Wildlife Health Australia

National Wildlife Biosecurity Guidelines

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Syringe—A Reiss, WHA
Koala—A Reiss, WHA
Bat—Gary Tabor

From Australia's Chief Veterinary Officer

Every day in Australia, frontline wildlife workers interact with wildlife through their work, study, volunteer activities or research. These people perform valuable roles in conservation, population management, veterinary care, animal welfare and community engagement. They are often the first people involved in detecting and responding to disease in wildlife, and therefore can have a significant impact on whether disease spreads in wildlife, or from wildlife to domestic animals or people. The adoption of good biosecurity practices by wildlife workers can help to protect free-living populations, communities and Australia's animal industries from new and emerging diseases, which most commonly arise from wildlife. For some it may not be routine to consider the broader impacts of diseases in their daily work, but all wildlife workers have a role to play in helping to prevent disease spread through their own biosecurity practices.

The National Wildlife Biosecurity Guidelines fill a gap in existing literature on biosecurity, which is often focussed on domestic animals and may not adequately cover the specifics of wildlife work. This valuable resource helps frontline wildlife workers (including volunteers) to understand disease risks and how to protect themselves, their staff or students, and the animals in their care. I urge all wildlife workers to use the guidelines to better understand the disease risks specific to their own situation and improve their biosecurity practices. Make a plan for yourself or your organisation, and seek input and assistance from professionals such as veterinarians and public health practitioners. Discuss the guidelines with others, including staff and students, to increase awareness and uptake of appropriate biosecurity practices. Good biosecurity practices can minimise disease spread, protecting health in individual animals, people and free-ranging wildlife populations and should be an important part of the endeavours of all wildlife workers in Australia.

Dr Mark Schipp
Australian Chief Veterinary Officer
Department of Agriculture and Water Resources

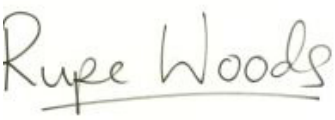
From the CEO of Wildlife Health Australia

It is well recognised that the majority of new infectious diseases arise from wildlife. The threats that such diseases pose to public health and the health of domestic animals have been acknowledged for some time. There is also a growing body of evidence that disease can contribute to the decline and extinction of vulnerable, threatened and endangered species. Disease in wildlife can be an early indicator of changes in the environment, signalling a change that can affect people, domestic species and the wildlife themselves.

There is a need to improve education and knowledge of wildlife diseases that may impact upon the health of people, agricultural production and the environment in Australia. We need to prepare for and respond to these risks.

To help the wildlife community in Australia understand and prepare for these risks, Wildlife Health Australia has produced the *National Wildlife Biosecurity Guidelines*. Andrea Reiss has capably taken the leading role, and as with all our work, the end product would not have been possible without the input of a large number of people from other organisations. A drafting group comprising members of Wildlife Health Australia's working and focus groups provided advice and input. We held extensive consultation with our stakeholders, including biosecurity, environment and human health agencies, as well as many non-government partners and individuals. We thank all these contributors for their helpful advice to improve the guidelines.

Biosecurity and risk management practices are constantly changing as new information becomes available. The risks posed by wildlife diseases to Australia will only become greater with changing land use, climate change and as societal attitudes bring wildlife, livestock and people into closer contact. We encourage readers to provide ideas, feedback and advice so that this volume can continue to evolve over time.



Dr Rupert Woods
Chief Executive Officer
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Executive summary

Everyone who works with, or interacts with, wildlife has a role to play in wildlife biosecurity

Biosecurity is the management of risks to the economy, the environment and the community of pests and diseases entering, emerging, establishing or spreading. It can be explained as the set of precautions taken to minimise the risk of spreading or introducing a pest or infectious disease. Everyone working with wildlife has biosecurity obligations that must be adhered to under Australian legislation.

Good biosecurity helps to keep wildlife, people and domestic animals safe and healthy by minimising the impacts of disease on individual animals and wildlife populations

Lapses in wildlife biosecurity can have serious or catastrophic consequences for individuals, populations, species and ecosystems. Australian bat lyssavirus transmission to a human, via a bite from an infected bat, can result in death. Chytrid fungus infection has resulted in catastrophic declines (and in some cases extinctions) of numerous amphibian species throughout the world. Salmonella infections (acquired from pet reptiles) can cause significant disease and sometimes death in children.

Good wildlife biosecurity includes risk assessment and management, appropriate work practices, hygiene, isolation, diagnosis and treatment of sick or diseased individuals, and surveillance and monitoring for disease in wildlife populations. Understanding and managing risk is the key to good biosecurity. Although it may not always be possible to eliminate risk when working with wildlife, everyone should work to an agreed acceptable level of risk.

The general principles of disease risk management in humans and domestic animals can be applied to managing disease risk associated with wildlife. In the absence of information on disease risk, the precautionary principle should be applied.

These guidelines lead the reader through the process of understanding biosecurity risk associated with wildlife, how to assess the risks (in general terms) and how to make appropriate decisions on developing and applying appropriate risk management. Although people may not need to implement everything in these guidelines, everyone needs to be aware of and manage the risks associated with their day-to-day interactions with wildlife.

These guidelines highlight the following key messages:

- Everyone working with wildlife should be aware of the biosecurity risks (including risks of zoonotic disease transmission) and should take steps to manage these risks appropriately.
- Wildlife workers should implement basic biosecurity practices for all contact with all animals, regardless of the animal's species, age, health or perceived disease risk.
- Hand, equipment and facility hygiene and care with movement of animals and other items, from one location to another, should be applied to all interactions with Australian wildlife.
- Appropriate veterinary advice, input and treatment is key. Wildlife organisations should engage the services of a veterinarian with relevant experience to provide wildlife biosecurity advice and support.
- The health status and biosecurity risk of every animal arriving into care should be assessed, including the relative risk of zoonoses. Indirect or direct contact between wildlife held in care and domestic, feral and pest animals should be minimised.
- A biosecurity risk management plan should be developed and implemented prior to any planned transfer or translocation of wildlife.
- Wildlife organisations and facilities should develop generic biosecurity protocols to identify and manage risk for each situation relevant to their work.

Anyone who suspects or knows that an emergency animal disease is occurring in wildlife should contact the National Emergency Animal Disease Watch Hotline on **1800 675 888**.

The guidelines have been developed to assist all people who work with wildlife and they acknowledge the wide range of circumstances under which people work and interact with wildlife in Australia. They provide the information needed to ensure biosecurity risks of wildlife engagement are appropriately assessed and managed. The guidelines can be tailored by wildlife workers to suit their individual circumstances and can also be used as a training tool.

All organisations which work with wildlife are encouraged to use the information in these guidelines to assess their own biosecurity risks, and to develop and maintain an optimum level of biosecurity for their operations.

Preface

Development and scope

The *National Wildlife Biosecurity Guidelines* are a cooperative initiative between Wildlife Health Australia (WHA), and the Commonwealth Department of Agriculture and Water Resources (DAWR), on behalf of all who work with Australian wildlife. Development included input via a technical writing group of subject matter representatives across Australia's states and territories. Wildlife Health Australia welcomes feedback on the guidelines from stakeholders (send to admin@wildlifehealthaustralia.com.au). Future significant updates to this document will be indicated by a change in Edition number and date of publication.

These guidelines cover wildlife biosecurity in the Australian context in native mammals, birds, reptiles and amphibians. Biosecurity of wild fish and invertebrates is **not** specifically covered in these guidelines and they do **not** specifically cover management of biosecurity in feral vertebrate species, but the principles of wildlife biosecurity outlined in this document may be of use when considering biosecurity in those taxa. The guidelines do **not** directly address biosecurity risks associated with toxins, plant pests or plant pathogens. The focus of the guidelines is on biosecurity practices relevant to mainland Australia (including Tasmania) and offshore islands, with the exception of Australian Antarctic Territory.

How to use these guidelines

The *National Wildlife Biosecurity* Guidelines are national protocols that have been developed to document best practice biosecurity measures for those working with wildlife. The guidelines are intended to be used by all people who work (or interact) with wildlife including wildlife managers, researchers, veterinarians, carers and others. The guidelines acknowledge the wide range of circumstances under which people work and interact with wildlife in Australia in terms of geographic location, species and numbers of animals, work practices and available resources. The guidelines can be tailored by wildlife workers to suit their individual circumstances and can also be used as a training tool. All organisations which work with wildlife are encouraged to use the information in these guidelines to assess their own biosecurity risks and to develop and maintain an optimum level of biosecurity for their operations.

These guidelines lead the reader through the process of understanding biosecurity risk associated with wildlife, how to assess the risks (in general terms) and how to make appropriate decisions on developing and applying appropriate risk management. Although people may not need to implement everything in these guidelines, everyone needs to be aware of and manage the risks associated with their day-to-day interactions with wildlife. These guidelines are **not** intended to be a comprehensive guide to every aspect of biosecurity risk management or to specific wildlife disease risks and subject matter experts should be consulted to assist with specific risk management assessment.

These guidelines can be used by organisations and individuals to gauge their own wildlife biosecurity requirements. **Organisations involved in wildlife work are encouraged to develop their own organisation-specific biosecurity plans, suitable for their particular circumstances, using these national guidelines as a template**. In the absence of an organisation-specific biosecurity plan, an organisation can achieve best practice by meeting all of the recommendations within these guidelines.

Chapter 1

Introduction

For the purposes of this document, the terms **working with wildlife** and **wildlife worker** refer to any person who comes into direct or indirect contact with Australian wildlife as part of their role, including as a paid employee, volunteer or student.

Biosecurity, in the national context, is defined as "the management of risks to the economy, the environment, and the community, of pests[1] and diseases entering, emerging, establishing or spreading". Biosecurity can also be explained as the set of precautions taken to minimise the risk of introducing a pest or infectious disease into an animal (or human) population.

Wildlife biosecurity means managing risks, primarily associated with infectious diseases transmitted from wildlife to humans (and vice versa), from wildlife to domestic animals (and vice versa), and between groups of wildlife. It focuses on minimising and managing the risk of **infectious disease** spreading from one individual or population to another and looks at practices which may play a role in decreasing the risk of infectious disease.

Biosecurity is important for everyone who works with wildlife. Good biosecurity practices help to:

- keep wildlife safe and healthy
- keep workers, members of the public and their families safe and healthy
- keep domestic animals, including pets and livestock, safe and healthy
- minimise impacts of disease on individual animals and wildlife populations.

Wildlife biosecurity includes, but is not limited to:

- ensuring work practices do not introduce or spread disease
- appropriate hygiene, including hand hygiene and use of personal protective equipment (PPE)
- assessing and managing risks to wildlife populations
- appropriate handling and housing of wildlife
- appropriate isolation of wildlife (from domestic animals, including pets and livestock) and feral animals
- management of physiological stress in wildlife
- appropriate diagnosis and treatment of sick or diseased animals and humans
- assessment of biosecurity risk prior to moving or releasing wildlife
- appropriate housing and care of wildlife while in temporary care for treatment and rehabilitation
- a zoonotic risk management program for those working with wildlife.

1 A pest is any species, strain or biotype of the Kingdoms Animalia (excluding human beings), Plantae, Fungi, Monera or Protista that has had an impact (i.e. significant negative consequences), or poses a likely threat of having an impact (IGAB).

It is important that those working with wildlife familiarise themselves with, and adhere to, the commonwealth legislation and their state-based legislation and these guidelines. The concepts of **shared biosecurity responsibility**[2] and **general biosecurity obligations** or **duties**[3] are a central part of the management of biosecurity in Australia. This means that anyone working with wildlife will have biosecurity obligations that must be adhered to. This includes the responsibility to report notifiable animal diseases[4], new and emerging diseases, and any other disease that may have biosecurity implications. In addition to their biosecurity responsibilities, **people working with wildlife must comply with the relevant workplace health and safety legislation and regulations of relevant agencies and jurisdictions (local, federal and state/territory)** (see Appendix A).

Everyone who works with, or interacts with, wildlife has a role to play in wildlife biosecurity.

Definitions and **abbreviations** are found at the end of this document. Some key definitions are also included in the main body of the document.

1.1 Why is wildlife biosecurity important?

Infectious diseases and pests can have serious impacts on wildlife, humans and domestic animals. Infectious diseases and pests can affect the individual, the population or, in some cases, the broader ecosystem. Diseases with wildlife as part of their ecology can negatively affect Australia's international trade and market access, biodiversity and tourism. The direct impacts of pests and infectious disease on individuals (animal or human) include ill health, increased mortality and reproductive problems such as reduced fertility or congenital disease. There may be more subtle effects which predispose individuals to death (e.g. the individual is compromised by disease to such an extent that death occurs by other means, such as starvation, trauma or predation).

Lack of evolutionary exposure to invasive pathogens now present in our country (e.g. Toxoplasma and sarcoptic mange mite) means Australian wildlife may not have natural defence mechanisms.

2 Everyone in the community needs to do their bit to protect the economy, environment and community from biosecurity threats. A key management tool as part of this shared responsibility is the general biosecurity duty.

3 General biosecurity obligations (GBO) means that everyone is responsible for managing biosecurity risks that are:
- under their control and
- that they know about, or should reasonably be expected to know about.

Under the GBO, individuals and organisations whose activities pose a biosecurity risk must:
- take all reasonable and practical steps to prevent or minimise each biosecurity risk
- minimise the likelihood of causing a 'biosecurity event', and limit the consequences if such an event is caused
- prevent or minimise the harmful effects a risk could have, and not do anything that might make any harmful effects worse (Qld Dept. AF).

4 A notifiable animal disease is one that must be reported to agricultural authorities. If you suspect or can confirm that an animal is showing signs of a notifiable disease, you must report it to your local vet or your state or territory's department of primary industries or agriculture by phoning the Emergency Animal Disease Watch Hotline on **1800 675 888** (www.agriculture.gov.au/pests-diseases-weeds/animal/notifiable).

Examples of important biosecurity concerns in the wildlife sphere (either in Australia or globally) include:

- Hendra virus (a fatal zoonotic disease), transmitted from flying-foxes to horses and then to humans (an example of a disease that does not affect the wildlife host but can be transmitted by them to a domestic animal and then to humans)
- sarcoptic mange in wombats (and other native mammals), the protozoal disease toxoplasmosis and koala chlamydia disease are all examples of infectious diseases that have been transferred from feral or domestic animals to wildlife
- Australian bat lyssavirus and Salmonella infection in reptiles are examples of infections which may pass directly from wildlife to humans
- white-nose syndrome (a fungal disease of microbats in North America) has been inadvertently spread by humans visiting caves; the global spread of chytrid fungus, a disease of frogs, has been linked to the trade of amphibians for pet, medical and food purposes.

Also of concern are human pathogens that can be transmitted to wildlife, resulting in disease, for example *Cryptosporidia* protozoa.

People working with, or responsible for, wildlife should take all reasonable and practical measures to prevent or minimise the risk of pests and infectious diseases entering, emerging, establishing or spreading.

1.2 Principles of disease transmission

1.2.1 Infectious disease and pathogen transmission

Infection with a pathogen, or agent of disease, may lead to infectious disease.

Disease is any disturbance in the health or function of an animal or human.

Pathogens (sometimes called **agents of disease**) are any infectious agent capable of causing disease in a host e.g. viruses, bacteria, fungi, protozoa, internal parasites such as worms and external parasites such as lice and mites.

Infectious diseases are those diseases caused by pathogens.

Infection refers to the presence of a pathogen (or infectious disease agent) within an individual. Not all infections result in disease.

Contagious diseases are infectious diseases that are spread through (direct or indirect) contact with infected individuals e.g. salmonellosis. Not all infectious diseases are contagious e.g. Ross River virus requires a bite from an infected mosquito rather than contact with an infected host.

Subclinical infection is an infection where there are no clinical signs of disease.

1.2.2 Infection versus disease

Exposure to a pathogen does not always lead to infection and not all infections lead to disease. Many infectious agents are a normal part of the biology of animals and humans, and a normal part of the wider ecosystem, and may be present without causing disease. Naturally occurring pathogens can play an important role in regulating numbers and maintaining genetic health of wildlife populations. Complex factors (host factors, at species and individual level, as well as pathogen and environmental factors) determine whether infection of an individual with a pathogen proceeds to disease.

An individual may have a subclinical infection and shed a pathogen without suffering any ill-health, and without showing signs of disease. An infectious agent may not cause disease in a wildlife species but may result in disease if it crosses to humans or another wildlife species.

Infectious disease risk may be present in an individual in the absence of signs of disease.

1.2.3 Pathways of disease transmission

Pathogens may be transmitted from one individual to another by a variety of different routes, both **directly** (through close contact) and **indirectly** (through contact with products or contaminated things, which are called **fomites**), or via vectors. Pathways for transmission and infection include:

- **inhalation** e.g. *Chlamydia* transmitted by inhaling aerosolised droplets containing bacteria exhaled by an infected bird; Q fever transmitted by inhaling aerosolised bacteria from macropod faeces
- **ingestion** e.g. *Salmonella* bacteria (transmitted by the faecal-oral route); infection with the protozoa *Giardia* after ingestion of water contaminated with faeces
- via skin or mucous membrane e.g. Leptospirosis can be transmitted via urine contact with mucous membranes or an open wound; ringworm fungus (direct contact with skin lesions); koala chlamydiosis (sexual transmission); amphibian chytrid fungus (via contaminated environmental water)
- via placenta or maternal milk (e.g. toxoplasmosis in pregnant humans)
- vector transmission (via bite of insect, tick or mite) e.g. trypanosomes, malaria, Ross River virus
- by a bite, scratch, needle stick or wound contamination (e.g. Australian bat lyssavirus and tularaemia).

Each pathogen has one or more typical pathways of transmission, for example:

- *Salmonella* are shed in faeces and infect the new host via ingestion (faecal-oral route).
- ringworm fungus is present on the skin of the infected host but can survive for a long time in a contaminated environment. The fungus is typically transmitted by direct contact with infected skin, but also through skin contact with contaminated products.

An understanding of the major routes for pathogen transmission helps us to implement effective strategies to minimise disease risk.

See Appendix C for more information on infectious disease transmission in Australian wildlife.

1.2.4 Pathogen and host ranges

Pathogens vary in their 'species specificity' (how wide or narrow the range of host species in which they cause disease). For example, all Australian mammals are considered susceptible to disease from *Toxoplasma gondii*, the protozoal parasite responsible for toxoplasmosis; this is an example of a pathogen with a wide host range. Only macropods are susceptible to Wallal virus (which causes blindness); this is an example of a pathogen with a narrower host range.

Some host species are recognised as **reservoir hosts** and provide an environmental 'reservoir' for apathogen. For example, flying-foxes don't show any signs of disease when they are shedding Hendra virus, but can infect horses.

1.2.5 The role of stress and intervention in infectious disease

Physiological or biological stress is the body's method of reacting to a condition such as a threat, or physical, physiological or psychological challenge. Physiological stress can reduce an individual's natural ability to fight disease by reducing the functionality of the immune system, making individuals more susceptible both to acquiring and shedding pathogens and developing disease. Reduced genetic diversity may also result in reduced immune competence.

Stress in wildlife can be related to **human interventions** such as trapping, handling, data collection, sampling and marking, chemical restraint, treatment and diagnostic interventions and captive care. Pre-existing disease and other factors such as inappetence, dehydration, physical injury, inadequate shelter, poor nutrition, inappropriate ambient temperature and humidity, and pressure from conspecific animals, competitors and predators may all contribute to physiological stress. Stressors can vary in their impact on the individual's physiology. In general, one-off or acute stresses such as trapping, handling, sampling and short interventions are less likely to negatively impact an individual, compared to ongoing stresses such as poor nutrition, prolonged interventions or being held in close proximity to predator species and other threats.

Exposure to pathogens can also increase when **species come into contact, that would not normally do so**. Wildlife rehabilitation and wildlife field studies or management programs are situations where abnormal species contact is highly likely to occur as a result of human intervention. It should not be assumed that cohabiting free-ranging species are in the same "exposure" space with respect to infectious disease. Human interactions may increase exposure to pathogens which may be in the "environment" but to which the animal would not normally be exposed. For example, an arboreal possum and a terrestrial bandicoot may not normally interact and there may be no natural pathway for disease transmission, but if both are caught on the same or subsequent nights, in the same trap, transfer of pathogens may occur if the trap becomes contaminated and is not appropriately cleaned.

1.3 The concept of inputs and outputs

The concepts of **inputs** and **outputs** can be used to help identify, understand and manage biosecurity risk when managing risk in a workplace or within definable regions, zones or populations. **Inputs** refer to any human, animal, biological or non-biological product which **enters** a facility, work area or geographic location. **Outputs** refer to any human, animal, biological or non-biological product which **leaves** a facility, work area or geographic location. Each input and output can be assessed and managed for biosecurity risk. The facility or location may be wide (a whole field location or an entire veterinary hospital, captive breeding centre or rehabilitation facility) or more specific (e.g. a single room, enclosure, trap or transport crate).

Inputs and outputs should be carefully assessed for biosecurity risk. Work and management practices should ensure biosecurity risks associated with inputs and outputs are appropriately managed.

In a wildlife population or wildlife care facility, pathogens may enter or leave via a number of routes. Any animal, human, biological product, vehicle, equipment or other product entering (an input) or leaving a facility or a geographic location (an output) should be seen as a possible route for disease transmission.

Inputs and outputs relevant to wildlife field situations and wildlife care facilities include:

- **People:** wildlife workers (including volunteers and students) enter and leave wildlife care facilities or field locations, and return to the community, generally on a daily basis, where they may have contact with other animals (domestic animals, other wildlife or feral species) and humans. Workers, and other people such as visitors or members of the public, can transmit pathogens both directly and indirectly as they move from one area to another.
- **Animals:** animals entering and leaving a facility or field site can provide routes for disease transmission. Domestic, stray, feral and pest animals may move into or out of a facility or site, without control, and may have direct or indirect contact with wildlife. Insects such as flies and mosquitoes, and other invertebrates such as ticks, may carry or mechanically transmit infectious diseases. The arrival, departure or interactions of any animal may pose a biosecurity risk.
- **Tools, equipment, clothing and vehicles:** traps, crates, feeding equipment, handling bags, scientific and veterinary tools, enclosure furnishings, clothing, vehicles and other equipment entering or leaving a location or facility may be a route for disease transmission.
- **Biological specimens and waste products:** biological samples may be collected for diagnostic or research purposes. Faeces, food waste, carcasses and other waste may leave a facility. Movements of these products may be a route for disease transmission.
- **Feed and other consumables:** animal feed products may carry pathogens or may be contaminated by the raw materials used, post-production, during transport and storage or by exposure to rodents, birds, other pests or insects.
- **Water:** water used for drinking, bathing, washing and cleaning may carry pathogens to or from a facility or location. Water may become contaminated with waste products or animal or human faeces.
- **Air:** Some infectious agents can be transmitted via air-borne particles, such as dust, aerosolised water and aerosolised faeces.

1.4 Pathways of disease transmission relevant for Australian wildlife

As a general concept, infectious disease can be transferred in any direction between people, wildlife and domestic animals. Most pathogens have specific routes of transmission (e.g. *Toxoplasma* from cats to a range of intermediate hosts). Pathogens with a wide host range may pose a greater risk for transmission between different species. Some pathogens may pass first from wildlife to domestic animals and then on to people (e.g. Hendra virus, Menangle virus), but not directly from wildlife to humans. Detailed knowledge of transmission pathways and host range for a specific pathogen enhances our ability to manage biosecurity risks (see Appendix C).

1.4.1 Human to wildlife

Humans can act as fomites and transmit infection to wildlife via contamination on their hands, clothes and equipment, or they may pass their own infection directly to animals. Fortunately, in the Australian context, there are few currently recognised human pathogens that cause disease in Australian wildlife. The human ringworm fungus can be transmitted from people to wildlife. Humans defecating near waterways whilst camping or walking can contaminate the environment with faecal pathogens such as *Cryptosporidia* and *Giardia* protozoa, which can then infect wildlife. Diseases spread from humans to animals are referred to as **anthroponoses** or "reverse zoonoses".

Risks of human-to-wildlife disease transmission should be managed by maintaining hand, clothing, equipment and environmental hygiene and ensuring fomites do not transfer infection to wildlife.

1.4.2 Domestic animals to wildlife

Domestic animals are hosts to a number of pathogens that can cause disease in Australia wildlife. As a general principle, wildlife workers should adopt practices to ensure that domestic animals do not come into contact with wildlife. Examples of pathogens that may be transmitted from domestic animals to wildlife include *Toxoplasma*, sarcoptic mange, avian chlamydiosis, avian influenza virus, reptile skin fungal disease, snake mite and *Echinococcus* spp.

Risks of domestic animal-to-wildlife disease transmission should be managed by strict segregation of domestic animals and wildlife including separation of work practices and equipment.

Appropriate personal hygiene and equipment hygiene practices should also be used to ensure fomites do not indirectly transfer infection from domestic and captive animals to wildlife. This is of particular importance when managing sick, injured or orphaned wildlife in care as these individuals are often also immunosuppressed (see also 8.5 Managing risk associated with pest, feral and domestic animals).

1.4.3 Wildlife to wildlife

Disease may be transmitted from one wildlife group, individual or species to another. Risks increase with physiological stress and when human intervention results in abnormal mixing of species or elevated population density (see 1.2.5 The role of stress and intervention in infectious disease). Many pathogens have a wide host range and may easily be transferred from one wildlife species to another (e.g. *Salmonella* bacteria, amphibian chytrid fungus, sarcoptic mange mite, reptile mites and ringworm fungus may all transfer between a wide number of wildlife host species). For other examples see Appendix C.

Risks of disease transmission between wildlife groups or individuals should be managed by adhering to the principles of general hygiene, isolation and quarantine, and ensuring there is no direct or indirect contact between long-term captive wildlife and wildlife in temporary care. Workers should manage biosecurity risks whenever moving individuals or groups of animals from one location to another.

See also 9.1 Managing biosecurity risk associated with wildlife translocation and release.

1.4.4 Wildlife to humans and domestic animals

Disease may be transmitted from wildlife to domestic animals, captive wildlife and humans. Diseases transmitted from animals to people are called **zoonoses** or **zoonotic diseases**. A number of recognised zoonotic diseases may originate from Australian wildlife e.g. Australian bat lyssavirus, salmonellosis, avian chlamydiosis (called psittacosis in humans), leptospirosis, ringworm fungus, sarcoptic mange, pinniped tuberculosis, brucellosis from marine mammals, Q fever, Ross River fever and some internal parasites. The disease transmission risk from wildlife will vary according to the species of wildlife and the health status of the individual. Some wildlife taxa are recognised to represent a higher risk of disease transmission, due to the pathogens they carry or other risk factors. For example, bats are known to carry a number of diseases that can be transmitted to people.

Some wildlife diseases are recognised as a risk for domestic animals e.g. Hendra virus (from flying-foxes to horses), Menangle virus (from flying-foxes to pigs) and avian influenza viruses. These are examples of zoonotic diseases that originate from Australian wildlife and can affect domestic animals, with a risk of further transmission to humans.

Risks of disease transmission from wildlife to domestic animals and humans are best managed by strict segregation of domestic animals and wildlife, including separation of work practices and equipment, appropriate human hygiene practices and use of personal protective equipment.

Specific knowledge of the zoonotic disease risks associated with taxa of wildlife with which you are working is an important part of risk management (see 7 Zoonotic risk management).

Chapter 2

Principles of risk management

2.1 What do we mean by risk management?

Risk management is integral to management of biosecurity risks associated with wildlife interactions.

Understanding and managing risk is the key to good biosecurity.

Risk can be defined as the chance of encountering some form of harm, loss or damage. Risk has two components:

- the **likelihood** or probability of something happening and
- the **consequences** of the event.

Risk management is the process of:

- **identifying hazards:** identifying which infectious diseases (or pests) are of concern, where the disease may come from and be transferred to, and how it may be transferred
- **assessing the relative risk** associated with each hazard, including both the likelihood of the risk occurring and the consequences if the risk does occur (e.g. the difference between likely exposure to a low virulence ringworm compared to less likely exposure to a potentially fatal, and untreatable, bat lyssavirus infection)
- **deciding upon and implementing control measures**, either to eliminate the risk or, if that is not possible, minimise the risk as much as possible (e.g. deciding unvaccinated workers should not handle bats, using disposable gloves when working with animal wastes)
- **monitoring and evaluating** the risk and the control measures on a regular basis, to make sure that risks have not changed, that control measure are being properly implemented and followed, that the control measures are continuing to appropriately minimise the risk, that no additional control measures need to be implemented and that the controls are not causing any new problems.

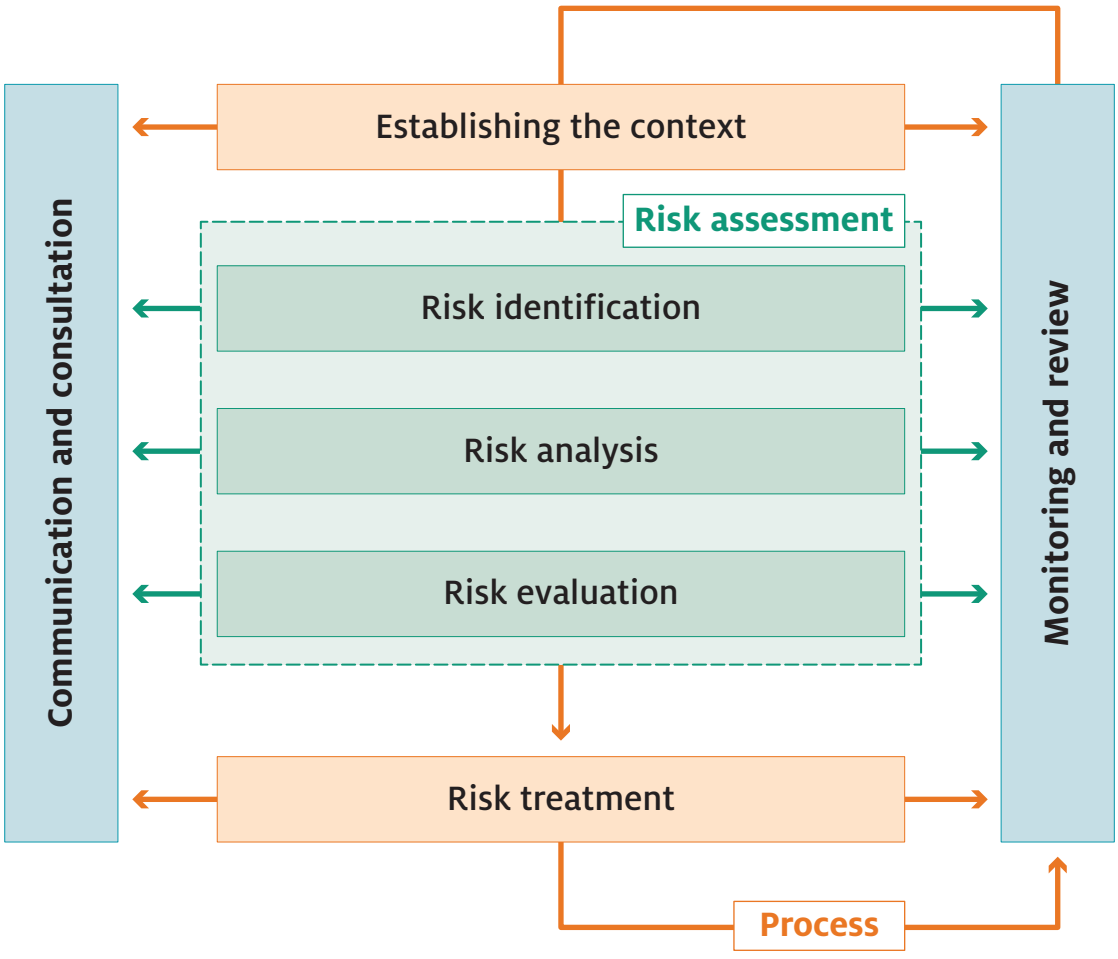
It may not always be possible to eliminate risk when working with wildlife, but everyone should work to an agreed acceptable level of risk (or a safe or minimum risk level). An acceptable level of risk is the maximum overall exposure to risk that can be accepted, based on the benefits and costs involved. This may be determined by the authorities, by an organisation or by an individual.

2.2 How do we apply risk management to managing biosecurity risks?

The best way to manage infectious disease risks is to understand both the hazard (pest or disease) and the available options for minimising risks to a safe or acceptable level. A knowledge of pathogens that are associated with animal species and environments allows workers to:

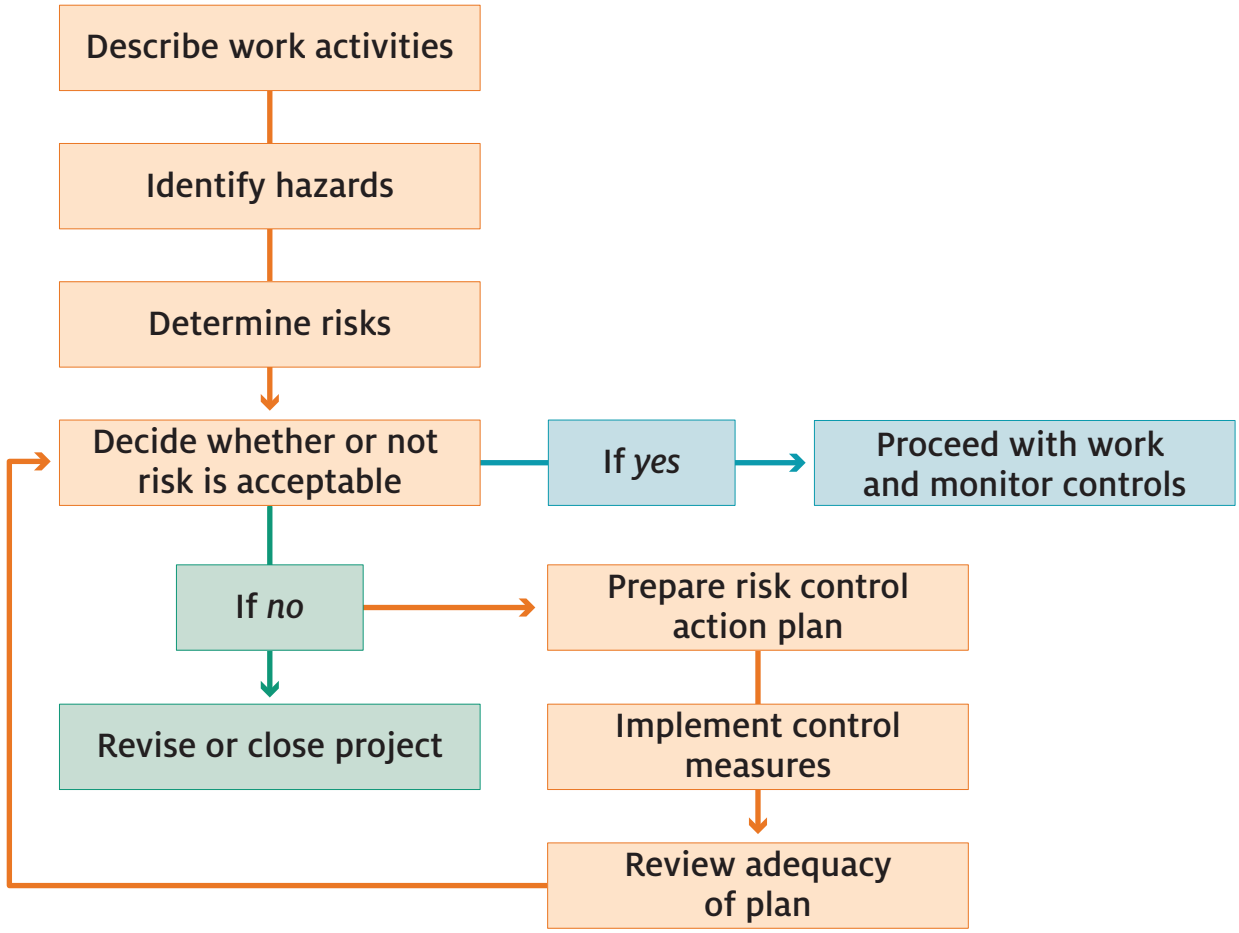
- identify hazards
- assess the risk associated with each hazard
- implement appropriate infection control measures to ensure both animal and human health risks are properly managed
- monitor and evaluate the control measures regularly.

FIGURE 1 Flowchart of the Risk Management Process



Sourced from AS/NZS ISO31000:2009

FIGURE 2 An example of one type of strategy for conducting a risk assessment



The general principles of disease risk management in humans and domestic animals can be applied to managing disease risk associated with wildlife, regardless of the host species or potential pathogens.

The "**chain of infection**" consists of three links: the source of infection, method of transmission and susceptible host. **Infection control measures** are targeted at the links in the chain with the aim of breaking the chain and so preventing the spread of infection.

Risk can be managed by first considering control measures that are less dependent on human factors and generally provide a higher level of risk control ("higher order controls"), followed by "lower order controls" which may be less effective or more dependent on human factors. Where possible, biosecurity risks should be managed by using both higher order and lower order controls and should not rely solely on lower order control measures.

Higher order controls include:

- elimination of unsafe work practices or substitution with a practice that presents a lower level of risk
- isolation of individuals or groups
- engineering or design controls (e.g. vaccines, design of the animal care environment, ventilation).

Lower order controls include:

- policies, guidelines, standard operating procedures, training
- hygiene practices
- use of personal protective equipment.

Biosecurity practices including infection prevention and control are discussed in more detail in 5 General approaches to managing biosecurity risks in wildlife.

2.3 Assessing and managing transmission pathway risk

Events or work practices may increase or decrease risks of exposure to disease, depending on the transmission pathway e.g. cleaning methods may generate aerosols. Environmental factors such as wind and prevailing conditions may contribute to transmission risk e.g. in foot and mouth disease virus transmission.

A knowledge of a particular pathogen's disease transmission pathway allows use of work practices to manage and minimise risks. For example, the application of hand and personal hygiene can significantly reduce the risk of transmission of *Salmonella* bacteria via the faecal-oral route.

When considering the best methods to minimise disease transmission risk it is important to have as much information as possible about the disease and how it is transmitted. **Assessment of transmission risk** should consider:

- the way the pathogen might be **shed by the host** (e.g. in faeces, in urine, by coughing)
- the way the pathogen **moves in the environment** (e.g. in air, water, on products)
- for how long might the pathogen **survive outside the host**, and under what conditions (e.g. moist, cool)
- how might the pathogen **gain access to the new host** (e.g. via a bite, by ingestion etc.)
- the length of the **incubation period**
- the **dose** of pathogen and/or **duration of exposure** needed to result in disease
- whether the individual may start shedding a pathogen **prior** to the onset of clinical signs
- for **how long** the host might shed the pathogen after infection.

Specific advice on disease transmission pathways, and best ways to manage risk, should be sought from subject matter experts (such as wildlife veterinarians or epidemiologists) or local animal biosecurity or human health agencies. If there is doubt, the precautionary principle should be applied.

See also 1.2 Principles of disease transmission and 1.3 Pathways of disease transmission relevant for Australian wildlife.

2.4 How do we proceed if little is known?

In Australia, knowledge of specific wildlife species, diseases and their impacts on wildlife, humans and domestic animals is constantly evolving. Recent emergence of "new" diseases in Australian wildlife such as Hendra virus, Australian bat lyssavirus, tularaemia, Bellingen River turtle virus and Leishmania in macropods, or emergence of disease in new host species (e.g. Australian bat lyssavirus in horses), suggests that the situation regarding infectious disease in Australian wildlife is changing (see Appendix C). When managing biosecurity risks associated with Australian wildlife, there will be a need to make assessments and apply management plans, even when there is not enough technical information. Assumptions may need to be made about the likelihood of a disease risk associated with a wildlife species, situation or event.

In the absence of information on disease risk, the **precautionary principle** should be applied. In the context of wildlife disease risk management, the precautionary principle states that if there is a suspicion that an interaction or situation with wildlife may pose a disease risk (to other wildlife, domestic animals or humans), a risk is assumed (and managed appropriately) until proven otherwise. For example, we assume any reptile (sick or healthy) may be shedding large amounts *Salmonella* bacteria in its faeces, even though no tests have been conducted; or we assume any bat may be infected with Australian bat lyssavirus.

Chapter 3

Veterinary and other professional input into wildlife biosecurity

Wildlife veterinarians can provide advice on the development of wildlife biosecurity programs or protocols. All veterinarians will have skills in infectious disease diagnosis and treatment that can be applied in general to wildlife species. Input from experienced wildlife veterinarians (in particular those with experience in the relevant wildlife species) will improve risk management. In addition, ecologists, wildlife biologists, public health advisors, land managers, local and state government representatives and other stakeholders may need to be consulted in preparation of appropriate biosecurity plans. Wildlife disease ecologists and wildlife epidemiologists often have a useful focus on population level risks and management.

Appropriate veterinary advice, input and treatment is a cornerstone of wildlife biosecurity.

Wildlife organisations should engage the services of a veterinarian with relevant experience and should involve an experienced veterinarian in developing and review of wildlife biosecurity protocols.

Veterinarians can provide advice and assistance in:

- design and management of wildlife facilities
- assessing containment and work flows
- general and situation-specific biosecurity protocols
- developing personal, equipment and facility hygiene protocols
- the appropriate choice or use of chemical disinfectants
- establishment and maintenance of isolation practices and facilities
- biosecurity management of waste, including water
- development of zoonotic disease risk management protocols
- specific zoonotic and non-zoonotic disease advice for relevant wildlife species
- wildlife disease risk assessment for translocation and release
- post mortem investigation and sampling
- disease and pathogen testing and investigation
- investigation, diagnosis and treatment of individual wildlife cases
- investigation of suspected or confirmed disease outbreaks in wildlife
- development of surveillance protocols for wildlife disease
- development of protocols for sampling or marking of animals
- development of protocols for recording and reporting (see below).

All people and organisations working with wildlife should establish a process for both routine and emergency access to veterinary advice and response.

Chapter 4

Recognising, recording and reporting wildlife biosecurity and disease issues

4.1 The importance of recognising signs of disease in wildlife

The amount of disease or unusual pathogens in individuals or populations of wildlife will impact the level of biosecurity risk. Detection of disease in wildlife can be challenging. Wildlife species are often cryptic by nature and may hide behavioural signs of disease. Evidence of disease, or unusual pathogen presence, in individuals may present differently to evidence of disease or unusual pathogen presence in populations. Good record keeping is essential and helps to identify and monitor changes in individuals or populations over time, which contributes to effective management of threats to and from wildlife.

Timely and accurate detection, recording and reporting of disease in wildlife allows for prompt and appropriate response to any biosecurity concerns.

4.2 Recognising and managing sick and diseased individuals

Appropriate management of sick animals is underpinned by experienced veterinary input. Wildlife workers have a duty of care (and a legal obligation) to respond appropriately to wildlife that is obviously diseased or otherwise compromised. This may include providing appropriate first aid and seeking veterinary support for alleviation of suffering, rapid and accurate investigation, diagnosis and treatment.

Veterinarians should be contacted for advice about disease in individual wildlife cases.

Wildlife workers should be trained to appropriately respond to and treat (with professional support) disease in individual animals and should consult with experienced veterinarians for assistance and advice, as required. Less experienced workers should be supervised or mentored in these situations. Wildlife workers should routinely monitor, observe and assess individual animals for signs of disease and should be aware when veterinary input is required.

Identification, management and treatment of disease in wildlife is outside the scope of these guidelines. Wildlife Health Australia produces a series of Fact Sheets (www.wildlifehealthaustralia.com.au/FactSheets.aspx) that provide information on a range of diseases in Australian wildlife.

Recognition of disease in animals relies on observation, experience, training and appropriate reporting. Wildlife workers should be trained to recognise, describe and document signs of disease in individuals and should maintain written records of any illnesses or deaths observed in wildlife and of interventions with wildlife (e.g. field work, rehabilitation and care), even if there is no legal requirement to do so. Written records should be shared with co-workers and managers to ensure all participants are aware of key information, including past events.

Processes should be documented for:

- assessing the need for intervention with sick or compromised wildlife
- first aid and initial care of debilitated animals
- obtaining appropriate veterinary assistance with wildlife cases.

Significant biosecurity (and business) risks can occur if lay people attempt diagnosis and treatment beyond their capabilities. It is illegal for non-veterinarians to perform acts of veterinary science (including anaesthesia) or to hold or administer veterinarian-only pharmaceuticals unless prescribed and supplied by a veterinarian.

4.3 Recognising signs of disease in wildlife populations

Disease may impact wildlife populations without observable signs of disease in individuals.

Changes in demographic patterns may be an indicator of the presence of pathogens or disease in wildlife populations, for example:

- change in population size or density (usually a decrease)
- increased morbidity or mortality
- reduced fertility or recruitment
- altered population structure (age or gender)
- reduced capture or recapture rate compared to previous data
- change (usually a reduction) in average body weight, body condition score or other body indices.

Pathogen surveillance may detect changes in prevalence of pathogens in a population (for example, changes in seroprevalence) and changes in pathogen distribution.

If there is evidence of disease or abnormal pathogen presence in wildlife populations, wildlife veterinarians, pathologists and wildlife epidemiologists should be consulted to assist in investigation.

These subject matter experts may assist in development of data and sample sets that can be used to assess the presence, absence or extent of disease.

4.4 Reporting animal disease or deaths for investigation

Documented processes for appropriate reporting and investigation of animal deaths or clusters of disease in wildlife will help to ensure that biosecurity risks can be investigated, identified and managed appropriately. This helps to minimise spread of disease to other wildlife individuals or populations, or to humans and domestic animals.

Wildlife workers must ensure they meet regulatory reporting requirements for deaths, diseases and incidents involving wildlife including to animal ethics committees and other regulatory authorities.

Suspicious signs of disease and unexpected or unexplained deaths in wildlife (whether in the field or in care) should be reported to the appropriate authorities, which may include animal ethics committees, permitting authorities and authorities responsible for disease investigation.

Australia has a well-developed wildlife health surveillance system and **any unusual signs of disease or deaths in wildlife can be reported to:**

- your local State/Territory WHA Coordinator (see www.wildlifehealthaustralia.com.au)
- the 24 hour National Emergency Animal Disease Watch Hotline on 1800 675 888.
- your local veterinarian
- the Department of Primary Industry or Agriculture in the state or territory in which the event occurred (see also 10.3 Wildlife and Emergency Animal Disease response).

A **standard wildlife incident submission form**, available from Wildlife Health Australia (www.wildlifehealthaustralia.com.au) can be used for recording and submitting information. The Australian Registry of Wildlife Health "Sick and Dead Bird Health Surveillance Sample Collection Protocol" (www.arwh.org) provides information and protocols for disease investigation in wild birds.

4.5 Wildlife and Emergency Animal Disease response

Australia has a nationally agreed process for responding to emergency animal diseases (EAD). EADs are diseases that are likely to have significant effects on livestock, potentially resulting in livestock deaths, production loss, and in some cases, impacts on human health, wildlife and the environment. Generally, an EAD is a disease that does not occur in Australia and it is considered to be in the national interest to maintain freedom from this disease. The Australian Veterinary Emergency Plan (AUSVETPLAN; see www.animalhealthaustralia.com.au/) is a series of technical response plans that describe the proposed Australian approach to an (EAD) incident. During an emergency response, these documents provide detailed information on biosecurity procedures to be followed. The Wild Animal Response Strategy (or WARS) is a part of AUSVETPLAN and is a national policy document covering response to an EAD incident in Australian wildlife.

An **emergency wildlife disease** (EWD) is a disease that is either exotic to Australia, a variant of an endemic disease, a serious infectious disease of unknown cause or a severe outbreak of a known endemic disease, **and** that is considered to be of national significance. EWDs can also affect people, trade and biodiversity and the potential impacts of many of these diseases are unknown. A high-level framework outlining the authority and roles and responsibilities of agencies during a EWD response (including how the response is to be managed) is under development. The EWD response framework aligns with other current EAD management documents.

Wildlife workers who suspect or know that an emergency wildlife disease is occurring should contact the National Emergency Animal Disease Watch Hotline on 1800 675 888.

In the event of an EWD or an EAD impacting wildlife, local knowledge will be essential in assessing the status of wildlife populations. Wildlife and vertebrate pest technical experts, species experts and wildlife biologists will be consulted to obtain current and local information on the ecology and behaviour of susceptible wild animal species. Basic principles and practices in biosecurity and risk management will prevent or minimise the impact of an EAD on wildlife.

Chapter 5

General approaches to managing biosecurity risks in wildlife

5.1 Basic biosecurity practices

Basic biosecurity practices (also known as 'standard precautions' or 'general infection prevention and control practices') protect against many infectious disease risks associated with wildlife interactions.

Standard precautions or basic biosecurity practices should always be adopted, regardless of the perceived risk.

Basic biosecurity practices include:

- hand hygiene
- keeping the work environment clean and tidy
- cleaning spills of blood and body substances
- cleaning and disinfecting (or safely disposing of) equipment after use
- appropriate management and disposal of waste material (including animal, food, water and clinical waste)
- appropriate management of laundry (bedding, towels and worker clothing)
- safe use and disposal of sharps such as needles and scalpel blades, as well as knives for food preparation
- managing accidental exposures to blood and body substances, as well as animal bites, scratches and sharps injuries
- care with the movement of animals and items from one location to another
- appropriate use of personal protective equipment (PPE)
- vaccination of workers, appropriate to the animal species encountered
- protection against biting insects and ticks that may transmit disease.

Basic biosecurity protocols may be sufficient to manage many infectious disease risks associated with wildlife interactions (and are explained in greater detail below)

All organisations working with wildlife should develop and maintain a set of operational protocols and guidelines to assist with biosecurity assessment and management. Protocols should be reviewed and updated on a regular basis. All workers should be familiar with the relevant protocols and competent in all relevant practices. See Appendix B for a recommended list of operational protocols and guidelines.

Wildlife workers should be aware of and implement basic biosecurity practices for all contact with all animals, at all times, regardless of the animal's species, age, health or perceived disease risk. At a minimum, hand, equipment and facility hygiene and care with movement of animals and other items from one location to another should be applied to all interactions with Australian wildlife.

5.2 Higher level infection prevention and control

In some cases, basic biosecurity practices may not be sufficient to manage the risks and a higher level of infection prevention and control and biosecurity is needed. For example, specific knowledge of Australian bat lyssavirus transmission (bite or scratch) means that enhanced PPE must be used when Australian bats are handled so that the risks to humans are adequately managed (see Qld Workplace Health and Safety "Australian bat lyssavirus and handling bats" www.worksafe.qld.gov.au/__data/assets/pdf_file/0003/82902/lyssavirus-handling-bats.pdf).

People working with Australian wildlife should be aware of situations where general disease risk management practices are appropriate, and when more specific, or enhanced, disease risk assessment and management is required.

Higher level (or enhanced) precautions are tailored according to the method of transmission of the disease (see 2.3 Assessing and managing transmission pathway risk).

Enhanced levels of biosecurity practices include:

- additional levels of hygiene e.g. hand hygiene prior to commencement of the work, as well as between handling each animal (rather than between cohorts)
- use of additional methods of cleaning and/or disinfection e.g. use of heat, pressure, radiation or chemical disinfection or sterilisation for both equipment and personnel
- use of disposable gloves (in addition to hand hygiene)
- use of appropriate personal protective equipment
- use of isolation areas
- use of dedicated equipment
- temporary bagging, followed by cleaning and disinfection, of equipment and clothing after use
- movement restrictions for animal and people
- use of ventilation controls, respiratory protective equipment, entry/exit processes, chemical foot baths etc.
- worker vaccination against at-risk diseases

- minimising the number of people participating in the procedure to those workers with appropriate training and protection, and only those required for the procedure
- restricting access of people with increased infection risk (e.g. those not immune to a relevant vaccine-preventable disease, pregnant or with a medical condition that increases infection risk).

People dealing with specific wildlife biosecurity issues should seek advice from subject matter experts (such as wildlife veterinarians or epidemiologists) or local animal biosecurity or human health agencies.

Wildlife workers should be aware of, and implement, additional or enhanced biosecurity practices for specific diseases, taxa or circumstances.

5.3 Hygiene practices

Hygiene refers to practices of cleanliness that help to maintain health and prevent disease. The main aim of good hygiene is to reduce the chance of pathogens contaminating hands, clothing or equipment and to reduce the build-up of pathogens in the local work environment. Reducing the pathogen load in the working environment reduces the chance of infection and disease transmission.

Good hygiene is an important cornerstone of wildlife biosecurity.

As an example, organic material and bacteria from a reptile's faeces may contaminate the reptile's skin. This may not be visible to the naked eye. Handling the reptile may result in the worker's hands also becoming contaminated. If hands are not washed appropriately, bacteria may be transferred via food items or utensils at meal time, and then ingested, leading to infection and possible gastro-intestinal disease in the person, their colleagues, family or others. Clothing and equipment e.g. pens, instruments, handling bags and traps may become contaminated and may be a method by which pathogens are transferred from one individual to another, or from one location to another.

Hygiene procedures usually involve removal of organic material (and associated pathogens) by the use of water, physical scrubbing and a product such as soap or detergent. **Chemical disinfection** (following cleaning) may also be used to help achieve appropriate hygiene.

The basic principles of hygiene should be applied to any wildlife biosecurity circumstance.

Specific knowledge of the relevant pathogens will assist in best practice infection prevention and control and biosecurity implementation. For example, a knowledge of the routes of pathogen transmission, how long the pathogen persists outside the host, and how the pathogen is affected by chemical or physical treatment will aid the development of biosecurity protocols.

Further detailed information on many of the practices outlined below can be found in the Australian Veterinary Association "Guidelines for Veterinary Personal Biosecurity" www.ava.com.au/biosecurity-guidelines.

5.3.1 Mechanical cleaning

Mechanical cleaning is the step-wise process of:

- removing obvious clumps of organic material (e.g. shake out the handling bag, knock the mud off your boots), followed by
- washing with water (preferably warm or hot), use of detergent or soap and scrubbing (use a brush, or dishwashing machine or clothes washing machine etc.), followed by
- rinsing clean with fresh water, followed by
- thorough drying.

The overall aim of mechanical cleaning is to reduce the pathogen load, rather than totally eliminate it.

Each step plays a key role in maintaining hygiene and lowering the pathogen burden:

- use of **hot or warm water** dissolves fats and oils. Heat may reduce virulence or kill some pathogens.
- **detergents or soaps** act as surfactants and also have some disinfection effects. They assist in removing organic material, which allows a chemical disinfectant, if used, to work more effectively.
- rinsing with water dilutes the pathogen load.
- **scrubbing or high-pressure** cleaning assists with removal of contaminated material. Care must be taken with high-pressure cleaning, as aerosolisation of organic material can increase pathogen transfer risk. Workers may need to use a respirator.
- **drying** is important because most pathogens don't survive in a very dry environment. Heat from the drying process may also help to kill some pathogens. UV radiation from sunlight will help to kill pathogens.

5.3.2 Hand hygiene

Hand hygiene is a term used to describe any method that removes or destroys microorganism (viruses, bacteria, fungi, parasites) on hands. In this document, hand hygiene generally refers to washing (with warm water and soap) and drying of hands, and/or use of alcohol-based hand sanitizer products. Hand sanitisers should contain a minimum of 60% alcohol and are only suitable for use on visibly clean hands. Hand sanitisers (even when used correctly) may not inactivate all pathogens[5].

5 Cryptosporidium is not killed by hand sanitisers such as alcohol-based hand rubs and is resistant to most commonly used chemical disinfectants. Bacterial spores (such as Clostridial spores) and Mycobacteria are resistant to many commonly used disinfectants.

Handwashing is one of the most effective measures for preventing the spread of common diseases and should be routinely practiced and regularly undertaken when handling wildlife.

Hand hygiene should be undertaken (at a minimum) at the following times during wildlife interactions:

- at the beginning and end of the work day
- before and after handling sick, injured, infant or orphaned wildlife
- after handling animals and their products (including faeces or other biological material)
- before eating, drinking, smoking
- before and after any invasive procedures (e.g. ear tagging, placing a microchip, collecting a blood sample)
- between handling wildlife and domestic animals
- between contact with different cohorts of animals
- before preparing and handling animal or human food
- before and after tasks such as wound care, bandage changes, preparing and administering medication
- after cleaning equipment, surfaces or the work environment.

Cuts, abrasions and other exposed skin (e.g. rashes or irritated areas) should be covered by a water-proof dressing, so there is no portal of entry for pathogens. See also 6 Work flow practices to manage biosecurity risk.

Disposable gloves (e.g. latex, vinyl and nitrile) should be worn for work activities that involve contact with potentially infectious materials to help:

- protect the hands of workers from contamination with blood and other substances such as urine, faeces, vomit, pus and semen
- to reduce the risk of transmission of pathogens to both the worker and animals
- protect the skin against chemicals and other hazards.

Some brands of disposable nitrile gloves also provide some puncture resistance.

These gloves are single-use items and should be stored, worn and disposed of appropriately. In general:

- equipment and tools should be collected before the gloves are put on
- the worker's hands should be washed and dried immediately (or alcohol-based hand rub applied) before putting on the gloves
- the gloves should be put on just before the start of the procedure and removed immediately after finishing the procedure, followed by hand washing.

Disposable gloves should not be worn for extended periods of time, or between different jobs or procedures. See also WHO's Glove use information leaflet www.who.int/gpsc/5may/Glove_Use_Information_Leaflet.pdf and AVA Gloves poster www.ava.com.au/sites/default/files/AVA_website/pdfs/Resource%204%20-%20Gloves.pdf).

Wearing disposable gloves is not a substitute for appropriate hand hygiene.

Wildlife workers should have disposable gloves available at all times, ready for use when needed, even if they are not worn for routine procedures.

5.3.3 Environmental hygiene

Maintaining hygiene in the environment in which the animal is cared for or housed is an important part of biosecurity risk management. Cages, surfaces, floors, furnishings and other structures should be maintained in a clean and hygiene manner when caring for or interacting with wildlife.

Facilities for workers to change clothing, wash or shower, and change or clean footwear will help to manage biosecurity risks.

5.3.4 Equipment hygiene

Maintaining good equipment hygiene is necessary to reduce the risk of disease transmission (see 1.3 The concept of inputs and outputs).

All equipment used on wildlife should be clean prior to use.

Equipment may need to undergo chemical disinfection after cleaning, particularly if:

- the equipment was contaminated with blood or body substances
- it was used on animals with infectious (particularly contagious) disease
- it is to be used with multiple animals, or on an animal's non-intact skin or mucous membranes
- there is a situation of increased biosecurity risk (e.g. animals are immunosuppressed or have a contagious disease; see 6.1 Recognising and managing higher biosecurity risk situations).

Dedicated equipment is equipment that is dedicated for sole use for an animal, task or area, with the purpose of reducing the risk of cross-contamination. It may be efficient and practical to have sets of dedicated equipment for use within an environment. If this is not possible or practical, cleaning and disinfection practices should be used.

In some instances, it may not be possible (or not necessary) to clean or disinfect equipment after each use. A knowledge of the relevant pathogens, and their transmission pathways (see Section 6 Principles of disease transmission) will be helpful for development of protocols. In most situations, there are multiple potential pathogens, and the operator should adopt the precautionary principle and use excellent personal and equipment hygiene, fomite management and work flow practices. See also 1.3 The concept of inputs and outputs.

5.3.5 Principles of chemical disinfection

A range of different chemical compounds can be used as disinfectants. They work by either killing or reducing the virulence of infectious agents. Disinfection does not necessarily kill all microorganisms, and some types of infectious agents are particularly resistant to disinfection[6]. Many disinfectants are not effective in the presence of organic material and mechanical cleaning is recommended prior to application of disinfectants. Use of a product with combined detergent/disinfectant properties (e.g. quaternary ammonium compound) may be appropriate, depending on the infectious agent and its susceptibility to chemical inactivation. All chemical disinfectants have potential toxic properties and should be used strictly according to the manufacturer's instructions and safety data sheet. Chemicals should be diluted as recommended and applied for the nominated minimum contact period. Professional advice should be obtained to ensure the most appropriate chemical disinfection products and protocols are used to manage wildlife disease risk. Inappropriate use of disinfectants can lead to microbial resistance.

Sterilisation refers to the complete eradication of all infectious agents. Techniques of high heat, pressure and/or irradiation are often used to sterilise equipment. These techniques are generally not practical to apply in the field but may be used when a sterile working environment is required e.g. sterile surgery.

Refer to the Australian Veterinary Association "guidelines for Veterinary Personal Biosecurity; Appendix 4: Disinfectants in Australian veterinary practice" (www.ava.com.au/biosecurity-guidelines) for more information on properties and choice of chemical disinfectants.

5.4 Personal protective equipment

Personal protective equipment (PPE) includes items such as:

- disposable gloves
- long-sleeved shirts, long trousers, coveralls, aprons
- boots
- gauntlets or puncture resistant gloves to protect against animal bites and scratches
- use of double-gloving[7]
- face masks and respirators[8].

PPE can be used to reduce risk of a worker being exposed to an infectious disease, as well as to reduce the risk of injury when handling wildlife, animal products or other items such as sharps. PPE can be used to reduce the risk of spreading infection to a third party (animal or human e.g. use of disposable gloves or waterproof boots).

6 Cryptosporidium, bacterial spores (such as Clostridial spores) and Mycobacteria are resistant to many commonly used disinfectants.

7 Double gloving is the practice of wearing two layers of disposable gloves to reduce the risk of infection from glove failure or penetration of the gloves by sharp objects during animal health care procedures.

8 A face mask is a loose-fitting mask that covers the nose and mouth area with two ear loops or ties to hold the mask in place. Face masks capture large particles and droplets from the wearer and prevent them from being spread to the environment. A respirator is a tight-fitting mask with a facial seal that provide protection for the wearer against aerosols. Respirators should be fit tested prior to use and a fit check performed each time worn. See Australian Veterinary Association "guidelines for Veterinary Personal Biosecurity; Appendix 5: Specifications and fitting instructions for respirators for Australian veterinarians" (www.ava.com.au/biosecurity-guidelines) for more information.

For PPE to be effective, it should be appropriately selected and used. Choice of PPE should be based on the method of transmission of the infectious agent.

PPE should be:

- a suitable size and fit
- worn correctly
- fit for purpose in the conditions in which it will be worn (e.g. does not cause heat stress or fogging and provides sufficient dexterity etc.)
- only used once, if disposable
- appropriately cleaned and stored (or disposed of) after each use.

5.5 Isolation

Isolation refers to the segregation of an animal, or group of animals, from other animals for veterinary, husbandry or management purposes. Isolation (sometimes referred to as quarantine) may be used to help manage biosecurity risks in wildlife, particularly those in care, and helps in the detection, treatment and elimination of infectious disease.

Isolation generally involves:

- separation of newly arrived cases to provide for examination, treatment, monitoring and acclimatisation
- physical examination of all animals on or soon after arrival, including performance of appropriate clinical and laboratory diagnostic tests as required
- veterinary treatment for disease or injury
- a defined, appropriate minimum period for isolation to ensure animals are free from infectious (including zoonotic) disease
- veterinary care and treatment as necessary to protect against infectious diseases.

The principles of isolation apply to all situations, but the practical applications may differ depending upon circumstance. For example, isolation processes may differ with **different categories** of animals such as:

- newly-arrived wildlife rescue cases for treatment and rehabilitation
- wildlife cases suspected or confirmed to be suffering from contagious disease
- wildlife cases confiscated from captivity with unknown history
- captive-bred or wild-caught wildlife prior to and immediately following translocation.

Wildlife care organisations and facilities should develop generic isolation protocols for each category relevant to their work. Species-appropriate and circumstance-appropriate isolation procedures can then be developed from these broader procedures.

Barrier keeping (or barrier nursing) is an important tool supporting the management of biosecurity and defines the use of stringent control measures designed to minimise the spread of infectious disease from one animal, group or environment to another. If used carefully, barrier keeping practices can minimise the risks associated with working with multiple different individuals or groups of animals on the same day, or within the same treatment area or facility.

Chapter 6

Workflow practices to manage biosecurity risk

Workflows and biosecurity risks should be considered when working with wildlife. Situations where people come into contact with wildlife, may be considered, in broad biosecurity terms as **lower risk** or **higher risk**. Some individuals or groups of animals may be considered less or more **vulnerable** to biosecurity risks. Work practices can be broadly classified as either "dirty" or "clean".

Classification of work situations as either higher or lower risk, "dirty" or "clean" will be influenced in part by the normal work practices for the organisation or team. An understanding of higher risk and lower risk biosecurity situations allows workers to better plan work processes and workflows with the aim of minimising biosecurity risks within the broader context of safe work practices. In the absence of sufficient information, or if there is doubt about the level of risk, it is strongly recommended that procedures are assumed to be of higher biosecurity risk until proven otherwise.

Wildlife workers should consider relative biosecurity risk when evaluating whether individual animals can be grouped or managed together (see also 8 Managing wildlife in care and 9.1 Managing biosecurity risk associated with wildlife translocation and release).

Whether assessed as high or low biosecurity risk, in a **work day** or **work session**, work practices should be organised with the aim of working from lower biosecurity risk to high biosecurity risk areas. This may involve, for example, starting the day working in "clean" or lower risk areas, and moving later in the day, or work session, to "dirty" procedures or higher risk areas. This reduces the risk of moving pathogens from dirty or higher risk areas, to cleaner or lower risk areas. Hand and equipment hygiene should be planned and repeated as necessary, as work flows proceed throughout the day.

Preferably, dedicated areas should set aside for "dirty" tasks such as cleaning soiled equipment and laundry. Dedicated areas should also be set aside for specific purposes such as animal food storage and preparation, and worker eating, showering and washing areas.

6.1 Recognising and managing higher biosecurity risk situations

Situations or work flows that are considered to hold higher biosecurity risk may require additional, or specific management practices and work protocols (referred to here as **higher-level biosecurity practices**), in order for risks to be minimised. The first step is to identify situations which may involve higher biosecurity risk, or factors that may increase biosecurity risk.

Individual animals that may be associated with **higher biosecurity risk** include those that**:**

- have known or suspected infectious disease (see 8.6)
- are injured, infant, orphaned or aged (see 8.6)
- have observable signs of disease (infectious or non-infectious)
- show signs of, or are likely to be suffering from, physiological stress (see 1.2.5)
- have been confiscated (from known or unknown sources), been taken illegally from the wild or illegally transported (see 9.2)

- have been housed in inappropriate cohorts or with inappropriate mixed species
- have had contact with domestic species (see 8.5)
- have been recently exposed to inappropriate husbandry or intervention
- are undergoing recent transition from wild to care
- are known or suspected to be from populations, or in cohorts with confirmed or suspected infectious disease
- are from populations as described below.

Work situations that may be associated with **higher biosecurity risk** include:

- more invasive procedures i.e. sample or blood collection, necropsy examinations and all tasks that involve handling sharps
- procedures that are dirty or involve a large amount of organic material
- procedures that generate potentially infectious aerosols
- instances where an animal's blood, body substances and faeces contact the worker's skin or mucous membranes (eyes, nose and mouth), or contaminate equipment such as pens or instruments
- procedures or situations where normal hygiene practices cannot be followed, for whatever reason (e.g. limited access to soap and warm water for washing and drying hands)
- work with wildlife species or taxa known (or suspected) to have higher risk of zoonotic disease transmission (see 7)
- work with birthing animals or when handling products of conception such as semen (e.g. risk of Q fever, brucellosis, leptospirosis)
- wildlife translocations or releases (both translocated individuals and those in the recipient population are considered to be at higher risk – see 9.1)
- work with animals or populations otherwise considered to be more vulnerable or of higher biosecurity risk (above and below).

Wildlife populations that may be considered of **higher biosecurity risk** include:

- populations with suspected or confirmed changes in demographics (e.g. population decline, poor fertility for species), regardless of whether infectious disease is currently suspected
- populations with recent introductions, releases or incursions
- populations with known high prevalence of disease.

Wildlife populations that may be considered **more vulnerable to biosecurity risks** include:

- populations known to be genetically depauperate or bottle-necked
- geographically isolated or restricted populations
- populations of threatened species or those considered vulnerable to extinction threat
- island (effective or real) populations
- translocated animals and in-contact animals in recipient populations.

If situations of higher biosecurity risk (or increased vulnerability) are identified, appropriately enhanced biosecurity practices should be put in place. Enhanced protocols should be tailored to the circumstances and the nature of increased biosecurity risk.

6.2 Lower biosecurity risk situations

In contrast, many routine procedures undertaken by managers and researchers on free-living wildlife may be assessed as being of lesser biosecurity risk. Some procedures on rehabilitated wildlife in care may be considered lower biosecurity risk.

Examples of **lower level biosecurity risk situations** include:

- routine monitoring (with no invasive sampling or procedures) of free-living wildlife populations considered to be demographically stable and otherwise healthy
- management of well-established, closed groups of wildlife in care, in appropriate social and species mix, with stable and appropriate husbandry (e.g. otherwise healthy birds recovering from traumatic wing fractures).

Regardless of perceived biosecurity risk, basic biosecurity practices should always be adopted.

Chapter 7

Zoonotic disease risk management

Diseases that are spread from animals to humans are called **zoonoses**. Diseases spread from humans to animals are referred to as **anthroponoses** or "reverse zoonoses". Zoonoses and anthroponoses may be spread through direct physical contact with animals and their products, or indirectly by sharing the same air space. (see 1.2 Principles of disease transmission and 1.4 Pathways of disease transmission relevant to Australia wildlife). Most zoonotic disease risks can be minimised through appropriate personal hygiene and good work practices (see 5 General approaches to managing biosecurity risks in wildlife). In addition, more specific measures, such as vaccination, isolation or disease screening may be required (see 8 Managing wildlife in care and 5.5 Isolation).

Everyone working with wildlife should be aware of the risks of zoonotic disease transmission and should take steps to manage these risks appropriately.

7.1 Zoonotic disease risk for wildlife workers

A number of factors influence zoonotic risk when working with wildlife, including:

- the **type of contact:** close contact with animals and their products, animal handling, cleaning enclosures, collecting biological specimens or undertaking a post mortem examination, which may increase the risk of acquiring, or transmitting a zoonotic disease. Animal bites, and contact with faeces, saliva, urine, birth fluids, blood and carcasses generally pose the greatest risks. There are potential risks in handling animal carcasses or body parts used as food for other animals. Injuries and accidents such as animal bites and needle stick injuries are generally considered high risk (see below).
- the **taxonomic group of wildlife:** bats, reptiles, pinnipeds, parrots and pigeons may be considered higher risk, due to infectious diseases of these taxa. Reptiles, in particular, may have faecal bacteria contaminating their skin (notably *Salmonella* spp.), which can be easily transferred during handling (see Appendix C for more detail).
- the **specific health profile of the individual human or animal:** children, the elderly, pregnant women and people with other diseases, or those who are immunosuppressed may be particularly susceptible to zoonotic disease risk, due differences in their immune systems. Pregnant women carry the risk that infection can be transferred to the foetus. Injured, infant, aged or already diseased animals may be more likely to be carrying or shedding pathogens.

People working with wildlife or their products should be aware of both general and specific zoonotic risks associated with their work and they should have a good understanding of the practices necessary to minimise these risks.

People should be aware of the personal factors (e.g. pregnancy, concurrent disease, medications and treatments) that may influence their susceptibility to infectious disease risk. They should discuss the risks with their doctor and should receive the appropriate vaccines to work safely with wildlife. This includes rabies vaccination if working with bats, Q fever if working with native wildlife such as macropods and bandicoots, and tetanus vaccination for all.

Some pathogens may have low likelihood of exposure but high consequences if infection occurs (e.g. Australian bat lyssavirus). These risks should be managed with the same degree of care as more commonly encountered zoonoses (i.e. low likelihood does not mean low risk, if the consequences are high).

Wildlife workers should also be aware that they may transmit infectious disease to the wildlife with which they work, for example ringworm fungus to juvenile animals in care. Appropriate biosecurity management, including hygiene and barrier nursing, can help to minimise these risks.

Wildlife workers should also be aware of relevant hazards in the work environment (e.g. potential for tick bites when rescuing animals, infectious diseases such as melioidosis or leptospirosis risks from working in flood waters, histoplasmosis and cryptococcosis from disturbing soil enriched with pigeon or bat excreta).

It is recommended that each wildlife facility conducts an organisation-specific zoonotic risk assessment with input from both human health and wildlife health professionals. Wildlife organisations should have documented protocols for zoonotic risk management and regular worker training programs in zoonotic disease awareness and risk management.

7.2 Managing biosecurity risk associated with bites, scratches and other injuries

There is a risk of bites and scratches when working with wildlife, which may transfer infection, and depending on the wildlife species and circumstances, may pose a very significant health risk. Procedures should be put in place to prevent or minimise bites, scratches, cuts, contamination of open wounds and needle stick injuries when working with wildlife. The species behaviour and individual animal temperament should be assessed and physical or chemical restraint and personal protective equipment should be used as needed, to manage risk.

General principles should be followed if such injuries occur:

- clean bites and scratches immediately with soap and water and apply a suitable antiseptic or disinfectant
- cover the wound with a water-proof dressing
- seek medical attention.

Bites, scratches or contact with saliva from bats should be treated as an emergency, with prompt, risk-appropriate first aid and follow-up medical care required (see Department of Health Rabies, Australian bat lyssavirus and other lyssaviruses Information for consumers www.health.gov.au/internet/main/publishing.nsf/Content/ohp-rabies-consumer-info.htm).

7.3 Reporting and responding to suspected zoonotic disease

If it is **suspected that a worker has a zoonotic disease** of wildlife origin, this should be reported to the organisation's management, to the veterinary service and to a medical practitioner. This ensures that the individual receives appropriate health care and also that the necessary information is recorded and shared, which is of importance if there is a significant disease event in wildlife that may place other humans at risk. A document detailing the risks of zoonotic disease in relation to Australian wildlife may be developed by wildlife organisations, for their workers to take to their physician.

Any unexplained or persistent disease in a wildlife worker should be referred for investigation by a medical practitioner as a potential zoonotic disease.

If it is suspected that a wildlife worker has received a high-risk exposure to wildlife, with resultant high risk of serious zoonotic disease, **IMMEDIATE** first aid and medical attention should be sought. The local Public Health Unit should be contacted for more information. Wildlife workers should be aware of legal requirements for notification (to the relevant state/territory Work Health and Safety regulator) of confirmed zoonotic disease acquired in the workplace.

7.4 Wildlife zoonosis risk to the public

In most situations, **members of the public** are at minimal risk of contracting zoonotic disease from wildlife due to the physical distance usually maintained between humans and animals. If members of the public do come into close or direct contact with wildlife (e.g. rescuing an orphaned marsupial), risks of zoonotic disease transmission may increase and it may become necessary to implement biosecurity practices such as hand hygiene, or personal health assessments to manage any risk. All workers assisting the public to interact with wildlife should have a good understanding of zoonotic diseases, the particular zoonotic risks in their situation and the appropriate practices to minimise these risks. If a wildlife worker is aware that a member of the public was involved in a wildlife case (e.g. rescue), the wildlife worker should question the person to determine if there was a biosecurity risk and should provide appropriate biosecurity advice e.g. apply first aid and visit a medical practitioner as soon as possible.

Chapter 8

Managing wildlife in care

The information in this section applies to wildlife held in care temporarily and is not intended to apply to wildlife held permanently in captivity, although the principles may also apply to captive wildlife. The National Zoo Biosecurity Manual (www.zooaquarium.org.au/wp-content/uploads/2011/10/National-Zoo-Biosecurity-Manual-March-2011.pdf) presents detailed biosecurity considerations for long term captive wildlife, applicable to zoos, fauna parks and other licensed holders of wildlife.

One of the key factors for consideration when addressing biosecurity concerns for wildlife in care is the intended fate of the animals: specifically, that the animal is to be **returned to a wild environment** from a temporary captive environment at some point in the future. This brings with it an increased risk of transporting pathogens from care into the wild and means that these animals should be treated as "high biosecurity risk", as the consequences of their movement may be significant (see 9.1 Managing biosecurity risk associated with wildlife translocation and release).

The ability to follow individual wildlife cases throughout the wildlife rehabilitation process and after release provides important information. Well-written records, maintained for an appropriate length of time, also provide access to important information that may assist in biosecurity management.

All animals in care should be identified individually and should have written records kept of key information (assessment, testing, diagnosis and treatment) during their rehabilitation process. Preferably, rehabilitated wildlife should be permanently identified prior to release back to the wild[1].

1 Permanent identification may be contraindicated in some bird and bat species. See the Australian bird and bat banding scheme www.environment.gov.au/science/bird-and-bat-banding

8.1 Reasons for maintaining wildlife in temporary care

Free-ranging wildlife may be temporarily held in care for a number of reasons and in a variety of situations:

- most commonly, wildlife is held in care for treatment and rehabilitation prior to release back to the wild. Animals may come into care because they are **young, orphaned, injured, sick, old or misplaced**.
- **confiscated wildlife** (animals legally impounded by the authorities) may also need to be held in care.
- **captive breeding facilities** may temporarily or permanently hold breeding animals in captivity, with a view to releasing offspring into the wild (as part of sanctioned breed for release programs)
- sometimes wild individuals are brought into captivity temporarily for breeding purposes, then released back to the wild (e.g. male breeding western swamp tortoise).

Holding wildlife in care has biosecurity implications for both captive and wild populations of wildlife, for domestic animals and for humans. Risks and suggested management are discussed in detail below. In all cases the concepts of "inputs" and "outputs" (and their identification and management) are central to good management of biosecurity of wildlife in care (see 1.3 The concept of inputs and outputs).

The health status and biosecurity risk of every animal arriving into care should be assessed by an experienced wildlife worker. Veterinary input may be required, especially if risks are complex or indeterminate, or if infectious disease is present. The assessment should include the relative risk of zoonoses. Animals should remain in isolation until their biosecurity risk has been established and an appropriate biosecurity management procedure developed.

8.2 Types of wildlife care facilities

Wildlife in care in Australia is typically housed either in:

- **veterinary facilities** (generally in the short term, for first aid and treatment)
- **wildlife rehabilitation facilities** (often for longer periods, for ongoing treatment, rehabilitation, hand-rearing and acclimatisation prior to release). Wildlife rehabilitation facilities vary widely in size and scope, and may range from a holding box within a domestic house to a large purpose-built facility
- **specific-focus wildlife facilities** (such as breed-for-release facilities).

The guidelines for facility management outlined in this document focus primarily on wildlife rehabilitation facilities, but also apply to veterinary facilities and other facilities holding wildlife.

8.3 Who cares for wildlife?

Wildlife in **veterinary facilities** are generally cared for by veterinarians and veterinary nurses, who have formal training in disease control and biosecurity risk management. Other lay staff may also be involved in this work.

Wildlife in **rehabilitation facilities** may be cared for by paid staff or by volunteers with variable levels of experience and training.

Wildlife in **specific-focus wildlife facilities** (such as breed-for-release facilities) are generally cared for by wildlife officers (or animal keepers) with training in wildlife care and some level of formal training in biosecurity and disease control. They may be assisted by volunteers with variable levels of training in these areas.

An understanding of the nature of the facility, staffing level, staff training and the presence and knowledge of supervisors is important when assessing biosecurity risk. A facility that employs fulltime, highly trained and qualified staff, with good supervision and written procedures and monitoring is likely to better manage biosecurity risk than a similar facility with smaller, part time and untrained workers with minimum supervision and no written procedures.

Employers and those overseeing volunteers should ensure that all workers are trained in appropriate biosecurity management, regardless of their background qualifications, "on the job" experience, the number of hours worked or the size or nature of the facility. Regular refresher training should be scheduled.

Facilities may also have various members of the community passing through on a regular basis. Tradesmen and others may need to attend for maintenance and repairs. In some cases, members of the public may visit the facility to view and engage with wildlife and may be encouraged to directly interact with animals. All of these practices have biosecurity implications and risks that should be identified, assessed and managed.

8.4 General facility construction and management

Ideally, every wildlife care facility should be designed and constructed with biosecurity risks in mind. All facilities should be maintained with biosecurity risks in mind. In practical terms, this involves the following considerations:

- easy and effective cleaning (and if necessary disinfection) of enclosures, furnishings and equipment
- ease of work flow management
- appropriate management of animal food, biological and water wastes
- good drainage (without cross-contamination), with no accumulation of water or waste products
- security from operational disruption by flood, bushfire, or other events
- appropriate areas for isolation of individuals or groups
- species-appropriate facilities to minimise physiological stress
- ease of capture, transfer and movement of animals
- appropriate air-flow and air exchange (to minimise pathogen load)
- appropriate ambient temperature and humidity (to minimise individuals' physiological stress)
- isolation from domestic animals, free-ranging wildlife, feral animals, pest species and invertebrate pests
- facilities that allow for safe and hygienic animal handling, examination, treatment and post mortem processes
- animal food preparation and storage areas
- hand washing and showering and change areas for workers
- wash bay for vehicles and larger equipment
- visitor hygiene facilities (at a minimum hand washing facilities)
- appropriate segregation of different groups of wildlife in care, so that abnormal species mixing does not occur, and to ensure social species are housed in appropriate age and health cohorts
- facilities for worker food preparation, storage and meals, separate to those used for animals.

Wildlife holding facilities should be secure, preferably with a well-defined and secure perimeter that prevents both escape of animals and entry by animals outside of the perimeter.

8.5 Managing risk associated with pest, feral and domestic animals

Direct contact and indirect contact (e.g. through contaminated clothing, equipment, facilities, food, water or waste) between wildlife in care and free-ranging wildlife, pets, therapy animals, and feral or domestic animals can pose biosecurity risks to all the animals involved. For example, both domestic and feral cats shed *Toxoplasma* cysts in their faeces. These pathogens survive for extended periods in the environment and can contaminate the food sources of macropods and other wildlife in care, and can result in serious infectious disease.

Direct and indirect contact (e.g. smells, noises) with domestic and feral animals is considered to be a stressful, "predator-threat" type interaction for most Australian wildlife species. Such exposure should be avoided, to minimise biosecurity risks, to reduce the physiological stress of the patient and to reduce the risk of predation and trauma.

Indirect or direct contact between wildlife held in facilities and free-ranging wildlife, domestic, feral and pest animals should be prevented or minimised.

Domestic animals (including therapy animals) should not be allowed in contact with wildlife in care. People caring for wildlife in a home/farm environment should ensure there is separation between companion/production animals and the wild animals in their care. Appropriate levels of hygiene should be used, if it is necessary to share equipment between these cohorts.

Wildlife cases temporarily housed in veterinary facilities that cater for domestic animals should be held in isolation from all domestic species, in a separate room, with noise protection and appropriate housing, to minimise risks of stress and disease transfer.

Feed, water and shelter should be provided to wildlife in care in a way that does not attract feral and free-ranging wildlife to the area. Pest species control programs may need to be implemented, including trapping or baiting for feral rodents.

8.6 Orphaned, injured and sick wildlife undergoing treatment and rehabilitation

The majority of wildlife in care are either orphaned, injured and/or sick, and are undergoing treatment and rehabilitation with a view to release back to the wild. This group of animals is considered to be of "higher biosecurity risk". Additionally, the biosecurity concerns are raised because animals are moving from one biosecurity space (the wild) to another (captive) and back again.

Factors that increase biosecurity risk associated with orphans:

- immune function is likely to be poorly developed due to the young age of the animal, physiological and nutritional stress, dehydration, hypothermia, loss of access to maternal antibodies provided in the mother's milk and loss of protection of the pouch or nest (see also 1.2.5 The role of stress and intervention in infectious disease)
- potential mixing with other wildlife species that would not interact in the wild, increasing the chance of exposure to infectious agents that are not normal parts of the animal's microbial flora
- a large amount of contact with humans, due to the level of care needed, with an associated increased chance of pathogen transfer in both directions
- potential mixing with domestic or feral animals.

Factors that increase biosecurity risk associated with injury:

- same factors as those for orphans, however if the animal is independent or of adult age, immune function will probably be stronger
- pre-existing disease may have predisposed to injury, and wounds and other injuries may be easily infected, with poor wound healing due to a range of factors, including reduced immune function.

Factors that increase biosecurity risks associated with being sick:

- organ function and physiology may be reduced due to illness, injury and poor immune function (regardless of whether disease is of infectious or non-infectious origin)
- the animal may be suffering from an infectious disease.

Some factors can be managed through good work practices (e.g. mixing with other wildlife, domestic or feral animals, and the level of contact with humans). It is of great importance that these are managed well because other factors such as reduced immune function, injury or illness are less easily managed.

Chapter 9

Managing biosecurity risk associated with specific wildlife situations

9.1 Managing biosecurity risk associated with wildlife translocation and release

Wildlife translocations, including translocations associated with captive breed-for-release programs, are considered to pose high biosecurity risk. Due to the recognised risks, a formal process has been developed by the World Organisation for Animal Health (OIE) and the International Union for the Conservation of Nature (IUCN) to assess biosecurity risks associated with wildlife translocations (Manual of Procedures for Wildlife Disease Risk Analysis https://portals.iucn.org/library/sites/library/files/documents/2014-007.pdf)

Prior to action, each animal movement should be assessed carefully for disease risk and appropriate biosecurity practices should put in place.

In addition to the risks associated with the necessary human intervention, the biosecurity risks are further amplified because:

- animals are generally moved over long distances, far greater than would occur through natural movements, allowing for abnormal or accelerated geographic spread of pathogens (e.g. the rapid and widespread global dissemination of the pathogenic Chytrid fungus)
- animals are usually moved in groups and there may be multiple translocation events. The greater the number of individuals within a group, or number of introductions, the higher the risk.
- during the process of translocation, individuals are assumed to be under increased physiological stress. This may be due to confinement, transport and stresses associated with settling into a new environment such as the need to seek sufficient food, water and shelter.

Strategies to minimise and monitor biosecurity risks associated with wildlife translocations include:

- collection of comprehensive health, disease and demographic data for both source and destination populations (including sympatric species, i.e. those occurring in the same geographic area), preferably in the years prior to translocation
- permanent identification of each individual prior to its movement, with this information recorded
- collection and recording of individual health and morphometric data before, during and after a translocation event
- maintenance of detailed individual animal records for an extended period (e.g. at least seven years) post translocation
- full and appropriate investigation and treatment of any sick or dead individuals before, during and after a translocation event, including full post mortem examination and investigation to a reach a diagnosis (rather than just to rule out a suspected cause of death or disease of concern)
- methods to track and monitor the animal remotely, which may provide information on movement, interference, morbidity and mortality
- identification, though a hazard assessment process of the known, likely and suspected infectious agents which may impact the species, or may be carried by the species and pose a risk to any sympatric species
- guided decision-making, through a risk assessment process, for pathogen testing, pathogen management, translocation approval, post translocation monitoring and surveillance and assessment of translocation success
- maintenance of strict hygiene and biosecurity protocols during capture, examination, sampling, transfer, release and post-release monitoring.

A formal disease risk assessment process helps to identify and prioritise risk management activities.

A biosecurity risk management plan should be developed and implemented prior to any planned transfer or translocation of wildlife.

Critical steps for development of a risk management plan include:

- prior to transfer, each individual should have a full health check (and preferably collection of samples for testing or storage) by a veterinarian with clinical experience with the species being moved
- prior to transfer, the health and disease status of the receiving populations (not just the transfer species but all at-risk species) should be surveyed and assessed
- post-transfer monitoring, reporting and disease surveillance of the receiving populations, for an extended period of time.

9.2 Managing biosecurity risk associated with confiscated wildlife

Management of confiscated wildlife is considered to pose very high biosecurity risks. In addition to the existing risks associated with the necessary human intervention, the biosecurity risks are amplified because:

- the disease status of each animal is unknown
- individuals may have an unknown and untraceable history and provenance
- there is a high likelihood of previous inappropriate or substandard husbandry, housing, grouping and poor biosecurity
- individuals may have been illegally transported, including across state or international borders
- individuals may have been illegally collected from the wild
- individuals may have been "abnormally" mixed with other individuals or species of similar or greater risk.

Assessing and managing the biosecurity risks associated with confiscated wildlife is challenging due to the high number of unknowns. Standard practice is to apply the precautionary principle and assume a high biosecurity risk, unless concrete information is available to indicate a different approach. In most cases this will involve euthanasia of the animals and appropriate disposal of the carcass to destroy any infectious agents that may be involved. In rare circumstances (e.g. for some endangered species or for legal reasons such as court cases), it may be necessary or desirable to hold the live animals in an appropriately biosecure facility. It should be kept in mind that confiscated animals may be infected with multiple pathogens, including novel pathogens or those for which there is no known testing regime. For these reasons, it is recommended that confiscated animals should be maintained in the strictest isolation and receive full veterinary inspection and investigation.

9.3 Managing biosecurity risk associated with sick animals

Interacting with sick wildlife can pose high biosecurity risks. In addition to the existing risks associated with the necessary human intervention, the biosecurity risks are amplified because:

- the animal may be infected with a contagious disease, which may be transmitted via handling or management practices
- the animal is likely immunosuppressed and is more likely to be susceptible to other infections or to be shedding a pathogen.

Most biosecurity risks can be managed by treating sick individuals as high risk.
Simple precautions include:

- strict hand and equipment hygiene when handling sick individuals or carcasses
- strict application and use of personal protective equipment and processes when collecting samples, treating animals and disposing of wastes
- appropriate handling and packaging of samples for laboratory analysis
- isolation of sick animals (see 5.5 Isolation).

9.4 Managing biosecurity risk associated with biological samples, animal carcasses and waste

Biological products including animal carcasses and waste products can pose biosecurity risks. Risks should be assessed and these products should be managed carefully to minimise risks to humans, animals and environment. If in doubt, products should be assessed and managed as high risk. The level of biosecurity risk for a dead animal that was sick prior to death should be considered the same as for a sick living animal.

Biological samples, waste products and carcasses should not be stored in the same fridge, freezer or container as human or animal food.

Appropriate processes to minimise biosecurity risk associated with biological samples, carcasses and waste include:

- documented procedures for handling, storage and disposal of animal carcasses, biological samples and wastes
- strict application and use of personal protective equipment and processes when collecting samples, undertaking post mortem examinations and disposing of wastes
- strict hand and equipment hygiene prior to and after handling specimens
- use of appropriate personal protective equipment (see 8.3) when handling specimens
- placing specimens in appropriate leak-proof containers (such as screw-top vials, plastic bags) for transport and storage
- storing specimens at appropriate temperature and in appropriate containers (e.g. fridge, icebox)
- careful handling to minimise contamination of external surfaces of containers
- cleaning, and if necessary disinfection, of containers and surfaces, especially prior to re-use
- safe and appropriate disposal of products, carcasses and other waste e.g. by clinical waste disposal service, deep burial, incineration
- adhering to safe packaging and handling regulations and contacting receiving laboratories prior to the submission of high risk material.

There are guidelines with detailed information on safe packaging and handling of biological samples (see Requirements for the packaging and transport of pathology specimens and associated materials www.health.gov.au/internet/main/publishing.nsf/Content/4F97263708B66C49CA257BF0001E012A/$File/Reqmts%20PackagingTransport%202013.pdf).

Animal carcasses may need to be retained for investigation of disease or death. Carcasses intended for post mortem examination should be kept chilled (not frozen) and should be stored appropriately to ensure biosecurity risks are managed and the carcass is preserved in the best possible state for investigation, research and other information retrieval. Animal carcasses must be disposed of in a manner that complies with any local, state/territory or federal regulations, including environmental compliance requirements.

Animals which are found dead or are euthanased by chemical means should never be fed to other animals. Such carcasses should be disposed of by secure means such as waterproof bagging, then into either a biological waste disposal service, deep burial or incineration.

Chapter 10

Managing risks of inappropriate use of antimicrobial medications

There are risks involved with inappropriate use of antimicrobial medication in wildlife which include:

- development of antimicrobial resistance (AMR)
- potential toxic or deleterious effects on the individual
- a failure to effectively treat infectious or non-infectious diseases.

Inappropriate use of antimicrobials may lead to biosecurity risks such as changes to the natural biome of an animal or human. This may result in increased risks to individual animal or workers. The development of AMR can lead problems such as infection with multi-resistant *Staphylococcus*. Although the role of wildlife (including administration of antimicrobials to wildlife) in the development of AMR is not well understood, the general principles of antimicrobial stewardship should be applied equally to their use in wildlife (see www.safetyandquality.gov.au/our-work/healthcare-associated-infection/antimicrobial-stewardship/book and the WHA Fact Sheet "Antimicrobial Resistance and Australian Wildlife" www.wildlifehealthaustralia.com.au/FactSheets.aspx).

Antimicrobial medication should only be administered to wildlife on an individual basis, following individual examination, diagnosis and prescription by a registered veterinarian.

Chapter 11

References and further reading

See also Appendix A: Relevant state, territory and national regulations, legislative bodies and agencies, and useful documents and websites.

Antimicrobial Stewardship in Australian Health Care (2018) www.safetyandquality.gov.au/our-work/healthcare-associated-infection/antimicrobial-stewardship/book/

Australian bat lyssavirus and handling bats (2016) Qld Workplace Health and Safety www.worksafe.qld.gov.au/__data/assets/pdf_file/0003/82902/lyssavirus-handling-bats.pdf

Australian bird and bat banding scheme www.environment.gov.au/science/bird-and-bat-banding

Australian Code for the Care and Use of Animals for Scientific Purposes (2013) NHMRC www.nhmrc.gov.au/_files_nhmrc/publications/attachments/ea28_code_care_use_animals_131209.pdf

Australian Immunisation Handbook (2017) www.immunise.health.gov.au/internet/immunise/publishing.nsf/Content/Handbook10-home

AUSVETPLAN Summary Document (Version 3.1) (2008) www.animalhealthaustralia.com.au/our-publications/ausvetplan-manuals-and-documents/

AUSVETPLAN Wild Animal Response Strategy WARS (Version 3.3) (2011) www.animalhealthaustralia.com.au/our-publications/ausvetplan-manuals-and-documents/

AUSVETPLAN Zoos Enterprise Manual (Version 3.0) (2013) www.animalhealthaustralia.com.au/our-publications/ausvetplan-manuals-and-documents/

Biosecurity and cross-contamination in epidemiological studies involving trapping and sampling wildlife (2016) Hillman, AE, Lymbery AJ, Robertson ID, Thompson RCA *Wildlife Biology in Practice* 12, 2 doi: 10.2461/wbp.2016.12.6

Disease risks associated with the translocation of wildlife Kock R, Woodford M, Rossiter P (2010) *Revue Scientifique et Technique (International Office of Epizootics)* 29(2): 329-350.

Emerging infectious diseases of wildlife: a critical perspective (2015) Tompkins D, Carver S, Jones M, Krkošek M, Skerratt L Trends in Parasitology 31(4): 149-159.

Emerging infectious diseases of wildlife – threats to biodiversity and human health (2000) Daszak P, Cunningham AA, Hyatt AD *Science* 287: 443–449.

Glove Use Information Leaflet World Health Organisation http://www.who.int/gpsc/5may/Glove_Use_Information_Leaflet.pdf

Guidelines for Veterinary Personal Biosecurity 3rd Ed (2017) Australian Veterinary Association www.ava.com.au/biosecurity-guidelines

How to Manage Work Health and Safety Risks, Code of Practice (2011) Work Safe Australia https://www.safeworkaustralia.gov.au/system/files/documents/1702/how_to_manage_whs_risks.pdf

Hygiene protocols for the control of diseases in Australian frogs (2011) http://www.environment.gov.au/biodiversity/invasive-species/publications/hygiene-protocols-control-diseases-australian-frogs

Hygiene Protocols for the Prevention and Control of Diseases in Australian Birds (2006) Department of Environment and Heritage www.environment.gov.au/resource/hygiene-protocols-prevention-and-control-diseases-particularly-beak-and-feather-disease

Keeping it clean: a Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens (2010) https://nrmsouth.org.au/wp-content/uploads/2014/10/keeping_it_clean.pdf

Manual of Procedures for Wildlife Disease Risk Analysis (2014) IUCN OIE; Jakob-Hoff RM, MacDiarmid SC, Lees C, Miller PS, Travis D, Kock R https://portals.iucn.org/library/sites/library/files/documents/2014-007.pdf

Minimising exposure of amphibians to pathogens during field studies (2010) Phillott A, Speare R, Hines H, Skerratt L, Meyer E, McDonald K, Cashins S, Mendez D, Berger L *Diseases of Aquatic Organisms* 92: 175-185.

National Zoo Biosecurity Manual (2011) www.zooaquarium.org.au/wp-content/uploads/2011/10/National-Zoo-Biosecurity-Manual-March-2011.pdf

Quarantine and Health Screening Protocols for Wildlife prior to Translocation and Release into the Wild Woodford M (2000) IUCN, OIE, EAZWV www.iucn-whsg.org/category/publication-tags/quarantine

Rabies, Australian bat lyssavirus and other lyssaviruses: Information for consumers Department of Health www.health.gov.au/internet/main/publishing.nsf/Content/ohp-rabies-consumer-info.htm

Requirements for the packaging and transport of pathology specimens and associated materials (2013) NPAAC www.health.gov.au/internet/main/publishing.nsf/Content/4F97263708B66C49CA257BF0001E012A/$File/Reqmts%20PackagingTransport%202013.pdf

Sick & Dead Bird Health Surveillance Sample Collection Protocol Australian Registry of Wildlife Health http://arwh.org/sites/default/files/2017-01/SickDead%20Bird%20Surveillance_with%20images_0_0.pdf

The Wild Side of Disease Control at the Wildlife-Livestock-Human Interface: A Review (2015) Gortazar C, Diez-Delgado I, Barasona JA, Vicente J, De La Fuente J, Boadella M Frontiers in Veterinary Science 1(27) https://doi.org/10.3389/fvets.2014.00027

Wildlife Health Australia Fact Sheets www.wildlifehealthaustralia.com.au/FactSheets.aspx

Chapter 12

Abbreviations

AHA	Animal Health Australia
AMR	Antimicrobial resistance
DAWR	Department of Agriculture and Water Resources (Commonwealth)
EAD	Emergency animal disease
GBO	General biosecurity obligations
IGAB	Intergovernmental agreement on biosecurity (add link)
NZBM	National Zoo Biosecurity Manual
PPE	Personal protective equipment
SOP	Standard operating procedure
WHA	Wildlife Health Australia

Chapter 13

Definitions

Acceptable level of risk: the maximum overall exposure to risk that should be accepted, based on the benefits and costs involved.

Aerosolisation: the process of converting a physical substance into particles small and light enough to be carried on the air.

Anthroponosis: a disease spread from humans to animals.

Antimicrobial stewardship: a coordinated program that promotes the appropriate use of antimicrobials (including antibiotics), improves patient outcomes, reduces microbial resistance, and decreases the spread of infections caused by multidrug-resistant organisms.

Antiseptic: chemical disinfectant for use on skin or mucous membranes.

Barrier keeping: the use stringent control measures designed to minimise the spread of infectious disease from one animal, group or environment to another.

Biosecurity: the management of risks to the economy, the environment and the community, of pests and diseases entering, emerging, establishing or spreading (IGAB). Biosecurity can also be defined as the set of precautions taken to minimise the risk of introducing a pest or infectious disease into an animal (or human) population, or to a group or individual.

Captive animal: an animal that lives under human control or care (in this document, permanent care, such as a zoo or fauna park).

Captive breed-for-release: the process of breeding wildlife in controlled environments with the intention of release to the wild, often to supplement wild populations.

Carrier: a human or animal which harbours a pathogen in its body without manifesting signs, thus acting as a potential source or distributor of infection.

Colonisation: the presence of pathogens, especially bacteria, on a body surface (e.g. skin, mouth, intestines or airway) without causing disease in the individual.

Cold chain: a temperature-controlled supply chain.

Confiscated wildlife: wildlife seized by an authority as a result of wrong-doing.

Contagious disease: those infectious diseases that are spread through (direct or indirect) contact with infected individuals e.g. salmonellosis. Not all infectious diseases are contagious.

Decontamination: the process of cleansing an object or substance to remove contaminants such as micro-organisms or hazardous materials. It includes all stages of cleaning and disinfection.

Dedicated equipment: equipment that is dedicated for sole use for an animal, task or area, with the purpose of reducing the risk of cross-contamination.

Disease: any disturbance in the health or function of an animal or human.

Disease agent: a general term for a transmissible organism or other factor that causes an infectious disease.

Disinfectant: a chemical used to destroy infectious agents outside a living animal.

Disinfection: the application, after thorough cleansing, of procedures intended to destroy the infectious or parasitic agents of disease; applies to premises, vehicles and different objects (fomites) that may have been directly or indirectly contaminated. Disinfection inactivates most but not all micro-organisms.

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.

Domestic animal: a species that has been domesticated by humans; an animal that is not wild and that is kept by humans as a pet, working animal or to produce food.

Double gloving: the practice of wearing two layers of disposable gloves to reduce the risk of infection from glove failure or penetration of the gloves by sharp objects during animal health care procedures.

Emergency animal disease: a disease not normally occurring in a place that requires emergency responses; an EAD is likely to have significant effects on livestock – potentially resulting in livestock deaths, production loss, and in some cases, impacts on human health, wildlife and the environment.

Emergency wildlife disease: a disease that is either exotic to Australia, a variant of an endemic disease, a serious infectious disease of unknown cause or a severe outbreak of a known endemic disease, and that is considered to be of national significance with serious social amenity or economic or environmental implications.

Endemic animal disease: a disease affecting animals (which may include humans) that is known to occur in Australia. See also Emergency animal disease, exotic animal disease.

Exposure: proximity or contact with a source of a pathogen in such a manner that effective transmission of the pathogen may occur.

Exotic animal disease: a disease affecting animals (which may include humans) that does not normally occur in Australia. See also Emergency animal disease, endemic animal disease.

Face mask: a loose-fitting mask that covers the nose and mouth area with two ear loops or ties to hold the mask in place. Face masks capture large particles and droplets from the wearer and prevent them from being spread to the environment.

Feral: domestic animals or exotic species that have become wild (e.g. cats, horses, pigs, rabbits, foxes).

Fomites: inanimate objects (e.g. boots, clothing, equipment, instruments, vehicles, crates, packaging) that may be contaminated with an infectious agent and may spread the disease via mechanical transmission to a new host.

Hand hygiene: any method that removes or destroys microorganisms on hands. In this document, generally refers to washing and drying of hands with warm water and soap, and/or use of alcohol-based hand sanitizer products.

Hazard: a danger or risk; an entity that can cause disease, injury or damage.

Healthy: apparently normal in all vital functions and free of signs of disease.

Higher-level biosecurity practices: situations or work flows that are considered to hold higher biosecurity risk and may require additional or specific management practices and work protocols for risks to be minimised.

Host: a person or animal that can become infected with and provides sustenance for another organism (such as an infectious agent in our case).

Hygiene: practices of cleanliness that help to maintain health and prevent disease.

Immune system: the collection of organs, cells and molecules that together provide the animal or human with defence against invading organisms.

Incubation period: interval between the time of infection and the onset of clinical signs or symptoms.

Infection: the presence of a pathogen or infectious agent within an individual.

Infectious agent: organisms that live on or within a host and that survive at the expense of the host regardless of whether disease follows or not. This includes both microparasites (viruses, bacteria, fungi, protozoa) and macroparasites (worms and external parasites).

Infectious disease: those diseases caused by pathogens (or organisms).

Input: any human, animal, biological or non-biological product which enters a facility, work area or geographic location.

Isolation: the separation of an animal (or human) from its conspecifics for veterinary, husbandry or management purposes, which generally involves confinement to a defined area.

Laundry: (for the purposes of this document) bedding, clothes, towels and other washable items.

Microorganism: any organism (usually bacteria or viruses) that cannot be seen with the naked eye; also called a microbe.

Mitigate: make (something bad) less severe or serious. In the context of risk management, this means to apply a treatment that lessens, or decreases the severity or likelihood of a risk occurring.

Monitoring: routine collection of data for assessing the health status of a population.
See also Surveillance.

Mucosa: the lining of body tracts such the respiratory, gastrointestinal tract and the reproductive tract.

Native species: A species of animal indigenous to Australia, independent of human introduction.

Organic material: matter that has come from a recently living organism.

Organism: any biological entity with the capacity for replication and response to evolutionary forces; includes plants, animals, fungi, protozoa, metazoa, viruses and bacteria.

Outbreak (of a disease): a unit or group of disease cases which occur in the same location during a limited period of time.

Output: any human, animal, biological or non-biological product which leaves a facility, work area or geographic location.

Quarantine: a period of isolation, to aid in detection, management and/or elimination of infectious disease.

Parasite: an organism that, for all or some part of its life, lives in or on a living organism of another species (the host).

Parturient: in labour, about to give birth, or having recently given birth.

Pathogen: (sometimes called agents of disease) are any infectious agent capable of causing disease in a host, e.g. viruses, bacteria, fungi, protozoa, internal parasites such as worms and external parasites such as lice and mites.

Pathogenic: capable of causing disease.

Personal protective equipment (PPE): barrier protection worn to reduce the risk of infection or injury.

Pest: any species, strain or biotype of the Kingdoms Animalia (excluding human beings), Plantae, Fungi, Monera or Protista that has had an impact (i.e. significant negative consequences), or poses a likely threat of having an impact (IGAB).

Physiological or biological stress: an individual's response to a stressor such as an environmental condition.

Precautionary principle: where there is limited information, a risk is assumed (and managed appropriately) until proven otherwise.

Protocol: a system of rules that explain the correct conduct and procedures to be followed in formal situations.

Protozoa: single celled organisms; some are parasitic and cause disease (e.g. toxoplasma), others live harmlessly in the environment or assist hosts (e.g. gut flora).

Quarantine: see Isolation.

Reservoir host: a species which can harbour a pathogen indefinitely with no ill effects.

Respirator: a tight-fitting mask with a facial seal that provides protection for the wearer against aerosols.

Risk: the likelihood of encountering some form of harm, loss or damage, combined with the severity or consequence of the event.

Risk assessment: the process used to assess and understand risk.

Risk management: the process of identifying, selecting and implementing measures that can be applied to reduce the level of risk.

Seroprevalence: the frequency of individuals in a population that have a particular element (e.g. antibodies to *Toxoplasma*) in their blood serum.

Standard operating procedures (SOPs): detailed written instructions describing the practical procedures and management operations to be performed or followed, precautions to be taken and measures to apply.

Sterilisation: the complete eradication of all infectious agents using techniques such as high heat, pressure and/or irradiation.

Subclinical infection: infection with a pathogen, without development of disease.

Surveillance: a systematic program of investigation designed to establish the presence, extent of or absence of a disease, or of infection or presence of a pathogen. It includes the examination and testing of animals for clinical signs, antibodies or the presence of a pathogen.

Susceptible animals: animals that can be infected with a particular disease.

Sympatric: species or populations which exist in the same geographic area and frequently encounter one another.

Vector: a living organism (frequently an arthropod) that transmits an infectious agent from one host to another.

Veterinarian: a registered veterinarian.

Virulence: the ability of an infectious agent to produce disease and a measure of the severity of the disease it causes.

Wildlife: A species of bird, mammal, reptile or amphibian native to Australia.

Wildlife carer: a person who temporarily cares for sick, diseased, injured or orphaned wildlife until it is recovered and becomes capable of fending for itself.

Wildlife organisations: organisations such as government or non-government wildlife research and management agencies, wildlife care and rehabilitation organisations etc.

Wildlife rehabilitation: the temporary care of sick, diseased, injured or orphaned wildlife, until it is recovered and becomes capable of fending for itself.

Wildlife worker: any person who comes into direct or indirect contact with Australian wildlife as part of their role, including as a paid employee, volunteer or student.

Working with wildlife: any activity which involves direct or close contact with wildlife, holding facilities, equipment or wildlife products.

Zoonosis/Zoonotic disease (Plural zoonoses): a disease of animals that can be transmitted to humans. See also Anthroponosis.

Appendix A

Relevant state, territory and national regulations, legislative bodies and agencies, and useful documents and websites

The **AUSVETPLAN Wild Animal Response Strategy** (AHA 2011) and the **Australian Code for the Care and Use of Animals for Scientific Purposes** (NHMRC 2014) contain useful lists of Australian legislation relevant to wildlife disease, welfare and management.

AUSTRALIAN ANTARCTIC DIVISION www.antarctica.gov.au/

AAD Unusual Animal Mortality Response Plan 2013-2017 www.antarctica.gov.au/__data/assets/pdf_file/0015/134007/2013-2017-Unusual-Animal-Mortality-Response-Plan.pdf

Australian Capital Territory

ACT Environment, Planning and Sustainable Development Directorate
www.environment.act.gov.au/

ACT Biosecurity www.environment.act.gov.au/parks-conservation/plants-and-animals/Biosecurity

New South Wales

NSW Department of Environment and Heritage (DEH) www.environment.nsw.gov.au

NSW Wildlife licenses www.environment.nsw.gov.au/licences-and-permits/wildlife-licences

Code of Practice for Injured, Sick and Orphaned Protected Fauna www.environment.nsw.gov.au/resources/wildlifelicences/110004FaunaRehab.pdf

Northern Territory

NT Department of Environment and Natural Resources https://nt.gov.au/environment

About caring for wildlife https://nt.gov.au/environment/animals/caring-for-wildlife/about-caring-for-wildlife

Queensland

Qld Department of Environment and Science www.ehp.qld.gov.au

Qld Code of Practice Care of Sick, Injured or Orphaned Protected Animals www.ehp.qld.gov.au/wildlife/caring-for-wildlife/pdfs/cp-wl-rehab.pdf

Qld Workplace Health and Safety "Australian bat lyssavirus and handling bats"
www.worksafe.qld.gov.au/__data/assets/pdf_file/0003/82902/lyssavirus-handling-bats.pdf

South Australia

SA Department for Environment and Water (www.environment.sa.gov.au/Home) and licenses and permits (www.environment.sa.gov.au/licences-and-permits) and guidelines for the management of a range of native species in captivity.

SA Department for Health and Aging "Animal contact guidelines" (2015) www.sahealth.sa.gov.au/wps/wcm/connect/e0947b00492e1a49ac0afd9006c065a9/14167.1+A4+guidelines+Book-ONLINE+%283%29.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE-e0947b00492e1a49ac0afd9006c065a9-llKd.r6

SA environmental legislation www.environment.sa.gov.au/about-us/Legislation

Tasmania

Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE) http://dpipwe.tas.gov.au/

Strategy for managing wildlife disease in the Tasmanian Wilderness World Heritage Area http://dpipwe.tas.gov.au/Documents/Strategy-for-Managing-Wildlife-Disease.pdf

Tasmanian Chytrid Management Plan http://dpipwe.tas.gov.au/Documents/Tasmanian-Frog-Management-Plan.pdf

DPIPWE Biosecurity and Disease Management Protocols for Captive and Wild Orange-bellied Parrots in Tasmania http://dpipwe.tas.gov.au/Documents/DPIPWE%20Biosecurity%20and%20Disease%20Management%20Protocols%20for%20Captive%20and%20Wild%20Orange-bellied%20Parrots%20in%20Tasmania.pdf

List of biosecurity videos for recreation park users and researchers in the Tasmanian Wilderness World Heritage Area (TWWHA) (note that the principles apply more broadly) https://www.youtube.com/playlist?list=PL-VKM4GZeXXQxwyGHD5M68TtqTJCkrCnE

Guidelines for Applicants of Scientific Permits (see Attachment 1) http://dpipwe.tas.gov.au/Documents/guidelines%20for%20Applicants%20of%20Scientific%20Permits%20FLORA.pdf

Natural Values Atlas (logon to obtain a Biosecurity Report to identify biosecurity risks before travel to an area) dpipwe.tas.gov.au/conservation/development-planning-conservation-assessment/planning-tools/natural-values-atlas

Victoria

Vic Department of Environment, Land, Water and Planning (DELWP) www.delwp.vic.gov.au

Vic rehabilitation shelters and carers www.wildlife.vic.gov.au/sick-injured-or-orphaned-wildlife/wildlife-rehabilitation-shelters-and-foster-carers

Western Australia

WA Department of Biodiversity, Conservation and Attractions (DBCA) www.dbca.wa.gov.au

Managing Disease Risk in Wildlife Management (SOP) www.dpaw.wa.gov.au/images/documents/plants-animals/monitoring/sop/sop_managing_disease_risk_in_wildlife_management_v1.1_2017.pdf

WA environmental legislation www.legislation.wa.gov.au/legislation/statutes.nsf

WA Standards for wildlife rehabilitation www.dpaw.wa.gov.au/images/documents/get-involved/wildlife-courses/20140408_standardsforwildliferehab_final.pdf

WA Work Safe – zoonoses www.commerce.wa.gov.au/worksafe/zoonoses

Appendix B

Recommended operational protocols to be developed and maintained by organisations working with wildlife

B1 Cleaning, disinfection and personal protective equipment protocols (see Chapter 5)

Wildlife organisations should have documented protocols for:

- personal hygiene, including hand hygiene
- biosecurity management of clothing, boots and other personal equipment
- selection and use of personal protective equipment
- equipment hygiene
- facility hygiene
- waste management
- managing biosecurity risks associated with sick wildlife, carcasses and biological samples.

B2 Animal identification, record keeping and reporting (see Chapter 4)

Wildlife organisations should have documented protocols for:

- identification (or marking) of individual animals
- recording relevant written information on individual and group animal cases
- maintaining and storing records
- reporting suspicious signs of disease and unexpected or unexplained deaths in wildlife to appropriate authorities.

B3 Zoonotic risk management (see Chapter 7)

Wildlife organisations should have documented protocols for:

- zoonotic disease risk management
- worker training programs around zoonotic disease risk management (see also B5 Staff training and operational practice protocols)
- reporting and notifying suspected zoonotic disease of wildlife origin in a wildlife worker
- worker disease screening and/or vaccination, if required.

B4 Planning for wildlife procedures - recommended checklists

Wildlife organisations should have documented protocols and general planning lists to assist in undertaking any procedure with wildlife. These may include protocols and checklists covering the following areas:

Biosecurity considerations to be included in planning for wildlife field operations such as trapping, sampling, etc:

- the type and amount of equipment (including vehicles) to be used. All need to be clean and ifnecessary disinfected prior to use
- have workers been sufficiently trained in appropriate biosecurity?
- contingency plans and organisation of necessary emergency equipment e.g. for sick or dead animals or unexpected situations
- protocols for managing hygiene in the field
- data recording
- any specific pathogen or biosecurity concerns for this environment and species or for individual workers
- workflow management
- protocols for managing biosecurity risk associated with sampling or other interventions
- handling and managing samples including maintenance of the cold chain
- any movement of individual animals out of a biosecurity "zone" and any increased risk and or additional protocols required
- clean up of personnel and equipment at end of procedure
- management of samples, live animals, carcasses and waste at end of procedure
- access to veterinary services.

Biosecurity considerations to be included in planning for wildlife rescue and rehabilitationoperations (as above, plus):

- examination and testing
- treatments and interventions
- isolation
- any grouping of individuals or movement of individuals from one rehabilitation cohort to another
- movement of animals from one enclosure or facility to another during rehabilitation
- biosecurity assessment and preparation for release.

Biosecurity considerations to be included in planning for wildlife translocation and release, captive-bred and rehabilitation release (as above, plus):

- wildlife disease risk assessment undertaken for procedure including disease risk for source and destination populations
- any specific pathogen or biosecurity concerns for individual workers.

B5 Staff training and operational practice protocols

Protocols should be developed and implemented for **training all** wildlife workers in the following areas:

- principles of biosecurity
- principles of risk management
- methods of disease transmission
- personal hygiene and infection prevention and control
- cleaning and disinfection procedures, both personal and for equipment
- recognising and recording events such as management, treatment and signs of disease
- zoonotic disease risk management including:
  - vaccinations required to work safely with wildlife taxa and which workers need to take special care (e.g. pregnant, immunocompromised, very young, elderly) (see 7 Zoonotic risk management)
  - recognising and reporting accidental exposures and signs of disease and when to seek medical advice.

Training protocols may also be required in the following areas:

- selection and use of personal protective equipment
- isolation practices for at-risk wildlife
- responding to sick or injured wildlife
- assessing and managing biosecurity risk prior to translocation or release of wildlife.

Appendix C

Infectious diseases of concern in Australian wildlife

This table summarises information on key infectious diseases in Australian wildlife that carry biosecurity concerns. It was created **September 2018**; due to the evolving nature of wildlife health information, some information in this table may not be current at the time of reading. The information in this table can be found as a standalone document (regularly updated) on the WHA website (www.wildlifehealthaustralia.com.au); further information on many of these diseases can be found in the specific WHA Fact sheets (www.wildlifehealthaustralia.com.au/FactSheets.aspx).

Pathogen	Wildlife taxonomic range	Zoonosis	Transmission pathway or main route of infection	Primarily captive or in-care wildlife?	Main biosecurity practices
Viruses					
Australian bat lyssavirus*	Bats; infection found in all four mainland species of flying-fox (*Pteropus* spp.) and yellow-bellied sheath-tailed bat; serological evidence in other bat species; assume all Australian bat species are potential hosts.	Yes	Bite or scratch from an infected bat, or saliva contamination of mucous membranes/ broken skin.	No	Safe handling (only rabies-vaccinated people, experienced in handling bats and wearing appropriate PPE should handle, rescue or examine a bat); first aid and medical assessment in the event of a bat bite or scratch or other significant contact; post exposure prophylaxis as needed.
Bellinger River turtle virus	Bellinger River turtle	No	Currently unknown.	No	Suggest isolation and safe disposal of water and waste products.
Hendra virus*	Flying-fox; Black (*Pteropus alecto*) and spectacled (*P. conspicillatus*) flying-foxes are believed to be the reservoir hosts.	Yes	Contact, aerosol. Via urine to horses; all body substances in a horse may be infectious to others notably humans.	No	Vaccination of horses; limiting exposure of horses and their feed to flying-fox contamination; appropriate PPE particularly when dealing with sick horses; other hygiene practices
Herpesviruses (various)**	Various - mammals, birds, cetaceans. Generally, host-species specific but spillover can result in dramatic disease.	No	Close contact (most likely), aerosol over short distances possibly; latent infections common.	Probably, disease more often reported in captivity.	Isolation; minimise stressors; avoid abnormal mixing of species.

Pathogen	Wildlife taxonomic range	Zoonosis	Transmission pathway or main route of infection	Primarily captive or in-care wildlife?	Main biosecurity practices
Morbilliviruses (marine mammal)*	Cetaceans and pinnipeds.	No	Aerosol during close contact (most likely).	No	Isolation, avoid mixing host species.
Murray Valley encephalitis virus*	Birds, mainly waterbirds.	Yes	Vector, mosquito bite.	No	Avoid mosquito bites. Environmental mosquito control.
Nidovirus (reptile)*	Shingleback lizards, possibly other skink species.	No	Currently unknown.	Wild skinks in care.	Hygiene, isolation recommended.
Orbiviruses (macropod)*	Tammar wallabies (Tammar wallaby sudden death syndrome – Eubangee serogroup viruses); large macropod species (Wallal and Warrego viruses).	No	Vector; bites of Culicoides and similar spp. midges (presumed).	No	Vector control recommended, especially after rain, where possible.
Poxviruses (avian, reptile and marsupial)*	Wide range of host species (viruses are generally taxa- or species-specific).	No	Arthropod vector or close contact (needs a wound or puncture of the skin).	No	Vector control; isolation; environmental hygiene; minimise stressors.
Psittacine beak and feather disease virus*	Psittacine and non-psittacine birds.	No	Indirect contact (extremely robust virus).	No	Isolation; strict hygiene and disinfection; testing of individual birds.
Ranavirus (amphibian)*	Amphibians.	No	Direct and indirect contact, including contaminated water bodies.	No	Isolation; hygiene and disinfection; fomite control.
Ross River virus*	Wide range of native and introduced mammals, birds and some reptiles may be infected, mostly with no clinical disease.	Yes	Mosquito vector.	No	Avoid mosquito bites. Environmental mosquito control.
Snake viruses (Sunshine, inclusion body disease virus)**	Snakes, especially pythons.	No	Likely faecal-oral and aerosols.	Yes	Isolation, hygiene, serial testing, mite control.

Pathogen	Wildlife taxonomic range	Zoonosis	Transmission pathway or main route of infection	Primarily captive or in-care wildlife?	Main biosecurity practices
Bacteria					
Brucella suis (Brucellosis)*	Feral pigs.	Yes	Direct contact; aerosol; fomites.	No	Hygiene; PPE; keep dogs away from pig carcasses
Campylobacter spp.	Birds, possibly others.	Yes	Contact, ingestion (food, water).	Probably	Hygiene, appropriate disposal of faeces
Chlamydia psittaci (avian)*	Birds.	Yes	Contact, aerosol, inhalation (potential for bird-horse and then horse- human transmission).	Yes	Hygiene; PPE (respirator and gloves); isolation; ventilation controls, practices that minimise aerosols and dust (e.g. wet cleaning methods, low pressure hosing).
Chlamydia spp. (mammalian)*	Koalas, other marsupials.	No	Direct (venereal) contact.	No	Separation, testing; treatment.
Coxiella burnetii (Q fever)*	Macropods, bandicoots.	Yes	Contact, aerosol, inhalation, ingestion, fomites.	No	Q fever vaccination (in humans); ventilation controls, dust management, respirator, treatable with antibiotics.
Cryptosporidia spp.*	Reptiles, marsupials, possibly others.	Yes	Ingestion, faecal-oral.	Probably	Hand and environmental hygiene.
*Escherichia. albertii**	Birds.		Ingestion, faecal oral.	No	Hygiene, including hand and environmental (bird feeder) hygiene.
Leptospira spp.**	Rodents, possums, platypuses, feral pigs.	Yes	Contact with urine, aerosol, ingestion (food and water).	No	Hygiene, including hand and environmental cleaning; PPE to protect exposed skin, mucous membranes (eyes, nose and mouth), open wounds; rodent control.
Mycobacteria species*	Marsupials, dasyurids, birds, reptiles, pinnipeds.	Maybe	Inhalation, contact, ingestion.	Yes	Environmental management, hygiene including hand hygiene; ventilation controls and respirator for *M. avium*.
*Mycobacterium ulcerans**	Cases in a range of marsupial species. A possible role for common ringtail possums as reservoir hosts.	Humans affected, unknown source.	Transmission routes unknown, possibly insect bite or wound contamination.	No	Unknown.

Pathogen	Wildlife taxonomic range	Zoonosis	Transmission pathway or main route of infection	Primarily captive or in-care wildlife?	Main biosecurity practices
Salmonella spp.*	Reptiles, macropods, birds (DT160).	Yes	Ingestion, faecal-oral (food and water), contact.	Yes	Hand, food and environmental hygiene.
Tularaemia (*Francisella tularensis*)*	Unknown possibly common ringtail possums.	Yes	Bites and scratches (Australian context).	No	Hygiene, safe animal handing including PPE.
Fungi					
Chytrid fungus (*Batrachochytrium dendrobatidis*; Bd)*	Frogs.	No	Environmental contamination.	No	Isolation; hygiene including water hygiene.
Ringworm (*Microsporum* spp., *Trichophyton* spp.)	All mammals, especially orphaned macropods.	Yes	Contact; fomites.	Yes	Hand, equipment and environmental hygiene; isolation; treatment.
Yellow fungus of reptiles (previously CANV)*	Lizards, snakes, tuatara, crocodiles, possibly others.	No	Direct and indirect contact.	Yes	Environmental hygiene.
Cryptococcosis*	Koala, other marsupials, pigeons, psittacines, reptiles.	No	Environmental presence; aerosol most likely (not contagious).	Yes	Hygiene, including hand and environment; PPE; isolation and testing if captive.
Macrorhabdus fungus*	Birds.	No	Faecal-oral, parent feeding of nestlings.	Yes	Hygiene, hand-raising chicks, testing and treatment if captive.
*Mucor amphibiorum**	Platypus (in Tasmania).	No	Probably via infection of skin wounds. Source unknown.	No	General hygiene, otherwise unknown.
Protozoa					
*Toxoplasma gondii**	All mammals.	Yes	Ingestion following environmental contamination.	Possibly	Hand and food hygiene; cat control; hygienic disposal of cat faeces; cook meat adequately before human consumption.
Trichomona spp.*	Birds.	No	Direct and indirect contact (food).	No	Environmental hygiene including feeding areas.
Haemosporidia spp.*	Birds.	No	Insect vector.	No	Vector control if possible. Care with host or vector translocations.

Pathogen	Wildlife taxonomic range	Zoonosis	Transmission pathway or main route of infection	Primarily captive or in-care wildlife?	Main biosecurity practices
Coccidiosis (marsupial)*	Primarily hand-raised macropods.	No	Environmental contamination, ingestion.	Yes, juveniles	Hygiene, separation, prophylactic treatment.
Giardia spp.	Mammals, reptiles, birds.	Potentially	Contact, ingestion (faecal-oral; food and water).	No	Hand and food hygiene, treatment of drinking water; appropriate disposal of faeces (human and animal).
Trypanosoma spp.*	Unknown, probably a wide range of mammals.	No	Unknown invertebrate vectors.	No	Manage exposure to vectors, if known.
Internal parasites					
Angiostrongylus spp.*	Rodents (DH), wide range of other mammals (aberrant IH).	Yes, from rodent and invertebrates	Faecal-oral, environmental contamination.	Probably	Hygiene, control rodent and invertebrate hosts.
Echinococcus granulosus (hydatid disease)*	Dingoes (DH); macropods (IH).	Yes	Ingestion.	No	Hand hygiene, treatment of dogs.
External parasites					
Sarcoptes scabei (sarcoptic mange)*	Wombats, koalas, (introduced carnivores).	Yes (low risk)	Direct and indirect contact.	No	Isolation of infected hosts, treatment, hygiene including environmental, equipment and hand.
Snake mite (*Ophionyssus natricis*)*	All reptiles, particularly snakes.	No	Direct and environmental contamination with all life stages.	Yes	Environmental, equipment and hand hygiene; isolation & treatment of infected individuals and environments.

DH definitive host. **AH** aberrant host. **IH** intermediate host. **PPE** personal protective equipment. ***** WHA Fact Sheet available.

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