AUSTRALIAN VETERINARY EMERGENCY PLAN

AUSVETPLAN

Resource document

Understanding and responding to *Culicoides* sp. vectors in an emergency animal disease response

Version 5.1

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

National Biosecurity Committee

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

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EMERGENCY ANIMAL DISEASE WATCH HOTLINE: 1800 675 888

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

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1 Background

Personnel undertaking Planning, Operations and Public Information functions in a control centre assist in developing and implementing disease response and operational plans, and provide disease control advice to livestock holders, livestock industry organisations and the public. To support these roles, this resource document compiles scientifically verifiable information and identifies knowledge gaps on biology of *Culicoides* midge vectors and disease epidemiology relevant to the control of vector-borne diseases of horses and livestock. It is not a comprehensive reference on all aspects of *Culicoides* ecology.

This document provides several references to sources of additional information.

The document should be used in conjunction with the relevant **AUSVETPLAN response strategy**.

2 Introduction

2.1 Purpose

As part of AUSVETPLAN (the Australian Veterinary Emergency Plan), this resource document has been developed to provide a general overview of *Culicoides* vector biology and disease epidemiology for arboviral (arthropod-borne) diseases where the main vector(s) are biting midges from the genus *Culicoides*. The document is aimed at personnel in Planning, Operations and Public Information functions of a control centre during an emergency animal disease (EAD) response. Information in this resource document may help to inform response planning and communications during a response to a *Culicoides*-borne EAD.

This publication provides background advice only; it is not intended to be a detailed technical resource. Scientific and technical matters will require input from professional entomologists who have personal expertise in *Culicoides* biology in an Australian context. Specialist entomologists actively service the National Arbovirus Monitoring Program (NAMP). Relevant jurisdictional NAMP representatives can be consulted for advice, appropriate sampling methods and supply of equipment, as required.

2.2 Scope

This resource document covers the biology and epidemiology of endemic *Culicoides* midges involved (or suspected to be involved) in the transmission of viral EADs of horses and ruminants – for example, African horse sickness in horses and bluetongue in ruminants. The document also outlines some protective measures to reduce exposure of animals to *Culicoides* species that transmit arboviruses.

2.3 Development

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

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

2.4 Complementary documents

This resource document should be read and implemented in conjunction with other AUSVETPLAN documents, including the response strategies; operational, enterprise and management manuals; and any relevant guidance and resource documents. The complete series of manuals is available on the Animal Health Australia website.[1]

[1] https://animalhealthaustralia.com.au/ausvetplan/

3 *Culicoides* vectors

3.1 Summary

- The species of *Culicoides* that will act as the main vector for virus transmission may not be known at the beginning of a disease incident.
- The National Arbovirus Monitoring Program (NAMP) Bluetongue Virus Zone Map[2] indicates the regions in which bluetongue virus (BTV) transmission may occur, and may describe a potential viral transmission zone for African horse sickness (AHS) if the viruses share common vectors (eg *C. brevitarsis*).
- *Culicoides* species are unlikely to be active outside the 13–35 °C temperature range.
    - In southern areas of Australia, activity may be reduced in winter and may cease after the first killing frost, meaning that viral transmission is less likely and ongoing vector protection of livestock may be unnecessary.
    - In northern Australia, vector activity may occur year-round, but transmission of arboviruses is still likely to be seasonal (driven by variation in *Culicoides* numbers).
- *Culicoides* only feed 1–4 times in their lifetime. For disease transmission to occur, female adult midges must bite an infected (viraemic) animal, survive until virus has reached and replicated in the salivary glands, and then bite another susceptible animal.
- *Culicoides* has also been demonstrated to be involved in mechanical transmission of some diseases (eg fowlpox).

3.2 Species of interest

Biting midges from the genus *Culicoides* (family Ceratopogonidae) are vectors for several viral diseases of animals worldwide.

Arboviral diseases are biologically transmitted by arthropod vectors, and differ from other infectious diseases of livestock in that they are not usually contagious. Clinical bluetongue disease and AHS are nationally notifiable and considered emergency animal diseases (Table 3.1). AUSVETPLAN response strategies describe Australia's technical plan to respond to outbreaks of these diseases.

Culicoides brevitarsis is the most widespread vector for BTV in Australia, and preferentially feeds on cattle. It is closely related to *C. imicola*, which is not known to be present in Australia, but is one of the main vectors for AHS virus overseas. It is currently unknown which, if any, of the Australian horse-feeding *Culicoides* species would be competent vectors for AHS virus.

[2] https://namp.animalhealthaustralia.com.au/public.php?page=pub_home&program=2

Table 3.1 Notifiable emergency animal diseases for which *Culicoides* and other species act as vectors and the species thought to be involved in Australia

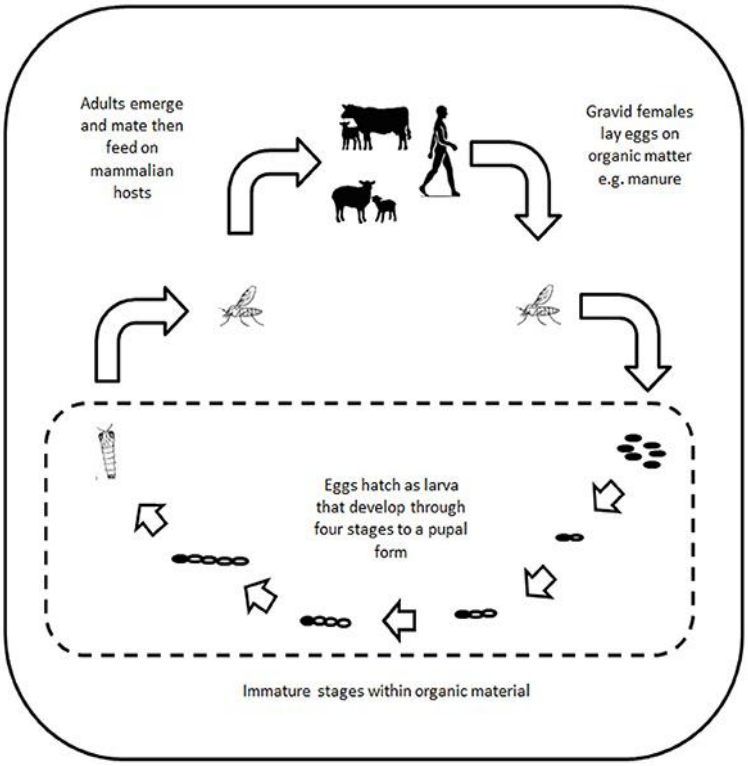
Disease	Species affected	Vector or potential vector
Bluetongue	Cattle and sheep	*C. brevitarsis* *C. actoni* *C. fulvus* *C. wadai* *C. dumdumi*
African horse sickness	Equids – horses, donkeys and their crosses; zebras	Potentially any species that feeds on horses, but the most likely species are the known vectors of BTV listed above
Lumpy skin disease	Cattle	Mechanical transmission of LSD virus by mosquitoes (*Aedes aegyptii*) and hard ticks (*Rhipicephalus appendiculatus*) has been demonstrated experimentally. Stable flies (*Stomoxys calcitrans*), tabanid flies, other flies, midges (*Culicoides* spp.) and other hard ticks (eg *Amblyomma hebraeum*) have also been mooted as mechanical vectors.
Japanese encephalitis	Evidence of exposure to JEV and/or infection has been detected in a wide range of animal species, including waterbirds, pigs, equids (horses and donkeys), cattle, sheep, goats, water buffalo, chickens, ducks, dogs, cats, monkeys, raccoons, rodents, insectivorous bats, flying foxes, snakes, lizards and frogs. Few species are thought to play a significant role in the natural transmission of JEV – most commonly waterbirds and pigs. As well, few species show clinical signs of disease – most commonly equids, pigs and humans.	Mosquito vectors in the *Culex*, *Aedes* and *Anopheles* genera.
Vesicular stomatitis	Clinical disease occurs most commonly in cattle, equids and pigs, but has also been reported in sheep, goats and camelids.	Vesicular stomatitis virus has been isolated from several insect species, including sandflies and midges (*Lutzomyia*, *Phlebotomus*, *Culicoides*), mosquitoes (*Aedes*, *Culex*, *Trichoprosopon digitatum*), mites (*Gigantolaelaps*), gnats (*Hippelates pusio*), horn (buffalo) flies (*Haematobia irritans*), horse flies (*Tabanus*), stable flies (*Stomoxys calcitrans*) and black flies (*Simuliidae*).

3.3 Culicoides biology

Culicoides are haematophagous dipterans (blood-feeding flies). The females of most species are anautogenous, meaning that they require a blood meal to produce their first batch of eggs (Mills et al 2017). Immature stages live in moist, organically rich substrate. Potential sites include soil that is wet as a result of leaking pipes, areas around rivers or dams, swamps or marshes, rotting vegetation, water-containing tree holes and animal manure (Mellor et al 2000). The principal midge vector species in Australia, *C. brevitarsis*, oviposits exclusively in cattle dung.

Adult *Culicoides* have a body length of <1 mm to 2.5 mm and become sexually mature within 24–48 hours of emerging. The females oviposit 2–3 days after mating and feeding on a host. They are capable of up to three or four gonotrophic cycles in their lifetime. Eggs are laid in batches and adhere to the substrate in which they are laid. They usually hatch within 2–7 days, but are susceptible to drying.

Figure 3.1 summarises the *Culicoides* lifecycle.



Source: Folly et al (2020)

Figure 3.1 *Culicoides* lifecycle

There are four larval stages, which need a moist habitat for development. The duration of these stages varies with temperature and species from 4–5 days to several months (Mellor et al 2000). Larval stages can be particularly extended in temperate climates because larvae in the fourth stage are capable of diapause over winter; they can survive up to 2 months after the cessation of adult activity (Bishop et al 2015).

The total time for development from egg to adult is usually around 15–25 days (Benelli et al 2017). Adult *Culicoides* are relatively short lived, with a lifespan of 10–30 days, although very occasionally they can survive up to 40–90 days (Mellor et al 2000).

For most *Culicoides* species, the adults are crepuscular, meaning that their peak activity periods are around sunrise and sunset. They tend to be active to a lesser extent at night, and only a few species bite during the day. Their activity decreases, both daily and seasonally, with a decrease in temperature. Temperature is considered a critical factor for *Culicoides* – it is the main factor that influences the development of immature larvae into adult midges. Although species-dependent, the optimal temperature for larval emergence is generally 25–28 °C, and larvae will not emerge at temperatures below 17 °C. Their development will stop at temperatures above 36 °C, and they are unlikely to survive at temperatures above 40 °C. Temperature also significantly affects *Culicoides* flight, mating, host-seeking, feeding, oviposition and resting behaviours.

High rainfall has also been reported to have a significant effect on the population of adult *Culicoides*, particularly after a period of drought (Baylis et al 1999, Wilson et al 2009).

Culicoides have a very short flight range, usually only a few hundred metres or 1–2 km at most; however, they can be dispersed passively over much greater distances. In the case of BTV, there are reports of long-range movement of *Culicoides* over water from north Africa to Sardinia and from Southeast Asia to northern Australia (Mellor et al 2000, Eagles et al 2014). Investigation of potential pathways of spread into Australia suggests that incursions from Papua New Guinea, Indonesia and Timor-Leste are possible and have occurred (Eagles et al 2014, Bellis et al 2015).

3.4 Vector competence

Transmission of arboviruses requires the presence of competent vectors. Vector competence is the ability of a vector to biologically transmit arboviruses between susceptible hosts (Carpenter et al 2015). Not all *Culicoides* species that feed on livestock are competent vectors for arboviruses, and the species that will act as the main vector for transmission may not be known at the beginning of an exotic viral disease outbreak.

The *Culicoides* vector ingests blood containing the virus from a viraemic host. The virus then infects the midgut cells of the vector and replicates before disseminating into the extraintestinal tissues (including the salivary gland), before being transferred to another animal host via a bite. The time taken for this process to occur is called the extrinsic incubation period.

Replication of the virus within the midge is temperature-dependent. Higher temperatures (30 °C) result in faster replication and can shorten the extrinsic incubation period by 2–3 days. Lower temperatures (20 °C) result in slower replication, around 12 days. The prevalence of the virus in *Culicoides* is also temperature-dependent (Mills et al 2017).

Reports of *Culicoides* susceptibility to various viruses, including BTV and AHS virus, vary considerably. For example, one study found infection rates in *C. imicola* as low as 0.003% for AHS virus, whereas another reported susceptibility as high as 26.8% (Venter 2000). BTV infection rates in midges have been variously reported as 0.4–7.4% for *C. obsoletus,* and 1.3–1.5% for Australian populations of *C. brevitaris* and *C. wadai* (Bellis et al 1994, Paweska et al 2002, Carpenter et al 2006, Venter et al 2006). There is evidence to suggest that vector competence is heritable in *Culicoides*, which may explain variability between midge populations (Mills et al 2017).

3.5 Distribution

The distribution of *Culicoides* species is an important consideration for risk assessment and control of the viral diseases they transmit. For arboviruses to be maintained in an area over time, suitable conditions must be present for competent *Culicoides* species to be active year-round, or for animals to carry the viruses over winter so that they can infect the *Culicoides* vector once climatic conditions allow *Culicoides* activity to resume. Intermittent spread of arboviruses from endemic areas to surrounding regions can occur with seasonal *Culicoides* activity.

The distribution of *Culicoides* is mainly dependent on temperature, although species, rainfall and host availability could also be factors (Bishop et al 2015). Regions with minimum average daily temperatures above 13.5 °C in winter and maximum temperatures below 35 °C are most suited to *Culicoides* activity and survival. Many species are found mainly in coastal areas where the climate is within this range; however, some, such as *C. brevitarsis*, can be found in areas with temperatures outside the optimal range.

Dispersal of *Culicoides* can be restricted by geographic barriers such as deserts, mountain ranges, large urban areas or large host-free areas (Bishop et al 2015). One such barrier in Australia is the Great Dividing Range, which is thought to prevent dispersal of *C. brevitarsis* west from coastal New South Wales through a combination of altitude and temperatures limiting activity (Bishop et al 2004). The deserts in central Australia, as a result of low rainfall and lack of hosts, may have a similar effect. Some species of *Culicoides* found in the climatically favourable tropical regions of northern Australia are absent from southern Australia. It is considered that this is a result of their dependence on warm, moist conditions and decaying vegetation for suitable development of early life stages. In contrast, *C. brevitarsis* uses similar conditions of temperature and humidity in aging cattle dung. Although some species, including *C. marksi* and *C. victoriae*, are present in southern Australia, the species that are competent vectors for BTV, such as *C. brevitarsis*, do not occur in the very southern regions of Australia; as a result, neither BTV nor Simbu viruses have become established in the south.

C. brevitarsis is only found outdoors; adults are not found indoors or under the cover provided by buildings. In contrast, some of the vectors found in the Northern Hemisphere readily enter buildings and feed on animals indoors. The capacity of other Australian vector species to move under cover is not known.

The distribution within Australia of various *Culicoides* species, including *C. brevitarsis, C. actoni, C. fulvus* and *C. wadai*, is monitored as part of NAMP. A Bluetongue Virus Zone Map[3] is developed annually based on NAMP surveillance data. The map, combined with NAMP data on distribution of orthobunyaviruses from the Simbu serogroup (ie Akabane and related viruses), should help identify high-risk areas for transmission of *Culicoides*-borne diseases.

NAMP is inherently biased towards cattle-feeding *Culicoides* because it is based on a targeted trapping system that is focused on detection of BTV in cattle. Caution should be used for applying NAMP data to mapping the risk of AHS.

[3] https://namp.animalhealthaustralia.com.au/public.php?page=pub_home&program=2

4 *Culicoides* surveillance

4.1 Summary

Light traps are most commonly used for trapping *Culicoides* and are used as part of the National Arbovirus Monitoring Program (NAMP).

NAMP entomologists and coordinators in each state and territory, and the NAMP manager at Animal Health Australia, can provide advice on sourcing *Culicoides* traps, positioning them in the field, and storing and subsequently processing collections.

The placement of insect traps will need to take into consideration:

- the objective of trapping (ie identifying vectors, determining vector distribution and density, determining the distribution of the disease agent, determining the species of potentially competent vectors)
- the location of the primary case in relation to other infected premises
- known meteorological conditions (eg prevailing winds, temperature, rain, humidity) during the period before the first recorded disease outbreak
- lifecycles and feeding preferences of known competent vectors
- the availability of traps
- the distribution of susceptible livestock species
- availability of staff to sort collections and identify specimens.

4.2 Importance of surveillance

Vector surveillance can contribute to an understanding of the potential epidemiology and geographic distribution of arboviruses before incursion of an exotic pathogen. When an outbreak of an arboviral disease occurs, it is important to determine which vector species are responsible for transmission of the virus, in order to completely understand the epidemiology of the virus for response planning. During an outbreak, additional targeted surveillance at the site of detection may be required to better understand local factors affecting spread and to assist in predicting dispersal. Vector surveillance and research into vector competency to transmit the virus are therefore important in determining the potential for disease spread to new areas.

4.3 Factors to consider

4.3.1 Vector identification

Australia has limited taxonomic expertise to identify insect vectors of emergency animal disease (EAD) agents, especially where species differentiation depends on minute anatomical details (eg for *Culicoides*). Examination of samples from one trap may take several hours. Identification aids are limited to an atlas of wing photographs of all Australasian species of *Culicoides*, and a key to female specimens of species reported from the Northern Territory, Western Australia and South Australia (Dyce et al 2007, Bellis et al 2014).

The use of polymerase chain reaction (PCR) technology for vector identification may overcome this difficulty but will not identify vectors for which no molecular data exist. It is also possible that *Culicoides*-specific PCR technology will not be widely available at the start of an EAD outbreak. Testing of individual specimens by PCR is also impractical for identifying large numbers of insects that may be generated by a light trapping network. Pools of insects can be screened by PCR to determine the presence or absence of a known vector species, but this approach is not routinely used at present.

Certain insect species may be known to be competent vectors for the EAD agent under consideration. However, in an area where an EAD is being investigated for the first time, it is possible that a species that has not previously been recognised as a vector could be wholly or partially responsible for viral spread.

Larval sampling is time-consuming and impractical, and may not be as reliable an indicator of presence or prevalence as adult trapping. In addition, the breeding sites of some vector species are unknown.

4.3.2 Disease agent identification

Recovering evidence of an EAD agent from a pool of suspected vectors is currently carried out only by certain laboratories.[4] The process is labour-intensive, time-consuming and not as sensitive as testing host animals, so should only be used to establish:

- the presence of the agent
- the possible role of the vector.

4.4 Trap design

Vector trapping is an important tool for the management and risk assessment of vector-borne diseases, enabling determination of vector-free time periods and areas. Most surveillance systems aim to catch the maximum possible number of potential vectors in the vicinity of their potential hosts (Venter et al 2009). It is important to note that vector traps are a surveillance tool rather than a control tool, as they will only catch a small portion of the vectors present.

Selection of trap types and field positioning for vectors of bluetongue virus (BTV) and other arboviruses should be chosen with epidemiological input and in consultation with members of the NAMP Technical Committee and particularly the NAMP entomologists. Several different types of traps may be used, depending on the objective of the sampling.

A thorough knowledge of the ecology of known and potential vectors is essential to determine the most appropriate trapping technique. It is possible that a combination of different trapping techniques may need to be used because vectors have different responses to traps and hosts. Biting midges are susceptible to desiccation, which makes them difficult to identify, so they need to be stored in liquid at all times. If mosquito traps, which generally collect insects dry, are to be used, they need to be adapted to collect directly into liquid. Collections can be made into ethanol, 50% propylene glycol preservative, or water to which a few drops of liquid soap have been added to lower the surface tension. If using water, specimens will need to be transferred into ethanol or propylene glycol within 12 hours of collection to prevent degradation.

[4] Berrimah Veterinary Laboratory, Northern Territory; Elizabeth Macarthur Agricultural Institute, New South Wales; CSIRO Australian Centre for Disease Preparedness, Victoria

The following sections describe potential sampling tools.

4.4.1 Light traps

The relevant jurisdictional NAMP Technical Committee representative should be consulted on supply and use of traps for *Culicoides* surveillance.

Light traps are the most commonly used method to collect biting midges to assess vector presence and abundance, and are practical and effective. A limited number of traps are commercially available, many of which were originally designed to catch mosquitoes. The basic components of these traps are a light source to attract the midges, a fan to draw them in and a container to hold them. An additional component that may be included, particularly for mosquito traps adapted to catching midges, is a mesh to exclude larger insects, to facilitate ease of sorting and identification. Studies suggest that LED light is more effective than incandescent white light for attracting *Culicoides* and that the wavelength of light may also be significant (Venter et al 2009, González et al 2016). In an Australian study, green light generated by LEDs was most effective for Australian vector species (Bishop et al 2006).

Some other considerations when selecting trap types are that light traps do not catch diurnal species (those active during the day), and may be less effective when other light sources are present (eg full moon) or at high wind speeds. As well, the number of *Culicoides* individuals collected by light traps does not necessarily correlate with host attack rates (Venter et al 2009, Probst et al 2015).

The traps currently used in Australia, as part of NAMP surveillance, are modified CDC light traps. These are lightweight and able to run on battery power, making them convenient for transport and placement around livestock (where there may be no access to mains power).

4.4.2 Chemical attractant traps

More mammophilic species (those preferring to feed on mammals) of *Culicoides* can be collected when there are livestock near the traps, which suggests that the sensitivity and specificity of traps could be significantly enhanced by olfactory cues (Harrup et al 2012, Venter et al 2016).

Many local government medical authorities use carbon dioxide–baited light traps to collect mosquitoes, and these could be adapted for biting midges, if necessary. However, it should be noted that some species of *Culicoides* appear to be highly attracted to carbon dioxide, whereas others are not.

Trials undertaken by the Tropical Population Health Unit, Cairns, have indicated that octenol-5 and carbon dioxide are useful attractants for biting midges when used with light traps,[5] which corresponds with findings from previous studies. However, limited experience in the Northern Territory suggested that the use of octenol was not particularly beneficial in the collection of *Culicoides* species of veterinary interest.

Chemical attractant traps are not recommended until further research has been done to support their use.

[5] Octenol appears to act as a synergist with carbon dioxide for certain species and may increase the number of biting midges trapped, thus improving the sensitivity of surveillance.

4.4.3 Truck traps

Truck traps involve collecting insects by intercepting their flight and using the forward motion of the vehicle to direct them into a bag. The major components are a large funnel with an opening facing forward, mesh to exclude large insects and a bag to collect the insects. The traps are generally affixed to the top of a vehicle, which is then driven at relatively slow speeds (around 20–30 km/h) in the area and at times of interest for surveillance (Dyce et al 1972, Sanders et al 2012).

A truck trap is most effective where there is adequate insect activity before dark and the temperature is not low enough to reduce insect activity. An advantage of this type of trap is that it does not require darkness to be effective and can therefore be used to catch diurnal species (Probst et al 2015). Truck traps are also not prone to bias, such as differences in attractiveness of lights and hosts.

4.4.4 Aspiration

Vacuum devices (eg modified garden vacuums and leafblowers) can be used to aspirate feeding vectors from the skin of sentinel animals in situations where vectors are unlikely to be attracted to carbon dioxide or light traps – for example, diurnally active species. They also have the advantage of providing data on what insects are actually feeding on hosts. Although labour-intensive, they would be useful in an outbreak of African horse sickness to provide data on *Culicoides* species feeding on horses. Care must be exercised when using this technique because of the potential for flighty horses or horses not habituated to the noise to accidentally injure the handler or collector.

4.4.5 Sweep netting

Entomological sweep nets can be used to sample insect populations around host animals during periods of peak activity. Although sweep nets are unlikely to collect more insects than aspiration, they offer a simple and economical means of collecting insects that are attracted to hosts. Midges are easily damaged in sweep nets, and so should be removed from the net every 4 or 5 minutes.

4.4.6 Sticky traps

Sticky traps can be used to collect flying insects, although traps hung in the host environment are unlikely to yield useful information. They are indiscriminate and may collect numerous nontarget species, but have the benefits of being readily available, cheap and rapidly deployable in large quantities. There are few, if any, cases of their use to monitor for biting midges, and little work has been done to support the use of any particular colour, although one study suggested a preference for white or clear traps by certain *Culicoides* species (Thompson et al 2014). Sticky traps have the disadvantage of damaging specimens, and specimens are very difficult to sort and handle in the laboratory.

However, sticky traps applied to host animals may provide information on the insects on the hosts and the biting rates of various species (Viennet et al 2011).

4.4.7 Drop traps

Drop traps are a form of host-baited trap that can be used to collect *Culicoides*. They consist of a cage covered with midge mesh in which an animal is kept. One side of the cage is left open for a period to allow attracted insects to enter, before being closed; the netting is then vacuumed to collect all the trapped insects. This type of trap has been very effective in catching *Culicoides*, particularly engorged females, making it useful for assessing biting rates (Viennet et al 2011). However, is it a labour-intensive form of trap and would therefore be difficult to implement as a surveillance tool in an EAD response.

4.5 Trap placement

Siting of traps for vectors of BTV and other arboviruses should be chosen with epidemiological input and in consultation with members of the NAMP Technical Committee.

The placement of traps on national, regional and local scales is an important consideration. Consistency in trap placement is important because factors such as the height of the traps can influence the number of *Culicoides* individuals collected. A study in South Africa found 2.8 m to be the optimum trap height for collecting the most *Culicoides* (Venter et al 2009). This factor can be significant when vector numbers are used to infer disease risk.

Another important variable to consider is the distance from animals (Garcia-Saenz 2011). For housed animals, it is important to place traps both inside and outside housing to enable surveillance of endophilic species (those that are found preferentially indoors) and exophilic species (those that are found preferentially outside), as well as to monitor the effectiveness of preventive measures.

Considerations such as the practicality of placing traps where they cannot be interfered with by nearby animals may also influence trap placement.

4.6 Sample storage

Samples of potential vectors must be maintained in a high-quality state to enable either morphological or molecular identification. For morphology, specimens must not be allowed to dry out. The choice of storage solutions must also take into account the need to extract and identify the disease agent to determine whether the insect is actually a vector. The entomologists involved should be consulted before storing samples. General methods include:

- storage in alcohol – preferably 70% ethanol if molecular methods will be used (a lower percentage of ethanol is suitable for morphological studies); this does not allow virus isolation
- 50% propylene glycol – suitable for field collection of vectors but not for long-term storage in the laboratory, as it can damage insect morphology
- freezing – either through refrigeration or in liquid nitrogen; the latter may not be readily available, depending on where the EAD occurs, and is mainly used for virus isolation attempts. However, this has largely been replaced by the use of real-time PCR, which can be undertaken on ethanol-preserved specimens.

5 Protecting livestock from *Culicoides* species

Under Australian extensive grazing conditions, livestock cannot be protected from attack by *Culicoides* species. The following information is mainly applicable to valuable individual animals that can be housed or individually treated.

5.1 Summary

Use of a combination of measures will be necessary to effectively protect animals from *Culicoides* attack:

- House animals indoors in vector-protected housing, especially from 2 hours before sunset until 2 hours after sunrise (note that this will not protect horses from midges that are active during the day). This might involve use of
    - stables
    - insecticide-treated midge mesh (ie mesh that is appropriately sized to reduce midge entry) covering all openings, including doors; mesh reduces airflow, so fans or air-conditioners may be required to regulate temperature.
- Apply insect repellants to animals according to manufacturers' recommendations (generally twice-daily administration).
- Eliminate potential breeding sites around animal housing or where livestock are kept by
    - repairing leaks around taps and water troughs
    - draining wet areas
    - removing or covering manure
    - treating the environment with insecticides.
- Place traps around and within housing to monitor the effectiveness of protection measures.

Protecting infected animals from vectors (eg if treatment is to be attempted) requires complete exclusion of vectors. Requirements include:

- no unscreened gaps in the walls or ceiling (preferably solid construction to prevent damage that could create openings)
    - no unscreened doors or windows
    - positive-pressure ventilation or air-conditioning, if possible
- double-mesh-covered door entry and exit
- all openings covered by insecticide-treated 80% shadecloth or midge mesh (or other material with small openings to prevent midge entry); mesh must be re-treated [every 14 days (depending on product used)]
- filters covering all air inlets and drains to prevent vector entry
- use of automatic insecticide dispensers within the facility
- adequate drainage to prevent pooling of water around the facility
- regular removal of organic waste (manure)
- treatment of the environment with insecticides
- [systemic administration of avermectins].

5.2 Stabling

Stabling animals around peak *Culicoides* activity times has been suggested as a potential method of decreasing the risk of exposure. For livestock-feeding species in Australia, this would mean from 1–2 hours before sunset to 1–2 hours after sunrise (Doherty et al 2004). The effectiveness of this method is largely dependent on the behaviour of the specific vector species, as well as weather (eg temperature, wind speed) (Baylis et al 2010).

Cattle in shelters with walls and a roof, even if incomplete, are afforded some protection against exophilic species such as *C. brevitarsis* and *C. wadai. C. actoni* appears to be endophilic, and even more complete shelters may not afford protection against this species (Doherty et al 2004). Research in Europe has demonstrated that housing cattle in barns with open windows and doors will reduce, but not eliminate, exposure to many *Culicoides* species (Baylis et al 2010).

Overseas, exposure of equids to an exophilic species, such as *C. imicola*, is thought to be significantly reduced by stabling. However, exposure to an endophilic species, such as *C. bolitinos*, can be increased if stables are open (Meiswinkel et al 2000). The risk can be reduced by closing doors and covering any other openings, such as windows, with mesh – this has been found to decrease the entry of African and European *Culicoides* species by up to 14 times (Meiswinkel et al 2000, Page et al 2014, Baker et al 2015). Similar measures are likely to be necessary to protect horses in Australia from attack by endophilic horse-feeding *Culicoides* species.

The size of the mesh is an important consideration: smaller mesh sizes will reduce the entry of midges but also cause reduced airflow, which can have respiratory and welfare implications for the housed animals (Baker et al 2015). One study found that *Culicoides* were able to pass through 0.063 mm^2 mesh; however, the mesh reduced their entry by 56%. Mesh with a pore size of 0.058 mm^2 allowed only 5% of *Culicoides* to pass through, but reduced light and airflow (Porter 1959). Use of double-door entries and exits has also been recommended (Thailand Department of Agriculture, Forestry and Fisheries 2019). This means of protection is most suitable for individual animals or small groups of animals (eg horses).

5.3 Insecticides

Insecticides are substances that are intended to kill exposed insects. *Culicoides* are susceptible to various insecticides, including pyrethroid-based insecticides and macrocytic lactones.

5.3.1 Topical insecticides for animals

Insecticides applied topically to animals could have beneficial effects through reducing the survival rates of exposed midges and thereby reducing the risk of onward transmission of disease. However, they have not been found to reduce the risk of an animal being bitten (Harrup et al 2016, Murchie et al 2019). Systemic administration of insecticides could also reduce the risk of onward disease transmission, although considerations for this route of administration include potential toxicity (Harrup et al 2016). The recommended dose of ivermectin for treating lice in horses is 200 µg/kg orally every 2 weeks (Rashmir-Raven 2018); the oral dose required to have an effect on *Culicoides* survival is not known. The same dose has been administered subcutaneously in cattle and found to be effective against certain species, including *C. brevitarsis*, although not others (Standfast et al 1984, Holbrook & Mullens 1994, Carpenter et al 2008).

5.3.2 Insecticide application to mesh

Application of insecticides to mesh used to cover stable windows and openings can increase their effectiveness in preventing entry of *Culicoides* (Page et al 2014, Baker et al 2015). Treated or untreated mesh applied to fences around cattle paddocks or pens has shown little to no protective effects; this is attributed to the ability of *Culicoides* midges to fly over the barrier (Harrup et al 2016). However, Standfast et al (2003) achieved a 75–97% reduction in midge numbers by spraying vegetation and external building surfaces in peri-urban environments.

5.4 Repellents

Repellents are substances that are intended to deter the approach of insects.

5.4.1 Topical application – animals

Topical application of repellents to at-risk animals has the potential to reduce the risk of exposure, especially when used with other measures to protect animals from midges. A range of repellents, including deltamethrin, cypermethrin, fenvalerate and 'Fly Away' (a mixture of several repellents), all showed some repellent effect against Australian vector species (Doherty et al 2001, 2004; Melville et al 2004). They reduced the total numbers of *Culicoides* on cattle for 5–8 hours after treatment, but did not prevent blood feeding altogether. Additionally, Melville et al (2004) found a reduced incidence of bluetongue virus and Akabane virus infection in cattle treated with fenvalerate and deltamethrin.

Diethyltoluamide (DEET) is considered the gold-standard repellent to protect people from midge attack, but the data are not sufficient to say that this is also the case for animals (Harrup et al 2016). Neem-based formulations also have the potential to reduce *Culicoides* landing and feeding (Harrup et al 2016). Other repellents, such as citronella, have had variable efficacy and have even been reported to have potential attractive effects (Harrup et al 2016). Various DEET repellents are registered for use on livestock in Australia, including some that are specifically registered for use on horses or dogs; others are more versatile, for use on cattle, pigs, horses and animal housing. A few registered products contain both repellents and insecticides.

5.4.2 Application to mesh

Application of repellents, such as DEET, on mesh used to cover housing openings has the potential to provide short-term (4–5 days) area protection. Bifenthrin sprays, as a surface treatment for areas harbouring midges and mosquitoes, reduced midge numbers in urban habitats by 75–97%, and could be considered for mesh application or treatment of the environment around stables (Standfast et al 2003).

5.5 Habitat modification

Altering the habitats used as *Culicoides* breeding sites – such as removing manure, covering manure heaps or preventing accumulation of water – has shown little efficacy in reducing the population of *Culicoides* in areas where animals are kept (Harrup et al 2016). The effectiveness of habitat modification is limited by lack of knowledge on habitat preferences of various *Culicoides* species, as well by as the magnitude of midge populations (Harrup et al 2016). One study found that application of neem 'cakes' to breeding sites significantly affected *Culicoides* larval development; however, the significance of this in reducing the adult population is unknown (Benelli et al 2017). Elimination of potential breeding sites in the immediate vicinity of housing may still be considered for reducing the risk of exposure of the housed animals. If vector species are known to breed in bovid dung (eg *C. brevitarsis, C. wadai*), removal of bovids from areas surrounding horse stables may reduce populations of these *Culicoides* species.

5.6 Other methods of protection

Various other interventions have the potential to reduce the risk of exposure of equids. These include:

- physical barriers, such as rugs or hoods, potentially made of permethrin-treated material
- turning off lights inside housing to avoid attracting midges
- use of fans or positive-pressure ventilation in housing.

5.7 Protection of animals during transport

Interventions to reduce the risk of exposure to *Culicoides* vectors during transport of susceptible hosts include (OIE 2019):

- applying repellents to the animals before and during transport
- conducting loading, transporting and unloading outside periods of high vector activity (ie transport during daylight hours or when temperatures are low)
- avoiding stops around sunrise and sunset, or overnight, unless vector-proof housing is available (eg the transport vehicle is covered with vector-proof netting)
- where possible, planning routes to minimise the risk by using vector surveillance information to avoid areas of high vector activity
- cleaning and applying an insecticide to the interior of the vehicle before transport.

Glossary

Standard AUSVETPLAN terms

Term	Definition
Animal byproducts	Products of animal origin that are not for consumption but are destined for industrial use (eg hides and skins, fur, wool, hair, feathers, hoofs, bones, fertiliser).
Animal Health Committee	A committee whose members are the chief veterinary officers of the Commonwealth, states and territories, along with representatives from the CSIRO Australian Centre for Disease Preparedness (CSIRO-ACDP) and the Australian Government Department of Agriculture, Water and the Environment. There are also observers from Animal Health Australia, Wildlife Health Australia, and the New Zealand Ministry for Primary Industries. The committee provides advice to the National Biosecurity Committee on animal health matters, focusing on technical issues and regulatory policy. *See also* National Biosecurity Committee
Animal products	Meat, meat products and other products of animal origin (eg eggs, milk) for human consumption or for use in animal feedstuff.
Approved disposal site	A premises that has zero susceptible livestock and has been approved as a disposal site for animal carcasses, or potentially contaminated animal products, wastes or things.
Approved processing facility	An abattoir, knackery, milk processing plant or other such facility that maintains increased biosecurity standards. Such a facility could have animals or animal products introduced from lower-risk premises under a permit for processing to an approved standard.
At-risk premises	A premises in a restricted area that contains a live susceptible animal(s) but is not considered at the time of classification to be an infected premises, dangerous contact premises, dangerous contact processing facility, suspect premises or trace premises.
Australian Chief Veterinary Officer	The nominated senior veterinarian in the Australian Government Department of Agriculture, Water and the Environment who manages international animal health commitments and the Australian Government's response to an animal disease outbreak. *See also* Chief veterinary officer
AUSVETPLAN	*Aus*tralian *Vet*erinary Emergency *Plan*. Nationally agreed resources that guide decision making in the response to emergency animal diseases (EADs). It outlines Australia's preferred approach to responding to EADs of national significance, and supports efficient, effective and coherent responses to these diseases.
Carcase	The body of an animal slaughtered for food.
Carcass	The body of an animal that died in the field.

Term	Definition
Chief veterinary officer (CVO)	The senior veterinarian of the animal health authority in each jurisdiction (national, state or territory) who has responsibility for animal disease control in that jurisdiction. *See also* Australian Chief Veterinary Officer
Compartmentalisation	The process of defining, implementing and maintaining one or more disease-free establishments under a common biosecurity management system in accordance with OIE guidelines, based on applied biosecurity measures and surveillance, to facilitate disease control and/or trade.
Compensation	The sum of money paid by government to an owner for livestock or property that are destroyed for the purpose of eradication or prevention of the spread of an emergency animal disease, and livestock that have died of the emergency animal disease. *See also* Cost-sharing arrangements, Emergency Animal Disease Response Agreement
Consultative Committee on Emergency Animal Diseases (CCEAD)	The key technical coordinating body for animal health emergencies. Members are state and territory chief veterinary officers, representatives of CSIRO-ACDP and the relevant industries, and the Australian Chief Veterinary Officer as chair.
Control area (CA)	A legally declared area where the disease controls, including surveillance and movement controls, applied are of lesser intensity than those in a restricted area (the limits of a control area and the conditions applying to it can be varied during an incident according to need).
Cost-sharing arrangements	Arrangements agreed between governments (national and state/territory) and livestock industries for sharing the costs of emergency animal disease responses. *See also* Compensation, Emergency Animal Disease Response Agreement
Dangerous contact animal	A susceptible animal that has been designated as being exposed to other infected animals or potentially infectious products following tracing and epidemiological investigation.
Dangerous contact premises (DCP)	A premises, apart from an abattoir, knackery or milk processing plant (or other such facility) that, after investigation and based on a risk assessment, is considered to contain a susceptible animal(s) not showing clinical signs, but considered highly likely to contain an infected animal(s) and/or contaminated animal products, wastes or things that present an unacceptable risk to the response if the risk is not addressed, and that therefore requires action to address the risk.
Dangerous contact processing facility (DCPF)	An abattoir, knackery, milk processing plant or other such facility that, based on a risk assessment, appears highly likely to have received infected animals, or contaminated animal products, wastes or things, and that requires action to address the risk.
Declared area	A defined tract of land that is subjected to disease control restrictions under emergency animal disease legislation. There are two types of declared areas: restricted area and control area.

Term	Definition
Decontamination	Includes all stages of cleaning and disinfection.
Depopulation	The removal of a host population from a particular area to control or prevent the spread of disease.
Destroy (animals)	To kill animals humanely.
Disease agent	A general term for a transmissible organism or other factor that causes an infectious disease.
Disease Watch Hotline	24-hour freecall service for reporting suspected incidences of exotic diseases – 1800 675 888.
Disinfectant	A chemical used to destroy disease agents outside a living animal.
Disinfection	The application, after thorough cleansing, of procedures intended to destroy the infectious or parasitic agents of animal diseases, including zoonoses; applies to premises, vehicles and different objects that may have been directly or indirectly contaminated.
Disinsectation	The destruction of insect pests, usually with a chemical agent.
Disposal	Sanitary removal of animal carcasses, animal products, materials and wastes by burial, burning or some other process so as to prevent the spread of disease.
Emergency animal disease	A disease that is (a) exotic to Australia or (b) a variant of an endemic disease or (c) a serious infectious disease of unknown or uncertain cause or (d) a severe outbreak of a known endemic disease, and that is considered to be of national significance with serious social or trade implications. *See also* Endemic animal disease, Exotic animal disease
Emergency Animal Disease Response Agreement	Agreement between the Australian and state/territory governments and livestock industries on the management of emergency animal disease responses. Provisions include participatory decision making, risk management, cost sharing, the use of appropriately trained personnel and existing standards such as AUSVETPLAN. *See also* Compensation, Cost-sharing arrangements
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
Enterprise	*See* Risk enterprise
Enzyme-linked immunosorbent assay (ELISA)	A serological test designed to detect and measure the presence of antibody or antigen in a sample. The test uses an enzyme reaction with a substrate to produce a colour change when antigen–antibody binding occurs.
Epidemiological investigation	An investigation to identify and qualify the risk factors associated with the disease. *See also* Veterinary investigation
Epidemiology	The study of disease in populations and of factors that determine its occurrence.

Term	Definition
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
Exotic fauna/feral animals	*See* Wild animals
Fomites	Inanimate objects (eg boots, clothing, equipment, instruments, vehicles, crates, packaging) that can carry an infectious disease agent and may spread the disease through mechanical transmission.
General permit	A legal document that describes the requirements for movement of an animal (or group of animals), commodity or thing, for which permission may be granted without the need for direct interaction between the person moving the animal(s), commodity or thing and a government veterinarian or inspector. The permit may be completed via a webpage or in an approved place (such as a government office or commercial premises). A printed version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements. *See also* Special permit
In-contact animals	Animals that have had close contact with infected animals, such as noninfected animals in the same group as infected animals.
Incubation period	The period that elapses between the introduction of a pathogen into an animal and the first clinical signs of the disease.
Index case	The first case of the disease to be diagnosed in a disease outbreak. *See also* Index property
Index property	The property on which the index case is found. *See also* Index case
Infected premises (IP)	A defined area (which may be all or part of a property) on which animals meeting the case definition are or were present, or the causative agent of the emergency animal disease is present, or there is a reasonable suspicion that either is present, and that the relevant chief veterinary officer or their delegate has declared to be an infected premises.
Local control centre (LCC)	An emergency operations centre responsible for the command and control of field operations in a defined area.
Modified stamping out	A stamping out policy that is modified – based on risk assessment – to culling only a selected group of animals instead of all susceptible animals that are either infected or exposed to the agent of disease. This modified strategy may be implemented when the destruction of all susceptible animals is not financially or practically feasible. The term 'modified' is used when the stamping out measures are not implemented in full.
Monitoring	Routine collection of data for assessing the health status of a population or the level of contamination of a site for remediation purposes. *See also* Surveillance

Term	Definition
Movement control	Restrictions placed on the movement of animals, people and other things to prevent the spread of disease.
National Biosecurity Committee (NBC)	A committee that was formally established under the Intergovernmental Agreement on Biosecurity (IGAB). The IGAB was signed on 13 January 2012, and signatories include all states and territories except Tasmania. The committee provides advice to the Agriculture Senior Officials Committee and the Agriculture Ministers' Forum on national biosecurity issues, and on the IGAB.
National Management Group (NMG)	A group established to approve (or not approve) the invoking of cost sharing under the Emergency Animal Disease Response Agreement. NMG members are the Secretary of the Australian Government Department of Agriculture, Water and the Environment as chair, the chief executive officers of the state and territory government parties, and the president (or analogous officer) of each of the relevant industry parties.
Native wildlife	*See* Wild animals
OIE Terrestrial Code	OIE *Terrestrial animal health code*. Describes standards for safe international trade in animals and animal products. Revised annually and published on the internet at: www.oie.int/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access.
OIE Terrestrial Manual	OIE *Manual of diagnostic tests and vaccines for terrestrial animals*. Describes standards for laboratory diagnostic tests, and the production and control of biological products (principally vaccines). The current edition is published on the internet at: www.oie.int/en/what-we-do/standards/codes-and-manuals/terrestrial-manual-online-access.
Operational procedures	Detailed instructions for carrying out specific disease control activities, such as disposal, destruction, decontamination and valuation.
Outside area (OA)	The area of Australia outside the declared (control and restricted) areas.
Owner	Person responsible for a premises (includes an agent of the owner, such as a manager or other controlling officer).
Polymerase chain reaction (PCR)	A method of amplifying and analysing DNA sequences that can be used to detect the presence of viral DNA.
Premises	A tract of land including its buildings, or a separate farm or facility that is maintained by a single set of services and personnel.
Premises of relevance (POR)	A premises in a control area that contains a live susceptible animal(s) but is not considered at the time of classification to be an infected premises, suspect premises, trace premises, dangerous contact premises or dangerous contact processing facility.
Prevalence	The proportion (or percentage) of animals in a particular population affected by a particular disease (or infection or positive antibody titre) at a given point in time.

Term	Definition
Proof of freedom	Reaching a point following an outbreak and post-outbreak surveillance when freedom from the disease can be claimed with a reasonable level of statistical confidence.
Qualifiers	
– assessed negative	Assessed negative (AN) is a qualifier that may be applied to ARPs, PORs, SPs, TPs, DCPs or DCPFs. The qualifier may be applied following surveillance, epidemiological investigation, and/or laboratory assessment/diagnostic testing and indicates that the premises is assessed as negative at the time of classification.
– sentinels on site	Sentinels on site (SN) is a qualifier that may be applied to IPs and DCPs to indicate that sentinel animals are present on the premises as part of response activities (ie before it can be assessed as an RP).
– vaccinated	The vaccinated (VN) qualifier can be applied in a number of different ways. At its most basic level, it can be used to identify premises that contain susceptible animals that have been vaccinated against the EAD in question. However, depending on the legislation, objectives and processes within a jurisdiction, the VN qualifier may be used to track a range of criteria and parameters.
Quarantine	Legally enforceable requirement that prevents or minimises spread of pests and disease agents by controlling the movement of animals, persons or things.
Resolved premises (RP)	An infected premises, dangerous contact premises or dangerous contact processing facility that has completed the required control measures, and is subject to the procedures and restrictions appropriate to the area in which it is located.
Restricted area (RA)	A relatively small legally declared area around infected premises and dangerous contact premises that is subject to disease controls, including intense surveillance and movement controls.
Risk enterprise	A defined livestock or related enterprise that is potentially a major source of infection for many other premises. Includes intensive piggeries, feedlots, abattoirs, knackeries, saleyards, calf scales, milk factories, tanneries, skin sheds, game meat establishments, cold stores, artificial insemination centres, veterinary laboratories and hospitals, road and rail freight depots, showgrounds, field days, weighbridges and garbage depots.
Sensitivity	The proportion of truly positive units that are correctly identified as positive by a test. *See also* Specificity
Sentinel animal	Animal of known health status that is monitored to detect the presence of a specific disease agent.
Seroconversion	The appearance in the blood serum of antibodies (as determined by a serology test) following vaccination or natural exposure to a disease agent.
Serosurveillance	Surveillance of an animal population by testing serum samples for the presence of antibodies to disease agents.

Term	Definition
Serotype	A subgroup of microorganisms identified by the antigens carried (as determined by a serology test).
Serum neutralisation test	A serological test to detect and measure the presence of antibody in a sample. Antibody in serum is serially diluted to detect the highest dilution that neutralises a standard amount of antigen. The neutralising antibody titre is given as the reciprocal of this dilution.
Slaughter	The humane killing of an animal for meat for human consumption.
Special permit	A legal document that describes the requirements for movement of an animal (or group of animals), commodity or thing, for which the person moving the animal(s), commodity or thing must obtain prior written permission from the relevant government veterinarian or inspector. A printed version of the permit must accompany the movement. The permit may impose preconditions and/or restrictions on movements. *See also* General permit
Specificity	The proportion of truly negative units that are correctly identified as negative by a test. *See also* Sensitivity
Stamping out	The strategy of eliminating infection from premises through the destruction of animals in accordance with the particular AUSVETPLAN manual, and in a manner that permits appropriate disposal of carcasses and decontamination of the site.
State coordination centre (SCC)	The emergency operations centre that directs the disease control operations to be undertaken in a state or territory.
Surveillance	A systematic program of investigation designed to establish the presence, extent or absence of a disease, or of infection or contamination with the causative organism. It includes the examination of animals for clinical signs, antibodies or the causative organism.
Susceptible animals	Animals that can be infected with a particular disease.
Suspect animal	An animal that may have been exposed to an emergency disease such that its quarantine and intensive surveillance, but not pre-emptive slaughter, is warranted. or An animal not known to have been exposed to a disease agent but showing clinical signs requiring differential diagnosis.
Suspect premises (SP)	Temporary classification of a premises that contains a susceptible animal(s) not known to have been exposed to the disease agent but showing clinical signs similar to the case definition, and that therefore requires investigation(s).
Swill	Also known as 'prohibited pig feed', means material of mammalian origin, or any substance that has come in contact with this material, but does not include: (i) Milk, milk products or milk by-products either of Australian provenance or legally imported for stockfeed use into Australia.

Term	Definition
	(ii) Material containing flesh, bones, blood, offal or mammal carcases which is treated by an approved process.[1] (iii) A carcass or part of a domestic pig, born and raised on the property on which the pig or pigs that are administered the part are held, that is administered for therapeutic purposes in accordance with the written instructions of a veterinary practitioner. (iv) Material used under an individual and defined-period permit issued by a jurisdiction for the purposes of research or baiting. [1] In terms of (ii), approved processes are: 1. rendering in accordance with the 'Australian Standard for the Hygienic Rendering of Animal Products' 2. under jurisdictional permit, cooking processes subject to compliance verification that ensure that a core temperature of at least 100 °C for a minimum of 30 minutes, or equivalent, has been reached. 3. treatment of cooking oil, which has been used for cooking in Australia, in accordance with the 'National Standard for Recycling of Used Cooking Fats and Oils intended for Animal Feeds' 4. under jurisdictional permit, any other nationally agreed process approved by AHC for which an acceptable risk assessment has been undertaken and that is subject to compliance verification. The national definition is a minimum standard. Some jurisdictions have additional conditions for swill feeding that pig producers in those jurisdictions must comply with, over and above the requirements of the national definition.
Swill feeding	Also known as 'feeding prohibited pig feed', it includes: • feeding, or allowing or directing another person to feed, prohibited pig feed to a pig • allowing a pig to have access to prohibited pig feed • the collection and storage or possession of prohibited pig feed on a premises where one or more pigs are kept • supplying to another person prohibited pig feed that the supplier knows is for feeding to any pig. This definition was endorsed by the Agriculture Ministers' Council through AGMIN OOS 04/2014.
Trace premises (TP)	Temporary classification of a premises that contains susceptible animal(s) that tracing indicates may have been exposed to the disease agent, or contains contaminated animal products, wastes or things, and that requires investigation(s).

Term	Definition
Tracing	The process of locating animals, people or other items that may be implicated in the spread of disease, so that appropriate action can be taken.
Unknown status premises (UP)	A premises within a declared area where the current presence of susceptible animals and/or risk products, wastes or things is unknown.
Vaccination	Inoculation of individuals with a vaccine to provide active immunity.
Vaccine	A substance used to stimulate immunity against one or several disease-causing agents to provide protection or to reduce the effects of the disease. A vaccine is prepared from the causative agent of a disease, its products or a synthetic substitute, which is treated to act as an antigen without inducing the disease.
– adjuvanted	A vaccine in which one or several disease-causing agents are combined with an adjuvant (a substance that increases the immune response).
– attenuated	A vaccine prepared from infective or 'live' microbes that are less pathogenic but retain their ability to induce protective immunity.
– gene deleted	An attenuated or inactivated vaccine in which genes for non-essential surface glycoproteins have been removed by genetic engineering. This provides a useful immunological marker for the vaccine virus compared with the wild virus.
– inactivated	A vaccine prepared from a virus that has been inactivated ('killed') by chemical or physical treatment.
– recombinant	A vaccine produced from virus that has been genetically engineered to contain only selected genes, including those causing the immunogenic effect.
Vector	A living organism (frequently an arthropod) that transmits an infectious agent from one host to another. A *biological* vector is one in which the infectious agent must develop or multiply before becoming infective to a recipient host. A *mechanical* vector is one that transmits an infectious agent from one host to another but is not essential to the life cycle of the agent.
Veterinary investigation	An investigation of the diagnosis, pathology and epidemiology of the disease. *See also* Epidemiological investigation
Viraemia	The presence of viruses in the blood.
Wild animals	
– native wildlife	Animals that are indigenous to Australia and may be susceptible to emergency animal diseases (eg bats, dingoes, marsupials).
– feral animals	Animals of domestic species that are not confined or under control (eg cats, horses, pigs).

Term	Definition
– exotic fauna	Nondomestic animal species that are not indigenous to Australia (eg foxes).
Wool	Sheep wool.
Zero susceptible species premises (ZP)	A premises that does not contain any susceptible animals or risk products, wastes or things.
Zoning	The process of defining, implementing and maintaining a disease-free or infected area in accordance with OIE guidelines, based on geopolitical and/or physical boundaries and surveillance, to facilitate disease control and/or trade.
Zoonosis	A disease of animals that can be transmitted to humans.

Abbreviations

Manual-specific abbreviations

Abbreviation	Full title
AHS	African horse sickness
BTV	bluetongue virus
NAMP	National Arbovirus Monitoring Program

Standard AUSVETPLAN abbreviations

Abbreviation	Full title
ACDP	Australian Centre for Disease Preparedness
AN	assessed negative
APF	approved processing facility
ARP	at-risk premises
AUSVETPLAN	Australian Veterinary Emergency Plan
CA	control area
CCEAD	Consultative Committee on Emergency Animal Diseases
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVO	chief veterinary officer
DCP	dangerous contact premises
DCPF	dangerous contact processing facility
EAD	emergency animal disease
EADRA	Emergency Animal Disease Response Agreement
EADRP	Emergency Animal Disease Response Plan
EDTA	ethylenediaminetetraacetic acid (anticoagulant for whole blood)
ELISA	enzyme-linked immunosorbent assay
GP	general permit
IETS	International Embryo Technology Society
IP	infected premises
LCC	local control centre
NASOP	nationally agreed standard operating procedure

Abbreviation	Full title
NMG	National Management Group
OA	outside area
OIE	World Organisation for Animal Health
PCR	polymerase chain reaction
POR	premises of relevance
RA	restricted area
RP	resolved premises
SCC	state coordination centre
SP	suspect premises
SpP	special permit
TP	trace premises
UP	unknown status premises
ZP	zero susceptible species premises

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