low population densities will be difficult, expensive and ongoing.
- They are occasionally found in large groups, especially in tropical Australia (groups of more than 100 animals have been observed around waterholes); the interaction between individuals from different litters early in life facilitates disease transmission.
- Boars can move great distances daily, and over longer periods this facilitates disease spread.
- Pigs' wallowing habits may increase the probability of disease transmission to other species that drink from or share the wallows, especially buffalo. Wallows also create environments that favour insect breeding, which is important in vector-borne diseases.
- Feral pigs may become wary and nocturnal if they are subjected to intensive or prolonged disturbance. Under these circumstances, they may shift home range or disperse over large distances to remote areas, thereby complicating control and containment operations.

⁷ <https://feralpigs.com.au>

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Several factors reduce the risk of pigs maintaining, transmitting and dispersing diseases:

- Restricted access to water and shelter, especially in hot environments, and particularly in the Kimberly regions of Western Australia, limits dispersal.
- Effective control techniques for pigs are well established, given sufficient time and resources.
- The Judas animal method (see Section 6.3.4) may be successful with recalcitrant pigs.

4.2.13 Wild birds

Wild bird populations can act as reservoirs for several viral and other wildlife diseases. In many cases, birds show no clinical signs of the disease and are relatively unaffected (eg low pathogenicity avian influenza [LPAI], equine encephalomyelitis, Japanese encephalitis virus, Murray Valley encephalitis virus), but they can range through varying degrees of susceptibility from mild signs to severe signs and death (eg high pathogenicity avian influenza [HPAI], West Nile encephalitis, avian malaria). Some families of birds are more prone to certain diseases than others; for example, chlamydiosis is commonly more severe in Psittaciformes (parrots) and Columbiformes (pigeons), with most other bird species unaffected.

Wild birds, especially Anseriformes (waterbirds such as ducks, geese and swans) and to a lesser extent Charadriiformes (shorebirds such as plovers, gulls, terns and oystercatchers), are known natural hosts for LPAI viruses and have been implicated as a primary source of infection in outbreaks.

In all known outbreaks of HPAI in Australia, there has been evidence that poultry had contact with wild waterfowl or with inadequately treated drinking water that was potentially contaminated by wild waterfowl. These outbreaks were most likely caused by introduction of local wild bird LPAI viruses and subsequent mutation from LPAI to HPAI after circulation in poultry.

HPAI viruses circulating in the northern hemisphere and impacting commercial poultry and wild bird populations are not usually considered a significant threat to Australia because only shorebirds and no waterfowl undertake annual migrations from HPAI-affected areas in the northern hemisphere to Australia. Some overseas strains of HPAI viruses have been detected in apparently healthy wild birds, especially waterfowl, which suggests that these birds can spread the viruses. This has facilitated rapid intercontinental spread of these viruses through bird migration in the northern hemisphere. Incursions of overseas avian influenza viruses into Australia are infrequent (Kishida et al 2008, Vijaykrishna et al 2013, Bhatta et al 2020). Novel strains and increased frequency of outbreaks may result in periods of increased risk to Australia, especially when migratory birds return from the northern hemisphere to Australia (September to November).

For more information on wild bird distribution, see the BirdLife Australia Birddata website.⁸

Key factors — wild birds

Several factors increase the risk of wild birds maintaining, transmitting and dispersing diseases:

- Wild birds in Australia are distributed over a wide range and have the potential to move large distances in relatively short periods of time. Many species are nomadic, moving large distances in response to drought or flooding (McCallum et al 2008).
- Many species, including many shorebirds, annually migrate northwards, following recognised flyways throughout Asia.

⁸ <https://birddata.birdlife.org.au>

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- Environmental conditions such as drought and flood affect waterbird abundance and movement. Increased rainfall may lead to increased breeding success for many wild bird species, increased mixing of wild birds on water bodies, and increased movement as birds follow food, all of which increase the potential for disease transmission.
- The disease status of many species of Australian birds, and birds in nearby countries, is unknown, and broadscale surveillance is logistically difficult.
- Movement of pathogens by wild birds may occur through both mechanical and biological transmission.
- Pathogen transfer by people from an outbreak site (eg infected poultry sites/domestic settings) to areas with wild birds may facilitate subsequent onward spread via wild birds.

Several factors reduce the risk of wild birds maintaining, transmitting and dispersing diseases:

- The species of wild birds that migrate to Australia from the northern hemisphere typically do not pose a risk of introducing HPAI to Australia.⁹
- Outbreaks of diseases of concern that are carried by wild birds can result from direct contact with domestic stock, contact with range areas or contact with contaminated water — all preventable with good management techniques; for example, farms can discourage wild birds from landing and settling on range areas and water bodies by reducing wild bird attractants, preventing wild bird access to sheds, and using specific deterrents (decoys, lasers, drones). Methods are described in *Deterrence of wild waterfowl from poultry production areas: a critical review of current techniques and literature* (Atzeni et al 2018), by the USDA,¹⁰ and are available in the Farm Biosecurity manuals.¹¹
- Methods to reduce risks of introduction of pathogens into wetland areas or wild bird habitats can be found in *Ramsar Handbook 4: Avian influenza and wetlands* (Ramsar Convention Secretariat 2010).
- Relocation of wild birds to other areas can be decreased by reducing other forms of disturbance in environmentally protected areas.
- Biosecurity risks can be minimised by not feeding wild birds. The risk of zoonotic disease transfer associated with feeding wild birds is reduced if appropriate biosecurity practices are followed, including personal hygiene and hygiene of the feeding areas.

Other factors

- Experts do not recommend the lethal removal of wild birds to prevent the spread of LPAI/HPAI. Because of the high number and constant movement of wild birds, the use of lethal methods is neither practical nor environmentally sound.¹⁵
- Based on the advice of United Nations Food and Agriculture Organization (FAO) and World Organisation for Animal Health (WOAH) as well as under the international obligations of the Convention of Migratory Species and the Ramsar Convention, activities such as hunting, poisoning of wild bird populations, spraying toxic products or habitat destruction should not be considered as HPAI disease control measures. These activities are likely to accelerate their dispersal and potentially further spread the infection (Whitworth et al 2007, UNEP/CMS & FAO 2021).

⁹ The risk level may be changing, noting the high number of extended outbreaks of HPAI in wild birds across Europe, Asia and the USA throughout 2021-23.

¹⁰ www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-disease-information/avian/avian-influenza/ai-wild-birds

¹¹ www.farmbiosecurity.com.au/industry/chickens

4.2.14 Native animals (non-volant)

Native mammals are grouped according to suborders or families rather than species. Few data are available on the susceptibility of Australian native mammals to EADs. As a result, generic information is included. In the event of an EAD outbreak, advice should be sought from experts on the appropriate species. All Australian native mammal species are protected under state legislation. Additionally, Commonwealth legislation covers those species that are listed as threatened. Any management action designed to reduce native mammal populations must be done in accordance with the relevant state and federal legislation.

Social licence for the management of most native mammal species may be difficult to obtain, especially if it involves lethal techniques.

Suborder Macropodiformes (kangaroos, wallabies, pademelons etc)

Description — macropods

Macropod species are distributed widely across every state and territory in Australia. They vary considerably in size from the smallest (musky rat-kangaroo at ~30cm) to the largest (red kangaroo at ~2 metres). There are four species that are commercially harvested — eastern grey kangaroo (*Macropus giganteus*), western grey kangaroo (*M. fuliginosus*), red kangaroo (*M. rufus*) and wallaroo or euro (*M. robustus*). Commercial harvests occur in New South Wales, Queensland, South Australia and Western Australia. Accurate and current abundance data for these species are available as each of these states undertakes annual abundance monitoring.

Macropod abundance is generally climate dependent, with numbers decreasing during drought and increasing during good rainfall years. Most macropod species are capable of embryonic diapause, which can result in rapid rebounds in populations following drought periods. Larger macropods can cover long distances with little energy expenditure to find water and new food resources and are evolutionarily adapted to survive on poor feed with low energy content. The introduction of Mediterranean style grasses and high energy content crops into Australia has facilitated increase in macropod populations.

Susceptibility to most EADs is unknown; however, FMD (WHA 2022) was positively identified in an eastern grey kangaroo in a zoo in India (Bhattacharya et al 2003) and via experimental infection in a range of native marsupial and monotreme species (Snowden 1968). It is considered unlikely that native Australian species would play an important role in the epidemiology of an FMD outbreak (Snowden 1968). A *Besnoitia* sp. (*B. besnoiti* causes elephant skin disease in cattle and is spreading in Europe) was identified in western grey kangaroos in South Australia, with seroconversion in sympatric cattle (Hornok et al 2014; Nasir et al 2012).

Several factors increase the risk of maintaining, transmitting and dispersing diseases:

- Macropods are distributed over a wide range and larger species can move long distances quickly.
- Larger macropod species are generally gregarious and can form large groups with interchange between the groups.
- Larger macropod species move long distances when subjected to control measures.
- Rapid population changes can occur following drought conditions and after control activities.
- Macropod species regularly graze with livestock.
- Most species are predominantly nocturnal.

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Several factors reduce the risk of maintaining, transmitting and dispersing diseases:

- Smaller macropod species tend to be solitary or congregate in small groups.
- Identification of water points in drought can assist with management activities.

Suborder Vombatiformes (wombats and koalas)

Description — wombats and koalas

There are three species of wombat and one species of koala in Australia. Koalas are predominantly found in the eastern states and in some small areas in southern South Australia. Koalas are generally solitary; however, their home ranges can extensively overlap with other koalas. Overabundant populations can occur on islands and areas where emigration is not possible. Koalas are predominantly arboreal but move to the ground to move between trees and obtain water. Careful community engagement and messaging will be needed if lethal or invasive management methods are required to be undertaken in a koala population.

Wombats are generally solitary, nocturnal, and live in extensive burrow systems. On occasions the burrows can house small groups of wombats. The northern hairy-nosed wombat is listed as critically endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and has a very limited distribution. The southern hairy-nosed wombat population is fragmented and restricted to small regions of South Australia and Western Australia and is likely declining. The bare-nosed wombat is relatively widespread in south-eastern Australia and Tasmania.

Susceptibility to EADs is generally unknown, although bare-nosed wombats were experimentally infected with FMD virus (Snowden 1968).

Several factors increase the risk of maintaining, transmitting and dispersing diseases:

- Wombats and koalas have very low water requirements, and so are not reliant on water points during drought.
- Wombats and domestic stock can graze in the same areas.
- Wombat burrows are often used by foxes and other invasive and native species, increasing potential for disease transfer.

Several factors reduce the risk of maintaining, transmitting and dispersing diseases:

- They are nocturnal and predominantly solitary.
- They show limited daily movement from burrow or tree.
- The distribution of two wombat species is very limited.
- Koalas are tree dwelling, which limits their interaction with domestic stock.

Suborder Phalangeriformes (possums and gliders)

Description — possums and gliders

Possums and gliders are widely distributed across temperate regions of Australia, with some species common and widespread and others rare with restricted ranges. They are predominantly arboreal marsupials; however, the mountain pygmy possum is only found in boulder fields at high altitudes. Most species are solitary, but communal nesting is found in several species such as ringtail possums and mountain pygmy possums.

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Some species, such as brushtail possums, have adapted well to urban and peri-urban environments. However, most species are found away from human habitation due to a reliance on forested areas for obligate resources.

Several factors increase the risk of maintaining, transmitting and dispersing diseases:

- Most species are nocturnal and cryptic and are very difficult to detect during the daytime, which may not necessarily increase the infection risk but may increase the risk of not detecting the disease in a timely manner.
- They are predominantly arboreal, which limits containment options are limited and possibly increases the risk of not detecting the disease in a timely manner.
- Communal nesting may increase intraspecific transmission.

Several factors reduce the risk of maintaining, transmitting and dispersing diseases:

- Many species have limited or restricted distributions.
- They have limited interactions with domestic stock.
- They show limited dispersal and movement.

Family Dasyuridae (quolls, Tasmanian devils, phascogales etc)

Description of quolls, Tasmanian devils, phascogales etc

Dasyurid species are widely distributed across most of Australia in a variety of habitats from arid deserts to grassland to forested mountain regions. Individual species may be relatively widespread or may have a very restricted range. Dasyurids are mostly small (10–100 g), although some species, such as quolls and the Tasmanian devil, are larger (~6–8 kg). The smaller species are predominantly insectivorous, and the larger species are carnivorous or scavengers.

Dasyurids are nocturnal and predominantly arboreal but also forage on the ground for insect prey. Some species (eg Tasmanian devil and dusky antechinus) are completely ground dwelling. Most species are solitary while foraging but may nest communally. During the day, dasyurids shelter in tree hollows, hollow logs or burrows. Desert-dwelling species have regular boom-and-bust population cycles that depend on rainfall conditions.

Many species only breed once in their lifetime, which will result in decreased population abundance after mating and before the juveniles enter the population. Monitoring activities must consider this when assessing population abundances.

Several factors increase the risk of maintaining, transmitting and dispersing diseases:

- Communal nesting by some species may increase the potential for interspecific transmission.
- Small size and restricted diet make management activities difficult.
- Scavenging behaviour may increase the risk of transmitting or dispersing some diseases.
- Most dasyurids are cryptic and difficult to detect, making management and monitoring activities difficult.
- Limited dependence on water means that management activities are more difficult during drought as they will not need to access water points.

Several factors reduce the risk of maintaining, transmitting and dispersing diseases:

- They have limited interaction with domestic animals.
- Many species only breed once in a lifetime (semelparous) with all males dying after mating, reducing population abundance until juveniles enter the population.

Family Peremelemorphia (bandicoots and bilbies)

Description of bandicoots and bilbies

Bilbies and bandicoots are small- to medium-sized marsupial omnivores. Bandicoots are generally sparsely distributed across mainland Australia and Tasmania but can be common in coastal regions. Bilbies are sparsely distributed in hot, dry grassland regions in northern Western Australia and parts of the Northern Territory and western Queensland.

Bandicoots and bilbies are highly susceptible to predation by foxes and feral cats. Most are solitary and shelter in burrows or shallow holes covered in grass and leaf litter. Most species have limited home ranges and occur away from areas of high human habitation.

Most species are classified under the EPBC Act and some are considered iconic species (eg the greater bilby).

Several factors increase the risk of maintaining, transmitting and dispersing diseases:

- Bilbies and bandicoots are nocturnal, cryptic and difficult to detect and monitor.
- Limited management options are available to manage population abundance.

Several factors reduce the risk of maintaining, transmitting and dispersing diseases:

- They are predominantly solitary with limited interaction with domestic stock.
- Their distributions are sparse except in some coastal regions.
- They have limited home range sizes with animals not roaming far from their burrows or nests.

Order Monotremata (platypus and echidnas)

Description of platypuses and echidnas

There are two species of monotreme in Australia, the platypus and the short-beaked echidna. Monotremes are egg-laying mammals that produce milk to suckle young. Platypuses are generally nocturnal but are occasionally active during the day. Echidnas are generally crepuscular but can be active also during the day or night.

The platypus is restricted to waterways along the east coast and Great Dividing Range of mainland Australia, and in Tasmania. They are generally solitary, but several individuals can share the same stretch of river. Platypus forage for prey in the rivers and streams and live in burrows constructed in the riverbank with entry points just above the water level. Platypuses are generally hard to detect. Male platypuses can inject venom through spurs on the rear legs.

The echidna is widely distributed across the Australian mainland and Tasmania. They obtain most of their dietary water from invertebrates they consume except in severe drought conditions. Echidnas are generally solitary animals; however, their home ranges can overlap with several others.

Several factors increase the risk of maintaining, transmitting and dispersing diseases:

- Monotremes are predominantly nocturnal and cryptic making management and monitoring activities difficult.
- Echidnas do not rely on water points except in severe drought.

Several factors reduce the risk of maintaining, transmitting and dispersing diseases:

- Monotremes are generally solitary animals with limited potential for rapid interspecific disease transfer.

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- Their home ranges are relatively small, and monotremes have a limited ability to cover long distances rapidly.
- They have limited interaction with domestic stock.

5 Disease surveillance and sampling

5.1 Surveillance

Surveillance can be used to gain information on the presence or absence of disease in specific wild animal populations, the prevalence of the disease, modes of transmission and the geographical spread. The objective will determine the methods of surveillance used.

5.1.1 General surveillance

General surveillance is sometimes called passive surveillance as it doesn't involve personnel actively going out and finding animals to sample. It usually begins with the detection of sick or dead animals followed by reporting and investigation. General surveillance requires networks of people who are likely to encounter sick or dead animals. There must also be well defined reporting channels in place aligned to specific entities that can collect and analyse the data and facilitate disease investigation.

Ongoing general surveillance programs are an important part of national wildlife health systems and Australia has some established networks such as those that are run by Wildlife Health Australia (WHA), electronic Wildlife Health Information System (eWHIS) and DAFF's Northern Australia Quarantine Strategy (NAQS) indigenous ranger program.

WHA administers Australia's general wildlife health surveillance system in partnership with government and nongovernment agencies. Key elements of the national wildlife disease surveillance system include a network of surveillance partners reporting into a web-enabled national database (eWHIS) that captures wildlife health information. The network includes WHA Coordinators in the state/territory agriculture agencies (appointed by the respective chief veterinary officer), and WHA Environment Representatives, their counterpart in the environment agency in each jurisdiction. Other surveillance partners include zoo-based wildlife hospitals, sentinel veterinary clinics, universities, the Australian Registry of Wildlife Health, the Northern Australia Quarantine Strategy and the Australian Centre for Disease Preparedness (ACDP) as well as researchers, wildlife rehabilitators, other wildlife health professionals, WHA members and the public. The system relies on the detection, investigation and reporting of sick and dead free-living (both native and feral species) and captive wildlife. General wildlife health reporting focuses on the following categories: nationally notifiable animal diseases, diseases listed by WOAHA, mass mortalities, biodiversity diseases, public health and zoonotic diseases, poisoning events, and diseases considered interesting, unusual, new or emerging.

5.1.2 Targeted surveillance

Targeted surveillance is sometimes called active surveillance as it involves actively going out in the field to find animals to sample for specific diseases. In an EAD response this surveillance would be used to confirm the presence or absence of one specific pathogen in a specific population at a specific location. Sampling should focus on high-risk populations where the disease is most likely to be detected. Targeted surveillance can also be used to measure the prevalence once a disease is detected. Samples can sometimes be collected according to statistically based sampling plans allowing epidemiological estimates and analyses to be applied. However, sampling of wild animals will sometimes be limited to nonrandom, convenience or opportunistic sampling especially in remote locations where animals have ample opportunity to avoid detection. Several sampling techniques may be used including:

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- culling followed by collection of blood, tissue samples and swabs as appropriate. Culling may be useful when targeting feral species such as pigs and buffalo but may not be appropriate for native species
- collection of blood samples and swabs from live animals. Catch and release of significant numbers of animals will be difficult if not impossible for many target species. Netting of birds and bats may be feasible in some situations
- collection of environmental samples. Collection of fresh faecal samples may be possible where large numbers of animals congregate — for example collection of wild waterfowl faeces for avian influenza testing or pooled urine samples collected from under bat roosts.

The sampling strategy to be adopted will depend on the objective of the sampling exercise. Three major reasons for sampling wild animals are:

- to test for the presence of the disease
- to determine the extent of disease spread
- and to prove freedom from the disease at the end of the eradication campaign.

The key issues that need to be considered are:

- how many animals need to be sampled
- which areas should be sampled
- what tests should be performed
- which samples are required
- and how the findings should be interpreted.

It may be necessary to stratify populations into sections that have a similar risk of maintaining the disease. For wild animal populations, in most cases, stratification will be by geographical areas.

5.1.3 Testing

Some serological tests can be run on serum from any host mammal while other types of serological tests are specifically designed for the host species. In most cases, commercially available serological tests for pathogens in Australian laboratories have been developed for domestic animals. Few serological tests have been developed specifically for wildlife species, and most of the serological tests used for Australian wildlife fall into the category of those types of tests which are not host-species specific. In most cases in wildlife species, the duration of persistence of antibodies following infection is not known. Many of the tests used in wildlife have not been validated for the host species. A general overview of diagnostic test validation for wildlife is available from WOA (WOAH 2018).

Interpretation of test results must be undertaken with care in wild animals, where baseline knowledge is often limited, and tests may have not been validated for the species under investigation. Sensitivity and specificity of tests are often unknown for wildlife species and must be inferred or assumed based on expert knowledge. When conducting surveillance testing on wildlife populations, the impact of false results is likely to be greater, as sample sizes are often small. A lack of baseline information on wildlife disease, including disease prevalence, may also limit the ability to accurately interpret the results of disease testing in wildlife. Expert input, for example from a wildlife veterinarian, pathologist, pathogen expert, or epidemiologist, is recommended whenever disease testing is undertaken in wildlife species.

For further information, see the **AUSVETPLAN Management manual *Laboratory preparedness***.

5.1.4 Data analysis

Care needs to be taken when analysing data collected from opportunistic, convenience or nonrandom samples, or small sample sizes. Using routine analytical approaches will limit the nature of the conclusions that can be drawn from the data. In these cases, nonparametric statistical methods should be considered, and consulting suitably experienced wildlife pathologists/epidemiologists is recommended.

5.2 Proof of freedom

At the end of the outbreak, it will be necessary for Australia to demonstrate that the disease is no longer present in its wild animal populations, by meeting the requirements in the relevant chapter(s) of the WOAHP Terrestrial Animal Health Code.¹² For proving freedom from the disease, a wide-area survey (which could involve domestic animals) is required, rather than a focus on high-risk areas. Although a true random sample may be impossible, it is important to use a process that is as random and unbiased as possible to select animals for testing.

¹² www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access

6 Controlling disease in a wild population

Disease control can be defined as ‘any activity designed to reduce the frequency of occurrence or the effects of an existing disease within an individual animal or a population to an acceptable or tolerable level, or to contain the spatial spread of infection’ (Wobeser 2002).

Disease control options may include:

- manipulation of one or more of four factors contributing to the presence or persistence of disease in a population:
 - disease agent or its vector (eg removing the agent from the environment; altering the disease agent)
 - hosts, recognising that disease may involve multiple different hosts, including reservoirs, spillover and dead-end hosts (eg medical treatment, vaccination or genetic manipulation of the host; culling)
 - environment or habitat
 - human activities (eg addressing factors that may facilitate disease presence or transmission and spread).

Note that information may be lacking on the effectiveness of disease control options in wild animals. Some disease control measures (eg treatment, vaccination) may be difficult to apply to free-ranging animals. Controlling disease in wild animals often requires long-term commitment as repeated interventions and disease control measures (including monitoring disease) may have to be continued for prolonged periods. Public opinion may limit the viability of culling of wild animals as a disease control option. During disease control operations, measurable targets and ongoing monitoring of progress are vital (WHA, 2020).

6.1 Controlling a disease through targeting the causative agent (or its vector)

The overall aim is to reduce transmission of infection to limit, decrease or prevent exposure.

The causative agent of disease (infectious agent) may be targeted either:

- within the affected wild animal host, reservoir or carrier
- free in the environment or
- within a vector.

A combination of these options may be used.

6.1.1 Targeting the infectious agent within the wild animal host

This option involves treatment of the host with a product that will kill or inactivate the agent of disease. The aim is to reduce the duration and/or intensity of the infectious period and reduce the number of infectious individuals present at a time, or diminish the welfare impacts on the individual animals.

This option focuses on medicating wildlife and may include:

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- use of an antiparasitic (to kill pathogenic parasites in or on the host)
- use of an antibiotic (to kill or inactivate bacteria in the host)
- use of antiviral medications (to inactivate viruses in the host).

6.1.2 Targeting the infectious agent in the environment (outside the host)

This option involves inactivating or killing the infectious agent of disease in the environment, to prevent infection of the host.

This option includes:

- removal of carcasses that contain an infectious disease agent (eg avian influenza)
- disinfection or removal of substrates and items; for example
 - disinfect soil to kill parasite eggs or pathogen
 - sterilise or disinfect water sources or other items such as nest boxes or feeding areas with chemical disinfectants to kill a virus or bacteria.
- directly manipulating a free-living agent of disease within the environment
 - sterile insect release (eg for screw-worm fly control).

6.1.3 Attacking the vector of a vector-borne disease

This involves the management of vectors such as mosquitoes or rodents that are involved in spreading certain disease agents.

This option includes managing a vector through activities such as:

- clearing vegetation so that insects can't survive and multiply (eg tsetse fly)
- removing standing water or treating water bodies so that mosquitoes can't breed
- prescribed burning of vegetation to reduce tick populations
- treating a host with an antiparasitic agent so a tick, mosquito or other vector doesn't bite them
- insect trapping/chemical control in targeted areas
- emerging biocontrol approaches such as introduction of a predator of the vector; sterile or genetically manipulated vectors.

6.2 Targeting the hosts

Targeting the host is the most used method to manage disease in wild animals.

This option includes:

- vaccination of the host(s)
- altering host distribution or density, through lethal and nonlethal methods
- removing the host(s)
- genetic, physiological or immunological manipulation of the host(s) (other than vaccination).

6.2.1 Vaccination or immunisation

Immunisation or vaccination makes the individual resistant to the infectious agent by stimulating a specific host immune response to the disease agent, prior to infection. Effective vaccination of wildlife is often difficult, either because there are no effective vaccines for the disease and host in question or because there are no effective methods for delivery of the vaccine.

Vaccination may serve a primary purpose of:

- protecting the individual from disease, or reducing the impact of infection on the individual
- reducing transmission (and multiplication) of the disease agent.

Most vaccination programs are aimed at both reducing transmission and protecting the individual; some only focus on protecting the individual (Wobeser 2002). There are limited examples of successful mass immunisation of wildlife, mainly with oral bait vaccines (eg oral vaccination of badgers for bovine tuberculosis in the UK (Gormley et al 2017)) and rabies vaccination of foxes and other terrestrial hosts.

Expertise from existing oral vaccine bait formulations overseas should be drawn on as the need arises.

Vaccination of a domestic animal species may be used to manage disease risk in some zoonotic diseases of wildlife origin if there is an intermediate domestic animal host. For example, vaccination of horses for Hendra virus and vaccination of domestic dogs for rabies in areas where wildlife species carry rabies; vaccination of domestic dogs is both to protect dogs from disease and to reduce the risk that the infected dog may pass the virus on to a human. The decision to vaccinate wild animals will depend on whether vaccine is available in Australia (or can be obtained in a reasonable time from overseas) and its known or likely efficacy in the host species in question. The possible lack of information about efficacy vaccines in wild species could also influence decision making. Refer to the **Rare and valuable animals guidance document**.

6.2.2 Genetic technologies

Genetic technologies may prove to be a potential technique to aid in the long-term population management of a wild species impacted by an EAD. Nonlethal genetic sampling such as eDNA (environmental DNA) or eRNA (environmental RNA) can be used to detect the presence of animals within a location. This takes advantage of the natural shedding of DNA by all animals and identifications can be made using only very small (trace) samples of DNA. eDNA is especially useful for the detection of water-based species. It requires that there are suitable assays available, or able to be developed, for the target species.

6.2.3 Biocontrol

A variety of different biocontrol methods might be available to help in disease management in wildlife. Examples include sterile insect release (eg for screw-worm fly control in the Americas), or release of sterile/*Wolbachia*-infected mosquitoes in Queensland to reduce risk of dengue-fever (a mosquito-borne disease). Some biocontrol techniques are in their infancy and direct application to the wildlife setting may not be possible.

6.2.4 Altering the host density or distribution

This option aims to alter the host density or distribution, thereby reducing the rate of contact between infected and non-infected hosts and the resulting disease transmission rate. Methods used include:

- dispersing hosts
- controlling host movement ('movement control')
- controlling contact between hosts (if infectious disease)
- population reduction (culling the host)
- controlling the reproductive rate of the host.

Dispersal driving or forcing animals away in different directions is generally used with the aim of reducing host density or removing host clustering from an area of focus (eg waterbody, feeding area, nest site etc.). In the past, the technique of dispersal for wildlife disease control has been primarily used for birds (eg avian influenza outbreak etc.). Dispersal of wild animals is generally not recommended for infectious disease control as the result will be to spread the host and pathogen through a wider geographic area.

It is generally difficult to control the movement of wild animals. Efforts at relocation may be fruitless if the animals are able to return to the original location. Most techniques to discourage wild animals from entering an area rapidly become ineffective (Wobeser 2002).

Movement control means to stop the movement (often human-assisted, such as translocation or shipping) of animals, with the aim of stopping or reducing disease spread.

Methods include:

- fencing
- scaring off
- attracting animals elsewhere
- not allowing harvested wildlife carcasses to be shipped from one area to another
- ceasing movement of captive wild animals (eg zoo animal translocations, release of captive bred wildlife)
- restrictions on recreational hunting and harvesting of carcasses.

6.3 Population reduction

Culling means killing the host with the aim of reducing the host density, generally to a level below which the disease doesn't continue to spread. The aim may be to humanely reduce the host density to a level so that disease spillover to humans or domestic animals reduces or ceases.

Culling may also involve complete eradication of the host from a location, especially if it is an introduced species, or is within a contained area (eg island) or has a restricted distribution.

Culling ('stamping out') is a well-established technique for managing significant disease outbreaks in domestic animals (eg HPAI, ASF). However, there are more challenges when using culling as a disease control method in wild animals, where the situation is often less contained and more complex. In these situations, culling is more difficult and costly to achieve and may not be an effective method of disease control, depending on the ecology of the disease in question. Consideration of animal welfare implications and disease modelling, to better understand the likely impact of culling, is strongly recommended prior to any actions being taken.

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Culling is easier and more effective in domestic animals as all animals can be caught, sampled, tested and selectively culled if needed, based on their disease status.

Selective culling means removal of the subset of infected or shedding hosts. Each animal may only need to be handled once (depending on how the disease status is to be determined) and the effect (death and removal from the population) is immediate and permanent. In wild animals, selective culling can only happen when affected individuals are readily identifiable.

Culling methods include:

- hunting (generally shooting) — more targeted and specific
- trapping (including snaring)
- fumigation — flooding confined areas such as underground systems or caves with poisonous gas (eg for badgers, foxes, rabbits and bats)
- poisoning — which has nontarget risks and mostly indiscriminate focus; but some programs can be made highly specific with lures and baits that are attractive or accessible primarily to target species.

6.3.1 Objective

Population reduction to reduce the number of susceptible individuals is used to minimise the risk of disease transmission. If wild animals are a risk factor in the dissemination or persistence of infection, programs aimed at reducing contact between infected domestic animals, wild animals and uninfected susceptible domestic animals should be instigated as soon as possible. For further information on determining whether to instigate a population reduction program, follow the guidelines in Section 3.

In all disease situations, unrealistic expectations of wild animal control or depopulation operations must be avoided. Also consider that the removal of wild animals from an area may create a 'sink' into which healthy and infected animals may immigrate. Furthermore, aerial and ground shooting, hunting, shooting drives and inordinate numbers of control personnel in an area may cause dispersal of the wild animals, which may spread the disease. Many of the AUSVETPLAN response strategies indicate that, in many instances, wild animals should be left undisturbed, and their control limited to activities that will not cause their dispersal. Where domestic animals are infecting wild animals, it is possible that, once this source is eliminated, infection may naturally die out in low-density wild animal populations. Another option is vaccination; for example, the trap-vaccinate-release program used for rabies in countries such as Canada.

6.3.2 Planning the control strategy

The local control centre (LCC) controller, epidemiologist and wild animal control coordinator, together with appropriate species, local wildlife/vertebrate pest and environmental technical experts, will determine the type and extent of control operations to be undertaken (see Section 3; ensure that all factors have been considered in the decision-making process). Coordination of control efforts is critical to the success of any operation. Ensure that proper planning, recording of information and debriefing are always carried out.

The effectiveness of the techniques for reducing wild animal numbers will vary depending upon the species, density of the animals and the terrain. Some techniques (eg aerial shooting and poisoning) can give relatively rapid knockdowns, but others such as trapping may take longer to reduce the populations to the desired level. However, it is usually best to use a coordinated approach, which may

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involve a range of techniques. Appropriate permits for the destruction of any native vertebrates must be obtained.

Consideration should be given to:

- the potential flow-on effects of control operations, such as the risk to nontarget species
- the welfare of target and nontarget animals
- environmental contamination and persistence of chemicals
- the sequential use of different techniques
- the starting density of the population
- the varying of technique(s) as the population density falls.

Objectives and priorities for control operations should be set so that progress can be assessed. Areas where wild animals are infected, are suspected of being infected or have the greatest risk of contact with infected domestic animals should be preferentially targeted. Such an area is referred to as the wild animal control area.

Determining the level of population reduction required to achieve a threshold density at which disease will not be maintained or spread will be difficult when the dynamics of the disease can only be estimated and there is great variation in density between regions.

Disease sampling may be undertaken with population reduction to monitor the spread of the disease (see Section 5).

Control teams

Membership

Control teams should generally consist of:

- local vertebrate pest control or wildlife officers, where possible
- at least one officer (two is desirable) experienced in wild animal capture and control procedures.

If the workload is high, consider including one or more technical assistants to assist with counting, data recording and mapping.

Briefing

Control teams will be briefed at the LCC or forward command post about where each team is to operate, what to look for, what techniques are to be used, procedures for reporting and data recording, decontamination procedures, safety, and how to deal with carcasses. Teams will report to the wild animal control team leader, or the wild animal control and surveillance coordinator (or both), depending on the size of the outbreak.

Duties

Control teams will:

- use the safest and most environmentally sound practices available to humanely trap, examine, sample and/or destroy target wild animals
- complete a wild animal control form (see the example in Appendix 2) or use audited field notebooks that will clearly show the location and number of animals handled, sampled or destroyed, and the number of animals that escaped
- use a global positioning system (GPS) device to accurately record animals and the area of control

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- ensure that the mapping officer records the location of animals destroyed on topographic maps at the LCC.

Note: Carcasses should be treated or disposed of as directed by the LCC (see Section 7 of this manual or the **AUSVETPLAN operational manual *Disposal***).

6.3.3 Culling techniques and species-specific information

For further information on techniques relevant to a specific disease, refer to the relevant AUSVETPLAN response strategy. See also Section 7.1 of this manual on further destruction information.

Selection of culling technique will depend on:

- technique efficiency (ie the proportion of wild animals killed and how quickly given levels of reduction are achieved in the wild animal density)
- factors affecting the efficiency of the technique in different habitats
- availability of carcasses for disease sampling
- effect of the technique on the movement and dispersal of wild animals from the wild animal control area (Wilson & Choquenot 1997).

Techniques specific to each species are presented in Table 6.1. It will be necessary to compare and monitor the performance targets achievable with each technique for each species, considering density, dispersal, ease of carcass disposal, use of available resources and cost.

If aircraft are used, it will be necessary to obtain approval from the Civil Aviation Safety Authority to carry firearms on board.

There is the potential for some culling techniques (eg aerial shooting of feral pigs) to change the behaviour of target populations. This may result in dispersal of surviving individuals. For deer, the likelihood of dispersal because of different control techniques is, from highest to lowest: aerial shooting, ground shooting, spotlight shooting, mustering, trapping, fencing, ground poisoning and aerial poisoning. The potential risk that dispersal may create for disease spread must be considered.

Table 6.1 Population reduction techniques for wild animals used for disease control

Technique	Species	Comments
<i>Lethal control</i>		
Aerial shooting	Buffalo, camels, cattle, donkeys, goats, horses, pigs	Rapid control with concurrent control of multiple species possible in open floodplain, grassland and swamp habitats, and in inaccessible or uneven terrain Not suitable in heavy cover unless thermal imagery equipment is used May use Judas animals
Ground shooting	All species	Spotlight shooting for most species; from a hide for deer and birds May use Judas animals
Poisoning	Pigs, foxes, dogs, cats, rabbits	Achieved from ground or air (or both), depending on the habitat The following poisons are available: ^a

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Technique	Species	Comments
		<ul style="list-style-type: none"> • 1080 for all five species • PAPP for dogs, foxes and cats • Sodium nitrite (Hoggone®) for pigs • yellow phosphorus (Northern Territory only) and warfarin for pigs • Pindone for rabbits • strychnine wraps on traps for wild dogs and foxes (currently either being phased out or not allowed in most jurisdictions — check before use) <p>Before using any poison, check legal status and conditions for use, as these may vary across Australia. Licensed, experienced wildlife/vertebrate pest technical experts must be used to mix and distribute baits</p> <p>Canid Pest Ejectors are suitable for dogs and foxes with either 1080 or PAPP as the toxin</p> <p>Cyanide may be available for use in canid pest ejectors for wild dogs and foxes under an emergency use permit following application to the APVMA</p>
Fumigation	Foxes, rabbits	<p>Foxes: carbon monoxide gas; not labour efficient; appropriate only during breeding season</p> <p>Rabbits: Aluminium phosphide tablets. Best effect if done shortly before breeding season. Use in conjunction with other methods where possible</p>
Warren ripping	Rabbits	For use in conjunction with other control methods such as fumigation. Prevents re-invasion of the warrens after fumigation/poisoning
Explosives	Rabbits	R3 explosive gas device for small rabbit warrens
Biocontrol	Rabbits	RHDV K5 (rabbit haemorrhagic disease virus)
<i>Live capture</i>		
Trapping ^b	All species	Trap at water, using lures, food or baits. The best techniques and traps vary between species
Judas animals ^c	Buffalo, cattle, goats, donkeys, pigs, camels, some species of wild birds	<p>The characteristics that make for the best Judas animals vary between species:</p> <ul style="list-style-type: none"> • For cattle and buffalo, use young animals • For goats, avoid extremes of age <p>Use both sexes. Eliminate unhelpful Judas animals, but persevere with at least some animals of both sexes for species where segregation of the sexes occurs</p> <p>Although local animals are most suitable, it may be necessary to use disease-free animals from outside the</p>

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Technique	Species	Comments
		area and introduce them in pairs or small groups. Replace animals and regularly test them for disease Method has limited success with pigs
Mustering	Buffalo, camel, cattle, donkeys, goats, horses	Mustering each species separately and minimise disturbance to other species Take care not to disperse animals; back up with shooters (usually in helicopters) to immediately destroy recalcitrant animals
<i>Other</i>		
Bait vaccination for rabies	Canids	Oral vaccination is effective and more desirable than population reduction because: <ul style="list-style-type: none"> • it is less disruptive to species population dynamics • foxes are generally resilient to population reduction methods
Urban control of rabies	Urban and stray dogs	'Managed population' and 'immunised population' approaches
Large-scale burning off	Buffalo, camels, cattle, deer, donkeys, goats, horses, pigs	Use only in exceptional circumstances
Small-scale burning off	Buffalo, feral cattle, horses	To produce green pick during dry season
Human sweep line	Buffalo, camels, cattle, deer, donkeys, goats, horses, foxes	Use only in exceptional circumstances
Sedatives	Goats, birds, fallow deer	Unproven for other species Alpha-chloralose has been used Diazepam used successfully in Tasmania

1080 = sodium monofluoroacetate; APVMA = Australian Pesticides and Veterinary Medicines Authority; PAPP = *para*-aminopropiophenone

a Check state and territory legislation for regulations of use. Some poisons require a special permit. See PestSmart (pestsmart.org.au) for codes of practice and standard operating procedures.

b Trap design differs between species; nets will also be used for wild birds and bats; a wildlife biologist or wildlife/vertebrate pest technical expert will design or advise on traps.

c See Henzell et al (1999) and Section 6.3.4 for information on Judas animals.

6.3.4 Capture and control techniques for wild animals

Lethal control techniques

Lethal control methods primarily rely on shooting (aerial or ground shooting) or poisoning. Codes of practice and standard operating procedures PestSmart¹³ should be consulted for best-practice techniques and equipment requirements. State and territory CoPs and SOPs, where available, tend to have higher technical detail and reflect the relevant legislation/regulations in place for that jurisdiction.

The following subsections detail the advantages and disadvantages of several lethal control techniques.

Aerial shooting

During an outbreak, samples will be required early. Generally, the quickest retrieval method is recommended, and this is most commonly aerial shooting. Aerial shooting from helicopters using trained shooters is an effective technique for culling large herbivores and ungulates. It has been used successfully for the management of horses, camels, donkeys and deer. Aerial shooting can be effective at a much larger scale than ground shooting. Some states have restricted which species can be culled using aerial shooting and the status must be confirmed prior to the commencement of any culling operations. Most states have training and experience requirements and qualifications for aerial shooting operators.

Aerial shooting has the advantages that it:

- can obtain samples quickly
- can cover large areas rapidly
- can control many animals rapidly, with possible concurrent control of multiple species
- is suitable for a wide range of larger species, such as horses, donkeys, cattle, buffalo, goats, camels, deer and pigs
- can be used with thermal equipment that allows accurate and rapid identification of target animals in thick cover and in low light
- reduces mechanical disease spread by minimising ground contact.

Aerial shooting has the disadvantages that it:

- is only suitable where vegetation density permits good visibility and where animals are not grazing at night (if thermal vision equipment is not used)
- may cause dispersal (possibly mainly in high-density populations)
- may cause feral populations to become adapted to the sound of aircraft and seek cover
- is costly
- relies on a few trained, accredited aerial marksmen, which can be a scarce resource.

If sampling is required, then both pilot and sampling teams must be trained to muster animals into a location where the helicopter can be landed safely, samples can be collected and constant monitoring for hazards (eg other feral animals approaching, crocodiles, general safety of team) can be undertaken.

Ground shooting

Ground shooting, using suitably trained shooters, can be effective at culling animals over relatively small areas. Ground shooters are not able to cover as much area as aerial shooters. Ground shooting

¹³ pestsmart.org.au

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can be used to further reduce populations after an aerial shooting campaign or to maintain a population at a reduced level after it was reduced through aerial shooting or baiting.

The use of Judas animals to locate and manage herding species such as feral pigs and goats reduces the time spent searching for the target species and increases the effectiveness of ground shooting. Suitably trained detector dogs and handlers are another method to locate and track animals during ground shooting operations.

There are shooting groups that have suitably trained hunters that can assist with management operations. As an example, the Sporting Shooters Association of Australia has Conservation and Wildlife Management branches in some states that assist with government-implemented management operations such as the culling of feral goats in the Flinders Ranges in South Australia.

Recreational hunting of itself does not effectively reduce populations unless it is undertaken in a coordinated and controlled manner as part of a strategic management plan along with other population management actions.

Ground shooting has the advantages that it:

- can be used where terrain and vegetation cover preclude the use of helicopters
- can be used with spotlight and thermal imagery shooting, which is suitable for nocturnal animals such as deer, foxes, cats and pigs
- may be useful for follow-up surveys, especially if animals have learned to hide.

Ground shooting has the disadvantages that it:

- is relatively slow and time-consuming compared with aerial shooting
- will need many teams to cover large areas.

Poisoning

Baiting is the most effective technique for the large-scale culling of most small- to medium-sized wild animals. A range of toxicants are available and approved for use in Australia. Routine poisoning of vertebrate pests (feral pigs, rabbits, wild dogs, and foxes) is conducted throughout Australia using 1080 (sodium monofluoroacetate) and poisoning of introduced predator pests using *para*-aminopropiophenone (PAPP). This is carried out by government pest-management agencies in each state or territory. Other poisons such as warfarin (for pigs) and cyanide (for carnivores) are used under licence, mostly for research activities. Application for an emergency use permit from the APVMA will be required if they are to be used in management activities. In any instance where poisons are to be used in EAD control, local pest-management agencies must be consulted. There are legal restrictions on who can mix and distribute baits, and how baits can be distributed.

Commercial baits containing 1080 or PAPP are readily available across most of Australia and 1080 can also be injected into wet meat baits for foxes and wild dogs. Aerial delivery of 1080 baits for predators is common practice in many states. Canid pest ejectors are an effective and target-specific technique for the delivery of 1080 and PAPP for foxes and wild dogs. These devices minimise nontarget access to the toxin and can be used to maintain reduced population numbers following aerial baiting campaigns, or as a barrier to incursions into a managed area. Unlike injected meat-based baits, the toxin does not degrade over time. Monthly or bimonthly maintenance is required to ensure that triggered ejectors are replaced and that the bait heads remain attractive to predators.

Feral pig populations can be managed using sodium nitrite, which is currently marketed under the name HOGGONE®. It uses a paste-style bait matrix and is dispensed using hoppers that minimise impacts on nontarget species. Some states and territories in Australia allow 1080 to be mixed with natural baits, such as grain, to target pig populations.

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Cyanide may be available for use for some species under an APVMA emergency use permit when the carcasses of the target animals need to be recovered for testing. It is highly toxic and acts rapidly, and poisoned animals move only a few metres from the point of ingestion before dying.

The APVMA regulates the approval of toxins. If a suitable toxin exists for the target species but is not yet currently approved for use with a species, the APVMA can issue an emergency use permit. The use of toxins is regulated at a state level, and while a toxin may be approved by the APVMA at a national level, state legislation may preclude its use on certain species within that state.

This manual does not deal in detail with rodents and does not recommend widespread destruction of wild birds. Strict conditions apply to the use of poisons against these animals, and prospective users should consult state or territory departmental chemicals coordinators before using them.

Poisoning has the advantages that it:

- causes minimal disturbance
- can cover large areas quickly
- carries a small risk of dispersal of animals.

Poisoning has the disadvantages that it:

- requires a preparatory period of free feeding if poison baits are used
- is nonspecific and may kill nontarget species
- can cause carcasses to be hard to find unless a quick-acting poison, such as cyanide, is used
- its efficacy may be variable
- may cause retrieving fresh tissue samples to be difficult
- may have negative and unacceptable animal welfare impacts.

Many native species have a higher tolerance of 1080 than introduced species, particularly in Western Australia, Northern Territory and western Queensland, because it occurs naturally in some Australian plant species. This tolerance is less in the eastern states, where those plants are not endemic.

Nonlethal capture and control techniques

Live capture methods generally involve some form of trap or snare. With larger animals, tranquilliser guns and oral tranquillisers in feed baits should be considered; net guns can be used for animals such as deer. Nets (mist and hand nets) are also useful for capturing wild birds and bats. Sharp and Saunders (2005) detail the best-practice techniques and equipment requirements in their codes of practice and standard operating procedures.

Darting

Darting is a means of administering tranquillisers, to allow safe access to the animal, and is most useful for large animals. Tranquillised or sedated animals can be sampled, tested, treated, tagged or humanely euthanased, or have tracking devices fitted, for example. Darting may also be used to directly administer vaccines, treatments and, in some cases, tags or reproductive control. Darting is a specialised skill and requires species-appropriate equipment, and all darting efforts carry some risk for the target animal. Human health and safety must also be of high priority, as some tranquillisers and other medications used in darting wildlife can carry high risks for humans. In most cases, it will not be suitable to use personnel with skills only in ballistic shooting to dart wildlife.

Darting has the advantages that it:

- allows humane and safe capture and handling of wild animals

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- allows individual animals to be examined, sampled, treated, tagged and released, without the need for lethal approaches
- can be used to deliver vaccines, treatments and tagging devices remotely.

Darting has the disadvantages that it:

- is usually only useful for small numbers or individual animals
- may not work with the sedative agents suitable for the species in question, or such agents may not be available
- can only be used on larger species in open terrain, and if animals can be approached to within (generally) 30 metres
- is a specialised skill and requires species-appropriate equipment and expertise
- holds some risk for the target animal, from both trauma and the administration of sedative agents
- requires personnel to monitor animals and keep them safe during recovery, which can be prolonged.

Netting

A variety of netting techniques can be used to restrain wildlife for closer examination, sampling, and treatment. All netting efforts carry some risk for the target animal and should only be undertaken by those familiar with the techniques of netting and manually restraining wildlife.

Harp nets or traps are often used to trap bats. Mist or cannon nets can be used on birds. Hand nets can be used to restrain smaller mammals, generally in restricted areas.

Netting has the advantages that it:

- allows humane and safe capture and handling of wild animals, particularly small and flighty species such as birds, bats and small mammals
- means individual animals can be examined, sampled, treated, tagged and released, without the need for lethal approaches.

Netting has the disadvantages that it:

- carries some risk for the target animal
- requires the correct equipment and expertise
- there is some risk of trauma, depending on the species, when netted animals are examined (including bites and scratches from bats).

Trapping

Live trapping of animals can be effective at reducing populations over a small or local area. All types of trapping must be undertaken by trained operators to maximise catch rates, minimise the potential for trap aversion/shyness by the target species and ensure welfare is optimised. Traps require checking regularly to minimise the stress on captured animals. Shelter and water may need to be available to animals in traps to minimise stress. All trapping efforts carry some risk for the target animal and should only be undertaken by those familiar with the techniques of trapping and manually restraining wildlife.

Wing traps can be employed to trap larger ungulates, with animals mustered into the trap using vehicles, helicopters or operators on horseback. Judas animals can assist with finding herds, which helps with trap placement and minimises the time spent looking for the target species to muster it.

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Animals captured in traps can be humanely euthanased, transported to other areas and released, or vaccinated and released, depending on the management actions being undertaken and the outcomes sought.

Traps should be positioned close to suspected refuge areas, at permanent water, in association with barrier or temporary fencing, or along frequently used paths and pads. For traps at water, minimise dispersal by using separate one-way devices (ramps or spear gates) for entry and exit. Habituate the animals to using them and then close the exit device.

Trapping is more likely to be effective when food or water is in short supply.

Trapping has the advantages that it:

- causes minimal disturbance
- has a low risk of dispersal of animals
- can be very effective — traps at water points in dry conditions are effective for large numbers of pigs and ungulates
- provides live animals for use as sentinels or Judas animals.

Trapping has the disadvantages that it:

- may take a few weeks to achieve results
- is labour intensive to set and check traps
- can be costly
- is limited by the number of traps a trained trapper can check per day
- must be preceded by a period for free feeding or familiarisation
- may have significant negative welfare impacts.

Judas animals

The Judas animal method uses animals carrying transmitters. The animals are released into an area and join up with the local wild animals, allowing the entire group to be tracked using radio, GPS or satellite tracking techniques, depending on the transmitter used. In Australia and on many island communities, the Judas animal method has been used successfully to control feral goats (Campbell & Donlan 2005). Techniques to improve the efficacy of this technique for goats, such as pregnancy termination, sterilisation and prolonged oestrus, have been investigated (Campbell et al 2005, 2007). This method proved highly cost-effective during the brucellosis and tuberculosis eradication campaign for cattle and buffalo in the Northern Territory (Carrick et al 1990, Robinson & Whitehead 2003). It has also been tested with feral pigs (McIlroy & Gifford 1997), donkeys (Woolnough et al 2005) and starlings (Woolnough et al 2006) and has been suggested for use with camels (Edwards et al 2001).

Judas animals that are obtained from among the population to be controlled are no more likely to disperse than any other members of the population. However, Judas animals obtained from elsewhere may be more likely to disperse. For this reason, Judas animals should preferably be obtained from within the restricted area, possibly at an early stage of the control operation, when they can be caught easily. If necessary, they could be held until eventual deployment. If dispersal does occur, Judas animals allow the dispersal to be readily monitored.

Use of Judas animals has the advantages that it:

- minimises the disruption caused by human intervention in animal populations, and does not cause animals to disperse
- used animals that are cheap and, therefore, eradication is affordable in situations where it would not otherwise be contemplated

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- allows population estimation using the numbers of Judas animals and wild animals seen
- allows the use of free-ranging Judas animals as sentinel animals, to test for the presence of residual or re-invading animals and diseases — making it an ideal method for demonstrating freedom from disease at the end of a campaign.

Use of Judas animals has the disadvantages that it:

- takes time and specialised equipment
- can take weeks or even months for a Judas animal to join up with a small population of target animals
- relies on tracking devices that may fail — Judas animals must be double-collared if tracing is essential.

Exclusion fencing

Exclusion fencing can be used to exclude animals from entering an area where there is an ongoing management program or, following a management program, to prevent re-invasion by animals from outside the control area. Conversely, exclusion fencing can be used to prevent animals from leaving an area during a management program.

Exclusion fencing must cater for the specific behaviours of the target species. Higher fences are needed for animals that can climb or jump, such as foxes and deer, while reinforced and buried bases are needed for animals that burrow or push under, such as wombats and feral pigs.

Exclusion fencing is costly and must be maintained to prevent and repair damage to the fence that would allow animals to pass through the fence.

Exclusion fencing has the advantages that it:

- is nonlethal and unlikely to cause serious injuries to most species
- can be constructed with limited expertise, if an expert advises on design and construction
- can be useful for large mobs or numbers of animals
- can be left in place for extended periods (if regular safety checks are made).

Exclusion fencing has the disadvantages that it:

- must be designed specifically for the target species
- can result in some species being more easily traumatised when they collide with fencing (ie injury or entanglement)
- is costly and time-consuming to erect
- must be maintained to prevent damage and repair to the fence that could result in escape or trauma to animals (and humans).

6.4 Population containment

6.4.1 Objective

Population containment aims to alter host animal density or distribution and so prevent or minimise the risk of disease transmission by preventing infected or potentially infected animals contacting disease-free animals.

Methods of populations containment, other than culling, include:

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- controlling the dispersal of hosts
- controlling host movement (also called ‘movement control’)
- controlling contact between hosts
- controlling the reproductive rate of the host.

Forced dispersal of hosts is generally not recommended in infectious disease control; however, some methods are mentioned below.

Controlling host movement or natural dispersal may be achieved by:

- natural physical or environmental barriers (eg rivers, mountains, deserts)
- artificial barriers (eg fencing, bird-proofing).

Controlling contact between hosts may be achieved by surrounding the infected population with an ‘animal-free buffer area’ or a vaccinated wild animal control area.

Many AUSVETPLAN response strategies indicate that improved fencing or bird-proofing around domestic animal industries, or vector control, may reduce the risk of disease-agent contact between domestic and wild animals.

Dispersal involves driving or forcing animals away in many directions. It generally aims to reduce host density or remove host clustering from a specific area (eg waterbody, feeding area, nest site). In the past, dispersal for wildlife disease control has been primarily used for birds (eg to manage an avian influenza outbreak). Dispersal is generally not recommended for infectious disease situations because it spreads the host and pathogen through a wider area. Efforts at relocation may be fruitless if the animals can return to the original location. Most techniques to discourage wild animals from entering an area rapidly become ineffective (Wobeser 2002).

Movement control means stopping the movement (often human-assisted, such as translocation or shipping) of animals, with the aim of stopping or reducing disease spread.

Methods include:

- fencing
- scaring off
- attracting animals elsewhere
- not allowing harvested wildlife carcasses to be shipped from one area to another.

Examples include:

- encouraging free-ranging kangaroos to move away from a pasture where they are interacting with diseased livestock
- fencing off areas with high fluoride contamination of water and vegetation to protect free-living wildlife from excessive consumption of fluoride.

Dispersal is nonlethal to the host and generally has less impact on the host than other disease control techniques (eg culling).

It is very difficult to control the movement of wild animals. Generally, dispersal should not be used if the disease is a result of an infectious agent. Wild animals may become physiologically stressed by dispersal efforts and change or loss of habitat. These techniques may rapidly become ineffective (animals avoid or become habituated). Dispersal is most likely to be useful as a short-term solution in species that are not highly territorial.

In many cases, nonlethal population control will be more socially acceptable than lethal methods of control and containment.

When deciding whether to attempt containment, follow the guidelines in Section 3 and refer to the relevant AUSVETPLAN response strategy.

6.4.2 Planning the containment strategy

Appendix 3 lists sources of information that should be consulted when planning wild animal operations.

The LCC controller, epidemiologist and wild animal control coordinator, in consultation with appropriate species experts and wildlife biologists, will determine the type and extent of containment operations to be undertaken.

A variety of techniques can be used to contain wild animals. The most important criteria for deciding if, or which, containment techniques are appropriate are:

- the nature of the disease
- the biology and ecology of the wildlife host species
- the availability of existing natural or human-made barriers
- the timeframe available because it may take some time to fully implement a containment strategy
- the availability of resources.

Containment teams

Membership

Containment teams should generally consist of:

- local vertebrate pest control or wildlife officers, where possible
- at least one officer experienced in wild animal capture and control procedures.

If the workload is high, consider including one or more technical assistants to assist with counting, data recording and mapping.

Briefing

Containment teams will be briefed at the LCC or forward command post about where each team is to operate, what to look for, what techniques are to be used, procedures for reporting and data recording, decontamination procedures, safety, and how to deal with carcasses. Teams will report to the wild animal control team leader, or wild animal control and surveillance coordinator, depending on the size of the outbreak.

Duties

Containment teams will:

- establish and maintain physical barriers if they are used
- use safe and environmentally sound practices to humanely destroy target wild animal species, ensuring that dispersal does not occur
- complete a wild animal control form (see example in Appendix 2) or use an audited field notebook that will clearly show the locations and numbers of animals destroyed and, importantly, the number of animals that escaped
- immediately report the dispersal or escape of wild animals out of the wild animal control area

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- use a GPS device to accurately record the area of operation within the wild animal control area
- ensure that the mapping officer records the locations of animals destroyed on topographic maps at the LCC.

Where feasible, carcasses should be treated or disposed of as directed by the LCC (see the **AUSVETPLAN operational manual Disposal**). Note that, although the time and resources required to dispose of carcasses may compromise the speed of population containment, disposal may be necessary to ensure disease containment.

6.4.3 Techniques and species-specific information

Table 6.2 gives an outline of species-specific techniques.

Table 6.2 Containment techniques for wild animals

Technique	Species	Comments
Depopulation	All species	Use one or more of the techniques in Section 6 to create a buffer area of low or zero population density around the wild animal control area or the infected area
Helicopter patrol	Buffalo, camels, cattle, deer, donkeys, goats, horses, pigs	Patrol the perimeter of the wild animal control area Clearing lines of vegetation may be useful
Fences ^a	All species	Expensive, resource intensive and inflexible Useful to contain a relatively undisturbed wild animal population while it is tested for disease presence, or while Judas animals are released and allowed to join up with local wild animals Most effective against small species; large herbivores, if agitated, will penetrate fences, so disturbances in the vicinity should be minimised For very large species, consider fences that alter dispersal paths and allow passage to be detected (eg electric fences that funnel buffalo to movement detectors)
Live traps	Species respond to lures in different ways	Live traps may use various lures to attract live animals to them; lures can include water, food, visual cues (eg another animal) and scents
Cordon of armed personnel	Likely all species but not tested	Resource intensive and inflexible Use only when 100% containment is vital Combine with illumination

^a Consult experts in feral animal and wildlife fencing.

Note: Many of these techniques will be resource- and time-consuming.

7 Destruction, disposal and decontamination

This section is to be read in conjunction with the listed documents. It is not intended to replace those documents but rather is a brief overview of the decisions that must be made and factors that must be considered when planning or undertaking these actions. Where there are differences between this guide and the listed manuals, the information in the manuals takes precedence.

- **AUSVETPLAN operational manual *Destruction of animals***
- **AUSVETPLAN operational manual *Disposal***
- **AUSVETPLAN operational manual *Decontamination***.

7.1 Destruction

This section deals only with the destruction (euthanasia) of animals that have been trapped or are closely contained as part of an emergency animal disease (EAD) management action. Details on techniques available for broadscale culling of free-roaming wild animals are contained in Section 6.3 of this manual.

All animals that are to be destroyed must be killed humanely with minimal pain and distress to the animal as it dies. This must be undertaken by persons trained and skilled in the techniques being used. Death must be confirmed before any disposal actions are taken.

The methods and techniques used for destroying an animal must be humane and:

1. avoid pain or distress and produce rapid loss of consciousness until death occurs
2. be appropriate to the species, age, developmental stage and health of the animal
3. require minimum restraint of the animal
4. be reliable, reproducible and irreversible
5. where possible, ensure that animals are killed in a quiet, clean environment away from other animals
6. be undertaken by appropriately trained and skilled operators/staff
7. ensure the health and safety of the operators/staff are maintained
8. ensure that death is established before disposal of the carcass.

Planning is essential to ensure that the destruction program is carried out efficiently and effectively and is not impeded by a lack of available resources once begun. The method for developing an action plan for the operation is detailed in the **AUSVETPLAN operational manual *Destruction*** and should be referred to extensively when planning the operation.

7.1.1 Destruction techniques

Many methods of euthanasia for captive animals may not be suitable for use in field conditions. This does not lessen the obligation to ensure that any wild animal is destroyed with the least pain and distress possible. Sound judgment must be used to ensure that the technique used is rapid and humane in all circumstances and that the health and safety of those undertaking the procedures are

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maintained. Where recommended by subject matter experts at the time, inhalational or injectable sedation may be used before an appropriate method of euthanasia. The choice of technique for destruction will depend on a range of factors including:

- the animal species and the age grouping
- the number of animals (individuals versus large numbers)
- the types of facilities available, including occupational health and safety aspects
- the level of restraint the animal is under (eg in a paddock, yards or trap)
- firearm safety — proximity of people and infrastructure
- the efficiency and acceptability (e.g. by Animal Health Committee) of the method
- the practicality of the method, including the availability of proficient operators
- the training required by operators to reach proficiency
- the overall level of stress on the animal, including consideration of whether it is fit or unwell
- the disposal technique used for the carcass (eg is carcass transport needed, is there potential for nontarget scavenging).

Native animals are protected by Commonwealth and state legislation, and it is likely that permits are needed to destroy native animals as part of the EAD management activity. Additionally, some states have prescribed a minimum calibre of firearm to be used to with certain animals in field situations. Advice must be sought from relevant state authorities when determining which calibre of firearm to use to destroy wild animals. The information in this section should only be used subject to the applicable legislative requirements in the jurisdictions where the management actions are being undertaken.

Table 7.1 Destruction techniques for wild animals

Animal	Techniques available	Comments
Bats	Barbiturate injection Carbon monoxide/ carbon dioxide	
Buffalo	Shooting (head or chest) Captive bolt	Headshot preferred
Camels	Shooting (head or chest) Captive bolt	Headshot preferred
Cats	Barbiturate injection Shooting (head shot) Captive bolt Carbon monoxide/ carbon dioxide	Sedation may be required before barbiturate overdose
Cattle	Shooting (head or chest) Captive bolt	Headshot preferred

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Animal	Techniques available	Comments
Deer	Shooting (head or chest) Captive bolt	Headshot preferred
Dogs	Barbiturate injection Shooting (head shot) Captive bolt Carbon monoxide/ carbon dioxide	Sedation may be required before barbiturate overdose
Donkeys	Shooting (head or chest) Captive bolt	
Foxes	Barbiturate injection Shooting (head shot) Carbon monoxide/ carbon dioxide	
Goats	Barbiturate injection Shooting (head or chest) Captive bolt	Headshot preferred
Horses	Shooting (head or chest)	Headshot preferred
Pigs	Shooting (head or chest) Captive bolt HOGGONE®	Headshot preferred
Wild birds	Carbon monoxide/ carbon dioxide Barbiturate injection Cervical dislocation (small/mid-size birds only) Shooting (chest)	Technique used depends on situation and size of birds
<i>Native animals</i>		

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Animal	Techniques available	Comments
Small native mammals (eg antechinus)	Carbon monoxide/ carbon dioxide Barbiturate injection Cervical dislocation Decapitation	Note: female animals must be examined for the presence of pouch young. These must be killed humanely.
Mid-sized mammals (eg quoll)	Barbiturate injection Shooting (head shot) Captive bolt Carbon monoxide/ carbon dioxide	Note: female animals must be examined for the presence of pouch young. These must be killed humanely.
Small macropods (1–4 kg)	Barbiturate injection Shooting (head shot) Captive bolt Carbon monoxide/ carbon dioxide	Note: female animals must be examined for the presence of pouch young. These must be killed humanely. Young at foot must be killed using a single shot to the brain or heart, barbiturate injection or blow to the head by a skilled operator.
Mid-size macropods (4–10 kg)	Barbiturate injection Shooting (head shot) Captive bolt	Note: female animals must be examined for the presence of pouch young. These must be killed humanely. Young at foot must be killed using a single shot to the brain or heart, barbiturate injection or blow to the head by a skilled operator.
Large macropods (>10 kg)	Barbiturate injection Shooting (head shot) Captive bolt	Note: female animals must be examined for the presence of pouch young. These must be killed humanely. Young at foot must be killed using a single shot to the brain or heart, barbiturate injection or blow to the head by a skilled operator.
Wombats	Shooting (head or chest)	Headshot preferred Note: female animals must be examined for the presence of pouch young. These must be killed humanely.

Note: for euthanasia of other marsupials seek expert advice.

7.1.2 Ensuring death has occurred

It is essential to confirm that death has occurred in the animal. There are several ways to confirm that death has occurred:

- Absence of respiratory movement: This sign alone is not sufficient, because the heart may continue to beat for some time after respiration has stopped.

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- Absence of heartbeat/pulse: Determined by stethoscope or appropriate palpation (in some small species, determining loss of pulse by palpation may not be possible).
- Corneal and palpebral reflexes are lost: The eye and eyelid does not move when the eye is touched.
- Glazed eyes: can occur rapidly after death but should be used in conjunction with other signs to confirm death and not solely relied upon.
- Wide, dilated unresponsive pupils
- Loss of colour of mucous membranes: mucous membranes in the mouth become mottled and do not refill after pressure is applied and released.

A minimum of two of these methods should be used to confirm death, especially when using barbiturates as a destruction method.

7.1.3 Additional reading on destruction of animals

Reilly JS (ed) (2001). *Euthanasia of animals used for scientific purposes* (currently under review), 2nd edn, Australian and New Zealand Council for the Care of Animals in Research and Teaching, Adelaide.¹⁴

NSW codes of practice and standard operating procedures for the effective and humane management of pest animals (2022). New South Wales Government, Sydney.¹⁵

National code of practice for the humane shooting of kangaroos and wallabies for non-commercial purposes (2008). Australian Government, Canberra.¹⁶

Code of practice for the humane destruction of wombats by shooting in South Australia (2018). South Australian Government, Adelaide.¹⁷

Sharp T (2016). *General methods of euthanasia under field conditions*, Standard Operating Procedure, PestSmart, Canberra.¹⁸

AVMA guidelines for the euthanasia of animals, 2020 edn (2020). American Veterinary Medical Association, Schaumburg, Illinois.¹⁹

7.2 Disposal

This section deals with the disposal of wild animals that have been destroyed as part of the EAD management actions or as part of the broadscale culling activities as described in Section 6.3. This section must be read in conjunction with the **AUSVETPLAN operational manual Disposal**. It is not intended that this section replace or supersede the instructions and guidelines set out in that manual. Where there are differences between this guide and the disposal manual, the information in the disposal manual shall take precedence.

Once death has been confirmed, the carcass must be managed in an appropriate manner. Carcasses awaiting disposal pose a risk of spreading the EAD and may need to be contained to prevent access by members of the public, domestic animals and pets, or other wild animals such as scavenging birds and

¹⁴ <https://nre.tas.gov.au/Documents/ANZCCART-Guidelines-for-Euthanasia-of-Animals.pdf>

¹⁵ www.dpi.nsw.gov.au/biosecurity/vertebrate-pests/publications/standard-operating-procedures

¹⁶ <https://cdn.environment.sa.gov.au/environment/docs/code-of-practice-kangaroos-wallabies-non-commercial.pdf>

¹⁷ <https://cdn.environment.sa.gov.au/environment/docs/cop-wombat-2018.pdf>

¹⁸ <https://pestsmart.org.au/pest-animals/general-methods-of-euthanasia-in-field-conditions>

¹⁹ <https://www.avma.org/sites/default/files/2020-02/Guidelines-on-Euthanasia-2020.pdf>

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mammals. Containment protocols are used to prevent access while the carcasses are awaiting disposal. The carcass of any animal killed with barbiturates must be managed so that the risk to scavengers through ingestion is minimised.

In some instances, it may be appropriate to leave carcasses in situ (ie 'leave and let lie') to allow for environmental degradation of the disease agent along with the carcasses. This would require a risk assessment to determine if temperature, pH changes in the carcasses and time are sufficient to inactivate the disease agent, and if there are unacceptable disease risks associated with leaving the carcasses to degrade.

A range of factors must be considered when determining how to dispose of the carcasses of the animals killed during a destruction or culling operation. The most important of these is that the disposal method chosen must prevent the dissemination of the EAD from the carcasses. All site hazards, including the exposure of personnel to potential zoonotic infection, must be identified and assessed, and appropriate controls must be implemented before disposal work begins. Personnel must be fully trained and briefed, including on the nature of the disease and any hygiene requirements. Advice should be sought from experts in the disposal techniques that are being considered before a decision to use that technique is made.

Many factors must be considered when determining an appropriate and effective technique for the disposal of destroyed carcasses:

1. The nature of the EAD: The epidemiology of the EAD will impact the methods of disposal and transport of the carcasses to the disposal site. The persistence of the disease in the carcasses must also be considered, as must the potential for scavenging of the carcasses before and after disposal.
2. The method of euthanasia: If barbiturates have been used, disposal methods must ensure scavengers cannot access the carcass, because secondary toxicity and death may occur.
3. Transportation of carcasses: Factors to consider include carcass accessibility, distance to be transported, method of transport, number and size of total carcasses and availability of biosecure transportation vehicles if needed. As an example, it will be more difficult to collect and transport animals from an aerial cull than those euthanased in a paddock or yard.
4. Available resources: Factors to consider include the availability of appropriate vehicles, machinery, staff, and materials needed for disposal activities such as dry timber if burning is to be used.
5. Costs: These include transport, staff, monitoring of sites, construction of disposal equipment if needed, decontamination of site and vehicles and machinery.
6. Environment: Evaluate the impact of the disposal method, weather, potential for pollution or leachate escaping into surface and ground water supplies, and so on.
7. Legislation: Compliance with appropriate legislation and obtaining regulatory approvals are essential.
8. Timeline: Consider how long the program will take and for how long monitoring of the disposal site is needed.
9. Operator/staff safety: Ensuring the workplace health and safety of all operators and staff involved in the activity is essential.
10. Community concerns: These may include concerns over potential for pollution (eg smoke or odour), leachate escaping into water supplies, EAD transmission from carcasses to livestock or pets, and cultural wishes.

Each method of disposal has advantages and disadvantages and each of these must be considered when deciding which method to use. Some methods are suitable for disposal of small volumes of animals, others are more suitable for disposal of large volumes of animals. The method used must ensure the destruction of the EAD during the disposal process.

Table 7.2 Methods of disposal.

Method		Description
Deep burial	Trench burial on-site	Carcasses are placed in an excavated trench and backfilled over the top
	Commercial landfill	Carcasses are disposed of in pre-existing commercially operated landfill operations (rubbish disposal sites) – some may have dedicated cells for animal disposal
	Mass burial — unlined	Used when many carcasses from multiple locations are disposed of and where soil type or geology prevents leachate escaping
	Mass burial — lined	As above except the pit is lined with absorbent material to prevent leachate escaping
	Above-ground burial (mounding)	Carcasses are piled above ground and covered with soil (generally obtained from elsewhere)
Burning	Open-air pyre	Carcasses are placed on pyres of dry wood or similar and incinerated
	Air-curtain incineration	Carcasses are burned in an earthen pit or metal firebox where a continuous flow of air is pumped over them to increase combustion
	Mobile incineration	Uses small gas-powered mobile incinerators that can be moved from site to site
	Commercial incineration	Uses commercially built incinerators for waste products
Rendering	Animals are commercially rendered to separate fats from other solid tissue	
Composting	Composting is undertaken in windrows, bins or vessels with other compostable material to produce usable byproducts	
Anerobic digestion	Disposes of carcasses in purpose-built anerobic digestion chambers to produce usable biogas	
Alkaline hydrolysis	Uses heat, pressure and an alkaline solution to dissolve and sterilise biological material	
Leave in situ	Carcasses are left where they are destroyed	
Ocean disposal	Carcasses are disposed of into the ocean	
Re-feeding	Carcasses are fed, either whole or cut up, to animals that are not susceptible to the disease	

7.3 Decontamination

This section deals with the decontamination of personnel, equipment and areas that have been used for the destruction and disposal of wild animals euthanased as part of the EAD management actions or as part of broadscale culling activities, as described in Section 6.3 This section must be read in conjunction with the **AUSVETPLAN operational manual *Decontamination***. It is intended that this section provide only a brief overview of what is needed, and it is not intended that this section replace

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or supersede the instructions and guidelines set out in that manual. Where there are differences between this guide and the decontamination manual, the information in the decontamination manual shall take precedence.

Decontamination of areas inhabited by wild animals that have been identified as being infected with an EAD is more difficult than would be normally encountered when undertaking decontamination activities following an EAD detection in domestic animal herds. Landscape-scale decontamination is rarely likely to be feasible, economically viable or effective. Expert advice must be sought as to the potential impacts of not being able to undertake decontamination at a landscape scale as well as on ways to mitigate these impacts as part of the EAD management plan.

The appropriate procedures and disinfectants for key EADs are listed in the **AUSVETPLAN operational manual *Decontamination*** and that manual should be referred to for advice for the EAD being managed. Decontamination of personnel, equipment and localised areas that have been used for the destruction and disposal of wild animals is essential, and a decontamination protocol suitable for the specific EAD must be detailed in the EAD management plan.

Personal decontamination (see *AUSVETPLAN operational manual Decontamination*)

The aim of personal decontamination is to safely remove any contamination from the body or clothing. The process minimises the risk of cross-contamination, so that people can confidently move out of the contaminated environment with no or minimal risk of dissemination of the disease agent. Personal decontamination procedures must be rigorously applied. Having a personal kit (see ***AUSVETPLAN operational manual Decontamination***) in the vehicle at all times will enable correct disinfection.

The heaviest contamination will occur:

- when living infected animals are physically inspected
- at the site of destruction of wild animals
- when destroyed animals are being inspected and having diagnostic samples taken
- at the carcass disposal site
- when removing manure and detritus from the trap or area where the wild animals were enclosed before destruction.

Personal decontamination sites must be available near the entry and exit points of areas where wild animals are tested, held, destroyed and/or disposed of. A suitable receptacle for disposal of PPE used at the site must be provided. All personnel leaving the site must follow the decontamination protocol outlined in the EAD management plan. People leaving the site must not have contact with any animals (domestic or wild) that are susceptible to the EAD for the period specified in the EAD management plan or as directed by the local disease control centre.

7.3.1 Equipment/vehicle decontamination

All equipment (including traps), machinery and vehicles used as part of the destruction and disposal of wild animals can pose a risk of dissemination of the EAD. No vehicle, machinery or equipment (including traps) should leave the site without first undergoing appropriate decontamination. Protocols for the appropriate decontamination of vehicles, machinery and equipment are detailed in the **AUSVETPLAN operational manual *Decontamination*** and should also be specified in the EAD management plan. Vehicles used to transport personnel to and from the site should remain outside the site boundaries when possible to minimise the number of vehicles that must be decontaminated.

7.3.2 Cars

If cars are to be decontaminated, rubber floor mats should be removed for scrubbing with appropriate disinfectant. The dashboard, steering wheel, handbrake, gearstick and driver's seat should be wiped liberally with disinfectant. If the boot is considered contaminated, the contents must be removed and the interior wiped with disinfectant. The contents of the boot must be treated similarly before being replaced. The wheels, wheel arches, undercarriage and bodywork of the car should be sprayed with noncorrosive disinfectant, not plain water. Caustic soda should not be used on paintwork. If possible, all vehicles should be washed on-site, because most cleaning processes, including power hoses, spread the infectious agent.

Plain water is not to be used with power hoses, because the process will release contaminated aerosols of the pathogen. A mixture of disinfectant and water should always be used with power hoses. However, using disinfectant or soap and water with brushing to dislodge encrusted dirt and organic matter is preferable to washing with strong water streams.

Heavily contaminated vehicles must be cleaned on the site and must not be moved elsewhere for cleaning.

7.3.3 Vehicles used for transporting wild animals and/or carcasses for disposal

For any vehicle that has transported wild animals either before destruction or afterwards to disposal sites, the principles of vehicle and trailer decontamination are the same.

All solid debris, faecal matter and bedding must be removed. All water, feedstuff and litter carried in the vehicle must be disinfected and burned or buried. The vehicle should then be soaked in disinfectant using a detergent and scrubbed down to paint, bare metal or bare wood, as appropriate.

All fixtures and fittings must be dismantled to ensure that infected material has been removed. All surfaces must be cleaned down to paint or, bare metal as appropriate and then disinfected. Wooden surfaces must be cleaned and disinfected, where appropriate, or valued before removal and destruction. The wheels, wheel arches, bodywork and undercarriage must be cleaned of detritus, and disinfected. The driver's cabin and sleeping compartment, if fitted, must also be cleaned and disinfected.

When the crate structure of a trailer has been decontaminated, the stock crate should be lifted free from the body. The underside of the stock crate and the parts of the trailer on which it rests should be decontaminated. The vehicle must be closely inspected to determine if any surfaces are layered. If this is so, the top layer of metal tread plate or wood must be removed to reach areas where contaminated material could be trapped. Any metal flooring that appears solid must be weight tested to ensure that

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welds are not cracked and that there is no rubbish under the flooring. Some trailers may carry extra equipment under the body; if so, this must be treated.

The outside dual wheels and spare wheels must be removed to ensure adequate decontamination of the wheel hubs and to allow inspection of the spare wheel hangers, which can be hollow and therefore could hold contaminated material.

Where carcasses, offal and other contaminated material must be moved off the destruction site for disposal elsewhere, the alternative disposal site should be as close as possible to the destruction site, and the access route must be chosen to minimise danger to susceptible animals. The site must be designated as a quarantined area.

The transport vehicle's container must be leak-proof, and preferably have a rear opening, be capable of tipping, and be capable of being sealed at the top. If the vehicle cannot tip, there must be a crane at the disposal site for lifting carcasses out.

The vehicle must be loaded using a suitable 'lift' crane and cargo net, or front-end loader. Once the vehicle is loaded, the carcasses or contaminated material must be sprayed with disinfectant. The driver and the vehicle's body, wheels and undercarriage must be decontaminated thoroughly before departure. The cover of the container must be strapped down tightly and decontaminated.

At the disposal site, there must be sufficient equipment, water supply, drainage and materials to decontaminate the expected number of vehicles. Each driver and vehicle must be decontaminated before leaving the disposal site.

On completion of disposal:

- all vehicles and equipment must be decontaminated off the site
- the area of disposal must be soaked in disinfectant
- the area must be securely fenced
- after 21 days, the burial site must be revisited and the mound and surrounds disinfected again under the supervision of a departmental officer
- quarantine must remain in force for a period to be determined by the local control centre controller.

7.3.4 Machinery

Heavy machinery used at a destruction or disposal site will be significantly contaminated. This machinery includes:

- mechanised diggers for burial pits
- bulldozers for pushing carcasses
- front-end loaders, tractors and trailers for carrying carcasses and faecal and other material
- cranes for carcass lifting
- chains, hooks and cargo nets.

Such equipment must remain on the infected premises (IP) until needed elsewhere.

Once carcass disposal has been completed, drivers and machinery must be decontaminated. Vehicles should be moved to the decontamination site for thorough decontamination. When the vehicle is moved again, the cab must not be re-contaminated by the driver. All ancillary equipment must be treated similarly.

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Where low-loader vehicle transporters are required, they should not be allowed onto the IP. Vehicles leaving the IP should be loaded outside the IP boundary.

7.3.5 Captive-bolt pistols and firearms

Weapons used to destroy wild animals will be significantly contaminated (especially if used at close range) but their mechanisms prohibit the use of many disinfectants. After completion of destruction, they should be cleaned with a noncorrosive disinfectant and thoroughly lubricated with liquid and aerosol lubricants, especially their internal mechanisms. The woodwork should not be immersed in disinfectant because this may lead to warping or splitting. If a weapon requires servicing, it should be taken in a disinfected plastic bag to a gunsmith. The gunsmith should be made aware that the mechanism needs disinfection. The weapon can be stripped down, the parts disinfected, and the weapon serviced and re-oiled.

Appendix 1 Relevant legislation

Authority	Name	Relevance
Commonwealth	<i>Biosecurity Act 2015</i> (Cwth)	Monitoring, control of and response to biosecurity risks and emergencies posed by pests and diseases
	<i>Agricultural and Veterinary Chemicals Code Act 1994</i>	Control of agricultural and veterinary chemical products
	<i>Environment Protection and Biodiversity Conservation Act 1999</i>	Protection of environment and conservation of biodiversity
Australian Capital Territory	<i>Animal Diseases Act 2005</i>	Prevention and control of outbreaks of animal diseases
	<i>Pest Plants and Animals Act 2005</i>	Pest animal management
	<i>Nature Conservation Act 1980</i>	Conservation of native flora and fauna
	<i>Environment Protection Act 1997</i>	Regulate use of hazardous substances, coordinate environment protection
	<i>Medicines, Poisons and Therapeutic Goods Act 2008</i>	Regulate use of poisons
	<i>Animal Welfare Act 1992</i>	Trapping, handling and destruction of animals
	<i>Firearms Act 1996</i> Firearms Regulation 2008	Regulate possession and use of firearms
	<i>Work Safety Legislation Amendment Act 2009</i> (or equivalent)	Secure health, safety and welfare of employees at work
New South Wales	<i>Biosecurity Act 2015</i> Biosecurity Regulation 2017	Control of outbreaks of animal diseases
	<i>State Emergency and Rescue Management Act 1989</i>	Emergency management
	<i>Local Land Services Act 2013</i> Local Land Services Regulation 2014	Pest animal management on private and agricultural land
	<i>National Parks and Wildlife Act 1974</i>	Pest animal management on public land, non-native liberation

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	<i>Biodiversity Conservation Act 2016</i>	Native flora and fauna conservation
	<i>Pesticides Act 1999</i>	Regulate use of pesticides and poisons
	<i>Game and Feral Animal Control Act 2002</i>	Regulate hunting of game animals and some pest species on public land
	<i>Prevention of Cruelty to Animals Act 1979</i>	Trapping, handling and destruction of animals
	<i>Firearms Act 1996</i> Firearms Regulation 2017	Possession and use of firearms
	<i>Work Health and Safety Act 2011</i>	Safe working environment
Northern Territory	<i>Livestock Act 2008</i>	Detection, prevention and control of stock diseases
	<i>Emergency management Act 2013</i>	Emergency management
	<i>Territory Parks and Wildlife Conservation Act 1976</i>	Feral animal management, use of pesticides
	<i>Poisons and Dangerous Drugs Act 1983</i>	Regulate supply and use of poisons
	<i>Agricultural and Veterinary Chemicals (Control of Use) Act 2004</i>	Regulate sale, use and application of chemical products
	<i>Animal Protection Act 2018</i>	Trapping, handling and destruction of animals
	<i>Firearms Act 1997</i>	Regulate possession and use of firearms
	<i>Work Health and Safety (National Uniform Legislation) Act 2011</i>	Health and safety of workers
Queensland	<i>Exotic Diseases in Animals Act 1981</i>	Control of animal diseases
	<i>Stock Act 1915</i>	Stock disease management
	<i>Disaster Management Act 2003</i>	Emergency management
	<i>Land Protection (Pest and Stock Route Management) Act 2002</i>	Pest animal management
	<i>Nature Conservation Act 1992</i>	Conservation of nature
	<i>Health Act 1937</i>	Regulate supply and use of poisons

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	Health (Drugs and Poisons) Regulation 1996	
	<i>Animal Care and Protection Act 2001</i>	Trapping, handling and destruction of animals
	<i>Pest Management Act 2001</i>	Protect public health from pest control and fumigation activities
	<i>Weapons Act 1990</i>	Possession and use of weapons, including firearms
	<i>Workplace Health and Safety Act 1995</i>	Protection in the workplace
South Australia	<i>Livestock Act 1997</i>	Regulate livestock matters, including exotic disease control
	<i>Emergency Management Act 2004</i>	Emergency management
	<i>Natural Resources Management Act 2004</i>	Pest animal management
	<i>National Parks and Wildlife Act 1972</i>	Conservation of wildlife
	<i>Controlled Substances Act 1984</i> Controlled Substances (Poisons) Regulations 1996	Sale and use of poisons
	<i>Animal Welfare Act 1985</i>	Trapping and destruction of animals
	<i>Dog Fence Act 1946</i>	Wild dog management
	<i>Firearms Act 1977</i>	Control possession, use and sale of firearms
<i>Occupational Health, Safety and Welfare Act 1986</i>	Health, safety and welfare of workers	
Tasmania	<i>Animal Health Act 1995</i>	Prevention, detection and control of animal diseases
	<i>Emergency Management Act 2006</i>	Emergency management
	<i>Vermin Control Act 2000</i>	Pest animal management
	<i>National Parks and Reserves Management Act 2002</i>	Protection of national parks and wildlife against introduced species and diseases
	<i>Nature Conservation Act 2002</i>	Protection and conservation of native flora and fauna
	<i>Poisons Act 1971</i>	Regulate sale, supply and use of poisons

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	<i>Agricultural and Veterinary Chemical (Control of Use) Act 1995</i>	Use and application of agricultural and veterinary chemical products
	<i>Police Offences Act 1935</i>	Illegal use of poisons
	<i>Animal Welfare Act 1993</i>	Use of traps and poisons, destruction of animals
	<i>Firearms Act 1996</i>	Regulation and control of firearms
	<i>Workplace Health and Safety Act 1995</i>	Health and safety of workers
Victoria	<i>Livestock Disease Control Act 1994</i>	Prevention, monitoring and control of livestock diseases
	<i>Emergency Management Act 2013</i>	Organisation of emergency management
	<i>Catchment and Land Protection Act 1994</i>	Pest animal management on public and private land
	<i>Wildlife Act 1975</i>	Wildlife protection and management
	<i>Flora and Fauna Guarantee Act 1988</i>	Management and control of native fauna and flora
	<i>National Parks Act 1975</i>	Management of natural environment in designated parks
	<i>Agriculture and Veterinary Chemicals (Control of Use) Act 1992</i>	Sale and use of poisons
	<i>Drugs, Poisons and Controlled Substances Act 1981</i>	Transportation of baits
	<i>Prevention of Cruelty to Animals Act 1986</i>	Trapping, handling and destruction of animals
	<i>Prevention of Cruelty to Animals Regulations 2019</i>	Regulation of traps
	<i>Firearms Act 1996</i>	Regulation and use of firearms
	<i>Control of Weapons Act 1990</i>	Use of M44 ejectors
	<i>Occupational Health and Safety Act 2004</i>	Health, safety and welfare of workers
	<i>Impounding of Livestock Act 1994</i>	Impounding of livestock and regulation of impounded livestock
Western Australia	<i>Exotic Diseases of Animals Act 1993</i>	Prevention and control of exotic diseases
	<i>Biosecurity and Agriculture Management Act 2007</i>	Control of declared pest or disease, use of chemicals

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	<i>Agriculture and Related Resources Protection Act 1976</i>	Pest animal management, control and prevention on agricultural land, regulate poison and trap use
	<i>Wildlife Conservation Act 1950</i>	Protection of fauna and flora, illegal use of traps
	<i>Poisons Act 1964</i>	Sale and use of poisons
	<i>Health Act 1911</i> Health (Pesticides) Regulations 2011	Use, storage and transport of certain pesticides
	<i>Animal Welfare Act 2002</i>	Humane handling, and destruction and control techniques
	<i>Firearms Act 1973</i>	Regulate use of firearms
	<i>Occupational Safety and Health Act 1984</i>	Improve standards of occupational safety and health

Appendix 2 Useful forms

Table A2.1 Wild animal sampling form

Date					Operator name or ID			
Geographical size					Location ID			
Animal ID	Location (GPS)	Time	Species	Age	Sex	Group size	Clinical signs	Sampled Y/N

Table A2.2 Wild animal control form

Date		Operator name/ID					
Geographical area/zone		Location ID					
Operation type (circle)							
Aerial Shooting Ground Shooting Baiting Trapping Other							
Location (GPS)	Time	Species	Number in group	Number destroyed	Number escaped	Comments	

Appendix 3 Sources of information about various species

Species	Sources of information
All species	Consult local or state vertebrate pest control authorities ^a and control officers, national park rangers, landholders, local hunters and wildlife biologists to determine the likely location and density of species. Also refer to key documents. ^{bc}
Bats	Consult state government wildlife unit, museums, universities, carer groups.
Buffalo and cattle	Consult the most recent aerial surveys of the Northern Territory and northern Western Australia.
Camels	As for all species (above). Consult most recent aerial survey data.
Deer	<p>The Australian Deer Association Inc. and similar state bodies should be able to recommend hunters with local knowledge who can:</p> <ul style="list-style-type: none"> • provide information on deer control and live capture • evaluate deer numbers from tracks and spotlight counts • advise on feeding areas and seasonal movements. <p>Consult university researchers and the Australian Wildlife Management Society.</p>
Dogs and dingoes	Consult local doggers and, where appropriate, the local or state authority responsible for wild dog destruction, and university researchers.
Feral cats and foxes	As for all species (above).
Feral goats	Consult commercial harvesters as to the location and number of goats shot and mustered in the area.
Feral horses and donkeys	As for all species (above).
Feral pigs	Consult commercial harvesters and chiller operators as to the location and number of pigs shot in the area.
Marsupials	In addition to national park rangers, consult state government wildlife units, commercial harvesters, local field naturalists and wildlife conservation organisations.

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Wild birds	Consult state government wildlife units, local and state ornithologist groups, Birds Australia and domestic bird producers as to the location and species of wild birds in the area, as well as Field and Game Australia, other hunting organisations and university researchers.
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a Refer to the state or territory emergency disease management manual for contact details of organisations.

b Refer to <https://pestsmart.org.au/>.

c Refer to <https://wildlifehealthaustralia.com.au/FactSheets.aspx> for wildlife disease fact sheets.

Glossary

Document-specific terms

Term	Definition
1080	1080 is sodium monofluoroacetate, a poison used in specified concentrations for specified baits for the lethal control of certain animal species.
Baiting	Baiting is generally used to describe the lethal control of a target species by incorporating a toxin/poison into a food-based lure (bait). Consumption of the bait leads to the death of the animal consuming it. Oral-based vaccines can also be delivered using baits. This has not been done in Australia, but has in other countries.
Canid pest ejector	This is a spring-activated device used to propel a specified poison into the mouth of a dog or fox as they attempt to eat a lure bait placed on top of the ejector.
Captive wildlife	A wild animal that lives under human supervision and control — for example, in a zoo or wildlife park.
Crepuscular	Animals that are primarily active during twilight periods.
Dispersal	Dispersal is the movement of young animals away from the natal home prior to the next breeding season. These animals move into the environment to form home ranges for themselves. This is different from animals moving within their home range or being part of a migration between, for example, summer and winter feeding areas.
Domestic animal	An animal that has been tamed and lives under human supervision and control to serve a purpose — especially a member of those species that have, through selective breeding, become notably different from their wild ancestors.
Feral animal	A previously domesticated animal that now does not live under human supervision or control.
HOGGONE®	A bait that uses sodium nitrite and has been developed to specifically target pigs, killing them quickly and breaking down after the pig has died.
Judas animal	An animal that has been fitted with a tracking device and released to join local wild populations, allowing wild populations to be found without physical human surveying.
Natal home range	The area around an animal's place of birth.
PAPP	PAPP, or <i>para</i> -aminopropiophenone, is a type of poison added to baits in specific concentrations for the lethal control of certain animal species.
Wildlife/wild animal	An animal that does not live under human supervision or control, and has not been selectively bred, or had its phenotype selected, by humans.
Wing trap	A wing trap is a physical trap with long 'wings' that help to guide or funnel animals from a wider area into a smaller area in which they become trapped.

Standard AUSVETPLAN terms

Term	Definition
Animal byproducts	Products of animal origin that are not for consumption but are destined for industrial use (eg hides and skins, fur, wool, hair, feathers, hooves, bones, fertiliser).
Animal Health Committee	A committee whose members are the chief veterinary officers of the Commonwealth, states and territories, along with representatives from the CSIRO Australian Centre for Disease Preparedness (CSIRO-ACDP) and the Australian Government Department of Agriculture, Fisheries and Forestry. There are also observers from Animal Health Australia, Wildlife Health Australia, and the New Zealand Ministry for Primary Industries. The committee provides advice to the National Biosecurity Committee on animal health matters, focusing on technical issues and regulatory policy. <i>See also</i> National Biosecurity Committee
Animal products	Meat, meat products and other products of animal origin (eg eggs, milk) for human consumption or for use in animal feedstuff.
Approved processing facility (APF)	An abattoir, knackery, milk processing plant or other such facility that maintains increased biosecurity standards. Such a facility could have animals or animal products introduced from lower risk premises under a permit for processing to an approved standard.
At-risk premises (ARP)	A premises in a restricted area that contains a live susceptible animal(s) but is not considered at the time of classification to be an infected premises, dangerous contact premises, dangerous contact processing facility, suspect premises or trace premises.
Australian Chief Veterinary Officer	The nominated senior veterinarian in the Australian Government Department of Agriculture, Fisheries and Forestry who manages international animal health commitments and the Australian Government's response to an animal disease outbreak. <i>See also</i> Chief veterinary officer
AUSVETPLAN	Australian Veterinary Emergency Plan. A series of technical response plans that describe the proposed Australian approach to an emergency animal disease incident. The documents provide guidance based on sound analysis, linking policy, strategies, implementation, coordination and emergency-management plans.
Carcase	The body of an animal slaughtered for food.
Carcass	The body of an animal that died in the field.
Chief veterinary officer (CVO)	The senior veterinarian of the animal health authority in each jurisdiction (national, state or territory) who has responsibility for animal disease control in that jurisdiction. <i>See also</i> Australian Chief Veterinary Officer
Compartmentalisation	The process of defining, implementing and maintaining one or more disease-free establishments under a common biosecurity management system in accordance with WOAHA guidelines, based on applied biosecurity measures and surveillance, to facilitate disease control and/or trade.

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Term	Definition
Compensation	The sum of money paid by government to an owner for livestock or property that are destroyed for the purpose of eradication or prevention of the spread of an emergency animal disease, and livestock that have died of the emergency animal disease. <i>See also</i> Cost-sharing arrangements, Emergency Animal Disease Response Agreement
Consultative Committee on Emergency Animal Diseases (CCEAD)	The key technical coordinating body for animal health emergencies. Members are state and territory chief veterinary officers, representatives of CSIRO-ACDP and the relevant industries, and the Australian Chief Veterinary Officer as chair.
Control area (CA)	A legally declared area where the disease controls, including surveillance and movement controls, applied are of lesser intensity than those in a restricted area (the limits of a control area and the conditions applying to it can be varied during an incident according to need).
Cost-sharing arrangements	Arrangements agreed between governments (national and states/territories) and livestock industries for sharing the costs of emergency animal disease responses. <i>See also</i> Compensation, Emergency Animal Disease Response Agreement
Dangerous contact animal	A susceptible animal that has been designated as being exposed to other infected animals or potentially infectious products following tracing and epidemiological investigation.
Dangerous contact premises (DCP)	A premises, apart from an abattoir, knackery or milk processing plant (or other such facility), that, after investigation and based on a risk assessment, is considered to contain a susceptible animal(s) not showing clinical signs, but considered highly likely to contain an infected animal(s) and/or contaminated animal products, wastes or things that present an unacceptable risk to the response if the risk is not addressed, and that therefore requires action to address the risk.
Dangerous contact processing facility (DCPF)	An abattoir, knackery, milk processing plant or other such facility that, based on a risk assessment, appears highly likely to have received infected animals, or contaminated animal products, wastes or things, and that requires action to address the risk.
Declared area	A defined tract of land that is subjected to disease control restrictions under emergency animal disease legislation. There are two types of declared areas: restricted area and control area.
Decontamination	Includes all stages of cleaning and disinfection.
Depopulation	The removal of a host population from a particular area to control or prevent the spread of disease.
Destroy (animals)	To kill animals humanely.
Disease agent	A general term for a transmissible organism or other factor that causes an infectious disease.
Disinfectant	A chemical used to destroy disease agents outside a living animal.

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Term	Definition
Disinfection	The application, after thorough cleansing, of procedures intended to destroy the infectious or parasitic agents of animal diseases, including zoonoses; applies to premises, vehicles and different objects that may have been directly or indirectly contaminated.
Disinsectisation	The destruction of insect pests, usually with a chemical agent.
Disposal	Sanitary removal of animal carcasses, animal products, materials and wastes by burial, burning or some other process so as to prevent the spread of disease.
Emergency animal disease	A disease that is (a) exotic to Australia or (b) a variant of an endemic disease or (c) a serious infectious disease of unknown or uncertain cause or (d) a severe outbreak of a known endemic disease, and that is considered to be of national significance with serious social or trade implications. <i>See also</i> Endemic animal disease, Exotic animal disease
Emergency Animal Disease Hotline	24-hour free call service for reporting suspected incidences of exotic diseases — 1800 675 888.
Emergency Animal Disease Response Agreement	Agreement between the Australian and state/territory governments and livestock industries on the management of emergency animal disease responses. Provisions include participatory decision making, risk management, cost sharing, the use of appropriately trained personnel and existing standards such as AUSVETPLAN. <i>See also</i> Compensation, Cost-sharing arrangements
Endemic animal disease	A disease affecting animals (which may include humans) that is known to occur in Australia. <i>See also</i> Emergency animal disease, Exotic animal disease
Enterprise	See Risk enterprise
Enzyme-linked immunosorbent assay (ELISA)	A serological test designed to detect and measure the presence of antibody or antigen in a sample. The test uses an enzyme reaction with a substrate to produce a colour change when antigen-antibody binding occurs.
Epidemiological investigation	An investigation to identify and qualify the risk factors associated with the disease. <i>See also</i> Veterinary investigation
Epidemiology	The study of disease in populations and of factors that determine its occurrence.
Exotic animal disease	A disease affecting animals (which may include humans) that does not normally occur in Australia. <i>See also</i> Emergency animal disease, Endemic animal disease
Exotic fauna/feral animals	See Wild animals
Feeding prohibited pig feed	Also known as 'swill feeding', it includes: <ul style="list-style-type: none"> • feeding, or allowing or directing another person to feed, prohibited pig feed to a pig • allowing a pig to have access to prohibited pig feed

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Term	Definition
	<ul style="list-style-type: none"> • the collection and storage or possession of prohibited pig feed on a premises where one or more pigs are kept • supplying to another person prohibited pig feed that the supplier knows is for feeding to any pig. <p>This definition was endorsed by the Agriculture Ministers' Council through AGMIN OOS 04/2014.</p>
Fomites	Inanimate objects (eg boots, clothing, equipment, instruments, vehicles, crates, packaging) that can carry an infectious disease agent and may spread the disease through mechanical transmission.
General permit	<p>A legal document that describes the requirements for movement of an animal (or group of animals), commodity or thing, for which permission may be granted without the need for direct interaction between the person moving the animal(s), commodity or thing and a government veterinarian or inspector. The permit may be completed via a webpage or in an approved place (such as a government office or commercial premises). A printed version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements.</p> <p><i>See also</i> Special permit</p>
Gross value of production	<p>The gross value of production in a particular industry is calculated in August each year and is based on a rolling 3-year average, using Australian Bureau of Statistics (ABS) data for the current year and ABS results for the 2 preceding years (or the most recently published Australian Bureau of Agricultural and Resource Economics and Sciences forecast, if ABS data are not available, or an estimate agreed to by the relevant Parties of the Emergency Animal Disease Response Agreement).</p>
In-contact animals	Animals that have had close contact with infected animals, such as noninfected animals in the same group as infected animals.
Incubation period	The period that elapses between the introduction of the pathogen into the animal and the first clinical signs of the disease.
Index case	<p>The first case of the disease to be diagnosed in a disease outbreak.</p> <p><i>See also</i> Index property</p>
Index property	<p>The property on which the index case is found.</p> <p><i>See also</i> Index case</p>
Infected premises (IP)	<p>A defined area (which may be all or part of a property) on which animals meeting the case definition are or were present, or the causative agent of the emergency animal disease is present, or there is a reasonable suspicion that either is present, and that the relevant chief veterinary officer or their delegate has declared to be an infected premises.</p>
Local control centre (LCC)	An emergency operations centre responsible for the command and control of field operations in a defined area.
Monitoring	<p>Routine collection of data for assessing the health status of a population or the level of contamination of a site for remediation purposes.</p> <p><i>See also</i> Surveillance</p>

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Term	Definition
Movement control	Restrictions placed on the movement of animals, people and other things to prevent the spread of disease.
National Biosecurity Committee (NBC)	A committee that was formally established under the Intergovernmental Agreement on Biosecurity (IGAB). The IGAB was signed on 13 January 2012, and signatories include all states and territories except Tasmania. The committee provides advice to the Agriculture Senior Officials Committee and the Agriculture Ministers' Forum on national biosecurity issues, and on the IGAB.
National management group (NMG)	A group established to approve (or not approve) the invoking of cost sharing under the Emergency Animal Disease Response Agreement. NMG members are the Secretary of the Australian Government Department of Agriculture, Fisheries and Forestry as chair, the chief executive officers of the state and territory government parties, and the president (or analogous officer) of each of the relevant industry parties.
Native wildlife	See Wild animals
Operational procedures	Detailed instructions for carrying out specific disease control activities, such as disposal, destruction, decontamination and valuation.
Outside area (OA)	The area of Australia outside the declared (control and restricted) areas.
Owner	Person responsible for a premises (includes an agent of the owner, such as a manager or other controlling officer).
Polymerase chain reaction (PCR)	A method of amplifying and analysing DNA sequences that can be used to detect the presence of viral DNA.
Premises	A tract of land including its buildings, or a separate farm or facility that is maintained by a single set of services and personnel.
Premises of relevance (POR)	A premises in a control area that contains a live susceptible animal(s) but is considered at the time of classification not to be an infected premises, suspect premises, trace premises, dangerous contact premises or dangerous contact processing facility.
Prevalence	The proportion (or percentage) of animals in a particular population affected by a particular disease (or infection or positive antibody titre) at a given point in time.
Prohibited pig feed	Also referred to as 'swill'. Material of mammalian origin, or any substance that has come in contact with this material, but does not include: (i) milk, milk products or milk byproducts either of Australian provenance or legally imported for stockfeed use into Australia (ii) material containing flesh, bones, blood, offal or mammal carcasses which is treated by an approved process ¹ (iii) a carcass or part of a domestic pig, born and raised on the property on which the pig or pigs that are administered the part are held, that is administered for therapeutic purposes in accordance with the written instructions of a veterinary practitioner (iv) material used under an individual and defined-period permit issued by a jurisdiction for the purposes of research or baiting.

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Term	Definition
	<p>¹ In terms of (ii), approved processes are:</p> <ol style="list-style-type: none"> 1. rendering in accordance with the Australian Standard for the Hygienic Rendering of Animal Products 2. under jurisdictional permit, cooking processes subject to compliance verification that ensure that a core temperature of at least 100 °C for a minimum of 30 minutes, or equivalent, has been reached 3. treatment of cooking oil, which has been used for cooking in Australia, in accordance with the National Standard for Recycling of Used Cooking Fats and Oils intended for Animal Feeds 4. under jurisdictional permit, any other nationally agreed process approved by the Animal Health Committee for which an acceptable risk assessment has been undertaken and that is subject to compliance verification. <p>The national definition is a minimum standard. Some jurisdictions have additional conditions for feeding of prohibited pig feed that pig producers in those jurisdictions must comply with, over and above the requirements of the national definition.</p>
Proof of freedom	Reaching a point following an outbreak and post-outbreak surveillance when freedom from the disease can be claimed with a reasonable level of statistical confidence.
Qualifiers	
– assessed negative	Assessed negative (AN) is a qualifier that may be applied to ARPs, PORs, SPs, TPs, DCPs or DCPFs. The qualifier may be applied following surveillance, epidemiological investigation, and/or laboratory assessment/diagnostic testing and indicates that the premises is assessed as negative at the time of classification.
– sentinels on-site	Sentinels on-site (SN) is a qualifier that may be applied to IPs and DCPs to indicate that sentinel animals are present on the premises as part of response activities (ie before it can be assessed as an RP).
– vaccinated	The vaccinated (VN) qualifier can be applied in several different ways. At its most basic level, it can be used to identify premises that contain susceptible animals that have been vaccinated against the EAD in question. However, depending on the legislation, objectives and processes within a jurisdiction, the VN qualifier may be used to track a range of criteria and parameters.
Quarantine	Legal restrictions imposed on a place or a tract of land by the serving of a notice limiting access or egress of specified animals, persons or things.
Resolved premises (RP)	An infected premises, dangerous contact premises or dangerous contact processing facility that has completed the required control measures, and is subject to the procedures and restrictions appropriate to the area in which it is located.
Restricted area (RA)	A relatively small legally declared area around infected premises and dangerous contact premises that is subject to disease controls, including intense surveillance and movement controls.
Risk enterprise	A defined livestock or related enterprise that is potentially a major source of infection for many other premises. Includes intensive piggeries, feedlots, abattoirs, knackereries, saleyards, calf scales, milk

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Term	Definition
	factories, tanneries, skin sheds, game meat establishments, cold stores, artificial insemination centres, veterinary laboratories and hospitals, road and rail freight depots, showgrounds, field days, weighbridges, garbage depots.
Sensitivity	The proportion of truly positive units that are correctly identified as positive by a test. <i>See also</i> Specificity
Sentinel animal	Animal of known health status that is monitored to detect the presence of a specific disease agent.
Seroconversion	The appearance in the blood serum of antibodies (as determined by a serology test) following vaccination or natural exposure to a disease agent.
Serosurveillance	Surveillance of an animal population by testing serum samples for the presence of antibodies to disease agents.
Serotype	A subgroup of microorganisms identified by the antigens carried (as determined by a serology test).
Serum neutralisation test	A serological test to detect and measure the presence of antibody in a sample. Antibody in serum is serially diluted to detect the highest dilution that neutralises a standard amount of antigen. The neutralising antibody titre is given as the reciprocal of this dilution.
Slaughter	The humane killing of an animal for meat for human consumption.
Special permit	A legal document that describes the requirements for movement of an animal (or group of animals), commodity or thing, for which the person moving the animal(s), commodity or thing must obtain prior written permission from the relevant government veterinarian or inspector. A printed version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements. <i>See also</i> General permit
Specificity	The proportion of truly negative units that are correctly identified as negative by a test. <i>See also</i> Sensitivity
Stamping out	The strategy of eliminating infection from premises through the destruction of animals in accordance with the particular AUSVETPLAN manual, and in a manner that permits appropriate disposal of carcasses and decontamination of the site.
State coordination centre (SCC)	The emergency operations centre that directs the disease control operations to be undertaken in that state or territory.
Surveillance	A systematic program of investigation designed to establish the presence, extent or absence of a disease, or of infection or contamination with the causative organism. It includes the examination of animals for clinical signs, antibodies or the causative organism.
Susceptible animals	Animals that can be infected with a particular disease.
Suspect animal	An animal that may have been exposed to an emergency disease such that its quarantine and intensive surveillance, but not pre-emptive slaughter, is warranted.

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Term	Definition
	or An animal not known to have been exposed to a disease agent but showing clinical signs requiring differential diagnosis.
Suspect premises (SP)	Temporary classification of a premises that contains a susceptible animal(s) not known to have been exposed to the disease agent but showing clinical signs similar to the case definition, and that therefore requires investigation(s).
Swill	<i>See Prohibited pig feed</i>
Swill feeding	<i>See Feeding prohibited pig feed</i>
Trace premises (TP)	Temporary classification of a premises that contains susceptible animal(s) that tracing indicates may have been exposed to the disease agent, or contains contaminated animal products, wastes or things, and that requires investigation(s).
Tracing	The process of locating animals, persons or other items that may be implicated in the spread of disease, so that appropriate action can be taken.
Unknown status premises (UP)	A premises within a declared area where the current presence of susceptible animals and/or risk products, wastes or things is unknown.
Vaccination	Inoculation of individuals with a vaccine to provide active immunity.
Vaccine	A substance used to stimulate immunity against one or several disease-causing agents to provide protection or to reduce the effects of the disease. A vaccine is prepared from the causative agent of a disease, its products or a synthetic substitute, which is treated to act as an antigen without inducing the disease.
– adjuvanted	A vaccine in which one or several disease-causing agents are combined with an adjuvant (a substance that increases the immune response).
– attenuated	A vaccine prepared from infective or ‘live’ microbes that are less pathogenic but retain their ability to induce protective immunity.
– gene deleted	An attenuated or inactivated vaccine in which genes for non-essential surface glycoproteins have been removed by genetic engineering. This provides a useful immunological marker for the vaccine virus compared with the wild virus.
– inactivated	A vaccine prepared from a virus that has been inactivated (‘killed’) by chemical or physical treatment.
– recombinant	A vaccine produced from virus that has been genetically engineered to contain only selected genes, including those causing the immunogenic effect.
Vector	A living organism (frequently an arthropod) that transmits an infectious agent from one host to another. A biological vector is one in which the infectious agent must develop or multiply before becoming infective to a recipient host. A mechanical vector is one that transmits an infectious agent from one host to another but is not essential to the life cycle of the agent.

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Term	Definition
Veterinary investigation	An investigation of the diagnosis, pathology and epidemiology of the disease. <i>See also</i> Epidemiological investigation
Viraemia	The presence of viruses in the blood.
Wild animals	
– native wildlife	Animals that are indigenous to Australia and may be susceptible to emergency animal diseases (eg bats, dingoes, marsupials).
– feral animals	Animals of domestic species that are not confined or under control (eg cats, horses, pigs).
– exotic fauna	Nondomestic animal species that are not indigenous to Australia (eg foxes).
WOAH Terrestrial Code	WOAH Terrestrial animal health code. Describes standards for safe international trade in animals and animal products. Revised annually and published on the internet at: www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access .
WOAH Terrestrial Manual	WOAH Manual of diagnostic tests and vaccines for terrestrial animals. Describes standards for laboratory diagnostic tests, and the production and control of biological products (principally vaccines). The current edition is published at: www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-manual-online-access .
Wool	Sheep wool.
Zero susceptible species premises (ZP)	A premises that does not contain any susceptible animals or risk products, wastes or things.
Zoning	The process of defining, implementing and maintaining a disease-free or infected area in accordance with WOAH guidelines, based on geopolitical and/or physical boundaries and surveillance, to facilitate disease control and/or trade.
Zoonosis	A disease of animals that can be transmitted to humans.

Abbreviations

Document-specific abbreviations

Abbreviation	Full title
APVMA	Australian Pesticides and Veterinary Medicines Authority
CNS	central nervous system
eDNA	environmental deoxyribonucleic acid
eRNA	environmental ribonucleic acid
eWHIS	electronic Wildlife Health Information System
FAO	Food and Agriculture Organization of the United Nations
GPS	global positioning system
HPAI	high pathogenic avian influenza
IUCN	International Union for Conservation of Nature
LPAI	low pathogenic avian influenza
NEBRA	National Environmental Biosecurity Response Agreement
PPE	personal protective equipment
RSPCA	Royal Society for the Prevention of Cruelty to Animals
WHA	Wildlife Health Australia
WHS	workplace health and safety

Standard AUSVETPLAN abbreviations

Abbreviation	Full title
ACDP	Australian Centre for Disease Preparedness
AN	assessed negative
APF	approved processing facility
ARP	at-risk premises
AUSVETPLAN	Australian Veterinary Emergency Plan
CA	control area
CCEAD	Consultative Committee on Emergency Animal Diseases
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVO	chief veterinary officer

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Abbreviation	Full title
DCP	dangerous contact premises
DCPF	dangerous contact processing facility
EAD	emergency animal disease
EADRA	Emergency Animal Disease Response Agreement
EADRP	Emergency Animal Disease Response Plan
EDTA	ethylenediaminetetraacetic acid (anticoagulant for whole blood)
ELISA	enzyme-linked immunosorbent assay
GP	general permit
IETS	International Embryo Transfer Society
IP	infected premises
LCC	local control centre
NASOP	nationally agreed standard operating procedure
NMG	National Management Group
OA	outside area
PCR	polymerase chain reaction
POR	premises of relevance
RA	restricted area
RP	resolved premises
SCC	state coordination centre
SP	suspect premises
SpP	special permit
TP	trace premises
UP	unknown status premises
WOAH	World Organisation for Animal Health
ZP	zero susceptible species premises

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