AUSTRALIAN VETERINARY EMERGENCY PLAN

AUSVETPLAN

Response strategy

Lumpy skin disease

Version 5.3

AUSVETPLAN is a series of 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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Contents

1 Introduction

1.1 This manual

1.1.1 Purpose

As part of AUSVETPLAN (the Australian Veterinary Emergency Plan), this response strategy contains the nationally agreed approach to the response to an incident — or suspected incident — of lumpy skin disease (LSD) in Australia. It has been developed to guide decision making to ensure that a fast, efficient and effective response can be implemented consistently across Australia with minimal delay.

1.1.2 Scope

This response strategy covers LSD caused by lumpy skin disease virus.

This response strategy provides information about:

- the disease (Section 2)
- the implications for Australia, including potential pathways of introduction; social, environmental, human health and economic effects; and the critical factors for a response to the disease (Section 3)
- the agreed policy and guidelines for agencies and organisations involved in a response to an outbreak (Section 4)
- declared areas and premises classifications (Section 5)
- biosecurity controls, including quarantine and movement controls (Section 6)
- response surveillance and establishing proof of freedom (Section 7).

The key features of LSD are described in the **Lumpy skin disease fact sheet** (Appendix 1).

1.1.3 Development

The strategies in this document for the diagnosis and management of an outbreak of LSD are based on risk assessment. They are informed by the recommendations in the World Organisation for Animal Health (WOAH) *Terrestrial animal health code* (Chapters 7.6 and 11.9) and the WOAH *Manual of diagnostic tests and vaccines for terrestrial animals* (Chapter 3.4.12). The strategies and policy guidelines are for emergency situations and are not applicable to policies for imported animals or animal products.

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

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

1.2 Other documentation

This response strategy should be read and implemented in conjunction with:

- other AUSVETPLAN documents, including the 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]
- relevant nationally agreed standard operating procedures (NASOPs). These procedures complement AUSVETPLAN and describe in detail specific actions undertaken during a response to an incident. NASOPs have been developed for use by jurisdictions during responses to emergency animal disease (EAD) incidents and emergencies
- relevant jurisdictional or industry policies, response plans, standard operating procedures and work instructions
- relevant Commonwealth and jurisdictional legislation and legal agreements (such as the Emergency Animal Disease Response Agreement — EADRA[2]), where applicable.

1.3 Training resources

EAD preparedness and response arrangements in Australia

The EAD Foundation online course[3] provides livestock producers, veterinarians, veterinary students, government personnel and emergency workers with foundation knowledge for further training in EAD preparedness and response in Australia.

[1] www.animalhealthaustralia.com.au/our-publications/ausvetplan-manuals-and-documents

[2] https://animalhealthaustralia.com.au/eadra

[3] https://animalhealthaustralia.com.au/online-training-courses

2 Nature of the disease

Lumpy skin disease (LSD) is an acute to chronic, highly infectious, generalised skin disease of cattle, buffalo and camels. It is characterised by widespread skin nodules, production losses and mortality. The disease is caused by LSD virus, which is similar to the viruses causing sheep pox and goat pox. Lumpy skin disease is a mechanically transmitted vector-borne disease, which can also be transmitted directly and through fomites.

2.1 Aetiology

Sheep pox, goat pox and LSD viruses belong to the genus *Capripoxvirus* of the family Poxviridae. These viruses are morphologically indistinguishable from each other; they are also difficult to distinguish serologically, and cross-protection does occur (Kitching 2003). However, they are phylogenetically distinct and are adapted to different host species (Tulman et al 2001, 2002). They can be differentiated using species-specific molecular diagnostic techniques (Le Goff et al 2009; Lamien et al 2011a, b).

2.2 Susceptible species

LSD mainly affects cattle. European breeds of cattle *(Bos taurus)* are generally more susceptible than zebu cattle *(Bos indicus)* (Davies 1991a, Gari et al 2011). Jersey, Guernsey, Friesian and Ayrshire breeds are particularly susceptible. Cases have also been seen in Asian water buffalo *(Bubalus bubalis)* (Ali et al 1990, El Nahas et al 2011, Elhaig et al 2017) and banteng (*Bos javanicus*). It has been reported that the morbidity rate in buffalo (1.6%) is significantly lower than in cattle (30.8%) (El-Nahas et al 2011). LSD has also been reported in camels (Kumar et al 2023). The epidemiological significance of camels is not clear, but they were shown to seroconvert, and live virus was detected in skin lesions.

Some strains of LSD virus may replicate in sheep and goats, although there is no epidemiological evidence of small ruminants acting as a reservoir for the virus (FAO 2017, Tuppurainen et al 2017).

LSD was reported in Arabian oryx in Saudi Arabia (Greth et al 1992); however, differentiation from sheep pox was not confirmed. Experimentally, impala and giraffe are also susceptible (Young et al 1970, Hedger & Hamblin 1983, Greth et al 1992). No wildlife reservoir species have been identified in Africa.

Antibodies to capripoxviruses have been detected in a range of African wildlife species, including Cape buffalo (*Syncerus caffer*), wildebeest, springbok, eland, impala, kudu and waterbuck (Davies 1982, 1991a; Hedger & Hamblin 1983; Barnard 1997). LSD virus nucleic acid has been detected in skin samples from springbok (Le Goff et al 2009, Lamien et al 2011a).

Native Australian fauna are unlikely to be susceptible to LSD.

2.2.1 Zoonotic potential

LSD does not affect humans (WOAH 2022).

2.3 World distribution

For the latest information on the distribution of LSD, refer to the World Organisation for Animal Health (WOAH) World Animal Health Information System.[4]

2.3.1 Distribution outside Australia

Before 2012, the distribution of LSD was limited to Africa and Israel. However, since then, LSD has spread to many parts of the Middle East, Turkey, Cyprus, eastern Europe, the Balkans and the Russian Federation (EFSA AHAW Panel 2015).

Since 2019, LSD has spread throughout the Asian continent, including India and China, and southwards through Southeast Asia. In 2020, outbreaks were reported in a territory of Taiwan and in Nepal (possibly from the movement of flies or mosquitoes from neighbouring countries or by animal movements). In 2021, LSD spread further into Cambodia, Malaysia and Thailand. In 2022, cases were reported in Indonesia and Singapore.

2.3.2 Occurrence in Australia

LSD has never been recorded in Australia.

2.4 Epidemiology

2.4.1 Incubation period

The incubation period for LSD is 6–26 days (Sohier et al 2019, EFSA 2020).

WOAH incubation period

For the purposes of the WOAH Terrestrial animal health code, the incubation period[5] for LSD is 28 days.

2.4.2 Persistence of agent and modes of transmission

General properties

General properties of LSD virus include:

- stable between pH 6.6 and 8.6 (Barnard et al 1994, Coetzer & Tuppurainen 2004)
- inactivated in 10 minutes at 60 °C, but dried virus (orthopoxviruses in general) can withstand 100 °C for 10 minutes (Andrewes et al 1978)
- persists in dark environmental conditions for many months (WOAH 2022)
- persists for long periods in chilled (4 °C) and frozen (–80 °C) material (Weiss 1968)
- susceptible to heat, with inactivation at 55 °C in 2 hours and 65 °C in 30 minutes; these values are also commonly cited for sheep pox and goat pox viruses (WOAH 2022)
- susceptible to sunlight and detergents containing lipid solvents

[4] https://wahis.woah.org/#/home

[5] In the OIE Terrestrial Code, 'incubation period' means the longest period that elapses between the introduction of the pathogenic agent into the animal and the occurrence of the first clinical signs of the disease. See www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=glossaire.htm.

- inactivated by a wide variety of disinfectants, including some detergents, ether, chloroform, formalin, phenol, sodium hypochlorite, iodine compounds and quaternary ammonium compounds (Weiss 1968, WOAH 2022).

Organic material surrounding the infectious virus in the environment will affect the efficacy of disinfectants.

Note that these are general properties, and research to validate specific values is limited. Data on LSD virus stability outside the ranges given above are lacking. For example, the range of pH values that the virus can tolerate may be wider than thought, and extremes of acidity or alkalinity may be required to reliably lead to significant inactivation (Polson & Turner 1954, Herd Health 2017).

Environment (including windborne spread)

Capripoxviruses can remain viable for long periods outside the animal host. They may persist for many months in a suitable environment, such as that provided by shaded animal pens (WOAH 2022, DoA & CSIRO 2019).

Windborne spread has not been documented, but dispersal of vectors by wind may facilitate disease spread (see 'Arthropod vectors').

Arthropod vectors

Mechanical transmission by biting insects is considered to be the main route of local transmission of LSD virus. Longer-distance spread (e.g. by wind dispersal of vectors) has been implicated in the introduction of LSD into new countries.

Uptake of virus by biting vectors is most efficient from clinically affected animals; asymptomatic animals in a herd are likely to have much lower virus titres and therefore play less of a role in propagation of the virus by vectors (Sanz-Bernardo et al 2021). LSD virus has been shown to persist for 2.4 days in the vector, and the vector has a 0.19 probability of transmitting LSD to cattle (Sanz-Bernardo et al 2021).

The likely insect species involved are expected to vary depending on local conditions and insect populations. Mechanical transmission of LSD virus by mosquitoes (*Aedes aegyptii*) and hard ticks (*Rhipicephalus appendiculatus*) has been demonstrated experimentally (Chihota et al 2001, Tuppurainen et al 2013a). Stable flies (*Stomoxys calcitrans*), tabanid flies, other flies, midges (*Culicoides* spp.) and other hard ticks (e.g. *Amblyomma hebraeum*) have also been demonstrated as mechanical vectors (Weiss 1968, Kitching & Mellor 1986, Muller et al 2011, Tuppurainen et al 2011, Lubinga et al 2015, EFSA AHAW Panel 2015).

LSD virus is not thought to remain infectious in mechanical vectors for long, although survival for at least 8 days has been reported in mosquitoes (*A. aegyptii*) and stable flies (*S. calcitrans)* (Spickler 2017, Sanz-Bernardo et al 2021). Variability in the mean duration of potential virus survival in vectors has been reported (Gubbins 2019), which should be considered along with the feeding behaviour of the likely vectors and vector life spans.

Recent experimental studies demonstrated mechanical transmission of LSD virus via *Stomoxys* species (including *S. calcitrans* — stable flies) (Sohier et al 2019, Issimov et al 2020). The ability for *Stomoxys* spp. to travel 21–28 km in 24 hours, in addition to virus survival times, means that *Stomoxys* activity can easily lead to localised spread (Gubbins 2019, Issimov et al 2020). Tabanid horseflies can transmit LSD virus (Sohier et al 2019).

Mechanical transmission by buffalo fly (*Haematobia irritans exigua*) has not been described but cannot be ruled out.

Ticks are unlikely to play a role in rapid spread of LSD virus in outbreaks because of their slow mobility. However, prolonged survival of the virus in hard ticks may be possible, and ticks may therefore act as an environmental reservoir and facilitate overwintering of the virus in endemic areas (EFSA AHAW Panel 2015). Transstadial transmission has been demonstrated in hard ticks (*R. appendiculatus* and *A. hebraeum*) (Lubinga et al 2013). Transovarial transmission has been demonstrated in *R. decoloratus*; LSD virus was detected in the eggs (Tuppurainen et al 2011) and larvae (Lubinga et al 2014) of female *R. decoloratus* ticks fed on LSD virus–infected animals — this tick is closely related to the Australian cattle tick, *R. australis* (previously known as *R. microplus*). Transmission of LSD virus back to susceptible cattle was subsequently demonstrated (Tuppurainen et al 2013b). Larvae from *A. hebraeum* female ticks fed on LSD virus–infected cattle were positive for LSD virus on PCR testing, but cattle exposed to these ticks did not develop clinical signs or seroconvert (Lubinga et al 2014).

Although there is no evidence of multiplication of LSD virus in these vectors, it cannot be excluded (Tuppurainen et al 2017). Recent studies did not find evidence of viral replication in the vectors studied; thus this is unlikely to be epidemiologically important in transmission (Sanz-Bernardo et al 2021, Paslaru et al 2022). Viral retention has been shown as feasible under experimental conditions — for one species (*Culex pipiens*), for up to 10 days. However, it is unknown how this relates to field situations.

Live animals

Transmission of LSD virus is incompletely understood; however, transmission through direct contact between infected animals is believed to be inefficient and plays only a minor role in the epidemiology of the disease (WOAH 2022).

LSD virus is present in nasal, lachrymal and pharyngeal secretions of infected animals, and in their semen, milk and blood (Thomas & Mare 1945, cited in Davies 1991b; Weiss 1968). Infectious LSD virus has been detected in saliva and nasal discharges for up to 18 days post-infection (Babiuk et al 2008) and in blood for up to 16–28 days post-infection (Tuppurainen et al 2005, 2011; Sanz-Bernardo et al 2021). Direct transmission between animals is likely to be more significant in animals managed under intensive scenarios (i.e. feedlot and dairy), and non-bloodsucking insects may play a role in transmission via secretions between animals in these contexts.

LSD virus is found at higher concentrations in skin lesions than in blood in animals with clinical disease (Sanz-Bernardo et al 2021).

LSD virus present in bull semen can be a source of infection for females (Tuppurainen et al 2017; see ‘Semen and embryos from live susceptible animals’).

LSD virus may be spread from cows to their progeny. There are reports of calves from infected cows being born with skin lesions; the virus is also thought to be rarely spread to suckling calves through infected milk, or from skin lesions on the teats (Tuppurainen et al 2017).

It is assumed that LSD virus is also excreted in vaginal secretions. The resistant nature of the virus would make venereal transmission very likely (Committee on Managing Global Genetic Resources 1993).

There is no known carrier state for LSD virus.

Carcasses

LSD virus is very resistant to inactivation, surviving in necrotic skin nodules for 33 days or longer, desiccated crusts for up to 35 days, and at least 18 days in air-dried hides (WOAH 2022) — these may pose a risk of transmission if they are accessible to arthropod mechanical vectors. Although some arthropod vectors may feed on body exudates other than blood, the pathways that enable insects to mechanically transmit infection are uncertain. Nevertheless, application of insecticides containing repellents to carcasses before

transport or burial is recommended (EFSA AHAW Panel 2015). Long-distance spread of LSD in Israel was associated with movement of infected carcasses to a disposal site (near where the new outbreak occurred), although a causal association was not proven (EFSA AHAW Panel 2015).

Most vectors of LSD virus are unlikely to feed on carcasses. Larvae under the skin of insects that feed on decomposing carcasses, that may retain the virus throughout metamorphosis into the adult stage, are very unlikely to transmit the virus. However, consideration should be given to the risk that feral pigs, wild dogs and carrion birds feeding on infected carcasses may spread the virus — noting that these species act only as contaminated fomites and do not become infected. This slight risk means that there are benefits in destroying carcasses of animals that exhibited clinical signs, preferably by burial on-site. Additional guidance on disposal options and methods can be found in the **AUSVETPLAN *Operational manual: Disposal*.**

Animal products

Meat, meat products and casings, including use as animal feed

Although LSD virus may persist in the meat of infected animals (Weiss 1968), trade in meat for human consumption is not a significant risk for transmission of the virus. LSD virus has been found in meat and offal after experimental infection, although virus was not found in deep skeletal meat, and the risk of transmission through deep skeletal meat has been assessed as minimal (Kononov et al 2019).

WOAH recommends that the following commodities should not require any LSD-related conditions regardless of the status of the animal population of the exporting country: skeletal muscle meat, casings, gelatine and collagen, tallow, and hoofs and horns.

Heat treatment of meatmeal from affected animals to a minimum internal temperature of 65 °C for at least 30 minutes will reduce the risk of LSD virus transmission (WOAH 2022).

Australia has well-developed national guidelines and state legislation that ban feeding to all ruminants of all meals derived from all vertebrates, including fish and birds.

Milk and dairy products, including use as animal feed

There is some evidence that conditions equivalent to the low temperature/long-time method of pasteurisation (62 °C for 30 minutes) will inactivate capripoxviruses (Wolff et al 2020), but the presence of fat, protein and other solids in the milk may protect the virus. Whilst LSD virus is considered susceptible to high alkaline or acid pH (WOAH 2022), the pH of cheese may also be insufficient to inactivate the virus.

A recent milk pasteurisation study by the CSIRO (2023) demonstrated that no viable virus remained in LSD virus contaminated milk treated by any combination of the following time, temperature or virus concentrations (7.5, 15, 30 seconds, 72C, 75C or 80C or 10^4, 10^5 and 10^6 $TCID_{50}$/ml).

The risk of LSD virus transmission by milk not intended for animal consumption can be mitigated by pasteurisation and transport in closed containers (Tuppurainen et al 2017). The WOAH recommendations for importation of milk and milk products include pasteurisation (WOAH 2024).

During a review of the Department of Agriculture, Fisheries and Forestry's *Import risk review for dairy products for human consumption*[6], new research was identified that demonstrates inactivation of LSD virus occurs in milk that has undergone high temperature short time (HTST), batch and UHT pasteurisation. One of the following heat treatments must be applied to the milk or the dairy ingredients during processing:

[6] https://www.agriculture.gov.au/biosecurity-trade/policy/risk-analysis/animal/dairy-products-for-human-consumption

- HTST pasteurisation at a temperature of no less than 72°C and retaining at such temperature for no less than 15 seconds, or
- batch pasteurisation at a temperature of no less than 63°C and retaining at such temperature for no less than 30 minutes, or
- UHT at a temperature of no less than 132°C and retaining at such temperature for no less than 1 second.

The WOAH recommendations for importation of milk and milk products are that the products have either been derived from animals in a country or zone free from LSD or were subjected to pasteurisation or any combination of control measures with equivalent performance, as described in the Codex Alimentarius *Code of hygienic practice for milk and milk products*.[7]

Animal byproducts

Hides, skin, wool and other fibres

Spread of LSD into new regions via contaminated hides is possible (Spickler 2017). LSD virus may remain infectious for up to 18 days in air-dried hides (Weiss 1968).

The WOAH Terrestrial Code recommends the following treatments:

- dry-salting or wet-salting for at least 14 days
- 7 days in salt (NaCl) with the addition of 2% sodium carbonate (Na_2CO_3)
- drying for at least 42 days at a temperature of at least 20 °C.

However, noting that hides with clinical LSD lesions are unlikely to be used because of damage and that clinical lesions are more significant for transmission than unaffected skin and tissue, partially tanned hides and skins may still present a risk — that is, hides and skins that have undergone only liming, acid pickling or salting with 2% sodium carbonate at 50% pelt weight for 28 days (T Ingle, Australian Government Department of Agriculture, Fisheries and Forestry, pers comm, 2021). Fully tanned hides and skins (e.g. 'finished' leather products such as shoes) are unlikely to present a risk of virus transmission.

Semen and embryos from live susceptible animals

Experimental transmission of LSD virus via semen from infected (but asymptomatic) bulls to both embryos and heifers has been proven (Annandale et al 2014). Shedding of LSD virus in the semen of infected bulls may be prolonged; virus has been isolated from semen for up to 42 days post-inoculation in an experimentally infected bull (Irons et al 2005). Viral DNA has been detected in all fractions of semen (Annandale et al 2010). Common semen processing methods are inadequate to wash semen free of LSD virus contamination (Annandale et al 2018).

Live LSD virus has been isolated from apparently healthy-looking testicular tissue in both clinical and subclinical animals (Kononov et al 2019).

There is one report of placental transmission of LSD virus (WOAH 2022), and infected pregnant cows are known to deliver calves with skin lesions (Tuppurainen et al 2017). However, because of insufficient information, the International Embryo Technology Society has not classified LSD virus regarding the likelihood of its transmission via embryos.

[7] www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre_lsd.htm

Viral replication was observed in blastocysts following successful fertilisation of embryos with semen containing LSD virus during artificial insemination. LSD virus was also shown to affect the success of fertilisation during the experiments (Annandale et al 2019).

Specimens

LSD virus is not zoonotic, and transmission of disease via laboratory specimens is not considered a risk.

Waste products and effluent

There are no reports of isolation of LSD virus from faeces or urine.

Biological products

The use of live, attenuated vaccines for LSD has been associated with disease in some countries (Brenner et al 2009, Ben-Gera et al 2015). Transmission of LSD virus through other biological products is theoretically possible but not documented.

Nonsusceptible animals

Nonsusceptible animals may act as contaminated fomites for LSD virus and may facilitate the movement of arthropod vectors. Application of insect repellents to animals on affected and neighbouring farms may help mitigate these risks (Tuppurainen et al 2017).

People

People can potentially act as contaminated fomites for LSD virus. Tuppurainen et al (2017) recommend that people leaving affected premises disinfect their hands, boots and clothes, and subsequently wash their clothes at a water temperature above 60 °C. There is also merit in adding a sanitiser or disinfectant when washing clothing, towels and so on. Use of a clothes dryer on high setting is probably also very effective (as it is for killing ticks on clothes). Training station workers, transport operators and so on in correct disinfection technique will be vital to minimising the spread of the virus through their movements.

Crops, grains, hay, silage and mixed feed

Experimentally, transmission has occurred between cattle in adjacent insect-proof enclosures only if they shared access to water or feed (Weiss 1968, Kononov et al 2020).

Long survivability of the virus in the environment and the potential for cross-contamination of feed may allow contaminated feed to act as a transmission pathway into naive populations (Spickler 2017).

Vehicles, including empty livestock transport vehicles

Vehicles can potentially act as contaminated fomites for LSD virus and may facilitate the movement of arthropod mechanical vectors. Cleaning and disinfection of the interior and exterior of the vehicle, and use of insecticides, mitigate these risks (Tuppurainen et al 2017).

Equipment, including personal items

Equipment and personal items can potentially act as contaminated fomites for LSD virus. Although not specifically documented, reuse of needles and surgical equipment contaminated with blood from viraemic animals may mechanically transmit LSD virus to uninfected animals. The Food and Agriculture Organization

of the United Nations LSD field manual for veterinarians (Tuppurainen et al 2017) recommends decontamination of equipment on exit from affected premises.

2.4.3 Factors influencing transmission

The prevalence of insect vectors may affect the rate of transmission of LSD virus. This could account for the wide variation in morbidity (1–95%) in different situations (EFSA AHAW Panel 2015). The sharp reduction in transmission of LSD after cold weather and frosts, which are associated with reduced insect vector populations, supports this hypothesis. A clear seasonal pattern was observed in outbreak events in the Balkans, Turkey and the Russian Federation (EFSA 2020). Studies that modelled outbreaks have drawn similar conclusions (Allepuz et al 2019, Machado et al 2019).

Movement of infected stock has been the cause of much of the spread of LSD between countries. Whereas insect vectors are important in local spread, road and rail transport play an important role in rapidly spreading the disease over large geographical distances (Tuppurainen et al 2017). In the Balkans, LSD spread mostly up to 4 km at a time (via vectors), but transmission events occurred over much longer distances (via animal movements) (EFSA 2018, Manić et al. 2019). In Odisha state, India, the average distance between outbreaks in 2019 was 6 km inside districts and 54 km between districts (Sudhakar et al 2020).

Larger herd sizes and proximity to lakes (presumably related to increased vector activity) have been associated with an increase in prevalence of LSD (Sevik & Dogan 2017).

Viral uptake by vectors and spread of disease are much more efficient from clinically affected animals than asymptomatic animals (Sanz-Bernardo et al 2021).

Camels have recently been identified as being vulnerable to infection (Kumar et al 2023). The role of camels in the epidemiology of LSD outbreaks is not yet clear.

2.5 Diagnostic criteria

2.5.1 Clinical signs

LSD typically presents in cattle and buffalo as fever, followed by the development of multiple nodules on the skin and mucous membranes; these nodules gradually become necrotic.

Clinical signs in cattle may range from inapparent to severe. Water buffalo may show similar clinical signs but are reported to be less severely affected (Sharawi & Abd El-Rahim 2011).

A fever of 40–41.5 °C may last 6–72 hours, occasionally up to 10 days, and is accompanied by increased lacrimation, increased nasal and pharyngeal secretions, loss of appetite, reduction in milk production, varying degrees of depression and reluctance to move.

Within 1–2 days, a cutaneous eruption of nodules occurs, which may cover the whole body. The most common sites are the head and neck, perineum, genitalia and udder, and limbs. The nodules are 5–50 mm or more in diameter, initially appearing as round, circumscribed areas of erect hair, firm and slightly raised from the surrounding skin. There is hyperaemia and drops of serum appear on the surface. The lesions are full skin thickness, involving the epidermis, dermis and subcutis, which may be oedematous. Regional lymph nodes are enlarged and oedematous.

Lesions develop in the muzzle, nostrils, mouth and pharynx. They show a ring-like margin where there has been separation from the surrounding healthy epithelium. Lesions in the larynx and trachea, and throughout the alimentary tract, especially the abomasum, become ulcerated and necrotic. Mucopurulent nasal discharges, persistent hypersalivation, coughing, and stertorous (snoring) and often distressed respiration result. Inflammation of the conjunctiva and cornea of the eyes is common.

Inflammatory and oedematous swellings of the limbs, brisket and genitalia may develop. Skin lesions become necrotic. Some remain in situ, known as a ‘sitfast’, while others slough, leaving a hole of full skin thickness, which becomes infected by pus-forming bacteria. Large areas of skin may slough. Lesions in the skin, subcutaneous tissue and muscles of the limbs, together with the severe skin inflammation caused by secondary infection of lesions, greatly reduce mobility. Rapid deterioration in body condition results, and animals that recover may remain in extremely poor condition for up to 6 months.

Pneumonia is a common and often fatal complication. Absence of oestrus cycles or abortion is frequent in females, and painful genitalia in bulls can prevent them from serving. Live neonates or aborted fetuses from infected cows may show skin lesions following parturition.

The lesions may persist for 4–6 weeks, and final resolution may take 2–6 months.

Morbidity rates vary greatly and range between 1% and 95% (EFSA AHAW Panel 2015). Mortality rates up to 75% have been reported (Babiuk et al 2008), but 1–5% is more usual (Davies 1991a).

In experimental studies, only about 50% of infected animals may develop clinical signs, but the majority may become viraemic (Tuppurainen et al 2005, Osuagwuh et al 2007, Annandale et al 2010, Sanz-Bernardo et al 2021).

Information on clinical signs of LSD in camels is limited, however, Kumar et al (2023) reports skin nodules ranging in size from 4 to 8 mm in diameter — smaller than skin nodules observed in cattle.

2.5.2 Pathology

Gross lesions

On necropsy, nodules may be found in subcutaneous tissues, muscle fascia and muscles, which are grey–pink with caseous necrotic cores. The subcutis is infiltrated by red, watery fluid. Similar nodules may be scattered through the nasopharynx, trachea, bronchi, lungs, rumen, abomasum, renal cortex, testicles and uterus (DoA & CSIRO 2019). Aborted fetuses may show skin lesions (Spickler 2017).

Microscopic lesions

Prozesky and Barnard (1982) described the histopathology seen with LSD. Clinically affected cattle have a granulomatous reaction in the dermis and hypodermis that extends to the surrounding tissue. In the early stages, a vasculitis and lymphangitis with accompanying thrombosis and infarction can be seen, with resultant necrosis and oedema. A characteristic feature of the acute to subacute stages of the lesions is the presence of intracytoplasmic eosinophilic inclusions in cells within the skin nodules (Prozesky and Barnard 1982, Amin et al 2021). Capripoxvirus-infected cells have a characteristic appearance and are sometimes referred to as 'sheeppox cells' or 'cellules claveleuses'. These cells have vacuolated cytoplasm, vacuolated nuclei with marginated chromatin, and often multiple cytoplasmic inclusion bodies (Embury-Hyatt et al 2012).

Electron microscopy reveals virus particles indistinguishable from the orthopoxviruses. These can be readily differentiated from the virus particles of contagious ecthyma (also known as contagious pustular dermatitis, scabby mouth or orf).

2.5.3 Differential diagnosis

Various diseases or conditions should be considered in the differential diagnosis of LSD (WOAH 2022). They may be endemic or exotic.

Endemic:

- urticaria
- pseudo-lumpy skin disease (bovine herpes mammilitis; bovine herpesvirus 2)
- bovine papular stomatitis (parapoxvirus)
- dermatophytosis
- pseudocowpox (parapoxvirus)
- streptothricosis (Dermatophilus congolensis)
- demodicosis
- insect or tick bites
- photosensitisation
- onchocercosis
- bovine papillomavirus.

Exotic:

- rinderpest
- *Hypoderma bovis* infection
- skin tuberculosis.

2.5.4 Laboratory tests

Samples required

Diagnosis of LSD is based primarily on detection of the virus in lesions. Detection of antibody in serum may also aid diagnosis. Specimens that should be collected from live animals include blood (from animals with fever), serum, nodular fluid, scabs, and skin scrapings from lesions or skin biopsies.

Virus can be detected in blood and secretions such as oral/nasal fluid but is present in significantly lower concentrations and for shorter periods than in skin lesions. Non-skin samples should not be relied on for exclusion of disease.

At postmortem, a range of samples, both fresh and fixed, should be taken from skin lesions, lesions in the respiratory and gastrointestinal tracts, and other internal organs.

Following the initial diagnosis, a more restricted sample set, still based on sampling lesions, may be defined.

Transport of specimens

Specimens should be submitted in accordance with agreed state or territory protocols. Specimens should initially be forwarded to the state or territory laboratory for appropriate analysis, and assessment of whether further analysis will be required by the CSIRO Australian Centre for Disease Preparedness (CSIRO-ACDP), Geelong.

If the state or territory laboratory deems it necessary, duplicate samples of the specimens should be forwarded to CSIRO-ACDP for emergency disease testing, after the necessary clearance has been obtained from the chief veterinary officer (CVO) of the state or territory of the suspect case, and after the CVOs of Victoria and Australia have been informed about the case and the transport of the specimens to Geelong (for the first case). Sample packaging and consignment for delivery to CSIRO-ACDP should be coordinated by the relevant state or territory laboratory.

LSD virus is a Security Sensitive Biological Agent (SSBA). Entities handling and transporting samples known or suspected to contain LSD virus should ensure that they meet their obligations under the SSBA Regulatory Scheme.

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

Packing specimens for transport

Unpreserved tissue specimens should be chilled and forwarded with water ice or frozen gel packs. If delays of more than 48 hours are anticipated in transit, these specimens should be frozen, if practical, and forwarded packed in dry ice. Frozen specimens will result in a better diagnostic outcome than those that are not frozen, but it is recognised that there may be challenges in keeping specimens frozen when travelling long distances from remote areas.

2.5.5 Laboratory diagnosis

CSIRO-ACDP tests

The testing method used by CSIRO-ACDP is shown in Figure 2.1. Further details of tests currently available at CSIRO-ACDP are shown in Table 2.1.

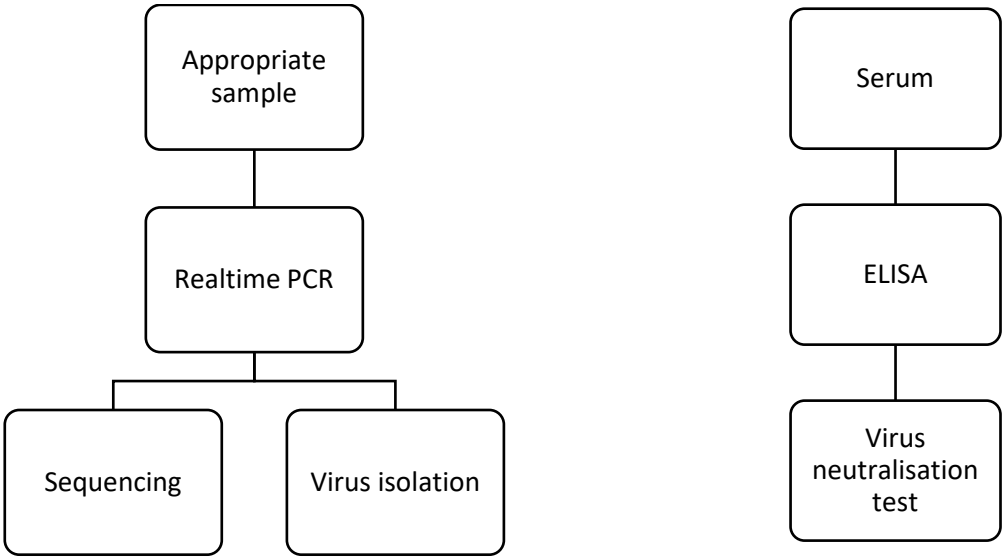

Figure 2.1 The current approach to diagnostic testing at CSIRO-ACDP for LSD

Table 2.1 Laboratory tests currently available at CSIRO-ACDP for diagnosis of LSD

Test	Specimen required	Test detects	Time taken to obtain result
Agent detection			
Capripox real-time PCR	Scabs, blood, tissues or cultured virus	Viral DNA	4–5 hours
LSD virus real-time PCR	Scabs, blood, tissues or cultured virus	Viral DNA	4–5 hours
Agent characterisation			
Sequencing	Scabs, blood, tissues or cultured virus	Viral genome	2 days
Virus isolation	Scabs, blood or tissues	Virus	5–10 days
Serology			
ELISA	Serum	Antibody	4–5 hours
Virus neutralisation	Serum	Antibody	7 days

ELISA = enzyme-linked immunosorbent assay; PCR = polymerase chain reaction

Source: Information provided by CSIRO-ACDP, 2022 (refer to CSIRO-ACDP for most up-to-date information).

A number of real-time and gel-based PCR methods are available for detection of capripoxviruses, several of which are species-specific and allow differentiation of LSD virus from sheep pox virus and goat pox virus (Bowden et al 2008; Le Goff et al 2009; Lamien et al 2011a, b; Gelaye et al 2013). Recently, a PCR method allowing differentiation of eight pox viruses has been developed; this also allows differentiation of LSD virus from bovine papular stomatitis, pseudocowpox and cowpox viruses (Gelaye et al 2017). Virus may also be isolated from cell culture assays. Sequencing of the viral genome, either from primary samples or from cultured material, will further aid characterisation of the causative agent and provide useful information to inform understanding of the epidemiology of the disease.

A tentative diagnosis of LSD can be made by electron microscopy and histopathology of tissue samples; however, with the advent of molecular techniques, these methods are now less commonly used for diagnosis.

Other tests

The virus neutralisation test and enzyme-linked immunosorbent assay (ELISA) tests are validated serological tests for LSD virus (WOAH 2023). ELISA is the preferred test for serosurveillance. The virus can be detected in milk; however, sensitivity is reduced when milk is pooled, thus making bulk milk surveillance unfeasible (Milovanović et al 2020). As all members of the Capripoxvirus genus share a common neutralising antigen, serological assays cannot distinguish between the individual members of the genus.

The immune response to LSD virus infection is dominated by cell-mediated immunity. For disease surveillance, although it may be difficult to detect low titres in individual animals, a herd-based approach is reasonable.

Other serological tests for LSD, such as indirect immunofluorescence and immunodiffusion, are possible, but lack specificity, cross-reacting with related viruses. These are not currently available in Australia.

DIVA testing

Recently, PCR tests have been developed that can differentiate certain vaccine strain viruses from wild-type strains, potentially allowing the limited use of DIVA (differentiating infected from vaccinated animals) testing as part of a vaccination strategy. The efficacy of this test will need to be assessed for any newly developed vaccines.

Most DIVA approaches for other diseases depend on detection of a serological response to the agent, rather than direct detection of virus, and this capability is required for any longer-term monitoring of vaccinated populations. No such assay exists for LSD, but the development of novel vaccines may offer an opportunity for parallel development of a serological DIVA assay.

2.6 Resistance and immunity

Susceptible cattle of all ages can develop serious clinical disease if infected with LSD virus. In countries previously free from LSD, mortality rates up to 75% have been reported (Babiuk et al 2008), but 1–5% is more usual (Davies 1991a) once the disease becomes endemic with rapid spread likely.

Different cattle breeds show different susceptibilities to LSD (see Section 2.2).

Maternal immunity provides some protection to calves born to vaccinated or previously exposed cows (Davies 1991c). In countries where vaccination against LSD is used, calves are vaccinated at 3–4 months of age.

Active immunity develops in response to vaccination or previous exposure to capripoxviruses. All strains of capripoxvirus share a major neutralising site, so that animals that have recovered from infection or are vaccinated with one strain are resistant to infection with any other strain. Animals that have recovered from natural infection with capripoxviruses are thought to have lifelong immunity. They do not become carriers.

2.7 Vaccination

Australia

A live, attenuated LSD (Neethling-type) vaccine has been approved by the Department of Agriculture, Fisheries and Forestry and the APVMA for use in Australia in the event of an LSD outbreak.

Overseas

A range of live, attenuated, homologous (LSD virus) and heterologous (sheep pox and goat pox viruses) vaccines are commercially available overseas. These vaccines have predominantly been used for control of endemic disease and only recently employed for eradication purposes in certain areas (e.g. the Balkans).

2.8 Treatment of infected animals

There is no effective cure for LSD.

2.9 Control overseas

Control of LSD overseas has invariably involved vaccination of cattle and buffalo with heterologous or homologous vaccines. Accompanying measures have differed according to the overall objective of a country's control program.

In endemic countries, herds are vaccinated annually and usually before periods that are associated with a high risk of transmission, to reduce overall clinical disease burden. Stamping out or other eradication activities are not usually undertaken in this scenario because the goal is to minimise the clinical effects, not eradicate disease from a region. The vaccine used is ideally homologous, but heterologous vaccines are also used for LSD control where goat pox and sheep pox are also present, and resources are limited.

Overseas, a combination of strategies — including vaccination — has generally been needed to control outbreaks. Refer to **Appendix 4** for more information.

3 Implications for Australia

3.1 Potential pathways of introduction

The most likely route for introduction of lumpy skin disease (LSD) into Australia is entry of vectors carrying the virus to northern Australia following establishment of the disease in neighbouring countries to the north.

Currently, the potential for LSD to enter Australia via insects from countries in the region is high — especially since the disease has been detected in Indonesia. There is an increased risk of infected insects translocating across the seas north of Australia or entering through international ports, despite disinsection protocols; changing insect resistance profiles may alter the risk rating for this entry pathway (Schmidt et al 2019).

With cattle produced in many parts of Australia and water buffalo present in northern Australia, it is reasonable to assume that infection would establish and an outbreak would occur if infected vectors encountered cattle or water buffalo. Extensive grazing of cattle and buffalo across northern Australia may lead to delays in recognition of an incursion.

Spread of LSD by the movement of infected animals that then interact with transmission vectors is one mechanism by which the disease is spread to new premises or new areas. However, there is little possibility of the disease entering Australia by this means because live bovids or their germplasm are not imported from LSD-endemic countries.

Introduction of LSD via insects entering Australia on aircraft or ships represents a relatively low risk because LSD virus has a short survival time in insects, and the numbers of vectors entering Australia in this way would be low. However, the World Organisation for Animal Health (WOAH) recommends that disinsection be conducted on aircraft coming from countries where animal diseases transmitted by insect vectors are present.

Because of the long survivability of the virus in the environment, stockfeed, supplements and fomites such as skins, hides or equipment may act as a transmission pathway into naive populations. However, Australia's strict biosecurity rules mean that this route would pose a low risk of introduction.

3.2 Social, economic and environmental effects

LSD is one of the biggest biosecurity threats to Australia's cattle (and buffalo) industries; the effect on animals and animal products would be significant. Trading partners would be expected to introduce emergency measures until any outbreak situation became stable, significantly disrupting exports of meat, dairy and other bovine-derived animal products. The impacts may include closure of markets, increased testing requirements, increased requirements for pre-export quarantine, vaccination requirements, and reductions in price premiums for Australian commodities.

The Meat & Livestock Australia State of the industry report 20208 records that Australian beef exports were valued at $10.8 billion in 2019 and that Australian live cattle exports were valued at $1.6 billion in 2018–19, with 1.3 million animals exported. The gross value of Australian cattle and calf production (including live cattle exports) in 2019–20 is estimated at $15.1 billion (ABARES Agricultural Commodities, September 2020). Australian dairy product exports were valued at $3.8 billion in 2021/22, and the dairy industry also contributed to high-value live export of heifers and export of meat commodities (Dairy

[8] www.mla.com.au/news-and-events/industry-news/state-of-the-industry-report-2020-released

Australia 2022). The full range of bovine-derived products affected would depend on individual trading partners' requirements for these commodities.

An incursion of LSD is very likely to involve an extended disease response and surveillance to establish proof of freedom (see Section 4.1.4). Disease response activities of naive countries trying to eradicate the disease (e.g. in the Balkans) have lasted many years. A swift return to country freedom status is also impeded by uncertainties about the ability of LSD virus to overwinter and persist in the environment. Trade impacts may occur before formal notification from Australian authorities to WOAH.

Most of northern Australian is dependent on cattle production and would suffer significant socioeconomic impacts in the event of an outbreak of LSD in Australia.

If stamping out of large numbers of animals was required, there would be a negative societal reaction to the killing of the animals, as well as effects on tourism and Australia's way of life.

3.3 Critical factors for an Australian response

Critical considerations for formulating a policy for the response to an incident of LSD in Australia include the following:

- LSD is a highly infectious disease of cattle (especially European – *Bos taurus* – breeds) and buffalo, with low mortality but medium to high morbidity predicted for a naive population. The disease has a characteristic clinical presentation, so should become apparent relatively soon after introduction, if cattle or buffalo are regularly observed. The epidemiological significance of camels in an outbreak is not yet clear.
- Responding to an incursion of LSD would be challenging in parts of Australia that have significant numbers of feral cattle and buffalo, and large areas that are only accessible with extreme difficulty (e.g. northern Australia, especially during the wet season). For example, administering vaccine to feral buffalo poses significant logistical difficulties.
- Susceptible cattle of all ages may develop serious clinical disease.
- Acute cases (the most common type in naive populations) should be readily diagnosed clinically.
- Identification of disease in feral or free-range buffalo, cattle, and camels is likely to be challenging due to the lack of regular observation, and would not be feasible in most situations. Recovered animals are immune, and there is no carrier state; however, recovery can be prolonged.
- Most infection is thought to result from mechanical transmission by insects.
- Under Australian conditions, understanding mechanical transmission by biting flies is important. Non-biting insects are also implicated. Daily flight ranges of flies and other insects will inform the likely transmission area.
- Fomites may be involved in spread of the disease.
- The virus is stable in the environment, especially in cool, shaded areas — this poses an increased risk for feedlots (and potentially live export depots in the north).
- The virus is susceptible to a range of disinfectants.
- Vaccination is recommended to support disease control procedures, because stamping out alone may not be sufficient to eradicate the disease.
- At the time of publication of this manual, a live, attenuated LSD (Neethling-type) vaccine has been approved for use in Australia in the event of an LSD outbreak.
- Market fluctuations due to public health perceptions or product withdrawals would reduce the value of the cattle industry.
- Skeletal muscle and pasteurised milk are considered safe commodities (WOAH 2024) and are unlikely to contribute to virus transmission.

- There is a risk that LSD could become endemic or be present in Australia for several years if the disease is not promptly controlled. Recurring incursions may be a risk if disease becomes endemic in countries in the region.

4 Policy and rationale

4.1 Introduction

Lumpy skin disease (LSD) is a World Organisation for Animal Health (WOAH)–listed disease that has the potential for rapid spread, and has a significant negative impact on cattle production and trade.

4.1.1 Summary of policy

The premise of AUSVETPLAN as it underpins the Government and Livestock Industry Cost Sharing Deed in Respect of Emergency Animal Disease Responses (Emergency Animal Disease Response Agreement — EADRA) is the establishment of a mechanism to facilitate a rapid response to an outbreak of LSD, and control and eradication, or containment with a view to eradication, of the disease. Thus, the policy set out in this AUSVETPLAN response strategy is to eradicate LSD in the shortest possible time, while minimising social, economic, animal welfare and environmental impacts, using *stamping out* with or without *vaccination*, supported by a combination of strategies, including:

- *immediate quarantine* of animals, animal products and fomites (facilities, equipment and other items) on infected premises (IPs) and dangerous contact premises (DCPs)
- rapid recognition and laboratory confirmation of cases
- immediate assessment of the epidemiological situation
- implementation of legislated *declared areas* for disease control purposes and to minimise the spread of infection
- *quarantine and movement controls* over animals, animal products and fomites in declared areas, to minimise the spread of infection
- *tracing and surveillance* to determine the source and extent of infection (including, as necessary, in feral animals), and to provide proof of freedom
- *immediate stamping out* on IPs and DCPs based on risk assessment to reduce disease transmission
    - *modified stamping out* (stamping out of clinically affected animals with nodules) is the priority
- assessment of likely vector species, their distribution and their ecology
- *management of insect vectors*, to minimise mechanical transmission of the virus
- *enhanced biosecurity* on all premises with cattle, buffalo and camels
- *valuation* of cattle, buffalo and camels on IPs and DCPs, subject to risk assessment
- *sanitary treatment and/or disposal* of destroyed animals and contaminated animal products, to remove sources of infection
- *decontamination and/or disposal of fomites* to minimise the spread of the virus from infected animals and premises
- *vaccination* to support eradication efforts
- provision of *epidemiological and other information* to support the resumption of international trade
- *zoning and/or compartmentalisation* (where appropriate) to support resumption of market access
- *management of feral cattle, buffalo and camel populations*, where required, based on the epidemiological assessment
- a public awareness campaign
- *industry engagement* to improve understanding of the issues, facilitate cooperation and address animal welfare issues.

Vaccination is recommended to support disease control procedures, because stamping out alone may be logistically challenging and in isolation may not be sufficient to eradicate the disease. However, if an incursion is detected very early and there has been very limited spread, stamping out alone may be a feasible option. If vaccine is not available promptly after detection of an LSD incursion, or not used, an aggressive response should be mounted as quickly as possible, using all the strategies listed above, to

attempt to eradicate the disease. The nature of disease means that this may ultimately result in large numbers of cattle being destroyed or slaughtered without complete control of the disease being achieved.

4.1.2 Case definition

For the purposes of this response strategy, a case of LSD is defined as laboratory-confirmed[9] infection with LSD virus in one or more cattle and/or buffalo and/or camel(s) with or without clinical signs.

Notes:

- Positive serology in the absence of detection of LSD virus, with no clinical or epidemiological evidence supporting infection, does not constitute a case.
- AUSVETPLAN case definitions dictate when a response to an emergency animal disease (EAD) incident should be undertaken. AUSVETPLAN case definitions do not determine when international reporting of an EAD incident is required.
- At the time of an outbreak, revised or subsequent case definitions may be developed with the agreement of the Consultative Committee on Emergency Animal Diseases (CCEAD).

4.1.3 Cost-sharing arrangement

In Australia, LSD is included as a Category 3 EAD in the EADRA.10 When cost sharing of the eligible response costs of an incident is agreed, Category 3 diseases are those for which costs will be shared 50% by government and 50% by industry.

4.1.4 Criteria for proof of freedom

The WOAH *Terrestrial animal health code* Chapter 11.9[11] states that a country may be considered to be free from LSD when LSD is a notifiable disease in the country concerned and the country has been historically free from the disease.

When a case of LSD occurs in a country previously free from LSD, one of the following waiting periods are applicable to regain free status when a stamping-out policy has been applied:

- 14 months after the slaughter of the last case, or after the last vaccination if emergency vaccination has been used, whichever occurred last, and during which period clinical, virological and serological surveillance demonstrated no occurrence of infection with LSD virus
- 26 months after the slaughter of the last case, or after the last vaccination if emergency vaccination has been used, whichever occurred last, and during which period clinical surveillance alone demonstrated no occurrence of infection with LSD virus.

The levels and types of surveillance that are necessary to provide proof of freedom are discussed in Section 7.1. Physical examination of animals on risk premises will also be necessary.

Australia will need to provide detailed information to demonstrate that surveillance and examinations in both the free and infected areas have been adequate, that quarantine movement controls have been maintained, and that the virus is not present in insect populations.

[9] See Section 2.5.5 for details of laboratory diagnosis.
[10] Information about the EADRA can be found at https://animalhealthaustralia.com.au/eadra.
[11] www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=1&htmfile=chapitre_lsd.htm

4.1.5 Governance

Governance arrangements for the response to EADs are outlined in the **AUSVETPLAN *Overview***.

Information on the responsibilities of a state coordination centre and local control centre is available in the **AUSVETPLAN *Management manual: Control centres management* (Part 1 and Part 2)**.

4.2 Control and eradication policy

LSD is primarily a mechanically transmitted vector-borne disease. Therefore, without enough susceptible hosts and infectious vectors (and contact between them), the transmission cycle in a region will slow and halt. Interrupting the transmission cycle is therefore critical to an effective response, and the strategies applied will depend on the circumstance and epidemiology of the outbreak. Strategies to interrupt transmission include one or both of two approaches.

1. Vector control.

2. Creating buffers free of susceptible animals to contain and eradicate the disease. These buffers can be achieved through one or more of:

    - animal movement controls
    - stamping-out activities
    - selective destruction/slaughter during the outbreak
    - widespread regional vaccination.

Spread rates of 1 km/day have been recorded (Mercier et al 2018). The long potential incubation period (up to 28 days), continuous, local propagation by mechanical vectors, and the time required to develop effective immunity if vaccination is used (potentially 21–28 days), mean that the minimum outer extent of the LSD-susceptible animal-free buffer must be at least 80–100 km from the nearest IP to halt spread of LSD. This buffer may include vaccinates.

These distances are given as guidance only and are based on successful overseas responses; the distance needed in Australian conditions will be highly dependent on climatic conditions, vector species, epidemiology, geography (see Section 4.2.1) and livestock management capability.

If a northern Australian incursion is identified, to enable effective mustering, an 80–100km wide buffer at an appropriate distance inland from the northern coast may be applied. LSD control activities will be applied within the area between the coast and the buffer and within the buffer. As an indicator, the location of the buffer may be similar to the cattle tick line or bluetongue transmission zone boundary under the National Arbovirus Monitoring Program.

Management of LSD in Australia through destruction of animals and operationalising buffers will present many challenges, some of which will depend on location. These challenges may include operating in remote or peri-urban environments, land accessibility, managing community expectations, carcass management, feral animal control, mustering efficiency, managing fomites, and resourcing. Such factors will be considered in determining application of the most appropriate control and eradication strategies according to the situation.

Vectors present in Australia and their relative importance in the spread of LSD are currently poorly understood — a better understanding will inform the creation of buffers appropriate for each specific situation. These buffers should ideally be based on sound epidemiological and geographic parameters rather than the classic circular shape (Tuppurainen et al 2020). Reactive local ring vaccination strategies in

other countries have repeatedly failed to contain the disease. Appendixes 3 and 4 provide more context and history on why larger vaccination areas are required for an effective LSD response.

Animal movement controls are required to prevent movement of potentially infected animals. The long potential incubation period of LSD, coupled with the time it takes to develop effective immunity through vaccination and potential failure of the vaccine to induce immunity, means that animals that are at risk of infection or that have been vaccinated should not be moved into uninfected areas.

The large number of cattle in Australia, the regular movement of cattle across long distances and the significant number of potential vectors mean that disease spread could be rapid. Eradication of virus from an infected area, including decontamination of the area, is a long-term project. Thus, initial response phases may also prioritise the creation of buffers against spread into new regions.

Wild, feral and/or unmanaged cattle (and buffalo) in northern Australia are an important consideration in response to an incursion of LSD. These animals typically do not have any identification (through the NLIS) and are often location on public land or land other than pastoral properties, which may be inaccessible.

Stamping-out activities should prioritise clinically affected animals with nodules (i.e. modified stamping out), because these are the animals that present the highest risk of providing virus for biting vectors to spread the virus within a region. Stamping out of all animals in an infected herd should be attempted if sufficient resources are available and this action will not impede vaccination activities. Differentiation of clinically affected and unaffected animals is not logistically possible for feral populations in remote areas, and therefore a blanket approach to stamping-out of the whole herd would likely be required if any such populations were to be included in an EAD response.

Control (including appropriate treatments), destruction and sanitary disposal of risk materials and commodities is also required, because these items constitute additional potential transmission pathways.

Vaccination and stamping-out activities would be supported by various strategies, including ongoing epidemiological assessment, quarantine and movement controls, tracing and surveillance, disinsection and use of insect preventives on premises at risk of contact, decontamination of premises and potentially contaminated fomites, enhanced biosecurity on premises with cattle, buffalo or camels, vector management, industry engagement and public awareness campaigns.

These strategies may be complemented by the implementation of zoning and compartmentalisation, where appropriate, and this may support a return to international trade (see Section 4.2.4 for more detail).

4.2.1 Epidemiological assessment

Epidemiological investigation or assessment draws on multiple sources of information to build understanding of the disease and how it is behaving in an outbreak. This helps inform response decision making.

The key objectives for an epidemiological assessment will be to identify:

- the spatial distribution of infected and free animal populations
- potential vectors involved
- relative competency of vectors
- virus survival in vectors
- the source of infection
- the prevalence of infection
- pathways of spread and the likely size of the outbreak
- risk factors for the presence of infection and susceptibility to disease (including weather and insect populations).

Epidemiological assessment, and tracing and surveillance activities (see Section 4.2.3) in an EAD response are interrelated activities. Early findings from tracing and surveillance will be inputs into the initial epidemiological assessment (e.g. considering spatial distribution of infection). The outcomes of the initial epidemiological assessment will then guide decisions on subsequent tracing and surveillance priorities.

The outcomes of the epidemiological assessment will also be used initially to determine the feasibility of eradication versus long-term control, and to guide the selection of other appropriate response measures (including the application of movement controls) and assess the progress of disease control measures.

Ongoing epidemiological assessment is important for any EAD response to aid evaluation of the continued effectiveness and value of response measures, and assessment of the progress of disease control measures. Ongoing epidemiological assessment will consider the outcomes of tracing and surveillance activities and will contribute evidence to support any later claims of disease freedom.

4.2.2 Biosecurity and movement controls

Guidance on declared areas and premises classifications can be found in the **AUSVETPLAN *Guidance document: Declared areas and allocation of premises definitions in an EAD response***.

Quarantine

Quarantine will be immediately imposed on all IPs and DCPs. Individual IPs and DCPs will remain under quarantine until at least 56 days after the completion of disease control activities on the premises (see Section 5.3 for further guidance).

Quarantine will also be immediately imposed on suspect premises (SPs) and trace premises (TPs) on a risk-assessed basis. These properties will remain under quarantine until their status has been further classified through risk assessment. The time for lifting of quarantine from these premises will depend on their assessed status (i.e. assessed negative or reclassified as IP, DCP, etc).

Movement controls

Implementation of movement controls will be underpinned by the use of legally declared areas and the associated permitted movements to and from these areas. The assistance of police and other relevant authorities will be sought to enforce these, as necessary.

Section 6 provides details on movement controls for live animals, reproductive material (semen and in vivo–derived embryos), animal products and byproducts, waste products and effluent, vehicles, equipment, animal feed, people and other items that might be contaminated.

Domestic movement controls for animal products are important for maintaining export trade.

Cultural, logistical, land ownership and land type (e.g. land trust land vs freehold land) issues will need to be addressed.

4.2.3 Tracing and surveillance

Tracing will need to include the movements from any IPs of cattle, buffalo, camels, products, people, vehicles and other things, such as equipment and feed, that could have been involved in transmission of LSD virus. The period to be covered should be from at least 28 days before the first clinical signs were seen on the IP to the time that movement restrictions were imposed.

The surveillance will include an epidemiological investigation of the possible vectors that are present, and the environmental and ecological factors that may influence their distribution and survival. Surveillance will

also determine the extent of infection and of vector activity within the area of the IPs and DCPs, to enable a realistic restricted area (RA) and control area (CA) to be established.

Any cattle, buffalo and camels on DCPs, TPs and SPs should be examined every day during the first 4 weeks of quarantine for signs of infection. If numbers are large, a statistically appropriate sample of animals on these premises must be examined.

Following destruction, disposal and decontamination on IPs, DCPs and vaccinated (VN) premises (see Section 4.2.8), the waiting period before restocking will be long. It will be based on a risk assessment that considers criteria such as season, climatic conditions and the infection status of the area. Stocking with nonsusceptible species may be possible.

If sentinel animals are part of the surveillance and restocking strategy, they may be introduced to the property earlier than the recommended period for general restocking, based on risk assessment and the need to demonstrate the low-risk status of a given property sooner.

See Section 7.1 for further details on surveillance.

Tracing

Rapid trace-back and trace-forward of movements of high-risk items from IPs are essential to effectively contain LSD.

Trace-back will be applied for a minimum of 28 days (one incubation period) before the onset of clinical signs but may be up 56 days (two incubation periods) to allow for the possibility that the first reported case (index case) is not the primary case. Similarly, trace-forward will be applied for a minimum of 56 days before the index case and up to the time that quarantine was imposed. Given the extended incubation period, epidemiological analysis at the time may suggest that the periods for trace-back and trace-forward of movements should be extended.

For extensively managed properties and areas with free-ranging cattle, camels and/or buffalo, consideration must be given to the timing of the most recent mustering, an estimation of the percentage of animals mustered from the area and other relevant information (e.g. data from the Bureau of Meteorology on weather conditions that may have brought vectors into the area).

Tracing should be prioritised according to the risk of further transmission events, particularly to other regions.

The primary means of transmission is vector spread between susceptible hosts, and thus the first priority for tracing is all live cattle, camels and buffalo. This will be mainly domestic cattle, but consideration should be given to wild or feral animals if an epidemiologically significant population exists. Priority should also be given to predicting vector dispersal and expected rate of spread in the outbreak region. These predictions should be based on travel patterns of the biting vectors present and other relevant data, such as expected wind dispersal or significant meteorological events (e.g. storms, wind events).

Indirect transmission (e.g. via contact with fomites or animal products) is an inefficient method of transmission, but the risk will increase with greater volumes of contaminated materials or greater contact with cattle, camels or buffalo. Therefore, tracing for products involved in indirect transmission pathways should be prioritised according to local or regional circumstances. For example, animal feed, hay and feed trucks (especially relevant for feedlot situations) are associated with large volumes of potential fomites coming into contact with cattle, camels and buffalo and so should generally be a tracing priority for the commodity and fomite pathways.

Germplasm provides a direct pathway for transmission and spread. However, it is generally stored before use and therefore might be addressed by a national prohibition on using material collected after a certain date and from declared areas.

Although personal vehicles might have a role as contaminated fomites, this pathway would generally be ranked lower in prioritisation for tracing. However, strong on-farm biosecurity practices should include a record of vehicle movements onto and off the property.

Overall, tracing should include:

- cattle, camels and buffalo, including feral animals
- nonsusceptible species, which may require consideration as fomites
- dispersal and likely movement of vectors
- animal products — meat, offal, milk and dairy products, skins, hides, semen and embryos, and wastes from the processing of these items
- vehicles — milk tankers, livestock transport vehicles, feed trucks, farm visitors' cars, local government cars (e.g. rangers) and other vehicles (e.g. forestry contractors, service companies)
- materials — hay, straw crops, grains and mixed feed
- people and equipment — people who live on the property, veterinarians, tanker and other vehicle drivers, artificial insemination personnel, sales and feed representatives, tradespeople, technicians, visitors, other rural industry contractors (e.g. pregnancy testing contractors, artificial insemination contractors), and equipment moved off the property that may have been in direct contact with stock.

Follow-up investigation of premises identified by tracing should be prioritised according to the likelihood of transmission and the potential consequences for disease control activities.

Information management systems should be used to support tracing activities, as well as examination of farm records, and interviews with farm workers and managers. Databases for the National Livestock Identification System, and documents such as National Vendor Declarations and other movement records, or Animal Health Statements should be used to assist with tracing and epidemiological investigations.

Additional guidance on tracing can be found in the **AUSVETPLAN *Guidance document: Tracing and surveillance***.

Surveillance

Surveillance during an LSD outbreak will initially be aimed at:

- defining the extent of infection
- detecting new outbreaks
- identifying the vector species involved and their distribution
- demonstrating that infection is not present in the CA and outside area (OA).

This will be achieved by investigation of SPs, TPs and DCPs, and surveillance of premises in declared areas that have cattle, camels and/or buffalo — that is, ARPs in RAs and premises of relevance (PORs) in CAs. Prioritising of surveillance should be risk based, and take into account the apparent rate of transmission, and profiles of cattle, camels, buffalo and implicated insect vectors in the local context. Surveillance may also occur in the OA to follow up on traces, investigate suspect case reports and demonstrate that infection is not present.

Surveillance in extensively managed properties and areas with free-ranging cattle, camels and/or buffalo may require postmortem examination following aerial shooting of cattle, camels and buffalo.

The surveillance program will include clinical, serological, virological and molecular approaches to the surveillance of domestic and feral cattle, camel and buffalo populations. In naive, unvaccinated herds, clinical surveillance for development of the characteristic generalised nodular presentation is reliable for detection. Molecular and virological surveillance of relevant vector populations may also be important.

See Section 7 for further details on surveillance and proof of freedom from LSD.

Additional guidance on surveillance can be found in the **AUSVETPLAN *Guidance document: Tracing and surveillance***.

4.2.4 Zoning and compartmentalisation for international trade

Where it is not possible to establish and maintain disease freedom for the entire country, establishing and maintaining disease-free subpopulations, through zoning and/or compartmentalisation,12 may be considered.

In the case of a limited disease outbreak, a containment zone13 may be established around the areas where the outbreak is occurring, with the purpose of maintaining the disease-free status of the rest of the country outside the containment zone.

All zoning applications would need to be prepared by the Australian Government in conjunction with the relevant jurisdiction(s) and agreed to by the CCEAD. Zoning is usually negotiated after a disease outbreak has begun.

Compartmentalisation applications typically need to be negotiated before an outbreak occurs and will require input from the relevant industries.

Recognition of both zones and compartments must be negotiated between the Australian Government and individual overseas trading partners. Zoning and compartmentalisation would require considerable resources that could otherwise be used to control an outbreak. Careful consideration will need to be given to prioritising these activities, because the resulting competition for resources could delay the quick eradication of the disease and recognition of disease freedom.

Agreements between trading partners take time to develop, consider and finalise, because of the need to provide detailed information on activities such as biosecurity, surveillance, traceability and diagnostics to support the approach that is developed. An importing country will need assurance that its animal health status is not compromised if it imports from an established disease-free zone in Australia. Trading partners may not accept a zoning or compartmentalisation proposal, regardless of the information provided. Eradication of disease may be achieved before zoning or compartmentalisation applications are finalised.

The WOAH guidelines for zoning and compartmentalisation are in Chapter 4.4 and Chapter 11.9 of the WOAH Terrestrial Code.

[12] With zoning, disease-free subpopulations are defined primarily on a geographical basis. With compartmentalisation, disease-free subpopulations are defined primarily by management practices (such as the biosecurity plan and surveillance practices of enterprises or groups of enterprises).

[13] WOAH defines a 'containment zone' as an infected zone within a previously free country or zone, which includes all suspected or confirmed cases that are epidemiologically linked and where movement control, biosecurity and sanitary measures are applied to prevent the spread of, and to eradicate, the infection or infestation. The Australian Government Department of Agriculture, Fisheries and Forestry commissioned a report on what would be required for the establishment of containment zones in Australia.

4.2.5 Biosafety and biosecurity for personnel

Movements of all personnel onto and off high-risk premises (IPs, DCPs, dangerous contact processing facilities (DCPFs), SPs and TPs) should be restricted and subject to strict biosecurity measures, including change of clothes and footwear, decontamination procedures and record keeping (see Section 6.4).

Personnel involved in destruction, disposal and vaccination activities, and sampling of animals for laboratory testing, should wear appropriate personal protective equipment (PPE) to avoid contamination and potential onward transmission of the disease to cattle, camels and buffalo. Appropriate PPE includes disposable coveralls and footwear. These should remain on the premises and be incinerated onsite.

Details of appropriate controls on the movement of people onto or off high-risk premises are provided in Section 6.4.11.

All other cattle, camel and buffalo production premises, particularly those in declared areas, will be encouraged to practise good on-farm biosecurity to limit the possible transmission of LSD virus by people acting as contaminated fomites.

4.2.6 Biosecurity for equipment

Movements of all equipment (including vehicles) onto or off high-risk premises (IPs, DCPs, DCPFs, SPs and TPs), where permitted, should be restricted and subject to strict biosecurity measures, including disposal or decontamination procedures, and record keeping (see Section 6.4).

Equipment used in destruction, disposal and vaccination activities, and for sampling animals for laboratory testing should be considered contaminated and either disposed of onsite (see Section 4.2.12) or decontaminated (see Section 4.2.13).

Details of appropriate controls on the movement of equipment onto or off high-risk premises are provided in Section 6.4.14.

All other cattle, camel and buffalo production premises, particularly those in declared areas, will be encouraged to practise good on-farm biosecurity to limit the possible transmission of LSD virus by equipment acting as contaminated fomites.

4.2.7 Animal welfare

An incursion of LSD into Australia would be a potentially catastrophic event for infected cattle herds. In the event of an LSD response, maintaining animal welfare standards, consistent with legislation, codes, and national standards and guidelines, is a priority.

There is no recognised veterinary treatment for cattle post-infection. An effective animal welfare response should include the rapid destruction of infected cattle, camels and buffalo. It should also consider the destruction of cattle, camels and buffalo at risk of infection to minimise the suffering of these animals.

Welfare issues can be expected to arise in cattle, camels or buffalo infected with LSD. Early destruction of animals is required to prevent welfare issues. Managing welfare conditions is likely to be challenging in feral animals and extensively managed pastoral areas, where the animals are not frequently observed.

Animal welfare issues may arise during the movement of animals as a result of border closures, the need for livestock inspection and quarantining. Welfare issues may also arise from the inability to transport animals, such as restrictions on movement of intensively housed animals (e.g. on feedlots) or of dairy animals to milking. Restrictions on the movement of milk and milk products off dairy premises may also necessitate the rapid drying-off of dairy animals, with associated welfare considerations.

If movement controls are applied over the longer term, welfare issues arising from increased stocking densities will need to be managed. Dealing with these welfare issues may include the use of emergency permits for movement or onsite destruction.

EAD respondents are required to refer to, and comply with, a range of existing welfare requirements, including:

- state and territory animal welfare legislation
- the **AUSVETPLAN operational manuals**, including ***Livestock welfare management*** and ***Destruction of animals***, which describe in detail the recommended operational procedures for an EAD response
- the EADRA guidance document *Livestock welfare management and compensation principles for parties to the Emergency Animal Disease Response Agreement*
- the Australian Animal Welfare Standards and Guidelines,[14] which is a single animal welfare regulation model that can be adopted by each state and territory government; the standards are the legal requirements for livestock welfare, and the guidelines provide recommended practices to achieve desirable livestock welfare outcomes
- *Australian Animal Welfare Standards and Guidelines: land transport of livestock*, which has now been implemented by all states and territories.

Additional guidance on rapid drying-off of dairy cattle is available in the **AUSVETPLAN *Enterprise manual: Dairy (cattle) industry.***

4.2.8 Vaccination

Vaccine availability

A live, attenuated LSD (Neethling-type) vaccine has been approved by the Department of Agriculture, Fisheries and Forestry and the APVMA for use in Australia in the event of an LSD outbreak.

The use of vaccination in combination with other control measures (including movement controls and culling) has been critical in the control of LSD overseas (EFSA AHAW Panel 2015). The European Union's experience in trying to control LSD led to several modifications of the control methods recommended by the European Food Safety Authority (originally just stamping out in 2015), resulting in a regional vaccination approach, which was successful in achieving eradication of LSD from the Balkans (Tuppurainen et al 2020). An incomplete understanding of the role of vector species in disease transmission under Australian conditions and the difficulty in managing vector control is likely to increase reliance on a safe and effective vaccination program and movement controls in Australia.

Vaccination of animals well before exposure to infected vectors is advisable to induce protection before the period of peak challenge. Development of protective immunity is expected to take up to 21 days post-vaccination (Haegeman et al 2021). Taking into account an incubation period of up to 28 days for clinical disease, this means that vaccination must be conducted well in advance of potential spread of LSD into a region to provide effective immunity and avoid vaccine failure (Gelaye et al 2015).

Importation of an LSD vaccine would occur under an import permit from the Australian Government department responsible for agriculture. Supply and use of the vaccine in Australia has been approved under an emergency use permit (PER93169) and consent to import from the Australian Pesticides and Veterinary Medicines Authority. Vaccination would be approved by the National Management Group based on the recommendation of the CCEAD.

[14] www.animalwelfarestandards.net.au

Spread of LSD due to vector dispersal would be expected during the period between detection of disease and the availability of vaccine in Australia. This will have implications for both the control measures implemented and the overall area affected during this interim period.

Vaccination strategy

If vaccine is to be used in Australia, several issues will need to be considered:

- According to the WOAH Terrestrial Code, there is no difference in time to recover country or zone disease-free status when using vaccination in combination with stamping out, versus stamping out alone.
- The time to recover free status is based on stamping out of the last infected case, or the administration of the last vaccination, whichever occurs later.
- Because products (e.g. meat and milk) from vaccinated animals are considered safe for human consumption, these animals and products may still potentially enter the domestic and international market.
- WOAH states that skeletal muscle and pasteurised milk are safe commodities and therefore international trade in these products may not be affected.
- Vaccination of large numbers of animals will probably be required to manage an outbreak and removal of all vaccinates from the population is likely to be impractical.

The challenges of balancing vaccine side effects, the potential for infected vaccinated animals to shed virus, and the potential for vaccine failure, must also be carefully considered when deciding on the vaccination program to be used.

For further information on other vaccine and vaccination considerations, see **Appendix 3**.

LSD will continue to spread from foci of infection for as long as sufficient susceptible hosts and vectors exist. The preferred vaccination strategy for isolated foci of infection would therefore be to blanket vaccinate or otherwise remove susceptible animals in large regional areas (e.g. all cattle and buffalo up to at least 80–100 km from an outbreak) to provide a sufficient buffer of immune animals to halt disease progression. Uniform mass vaccination against LSD with high vaccination coverage (over 95%) appears to be the most effective control measure overseas to prevent infection and inhibit further spread (EFSA 2017) (see **Section 2.9** and **Appendix 4**).

Decisions on the boundaries of the vaccination area should take into consideration:

- the delay between administration of vaccination and development of peak immunity (approximately 21 days but up to 28 days, according to overseas experience using homologous vaccines however neutralising antibodies are evident from day 13 (Haegeman et al 2017).
- the potential for animals to incubate the disease for up to 28 days before clinical signs appear
- in the northern pastoral region, the presence and location of boundary fencing, the location of water points, and the proximity to populations of feral cattle, camels or buffalo.

The overlap of the first two of these factors has contributed to outbreaks in ‘vaccinated’ herds overseas. However, given the need to vaccinate as many animals as possible around infected herds, it is inevitable that some degree of vaccine failure will occur while a vaccination campaign is being instituted. Delaying or skipping the vaccination of herds in the immediate area at risk of transmission for fear of vaccination failure is not advised, because even herds with partial immunity will reduce the overall production of virus, the number of clinically affected animals and viral uptake by vectors, and thereby contribute to outbreak control. In remote populations, if vaccination is utilised, some animals may miss mustering, which would reduce the vaccine coverage of a herd. The presence and distribution of feral or free-ranging cattle, camels or buffalo will also be an important consideration in terms of the development of a vaccination strategy. Vaccination in these populations is likely not feasible and therefore alternative control strategies, such as

stamping out, will be required, both for the purposes of disease control and to manage animal welfare impacts. A vaccination strategy should be risk based and implemented in association with other response components, such as vector control and movement controls.

Vaccination to protect valuable genetic lines may also be considered as part of longer-term control and proof-of-freedom strategies (see the **AUSVETPLAN *Guidance document: Risk-based assessment of disease control options for rare and valuable animals***).

Management of vaccinated animals[15]

Vaccinated animals need to be permanently identified and easily identifiable to assist interpretation of clinical and serological tests used for surveillance once the outbreak has been controlled, particularly as no serological DIVA (differentiating infected from vaccinated animals) test is currently available.

Management of vaccinated animals needs to be carefully considered, as vaccination of large numbers of animals may be required. Vaccinated animals may be considered potentially infected as LSD virus may still circulate in vaccinated populations because:

- it can take approximately 21 days for immunity to develop after vaccination, so a proportion of vaccinated animals may become infected if challenged with field virus
- available vaccines are live attenuated, and a proportion of vaccinated animals will develop clinical disease and shed vaccine virus (Neethling response)
- newly born or unsuccessfully vaccinated animals risk becoming infected from vector species like ticks, which can act as reservoirs.

The overall situation should be assessed once the outbreak has been controlled to decide whether stamping out or removal of these populations is appropriate, considering the total number of herds affected and the impact of stamping out.

Under the WOAH Terrestrial Animal Health Code, there is no difference in the time required to regain disease-free status for a country or zone when using vaccination with stamping out compared to stamping out alone. Therefore, in most cases, removing LSD vaccinates from the population after an eradication campaign offers no substantial benefit. EU legislation also does not require the removal of vaccinated animals for LSD management. However, based on the European approach of retaining vaccinated animals during outbreaks—such as in the Balkans (2015-2018)—movement restrictions within a defined vaccination zone are likely to be required during an outbreak in Australia.

4.2.9 Treatment of infected animals

There is no specific treatment for animals infected with LSD virus. To manage risks to animal welfare, including where destruction may be delayed, clinically affected animals should be isolated, protected from insects and provided with supportive care, where appropriate.

4.2.10 Treatment of animal products and byproducts

Meat from infected animals has not been implicated in the transmission of LSD. Although WOAH does not have any restrictions on the trade of meat, meat for human consumption in Australia still needs to meet the relevant Australian standard to ensure that it is a wholesome product. Movement controls will apply to the movement of meat from declared areas within Australia (see Section 6.4.4) and are important for maintaining export trade, when importing country requirements are met.

[15] See Chapter 11.9 of the WOAH Terrestrial Code for details on recovery of free status following use of vaccination (www.woah.org/en/what-we-do/standards/codes-and-manuals/terrestrial-code-online-access/?id=169&L=0&htmfile=chapitre_lsd.htm).

Milk and milk products from cattle, camels and buffalo, including from IPs, can be processed for human consumption if appropriately treated (i.e. pasteurised, or chemically treated by acidification). Alternatively, milk and milk products from cattle, camels and buffalo on IPs can be chemically treated by acidification or heat treated (if the process is available on the premises) and buried on the premises. The reason for these treatments is the potential for vectors to contact milk that has been disposed of.

Feed, and wastes such as faeces and straw will be treated and disposed of on the premises.

Untreated cattle hides present a major risk. If they originate from IPs and DCPs within 28 days before diagnosis of the disease, they will be destroyed unless they are already at a processing plant, in which case they will be immediately treated or destroyed. Suitable treatments would include commercial tanning because the pH levels achieved during the normal commercial processing of skins and hides are sufficient to inactivate the virus. This applies to fully tanned, 'wet blue' (lightly or fully chrome tanned, but not dried) or 'wet white' (pretanned with aluminium sulfate but limed and acid pickled only) skins and hides (DAFF 2001).

Virus can contaminate semen and embryos, which may be sources of infection, so semen and embryos collected from animals on IPs and DCPs after the likely date of infection will be destroyed. An informed judgment on semen and embryos in storage may be made when all relevant information is available.

Feed from IPs will be destroyed.

4.2.11 Destruction of animals

Destruction plans should be developed for each premises in which animals may be destroyed.

Guidance on destruction methods can be found in the **AUSVETPLAN *Operational manual: Destruction of animals*.**

Stamping out

Stamping out refers to the strategy of eliminating infection from premises through the destruction of live cattle, camels and buffalo in a manner that permits appropriate disposal of carcasses and decontamination of the site. Where resources are limited, stamping out clinically affected animals (predominantly animals with skin nodules) should be prioritised because these animals will contribute significantly more to disease spread than asymptomatic animals.

Where vaccination is not used, movement controls and stamping out are key to containing (and potentially eradicating) LSD. However, the nature of the incursion and the time taken detect it will likely influence the success of stamping-out activities and movement controls. Without vaccination, successful containment and eradication will depend on a fast and aggressive response.

If vaccine is available, stamping out may be used in conjunction with movement controls and a stringent vaccination program. Destruction of feral species and livestock that cannot be mustered should be considered if they pose a significant risk to the likely effectiveness of the vaccination strategy. For stamping out in remote locations, there may be a delay between destruction and carcass disposal. In these cases, carcasses should be protected from predation and access by insect vectors, where possible. Destruction and disposal strategies will be logistically difficult, and public perceptions about animals left in situ following aerial shooting will need to be managed.

4.2.12 Disposal of animals, and animal products and byproducts

Carcasses, animal products and byproducts, feed, wastes and bedding that may have been contaminated on IPs and DCPs will be disposed of as soon as possible to reduce exposure to vectors. The disposal method chosen will be influenced by the type of material to be disposed of, resources available, the local

environment, the prevailing weather, legislative requirements (including environmental protection legislation) and the risk of disease transmission.

Where possible, disposal will be by burial, burning or composting onsite. Other methods and potential locations will be considered under certain circumstances, based on risk assessment. This is especially the case for inaccessible locations that require aerial shooting of feral or infected animals, where burying or burning of carcasses is not possible, and access of insect vectors to carcasses cannot be prevented. 'Destroy and let lie' will be required for some remote, inaccessible and extensive properties. This is where animals are aerial shot in the field and are left in situ in the environment to decompose. This may contribute to disease spread in these areas and this risk will need to be considered in the overall response plan and addressed by other response measures such as vaccination. If there is a delay between destruction and disposal, methods of vector control should be implemented, taking into consideration local vector species and population dynamics. For example, items for disposal could be sprayed with sodium hypochlorite or Virkon (for their virucidal properties), or chemicals from the pyrethroid family (to prevent insects feeding on carcasses).

Decontamination of all equipment and machinery involved in onsite disposal will be required.

Disposal must also be in accordance with the requirements in Section 6, and auditable in terms of biosecurity, traceability and financial requirements.

Additional guidance on disposal options and methods can be found in the **AUSVETPLAN *Operational manual: Disposal***.

Disposal of milk

Disposal of milk will not usually be required. If it is required based on a risk assessment, it will pose a major challenge for a dairying area, especially if large volumes of milk require disposal (depending on the time of year, and the location and size of the outbreak). Further information on the disposal of bulk milk can be found in the **AUSVETPLAN *Enterprise manual: Dairy (cattle) industry***.

To limit the volumes of milk requiring disposal, dairy animals on premises subject to stamping out should be prioritised for destruction. For high-risk premises not subject to stamping out, options such as drying off cows (see the **AUSVETPLAN *Enterprise manual: Dairy (cattle) industry***) and using calves already on the farm may reduce the amount of milk that ultimately requires disposal.

4.2.13 Decontamination

Fomites such as bedding materials, feed, footwear, clothing, and animal-handling facilities and equipment will be appropriately decontaminated or destroyed.

Vehicles, people and equipment leaving the premises will be decontaminated. If decontamination cannot be reliably achieved, contact with cattle, camels and buffalo will be prohibited for a specified period that will be determined by other disease control activities at the time (e.g. use of vaccination in cattle and buffalo).

Further information is available in the **AUSVETPLAN *Operational manual: Decontamination***, and in DoA & CSIRO (2019).

4.2.14 Wild animal management

Disposal of contaminated materials (including feed) and carcasses will be prompt to minimise exposure of susceptible feral cattle, camels and buffalo, wild predators and vermin to LSD virus. Feral and free-ranging cattle, camels and buffalo are very difficult to contain; it is very likely that feral and free-ranging populations in the same area as infected cattle will become infected. Aerial shooting is the most common

method of control for feral populations that cannot be mustered. Control measures must not induce wild animal populations to disperse out of the RA. Remoteness, accessibility and ruggedness of the terrain will require consideration when selecting destruction methods. A range of options may be available, such as baiting, trapping, decoy feeding and aerial shooting.

Further information on management strategies and control procedures for wild animals during an EAD outbreak can be found in the **AUSVETPLAN *Operational manual: Wild animal response strategy*.**

4.2.15 Vector management

With input from an entomologist, a vector monitoring program will be implemented to identify the vectors of concern. A targeted approach to vector control to break the transmission cycle will then be devised. Recent literature has found that *Stomoxys calcitrans*, *Culicoides nubeculosis* and *Aedes aegypti* are potentially efficient transmitters of LSD virus (Sanz-Bernardo et al 2021); other biting insects are under investigation for their virus transmission competency.

Several potential vector species are present in Australia, so a range of approaches may be required to manage the risks. These may include aerial and ground application of insecticides as ultra-low volume (ULV) fogs, and treatment of cattle with either a systemic insecticide (e.g. ivermectin), an insecticidal or insect-repellent ear tag, or a topical (e.g. pour-on) insecticide, ideally to both repel insects and reduce the population of target insects. The treatment radius would be determined by risk assessment. Topical insecticides that repel insects and prevent or reduce biting are preferred, to reduce the likelihood of a naive herd becoming infected. The use and application of each of these options would vary in different areas of Australia and during different seasons, and will need to take into account safety, efficacy, environmental and food safety issues.

Where practicable, cattle, camel and buffalo producers should be encouraged to avoid placing animals in paddocks with high levels of insect activity (e.g. swampy areas).

The area over which vector management is undertaken should be determined taking into consideration the local vector species, vector dispersal, vector breeding sites, and the possibility of windborne spread of vectors.

If infected source animals can be destroyed and disposed of quickly, the risk of transmission to new vector populations will be reduced. Ticks as vectors will require consideration with regard to ongoing transmission risk.

Expertise in areas such as virology (including arbovirology), vector epidemiology and mapping will be sought to assist with any outbreak and help provide surveillance data and other advice for use in reopening international trade.

4.2.16 Public awareness and media

A considered public information campaign will help to address any public health concerns, foster engagement and support for response activities, and support minimising trade impacts.

Key public information messages in an outbreak of LSD will include:

- advice that LSD is not zoonotic
- advice that Australian beef and dairy products remain safe for human consumption
- information to support early recognition and reporting of the disease
- information to generate understanding of, and support for, disease control measures (e.g. movement controls, highlighting animal welfare; vaccination; culling)
- advice to address environmental concerns if aerial spraying for vector control is used
- advice on where more detailed information can be obtained.

Additional guidance on managing public information can be found in the *Biosecurity incident public information manual*[16].

4.3 Funding and compensation

Details of the cost-sharing arrangements can be found in the EADRA.[17] Details of the approach to the valuation of, and compensation for, livestock and property in disease responses can be found in the **AUSVETPLAN *Operational manual: Valuation and compensation***.

[16] https://animalhealthaustralia.com.au/bipim/

[17] https://animalhealthaustralia.com.au/eadra

5 Areas and premises

The epidemiology of the disease, as outlined in Section 2 of this manual, should be considered alongside the specific characteristics of an LSD outbreak when determining the appropriate size and boundaries of declared areas.

General information on declared areas and premises classifications is provided in the **AUSVETPLAN** ***Guidance document: Declared areas and allocation of premises definitions in an EAD response.***

6 Movement controls

6.1 Principles

General principles for movement controls for managing emergency animal diseases (EADs) are provided in the **AUSVETPLAN *Guidance document: Movement controls***.

Key considerations for movement controls for managing lumpy skin disease (LSD) are as follows:

- LSD is primarily a mechanically transmitted vector-borne disease. Biting vectors continually spread the disease as they encounter naive hosts, which, in turn, encounter new vectors. Infected animals (including vaccinated animals) present a significant, proven risk of spread to new areas when moved, including outside control areas.
- Transmission may also occur by direct and indirect pathways between animals and involving their secretions; however, these pathways are less efficient.
- Animals with clinical disease are highly infectious.
- *Bos taurus* cattle appear more susceptible than *Bos indicus* cattle; however, all breeds should be treated as equally susceptible when implementing control policies.
- Infected animals may shed virus without showing clinical signs. Infected animals can incubate the disease for up to 28 days.
- LSD virus is relatively stable in the environment.
- Germplasm may carry and transmit infection.
- LSD virus is not known to be shed in the faeces or urine of naturally infected animals.

6.2 Guidelines for issuing permits

Recommended biosecurity and movement controls provide guidance on which movements can be allowed and under what conditions. This is based on an analysis of the disease risks that are presented by a specific movement, of a specific commodity, at a specific time during the EAD response phase. This response strategy indicates whether a proposed movement is:

- allowed (under normal jurisdictional, including interstate, requirements)
- prohibited – except under the conditions of a general, special or emergency permit
- prohibited.

Permits may not be available until the relevant CVO provides approval for movements, and this may not be available in the early stages of a response.

Guidelines for issuing permits are provided in the **AUSVETPLAN *Guidance document: Movement controls***.

Movements not reflected within this manual may be considered by the relevant jurisdictional CVO on a risk-assessed case-by-case basis.

6.3 Types of permits

Permits are either general or special. Emergency permits are a form of special permit (see also Glossary).

They are legal documents that describe the animal(s), commodities or things to be moved, the origin and destination, and the conditions to be met for the movement. Both general and special permits may be in addition to documents required for routine movements between or within jurisdictions (e.g. health certificates, waybills, consignment notes, National Vendor Declarations – NVDs).

Details on permit types are provided in the **AUSVETPLAN *Guidance document: Movement controls***.

6.4 Recommended movement controls

Movements not reflected within any of the movement control matrixes or narratives may be considered by the relevant jurisdictional CVO on a risk-assessed case-by-case basis.

GPs and SpPs may not be available until the relevant CVO gives approval for movements, and this may not be available in the early stages of a response.

Permit conditions are listed in **Appendix 2**.

6.4.1 Live susceptible animals

All movements of live susceptible animals off infected premises (IP), dangerous contact premises (DCP), suspect premises (SP) and trace premises (TP) are prohibited, except when travelling under a movement permit and going directly to an appropriate processing facility.

Other than to slaughter

Table 6.1 outlines the controls for the movement of live cattle, camels and buffalo other than to slaughter.

Table 6.1 Movement controls for live animals moving other than to slaughter[18]

	To	RA		CA	OA
From		**IP, DCP, SP, TP**	**ARP**	**POR**	
RA	**IP, DCP, SP, TP**	Prohibited	Prohibited	Prohibited	Prohibited
	ARP	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 7, 13, 14, 21	Prohibited	Prohibited
CA	**POR**	Prohibited	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 7, 13, 14, 21	Prohibited
OA		Prohibited	Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 7, 13, 14, 21	Allowed under normal jurisdictional or interstate movement requirements

ARP = at-risk premises; CA = control area; DCP = dangerous contact premises; IP = infected premises; OA = outside area; POR = premises of relevance; RA = restricted area; SP = suspect premises; SpP = special permit; TP = trace premises

Cattle on live export vessels will be assessed as individual consignments by the Department of Agriculture, Fisheries and Forestry and relevant jurisdiction(s) to determine options for cattle.

See Section 6.4.10 for movement controls for nonsusceptible animals.

[18] Permit conditions are listed in Appendix 2.

To slaughter

Table 6.2 outlines the controls for the movement of live cattle, camels and buffalo to slaughter.

Table 6.2 Movement controls for live animals moving to slaughter[19]

	To	RA		CA	OA
From		**DCPF[a]**	**APF**	**APF**	
RA	**IP, DCP, SP, TP**	Prohibited, except under SpP — conditions 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 14, 21	Prohibited	Prohibited	Prohibited
	ARP	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10,11, 12, 13, 14, 21	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 21	Prohibited	Prohibited
CA	**POR (including premises with VN status)**	Prohibited Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 21[d]	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 21	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 21[a]	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 21[b,c]
OA		Prohibited	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 21[d]	Prohibited, except under SpP — conditions 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 21[a,d]	Allowed under normal jurisdictional or interstate movement requirements

APF = approved processing facility; ARP = at-risk premises; CA = control area; DCP = dangerous contact premises; DCPF = dangerous contact processing facility; IP = infected premises; OA = outside area; POR = premises of relevance; RA = restricted area; SP = suspect premises; SpP = special permit; TP = trace premises; VN = vaccinated

a It is important to ensure that processing facilities have approved the receiving of live cattle, camels and/or buffalo before the animals leave the premises of origin.

b The transit route taken by the consignment will ideally not cross into an RA or transmission area (TA).

c Should only be issued if there is no APF available in the RA or CA.

d Should only be issued if there is no abattoir reasonably available in the area of origin.

[19] Permit conditions are listed in Appendix 2.

6.4.2 Carcasses

The definition of the term 'carcass' for the purposes of AUSVETPLAN is 'the body of an animal that died in the field' (see the glossary).

Table 6.3 outlines the controls for the movement of carcasses.

Table 6.3 Movement controls for carcasses[20]

	To	RA			CA		OA
From		**IP, DCP, SP, TP**	**ARP**	**ADS[a]**	**POR**	**ADS**	
RA	**IP, DCP, SP, TP**	Prohibited	Prohibited	Prohibited, except under SpP — conditions 3, 4, 5, 6, 16, 17, 18, 19, 21	Prohibited	Prohibited	Prohibited
	ARP	Prohibited	Prohibited	Prohibited, except under SpP — conditions 1, 3, 4, 5, 6, 16, 17, 18, 19, 21	Prohibited	Prohibited, except under SpP — conditions 1, 3, 4, 5, 6, 16, 17, 18, 19, 21[b]	Prohibited
CA	**POR**	Prohibited	Prohibited	Prohibited, except under SpP — conditions 1, 3, 4, 5, 6, 16, 17, 18, 19, 21	Prohibited	Prohibited, except under SpP — conditions 1, 3, 4, 5, 6, 16, 17, 18. 19, 21	Prohibited
OA		Prohibited	Prohibited	Prohibited, except under SpP — conditions 3, 4, 5, 6, 21[c]	Prohibited, except under SpP — conditions 3, 4, 5, 6, 21	Prohibited, except under SpP — conditions 1, 3, 4, 5, 6, 21[c]	Allowed under normal jurisdictional or interstate movement requirements

ADS = approved disposal site; ARP = at-risk premises; CA = control area; DCP = dangerous contact premises; IP = infected premises; OA = outside area; POR = premises of relevance; RA = restricted area; SP = suspect premises; SpP = special permit; TP = trace premises

a The ADS in the RA could be another IP for the purposes of communal disposal, with appropriate biosecurity conditions.
b This movement is only permitted if there is no ADS in the RA.
c The preference is to use an ADS within the OA, or, if none available, the CA, or, if none available, the RA.

[20] Permit conditions are listed in Appendix 2.

6.4.3 Semen and embryos from live susceptible animals

Movements of fresh semen and embryos into, within and from the RA and CA should be prohibited.

Table 6.4 outlines the controls for the movement of frozen semen and embryos from live cattle, camels and buffalo.

Table 6.4 Movement controls for frozen semen and embryos from live cattle, camels and buffalo[21]

	To	**RA**		**CA**	**OA**
From		**IP, DCP, SP, TP**	**ARP**	**POR**	
RA	**IP, DCP, SP, TP**	Prohibited, except under SpP — conditions 15, 20, 21	Prohibited, except under SpP — conditions 15, 20, 21	Prohibited, except under SpP — conditions 15, 20, 21	Prohibited
	ARP	Prohibited, except under SpP — conditions 15, 20, 21	Prohibited, except under SpP — conditions 15, 20, 21	Prohibited, except under SpP — conditions 15, 20, 21	Prohibited
CA	**POR**	Prohibited, except under SpP — conditions 15, 20, 21	Prohibited, except under SpP — conditions 15, 20, 21	Prohibited, except under SpP — conditions 15, 20, 21	Prohibited
OA		Prohibited, except under SpP — conditions 15, 20, 21	Prohibited, except under SpP — conditions 15, 20, 21	Prohibited, except under SpP — conditions 15, 20, 21	Allowed under normal jurisdictional or interstate movement requirements

ARP = at-risk premises; CA = control area; DCP = dangerous contact premises; IP = infected premises; OA = outside area; POR = premises of relevance; RA = restricted area; SP = suspect premises; SpP = special permit; TP = trace premises

6.4.4 Meat and meat products

The World Organisation for Animal Health (WOAH) recommends that the following commodities should not require any LSD-related conditions, regardless of the status of the animal population of the exporting country, because the risk of transmission of the virus is very low: skeletal muscle meat, casings, gelatine and collagen, tallow, and hoofs and horns. Therefore, meat can be safely moved. However, movement controls on vehicles to avoid vector dispersal will still apply for the RA and CA (see Section 6.4.9).

Meat and meat products are still required to pass antemortem and postmortem inspection, to ensure the wholesomeness of the product. All meat that is to be exported must also comply with trading partner requirements, which may be more prescriptive than the WOAH requirements.

[21] Permit conditions are listed in Appendix 2.

6.4.5 Raw milk and raw milk products

The risk of transmission of LSD virus by milk not intended for animal consumption can be mitigated by pasteurisation and transport in closed containers (Tuppurainen et al 2017).

For the movement of raw milk and raw milk products from IPs, DCPs, DCPFs and SPs, a special permit and risk assessment is required in addition to the GP conditions below.

For the movement of raw milk and raw milk products from TPs, a special permit and risk assessment may be required in addition to the GP conditions below.

For the movement of raw milk and raw milk products from all other premises in declared areas, a GP is required with the GP conditions below.

GP conditions:

- Raw milk and raw milk products must not be fed to susceptible animals except where the milk is derived from the same epidemiological unit.
- Transport vehicles, personnel, and associated equipment are decontaminated and treated with an effective insecticide (including within the vehicle cabin), before transport to prevent adult competent vectors travelling.
- Raw milk and raw milk products are to remain contained in the transport vehicle during transit.
- Raw milk must be heat treated/pasteurised to a standard that inactivates the LSD virus (see Section 2.4.2) at the source or final destination or sent to an approved disposal site.

For raw milk and raw milk products originating in a declared area, any movements outside of the declared area of origin should be minimised.

All dairy that is to be exported must comply with trading partner requirements, which may be more prescriptive than the WOAH *Terrestrial animal health code* requirements (Chapter 11.9).

6.4.6 Hides, skin, wool and other fibres

LSD virus is found in the skin of infected animals, and unprocessed or partially processed hides pose a potential risk of transmission (via the contamination of mechanical vectors and fomites).

Hides that are fully tanned may be allowed to move without restriction, but records of their origin and the processing undertaken should be kept. All hides that are to be exported must also comply with trading partner requirements.

Partially tanned hides in the restricted area (RA) may move to an approved processing facility (APF) under SpP for further processing (full tanning) or to an ADS with conditions 3, 5 and 6. The issuance of an SpP will be based on risk assessment and subject to appropriate conditions to mitigate the identified risks (e.g. conditions to ensure biosecurity of the hides in transit, appropriate biosecurity and treatment at the APF, record keeping).

Movement of unprocessed hides in the RA is prohibited, except under SpP to an approved disposal site (ADS) or APF with conditions 3, 5 and 6. The issuance of an SpP will be based on risk assessment and subject to appropriate conditions to mitigate the identified risks (e.g. conditions to ensure biosecurity of the hides in transit, appropriate biosecurity and disposal at the ADS or treatment at the APF, and record keeping).

Unprocessed or partially tanned hides originating from the control area (CA) may move to an APF under SpP for further processing (full tanning) or ADS. The issuance of an SpP will be based on risk assessment

and subject to appropriate conditions to mitigate the identified risks (e.g. conditions to ensure biosecurity of the hides in transit, appropriate biosecurity and treatment at the APF).

Unprocessed or partially tanned hides originating from the outside area (OA) may be allowed to move without restriction, although records of their origin and any processing undertaken should be kept if they are processed at a premises within the RA or CA.

6.4.7 Other animal byproducts

Permission for movements of other animal byproducts will be based on risk assessment and subject to appropriate conditions to mitigate the identified risks.

Animal byproducts intended for export must comply with training partner requirements.

6.4.8 Waste products and effluent

At the time the outbreak is declared, management of all wastes from the RA or CA will be based on risk assessment and subject to appropriate conditions to mitigate the identified risks. The risk assessment should take into consideration the origin (and therefore the expected LSD virus status) of the animal products, any processing undertaken on the waste material, the potential for any post-processing cross-contamination from infected material, and the intended site and means of disposal of the wastes (including any proposed use for irrigation).

6.4.9 Vehicles, including empty livestock transport vehicles and associated equipment

Empty livestock transport vehicles and associated equipment may play a role in spread of infection by acting as fomites and carriers of insect vectors.

Movements from infected premises (IPs), dangerous contact premises (DCPs), dangerous contact processing facilities (DCPFs), suspect premises (SPs) and trace premises (TPs) are prohibited except under SpP. The issuance of an SpP will be based on risk assessment and subject to appropriate conditions to mitigate the identified risks. Conditions will include thorough cleaning and decontamination, vector control, inspection before leaving the premises, and appropriate record keeping.

Movements of empty livestock transport vehicles and other vehicles that service the premises (e.g. feed trucks) from the RA to the CA, or from the CA to the OA, are prohibited except under SpP. The issuance of an SpP will be based on risk assessment and subject to appropriate conditions to mitigate the identified risks. Conditions will include thorough cleaning and decontamination, disinfection to destroy the virus, vector control, inspection before leaving the premises, and appropriate record keeping.

For movements originating on at-risk premises (ARPs) or premises of relevance (PORs), a GP is required, with the following conditions: vehicles and equipment are thoroughly cleaned before exit from the premises, and records are kept of the movement (origin, destination and cleaning undertaken).

Movements originating in the OA are allowed without restriction.

6.4.10 Nonsusceptible animals

Nonsusceptible animals may play a role in spread of infection by acting as fomites.

Movement of nonsusceptible animals from IPs, DCPs, DCPFs, TPs and SPs will be based on risk assessment and subject to appropriate conditions to mitigate the identified risks (e.g. cleaning to remove mud, limiting access to cattle, camels and buffalo at the destination). The risk assessment and conditions applied should also consider the potential for vector movement associated with the proposed animal movement; for

example, some species of ticks may be present on both horses and cattle. To reduce the risk of nonsusceptible animals harbouring competent vectors during transport from IPs, DCPs, TPs and SPs, consideration should be given to effective treatment of such animals to remove vectors before their transport.

Movement of nonsusceptible animals from ARPs and PORs will also be based on risk assessment, taking into consideration the factors outlined above. Again, consideration should be given to controlling vectors before animal movements.

Movement of nonsusceptible animals from the OA is allowed without restriction (although permit requirements and conditions may apply to the movement of vehicles out of declared areas — see Section 6.4.9).

6.4.11 People

People may play a role in spread of infection by acting as fomites.

The conditions applied to movements of people off IPs, DCPs, DCPFs, SPs and TPs should be based on risk assessment, taking into consideration any potential contact with livestock and contaminated environments. Where the assessed risk is high, a change of clothes, headwear and footwear, or decontamination procedures, and record keeping should be implemented. Because viruses can be transmitted in nasal cavities, hair and so on, consideration should also be given to the potential need for showering before entering another property where there are cattle, camels or buffalo.

For ARPs, PORs and premises in the OA, no specific controls are required, but owners should be encouraged to enhance biosecurity measures on their premises to limit the movement of potential environmental contaminants (see also Section 4.2.5).

6.4.12 Specimens

The movement of biological specimens for laboratory testing is allowed without restriction.

6.4.13 Crops, grains, hay, silage and mixed feed

Crops, grains, hay, silage and mixed feed from IPs, DCPs, DCPFs, SPs and TPs may present a risk of transmission by acting as fomites.

Movements of these items, where applicable, should be based on risk assessment, taking into consideration a range of factors, including their location on the property (and the potential for contamination or cross-contamination), the time of harvest (feed harvested on the premises within two incubation periods from the onset of infection would be considered high risk), the intended end use, and any processing to be undertaken. Consideration should be given to the possibility of using only feed that is from a FeedSafe-accredited supplier or has a vendor declaration stating that the feed has not come into contact with cattle.

Potential animal welfare issues — especially for feedlots, where bringing feed into the premises is vital — will need to be considered in the risk assessment process.

Movement of crops, grains, hay, silage and mixed feed from ARPs should also be subject to risk assessment, taking into consideration the factors outlined above and the proximity of the ARP to known and expected areas of infection. Movements from the RA to the CA or OA are prohibited except under GP, with conditions 3, 5 and 6 (see Appendix 2).

Movement of crops, grains, hay, silage and mixed feed from premises in the CA or OA to the RA is allowed.

6.4.14 Equipment, including personal items

Equipment that has had direct contact with cattle, camels, buffalo or contaminated environments — or may be associated with potentially infected vectors — should be managed in the same manner as empty livestock transport vehicles and associated equipment (see Section 6.4.9).

Movements of other equipment and personal items are allowed without restriction.

6.4.15 Sales, shows and other events

Sales, shows and other events involving cattle, camels or buffalo in declared areas are prohibited.

6.4.16 Stock routes and rights of way

Movements of cattle, camels and buffalo on stock routes and rights of way in declared areas are prohibited.

6.4.17 Animal movements for emergency (including welfare) reasons

Permission for the movement of animals for emergency (including welfare) reasons will be based on risk assessment and subject to appropriate conditions to mitigate the identified risks.

6.4.18 Other movements

Permission for other movements will be based on risk assessment and subject to appropriate conditions to mitigate the identified risks.

7 Surveillance and proof of freedom

7.1 Surveillance

The key objectives and priorities for surveillance in response to an outbreak of lumpy skin disease (LSD) are outlined in Section 4.2.3. General considerations, and those specific to surveillance for LSD virus, are discussed below. The approach to surveillance on premises of different status is then outlined.

7.1.1 General considerations

General considerations for surveillance for LSD include the following:

- Evidence to support later proof of freedom should be collected throughout the response.
- Appropriate biosecurity measures must be used to prevent disease spread by surveillance activities; this includes preventing unnecessary property visits.
- Surveillance regimes may vary with different premises statuses; higher-risk premises will be subject to more intense surveillance.
- All properties with cattle, camels and/or buffalo within declared areas should be recorded on the information management system as soon as practicable, to enable generation of surveillance and tracing schedules and reports, and management of premises classifications.
- A standardised investigation protocol, and reporting and laboratory submission forms should be used.
- Following field surveillance visits, reporting, debriefing and provision of samples to the laboratory should follow a schedule that minimises delays in laboratory diagnosis.
- Communication strategies targeted at producers and animal health professionals (e.g. veterinarians, stock inspectors, meat inspectors) should outline key clinical signs, to encourage the early reporting of any suspicions of LSD to government veterinary services.

7.1.2 Specific considerations

Specific considerations for surveillance for LSD include the following:

- Surveillance for LSD virus will include an epidemiological investigation of the potential vectors that are present, and the environmental and ecological factors that may influence their distribution and survival. Surveillance will also determine the extent of infection and vector activity within the area of infected premises (IPs) and dangerous contact premises (DCPs), to enable a realistic restricted area (RA) and control area (CA) to be established.
    - There is a strong possibility that the disease will have already spread at the time of initial diagnosis, so establishment of RA and CA boundaries must account for the need for wider surveillance to establish the extent of spread (EFSA AHAW Panel et al 2021).
    - Allowance should be made for the possibility of virus overwintering in arthropod vectors, with subsequent seasonal resurgence of the disease.
    - Transovarial, transstadial and mechanical (intrastadial) transmission by hard tick species has been reported.
    - The National Arbovirus Monitoring Program undertakes surveillance of midge populations in Australia and may provide information to support an LSD virus surveillance program.
    - Public health vector monitoring programs may provide information on other potential vector populations in Australia.
- Surveillance of feral cattle, camels and buffalo populations in areas where disease is present will be important, because these may act as reservoirs of infection.

- Clinical surveillance should include groups of animals seen as high risk (e.g. through enhanced clinical inspection of livestock at abattoirs, saleyards and other aggregation points).
- In vaccinated populations, the severity of clinical disease may be significantly reduced; as a result, passive surveillance may have poor sensitivity for detection of disease. Therefore, active surveillance based on clinical examination (67–75% sensitivity in experimental trials) with confirmatory PCR testing on skin and blood samples will be more effective (EFSA 2019).
- Serological cross-reactions occur between LSD virus and sheep pox and goat pox viruses (although these are not present in Australia).
- Serological tests are of limited value for individual animals, as a result of low assay sensitivity, but may provide some information at the herd level.
    - Antibodies developed remain detectable for at least 3–6 months post-infection; further studies to ascertain long-term antibody persistence have not been done to date. This will be an important consideration for proof-of-freedom testing, which will need to rely on serological testing without having DIVA (differentiating infected from vaccinated animals) capability.
- The survey design should anticipate the occurrence of false positive reactions (as no diagnostic tests have perfect specificity), although specificity is generally very high in the assays proposed for this purpose, so the number of false positives is expected to be small. Appropriate follow-up procedures will be needed, including additional sampling from the animal or herd.
- If vaccination is used as part of the disease response, the use of laboratory tests that allow DIVA will be important.
    - There is no serological DIVA capability for LSD virus. DIVA can only be achieved through duplex PCR assays that detect vaccine strains vs wild type; however, these tests are proving ineffectual against the new recombinant LSD virus strains.

7.1.3 Surveillance on suspect premises

Surveillance on suspect premises (SPs) is a priority and should occur as soon as possible after suspicious signs are recognised or links to known IPs are identified. Where the number of these premises is large (compared with available resources), prioritisation of surveillance should be risk based, taking into consideration the likelihood that infection may be present and the impact on the response if infection were present on the premises.

Laboratory investigation is required to confirm the status of the suspect animals. Sampling should target cattle, camels and buffalo with clinical signs, and samples should be submitted for PCR testing with or without virus isolation.

If the laboratory results are positive, the premises will be reclassified as an IP.

If the initial laboratory results are negative, additional testing to establish an alternative diagnosis may be considered. If there is no alternative diagnosis, further actions will be based on risk assessment, taking into consideration the likelihood that the negative result is a true reflection of the status of the premises — for example, by considering the number of animals affected, the number of samples taken, the level of clinical suspicion, the implications for disease control if the result is a false negative result, the duration of clinical disease on the premises and the expected incubation period. Additional testing after a period may be warranted before the property is assessed negative and subsequently reclassified.

7.1.4 Surveillance on trace premises

Surveillance on trace premises (TPs) is a priority and should occur as soon as possible after links to known IPs are identified. Where the number of these premises is large (compared with available resources),

prioritisation of surveillance should be risk based, taking into consideration the likelihood that infection may be present and the impact on the response if infection were present on the premises.

Surveillance on TPs should include clinical inspection of livestock by surveillance teams. Ideally, every mob of cattle, camels or buffalo will be inspected and numbers accounted for. If the number of cattle, camels or buffalo on a premises is large, a statistically appropriate sample of animals on these premises must be examined, targeting those at higher risk of infection (e.g. those with known links to IPs and those in contact with these cattle, camels or buffalo). Because the expected disease prevalence remains low for some time after introduction into a naive population, for active surveillance to be effective, a large number of herds would need to be sampled at high frequency to allow early detection and prevent further spread of the disease (EFSA et al 2018).

Laboratory samples (EDTA blood in the absence of skin lesions) for PCR testing should be taken from higher-risk cattle, camels and buffalo at day 0. If the laboratory results are positive, the premises will be reclassified as an IP.

If the initial laboratory results are negative, stock should be monitored for development of clinical signs (see 'Surveillance on at-risk premises and premises of relevance') and higher-risk cattle, camels and buffalo retested at day 28.

If the laboratory results from day 28 testing are positive, the premises will be reclassified as an IP.

If the laboratory results are negative from testing samples at days 0 and 28, and there have been no clinical signs of LSD, the premises may be assessed as negative and subsequently reclassified.

7.1.5 Surveillance on dangerous contact premises

Cattle, camels and buffalo on DCPs will be subject to stamping out based on risk assessment. If there is a delay in stamping out (e.g. due to resource availability), clinical surveillance should be undertaken (see 'Surveillance on at-risk premises and premises of relevance'). Development of clinical signs and confirmation of infection on these premises may alter their prioritisation for destruction, disposal and decontamination activities.

7.1.6 Surveillance on at-risk premises and premises of relevance

On other properties at risk (at-risk premises (ARPs) and premises of relevance (PORs)), clinical surveillance should be undertaken to facilitate early reporting of suspected infection. The characteristic clinical signs of LSD mean that producers and stock managers can conduct clinical surveillance for these premises. Producers and stock managers should be provided with clear information on signs of LSD. They should be advised to inspect all groups of animals on the property — on declaration of the outbreak and regularly thereafter. Inspection would ideally occur twice weekly, but the frequency will be based on risk assessment, taking into consideration expected vector dispersal (including the potential for long-distance dispersal events), production systems and resource availability. Producers and stock managers should be given a standard reporting form to capture all relevant information and should be advised of triggers for reporting suspicion to the local control centre. Surveillance activities and resource allocation are a jurisdictional decision.

This surveillance should be maintained until the declared area in which the premises is located is resolved. Periodic field visits by surveillance teams to clinically inspect stock should be considered, subject to resource availability and risk assessment.

Where required, laboratory samples may be taken to support such investigations.

7.1.7 Restocking of infected premises, dangerous contact premises and vaccinated at-risk premises

Following destruction, disposal and decontamination on IPs, DCPs and vaccinated (VN) premises (refer to Section 4.2.8), the waiting period before restocking will be long. Decisions on the length of this period will take into consideration season, climatic conditions and the infection status of the area. A minimum waiting period of 6 months is recommended, but this may be substantially extended in wet or cooler conditions, or if infection is still present or suspected in the area.

7.2 Proof of freedom

Providing confidence that LSD virus is no longer circulating in Australia will be important to satisfy trading partners and regain access to international markets, and to underpin import controls to prevent reintroduction of the virus.

Although Chapter 11.9 of the World Organisation for Animal Health (WOAH) Terrestrial Code provides guidelines for recovering LSD-free status, acceptance of LSD-free status following an outbreak will have to be negotiated with individual trading partners and may take considerably longer than the minimum periods prescribed in the Terrestrial Code.

To support proof of freedom, a comprehensive surveillance program will be required to provide confidence that there are no seropositive animals remaining in the Australian herd and that there is no longer any virus circulation. This program will build on the surveillance, tracing and diagnostic testing done during the control phase. It will include clinical, serological, molecular and virological surveillance in cattle, camels and buffalo, and surveillance in relevant vector populations. The surveillance program will be designed to take into consideration the characteristics of the outbreak, and the general and specific considerations for surveillance for LSD outlined in Section 7.1.

Appendix 1 Lumpy skin disease fact sheet

Disease and cause

Lumpy skin disease (LSD) is an acute, highly infectious disease of cattle, camels and buffalo.

The disease is caused by a virus of the family Poxviridae that is similar to the viruses that cause sheep pox and goat pox. The virus is mostly transmitted by biting insects.

Species affected

LSD affects ruminants, primarily cattle, although a few cases have been seen in water buffalo and camels.

LSD is not a zoonotic disease (i.e. it does not affect humans).

Distribution

The disease has never been recorded in Australia.

LSD is generally considered endemic in sub-Saharan Africa, parts of the Middle East and Turkey. Since 2015, it has spread to the Balkan countries, the Caucasus and the Russian Federation.

Since 2019, outbreaks have been reported in south and east Asia, including Bangladesh, India and China. More recently, outbreaks have been reported in a territory of Taiwan and in Nepal, Indonesia and Singapore (possibly from the movement of flies or mosquitoes from neighbouring countries).

In 2022, the disease was reported in northern Indonesia.

Potential pathways for introduction into Australia

LSD may be spread by the movement of infected animals. However, it is unlikely that the disease will enter Australia through importation of live cattle or their germplasm, as cattle and genetic material are not imported from LSD-endemic countries.

The most likely route for the introduction of LSD into Australia is following establishment of the disease in neighbouring countries to the north, with the virus then carried by vectors into northern Australia.

Currently, the potential for introduction of LSD via insects entering Australia from countries in the region is high — especially since the disease has been detected in Indonesia. There is an increased risk of infected insects translocating across the seas north of Australia, or entering through international ports.

Key signs

Firm, raised nodules up to 50 mm in diameter develop on the skin within 1–2 days, especially around the head, neck, genitals and limbs. The centres of the nodules die, after which the resultant scabs (‘sitfasts’) may fall out, leaving large, ulcerous holes that are subject to secondary bacterial infections.

Nodules also develop in the nose, throat and gut. Oedema of the limbs, brisket and genitals also occurs.

Susceptible cattle of all ages can develop serious clinical disease if infected with LSD virus. Therefore, introduction of LSD into Australia could result in high mortalities and rapid spread of the disease.

Spread

LSD virus is present in eye, nose and mouth secretions, and in the semen, milk and blood of infected animals. Under Australian conditions, mechanical transmission of the virus by biting insects may be important. Non-biting insects have also been implicated in the transfer of infected body fluids.

Many different types of biting insects may be involved in transmission, but particularly mosquitoes and flies. Insect vectors on ships and aircraft may spread the disease, and the virus can be readily transported on clothing and equipment.

Spread by direct contact between cattle does not occur easily, unless animals share a water trough.

Persistence of the virus

LSD virus is very resistant to inactivation in the environment. It has been isolated from shed skin tissue up to 4 months after infection and may be found in blood for 16–28 days, saliva and nasal discharges for up to 18 days, and semen for 42 days.

Impacts for Australia

LSD is one of the biggest biosecurity threats to Australia's cattle (and buffalo) industries; the effect on products would be significant. Trading partners would be expected to introduce emergency measures until an outbreak situation became stable, significantly disrupting exports of meat, dairy, other bovine-derived animal products and some non-bovine products. The impacts may include closure of markets, increased testing requirements, increased requirements for pre-export quarantine, vaccination requirements, and reductions in price premiums for Australian commodities.

Appendix 2 Permit conditions

No.	Condition
1	No evidence of clinical disease in susceptible animals on the premises on the day of movement or in the previous 28 days.
2	Physical identification of animals (i.e. National Livestock Identification System — NLIS), with appropriate accompanying movement documentation (i.e. National Vendor Declaration — NVD, waybill).
3	Transport vehicles and associated equipment are decontaminated and treated with an effective insecticide (including within the vehicle cabin), before transport to prevent adult competent vectors travelling.
4	Animals/ carcasses are treated effectively (e.g. live animals treated with an effective insecticide) as appropriate before transport to control vectors.
5	Transport vehicles follow an agreed transport route and destination that includes only pre-approved stops en route.
6	The permit accompanies the livestock or vehicle during movement, and the person responsible retains a copy of the permit, consistent with the legal requirements of the jurisdiction.
7	Animals moved to or already on the destination premises are not permitted to move for 56 days (i.e. they must remain resident at the destination for a minimum of 56 days), except for subsequent movement to slaughter.
8	There must be no evidence of clinical disease consistent with LSD in animals being moved.
9	Movement directly to abattoir (either a dangerous contact processing facility — DCPF or an approved processing facility — APF) with no stopping en route.
10	Appropriate biosecurity at the DCPF or APF, including quality assurance systems; record keeping; compliance with traceability requirements; controlled entry of people, equipment and vehicles; pest and vector control, addressing transmission pathways for LSD virus; and training to recognise LSD and report suspicion or confirmation of disease.
11	Onward movement of the moved animals is not permitted.
12	Animals are slaughtered within 48 hours of arrival at the abattoir (DCPF or APF).
13	Animals were born on the property or resident on the property for the consecutive 28 days immediately before movement.
14	Any animals that develop any clinical signs consistent with LSD following movement are immediately reported to a government authority.
15	The semen is collected a minimum of 56 days[22] before identification of the index case and a risk assessment is conducted.
16	Carcases/carcasses are protected from contact with vectors (e.g. treated for vectors; disposed of within hours, such as by burial).
17	Carcases/carcasses for further processing are treated to inactivate virus.

[22] The appropriateness of the 56-day period will need to be considered based on epidemiological considerations (e.g. site of collection, whether the site is outside the declared areas).

No.	Condition
18	Consignment is processed in a single processing run.
19	Facility is cleaned, decontaminated and disinsected following processing of the consignment.
20	Frozen semen and embryos are delivered to predetermined low-risk location, such as the edge of the property.
21	Risk assessment - Under approval from CVO, or CVO-authorised delegate, after assessment indicates that the risk associated with the movement is acceptable within the response.

Appendix 3 Vaccines and vaccination

The vaccine approved for use in Australia is a homologous, live, attenuated lumpy skin disease (LSD) virus vaccine.

Currently, both homologous vaccines (live, attenuated LSD virus) and heterologous vaccines (live, attenuated sheep pox virus or goat pox virus) are available for LSD overseas. The homologous vaccines provide better protection against LSD virus than the heterologous types (Tuppurainen et al 2021). Vaccine strain matching is not required. More information on vaccination can be found in Section 4.2.8.

The degree of attenuation of live vaccines requires consideration:

- Side effects from the vaccine have been reported, including nodular skin disease, fever, viraemia and death, as well as a significant reduction in milk production (Ben-Gera et al 2015, ESFA 2017, Bedeković et al 2018, Katsoulos et al 2018).
- Vaccine viral particles have been detected in milk, skin nodules, blood and nasal swabs, and virus has been isolated on cell culture up to 21 days post-vaccination (Bedeković et al 2018).

Heterologous vaccines are not recommended for use in a country free from sheep pox and goat pox for the following reasons:

- Efficacy is variable, and recent evidence shows that they confer only partial immunity to LSD virus (Ayelet et al 2013, Tageldin et al 2014, Tuppurainen et al 2014, Gari et al 2015, Abutarbush et al 2016). However, goat pox vaccines are likely to afford better protection against LSD virus than sheep pox vaccines (Gari et al 2015, Zhugunissov et al 2020).
- The Kenyan sheep pox and goat pox strain vaccines (KSGP 0-240 and O-180) have recently been found to be LSD virus strains (i.e. these vaccines are homologous), and therefore their use is not recommended until trials in cattle are undertaken to determine true attenuation (Tulman et al 2002, Lamien et al 2011b, Tuppurainen et al 2014).
- There is a risk of clinical disease in vaccinated cattle due to low-level attenuation. The attenuation and quality of the available live sheep pox and goat pox strain vaccines may be associated with a risk of reversion, which could introduce sheep pox or goat pox into Australia during the response to LSD. This has not historically been an issue because countries with LSD have also had sheep pox and goat pox; however, it is a strong consideration for countries free from sheep pox and goat pox.

An inactivated vaccine has more recently been developed. Under experimental conditions, it provides good protection but requires multiple priming doses and 6-monthly boosters. Inactivated virus vaccines would be safer than live, attenuated vaccines in terms of negating the risk of reversion of vaccine virus in naive populations. However, there are potential challenges with increased time and cost for a program — multiple doses and booster doses may be required to produce sufficient immunity (Tuppurainen et al 2021).

DIVA-capable (differentiating infected from vaccinated animals) vaccines are not commercially available but are in development (Tuppurainen & Oura 2012, De Vleeschauwer et al 2017, Hamdi et al 2020). Likewise, no specific DIVA serological test is available.

Appendix 4 Control overseas

In 2015, a lumpy skin disease (LSD) outbreak occurred in the Balkans (Europe). The application of stamping out and then standard ring vaccination strategies did not appear to halt the progression of the disease. Initial recommendations from the European Food Safety Authority (EFSA) in 2015 considered the 'rapid detection and prompt culling of infected herds' as effective measures in limiting spread and impact. Adjunct measures included a protection zone of 3 km, a surveillance zone of 10 km and a restriction zone of 20 km (minimum); if vaccination was required, it should be used in the restricted zone (20 km). However, LSD propagated through Greece and into Bulgaria.

The 2016 EFSA recommendations changed to pre-emptive regional vaccination against LSD, to minimise the number of outbreaks. Vaccinating entire regions and countries well in advance of disease incursion brought the overall situation under control. This assertion is based on the distribution of outbreaks in the Balkans with respect to the level of vaccination coverage. In regions with sufficient pre-emptive vaccination coverage (e.g. northern Bulgaria, northern Serbia, Montenegro), the disease slowed, and progression halted. In the west and southwest Balkans, where vaccination coverage was insufficient and not far enough ahead of the disease, LSD outbreaks continued to occur, including among vaccinated herds.

EFSA produced a time-lapse video in 2018 demonstrating the progression of outbreaks through the Balkans with respect to vaccination coverage (EFSA 2017).

Other challenges encountered in the European response include:

- vaccine failure (e.g. outbreaks in herds vaccinated only a week or two before)
- significant geographical jumps of LSD (e.g. initial outbreaks in Greece made jumps of 80–100 km; early cases in Bulgaria were 80 km or more from the border with Turkey and Greece); it is not known whether these were due to movements of vectors, live animals or commodities
- the presence of many small, unconsolidated or backyard cattle herds in association with extensive or hilly production areas; for example, 70% of the outbreaks in Bulgaria were on farms with less than 10 cattle.

Animals may miss out on vaccination or routine clinical observation as a result of the remoteness and/or inaccessibility of their location, difficulties in mustering and/or lack of infrastructure.

LSD was first noted in Turkey in 2013. Controls included heterologous vaccination in response to outbreaks. In 2014, Turkey observed that transmission of LSD virus was faster than its vaccination program and opted to expand vaccination to any areas neighbouring outbreak regions. This was expanded in 2015 to include all provinces in the country. Animal movement controls have been progressively strengthened over time to deal with unregulated movements; it was recognised that asymptomatic animals (vaccinated or unvaccinated) have been linked to spread.

Greece, in response to outbreaks in Turkey close to the Greek border, set up an enhanced safeguard zone 10 km from the border. In this zone, enhanced clinical surveillance was performed by veterinarians, and authorisation was required to move cattle. When the first outbreaks began at the end of 2015, Greek authorities were limited to stamping out because pre-emptive vaccination and importation of vaccine were not legally permitted. With the eventual importation of vaccine, a traditional ring vaccination and surveillance method was initially applied to regional units where disease had been detected. However, in 2016, with ongoing spread of disease, the decision was made to apply blanket, preventive vaccination to the entire mainland and then the Greek isles. With the exception of the southwest region of Greece, by 2018, most of the mainland had suffered outbreaks, including sporadic cases in vaccinated populations (usually linked to naive animals but demonstrating continued viral circulation).

The Bulgarian response to LSD in 2016 involved total stamping out, movement controls, vector controls and vaccination of the entire country. Vaccination was initially conducted using a 20 km ring strategy, but the competent authority opted to expand this to blanket vaccination on observing the ongoing progression of LSD throughout the Balkans. Vaccination commenced in naive regions well in advance (~100 km) of outbreaks in neighbouring regions, with the result that LSD propagation was limited or not detected in these regions.

The former Yugoslav Republic of Macedonia (FYROM) was affected by LSD in April 2016. Stamping out was initially used to attempt to control the disease, but the strategy soon shifted to vaccination of infected regions and finally blanket vaccination of the entire country. However, although the number of outbreaks decreased significantly in response to vaccination of 100% of the national herd, outbreaks were recorded across the entire country between April 2016 and December 2016 (the area of the FYROM is approximately 100 km by 120 km). A significant number of outbreaks were noted in animals post-vaccination. The FYROM concluded that an incubation period of 28 days combined with a 28-day[23] period post-vaccination for immunity to peak should be used for planning purposes. Outbreaks were noted in 2017 in vaccinated animals, and the FYROM concluded that LSD virus was still circulating in the country.

Preventive vaccination was employed by Croatia (2016) in response to the progression of LSD through the Balkans, with annual vaccination of susceptible animals. Ongoing vaccination is performed for risk animals (e.g. newborn calves from unvaccinated dams, unvaccinated animals imported into Croatia). Surveillance for viral presence is performed using quantitative PCR. Surveillance is complicated by the lack of a DIVA-capable (differentiating infected from vaccinated animals) vaccine, in addition to vaccine virus shedding in various cattle secretions (Bedeković et al 2018). Croatia did not report any outbreaks in 2016 or 2017.

Efforts to control LSD in Asia via vaccination campaigns are ongoing.

Israel has suffered several outbreaks during the past few decades and has responded differently each time. The 1989 outbreak was reportedly eradicated by culling all cows in the region and vaccinating with a heterologous vaccine within 10 km of the outbreak. However, the 2006 and 2007 outbreaks led to ongoing vaccination and other measures in risk regions to prevent recrudescence. In 2012, another outbreak occurred and spread across the northern half of the country; it was not controlled until August 2013. Use of both heterologous and homologous vaccines was studied during this outbreak; one study demonstrated that the homologous (Neethling) vaccine was significantly more effective. The outbreak was eventually controlled (without culling) by vaccination of approximately 80% of the country's cattle. Relevant points not already covered include the following:

- Transport of infected animals caused disease spread (100 km).
- Transfer of diseased carcases seems to have caused disease spread (40 km).
- Some outbreaks may have been caused by long-range dispersal of infected vectors from other countries (e.g. Klausner et al 2017).

The approach currently favoured by Israel's competent authority is modified stamping out in combination with homologous vaccine coverage, as allowed by available resources. This is not sufficient if using a heterologous vaccine.

Vector controls (e.g. dipping, repellent spray) have been applied at a local herd level as adjunct measures. Larger-scale vector control (e.g. aerial spraying) has not typically been employed by countries. Throughout overseas responses, a link has been noted between climatic conditions favourable to vector propagation and outbreaks or renewed spread of LSD. Favourable conditions include proximity of holdings to rivers and water courses (FAO 2017). Import restrictions on live bovine imports and certain bovine commodities have formed a part of control responses for both infected and naive countries.

[23] The exact period for peak immunity is still debated, some authors using 21 days or other values; it will depend on the vaccine used, among other considerations.

This analysis is not comprehensive, and the knowledge base continues to evolve in response to experiences from various overseas outbreaks. Further information and case reports are available from the Balkan countries, including Albania, Montenegro, Serbia and Kosovo (FAO 2017). Several overarching lessons can be drawn:

- Control of LSD usually requires vaccination, and movement restriction on live animals and commodities (including infected carcases).
- Delays in vaccine procurement and administration have contributed to significant disease spread through countries.
- Movement restrictions should apply even to vaccinated or asymptomatic animals from transmission risk zones.
- Vaccination needs to be performed aggressively, pre-emptively and well in advance of disease progression to be effective in preventing spread into new regions. Reactive, local-zone ring vaccination strategies have repeatedly failed. Vaccination coverage should involve every susceptible herd in a risk region (because efficacy of individual vaccinations may vary from 60% to 90%). Bulgaria assessed the coverage required as a minimum of 85%. Turkey assessed the required coverage as 80–90%. EFSA in 2016 found that, with 95% of farms vaccinated, 75% of the vaccinated animals are effectively protected. Live, attenuated, homologous vaccines are the most effective for disease control.
- One of the most commonly reported reasons for vaccine failure is insufficient time between administration of the vaccine and natural challenge by the virus.
- Continuous, or somewhat contiguous, propagation of outbreaks is expected until the disease encounters a barrier involving a lack of susceptible animals (or temporary somnolence due to climatic conditions such as winter that are generally not conducive to vector spread).
- Larger leaps of disease may occur. They may be due to movement of infected animals, long-range vector dispersal and commodity movements.
- Viral circulation may be ongoing in vaccinated populations; naive animals within large, vaccinated units have been subject to infection.
- A return to country freedom may not be possible in short timeframes.
- During the 2019 Israel outbreak, bluetongue virus contamination in a vaccine batch delayed the vaccination program for a number of days (EFSA 2020). Contamination of a live, attenuated vaccine with other viruses, including LSD virus and bovine viral diarrhoea virus, is a considerable risk that may reflect issues with the quality and control of production inputs and the virus attenuation process for this type of vaccine.

Appendix 5 Flowchart of an emergency animal disease response

An overview of Australia's emergency animal disease (EAD) response structures and governance is provided in the **AUSVETPLAN** ***Management manual: Control centres management*** **(Part 1 and Part 2)** and summarised below to highlight the role of AUSVETPLAN.

The chief veterinary officer (CVO) in the state or territory in which the incident occurs is responsible for instituting animal disease control action within that state or territory. The strategies to control the disease, including the budget for the proposed response actions, are documented in an Emergency Animal Disease Response Plan (EADRP). Where the EAD is suspected or confirmed to be a zoonosis, the EADRP is developed in collaboration with the chief health officer (CHO) of the affected state or territory.

For a response to be cost shared under the Emergency Animal Disease Response Agreement (EADRA), EADRPs must be consistent with, and guided by, any relevant AUSVETPLAN manuals. However, the Consultative Committee on Emergency Animal Diseases (CCEAD) can, if it thinks reasonable, recommend to the National Management Group (NMG) an EADRP even if part of the response plan deviates from AUSVETPLAN (e.g. due to new knowledge). For responses that are not cost shared under the EADRA, the development of response plans consistent with AUSVETPLAN is voluntary and is usual practice. AUSVETPLAN therefore serves as the authoritative reference on policies and guidelines for the management of EADs in Australia.

The CVO is responsible for recommending the EADRP to the CCEAD. Unaffected jurisdictions may also need to develop response plans to address jurisdictional activities that may be eligible for cost sharing.

The CCEAD provides technical review of the EADRP and may recommend it to the NMG convened for the incident. The NMG decides on whether cost sharing will be invoked (following advice from the CCEAD) and whether to approve the EADRP.

CVOs and, where relevant, CHOs implement disease control measures as agreed in the EADRP and in accordance with relevant legislation. They make ongoing decisions on follow-up disease control measures — including termination of the response — in consultation with the CCEAD and, where applicable, the NMG, based on epidemiological information about the outbreak.

It is also important to note that the overall response policy contained in the various AUSVETPLAN manuals is used in informing responses to new and emerging diseases.

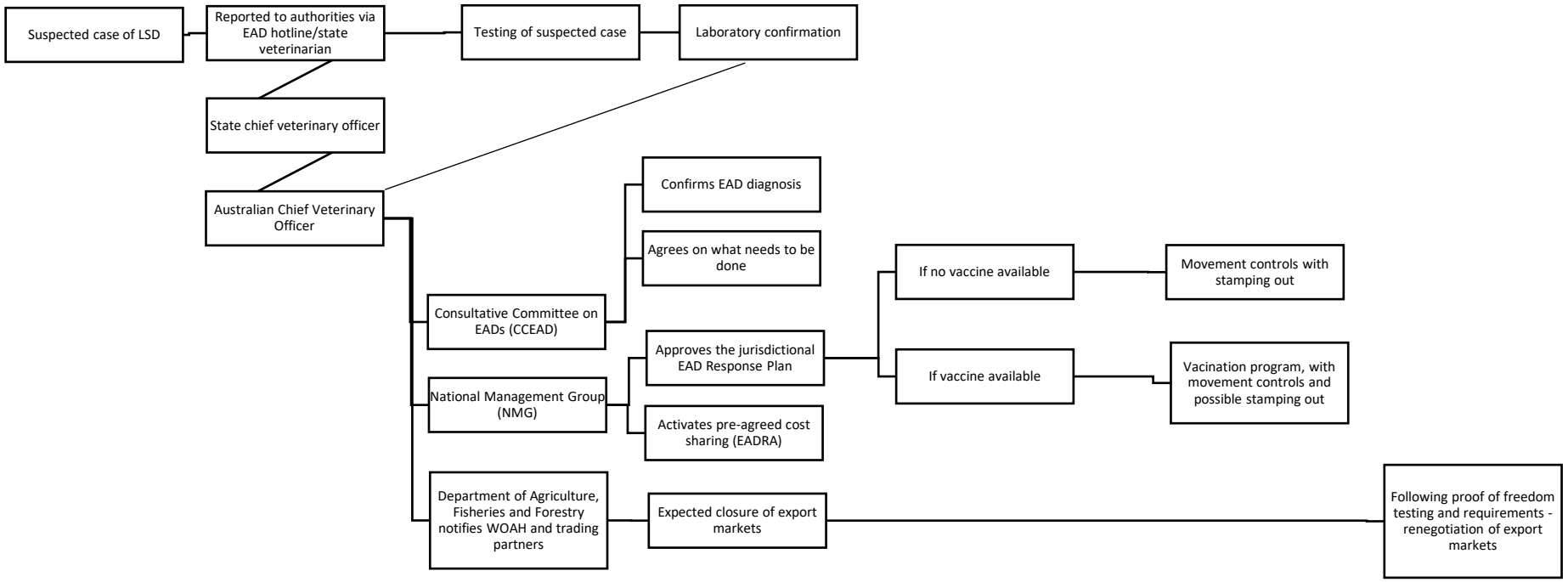

Figure A5.1 Summary of steps in the reporting of an emergency animal disease

Glossary

Terms and definitions

Standard AUSVETPLAN terms

For definitions of standard AUSVETPLAN terms, see the **AUSVETPLAN *Glossary***.

Manual-specific terms

Term	Definition
Abomasum	Fourth stomach of ruminants; also called the 'true' or 'rennet' stomach or 'reed'. Leads into the small intestine.
Hyperaemia	An increase in the amount of blood in a tissue or organ due to dilation of the supplying arteries or constriction of the veins.
Immunodiffusion test	A serological test to identify antigens or antibodies by precipitation of antibody–antigen complexes after diffusion through agar gel.
Indirect immunofluorescence	A technique in which the presence of antigen or antibody in a sample can be detected by binding of a specific antibody bound to a fluorescent marker molecule, which is visible under a fluorescence microscope.
Mucopurulent	Consisting of mucus and pus.
Regional blanket vaccination	Vaccination applied to large numbers of animals within regions where disease spread is suspected to be high.
Serosurveillance	Surveillance of an animal population by testing serum samples for the presence of antibodies to disease agents.
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.
Zebu (cattle)	Bovine animals (*Bos indicus*) with a characteristic large hump over the shoulders. Widely distributed in India, China, eastern Africa, etc. and used for cross-breeding in Australia.

Abbreviations

Standard AUSVETPLAN abbreviations

For standard AUSVETPLAN abbreviations, see the **AUSVETPLAN *Glossary***.

Manual-specific abbreviations

Abbreviation	Full title
DIVA	differentiating infected from vaccinated animals
EFSA	European Food Safety Authority
LSD	lumpy skin disease

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