Australian Government
Department of Agriculture, Fisheries and Forestry

Final report: Risk of lumpy skin disease via fresh (chilled or frozen) bovine skeletal muscle meat from applicant countries

Addendum to the *Fresh (chilled or frozen) beef and beef products from Japan, the Netherlands, New Zealand, the United States and Vanuatu – final review*

December 2023

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Acknowledgement of Country

We acknowledge the Traditional Custodians of Australia and their continuing connection to land and sea, waters, environment and community. We pay our respects to the Traditional Custodians of the lands we live and work on, their culture, and their Elders past and present.

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Summary

Lumpy skin disease (LSD) is a significant animal disease that is exotic to Australia and has potential to cause national socio-economic consequences and production losses to the Australian beef and dairy cattle and buffalo industries.

Australia's review of biosecurity import conditions for the importation of *Fresh (chilled or frozen) beef and beef products from Japan, the Netherlands, New Zealand, the United States and Vanuatu* (the beef review) was published in August 2017 (Department of Agriculture and Water Resources 2017). The beef review considered market access for fresh beef and beef products[1] for human consumption from Japan, the Netherlands, New Zealand, the United States and Vanuatu, referred to as applicant countries.

The beef review recommended that risk management for LSD was necessary for beef and beef products for human consumption from the applicant countries. It concluded that certification of country freedom from LSD was considered sufficient, reasonable and practical to address the risk of importation of LSD virus (LSDV) in fresh beef and beef products.

LSD has not been reported in the applicant countries and is a nationally notifiable or reportable disease in each of these jurisdictions. However, there have been significant changes in the global distribution of LSD since the beef review was published. The Department of Agriculture, Fisheries and Forestry (the department) has conducted a further analysis of LSDV as a possible hazard that may be transmitted by fresh bovine skeletal muscle meat.

This addendum to the beef review considers whether the requirement for certification of country freedom from LSD for fresh beef and beef products in Australia's current import conditions is necessary to achieve Australia's appropriate level of protection (ALOP) from LSD. It considers available scientific evidence (including recently published scientific research), international standards, relevant processes and production methods, and relevant inspection, sampling and testing methods.

Specifically, this addendum assesses the potential LSD risk associated with meat flesh[2] derived exclusively from bovine[3] skeletal muscle (fresh bovine skeletal muscle meat). It reviews current science relating to LSDV as a hazard that may be transmitted in fresh bovine skeletal muscle meat in light of accepted international standards for the production of meat for human consumption. In the absence of evidence specific to other bovine carcase tissues, it does not consider the LSD risk

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[1] Beef and beef products in the beef review were defined as meat, bone and offal from domesticated American bison (*Bison bison*), buffalo (*Bubalus bubalis*—water buffalo or domestic Asian water buffalo), or cattle (*Bos taurus* and *Bos indicus*), as fresh (chilled or frozen) beef and beef products derived from fresh beef for human consumption. Offal was considered the heart, oesophagus, organs of the abdominal cavity (other than reproductive organs), the muscular tissues of the head, tissues of the diaphragm, the tail, and tendons.

[2] Meat flesh is "skeletal muscle of any slaughtered animal, and any attached rind, fat, connective tissue, nerve, blood and blood vessels.

[3] Bovine animals are defined as domesticated American bison (*Bison bison*), buffalo (*Bubalus bubalis*—water buffalo or domestic Asian water buffalo), or cattle (*Bos taurus* and *Bos indicus*).

associated with the importation of bovine-derived carcase tissues that were excluded from the scope of the beef review as well as bovine-derived bone and offal, which were included in the definition of beef and beef products for the purposes of the beef review (Department of Agriculture and Water Resources 2017).

It finds that the overall risk of LSDV associated with the import of fresh bovine skeletal muscle meat for human consumption is **very low** and achieves Australia's ALOP with respect to animal biosecurity risk associated with that agent. This addendum concludes that specific biosecurity risk management measures are not justified for LSDV when bovine skeletal muscle meat is imported for human consumption into Australia from applicant countries. The final report recommends that country freedom certification for LSD for import of fresh bovine skeletal muscle meat from applicant countries is not required to achieve Australia's ALOP.

1 Introduction

A rigorous, evidence-based and consultative process, consistent with Australia's international obligations, has been established by the Australian Government to assess countries seeking market access to Australia for fresh beef and beef products.

Australia's review of biosecurity import conditions for the importation of *Fresh (chilled or frozen) beef and beef products from Japan, the Netherlands, New Zealand, the United States and Vanuatu* (the beef review) was published in August 2017 (Department of Agriculture and Water Resources 2017). The beef review considered market access for fresh beef and beef products for human consumption from the above specified countries, referred to here as applicant countries.

The beef review and this addendum meet the requirements of Australia's *Biosecurity Act 2015* and follow procedures that align with those specified by the World Organisation for Animal Health (WOAH).

The risk assessment procedure advised in the WOAH Terrestrial Animal Health Code (Terrestrial Code) is consistent with the process defined in Australian legislation. Australia's appropriate level of protection (ALOP) from biosecurity risk is defined in the *Biosecurity Act 2015* as 'a high level of sanitary and phytosanitary protection aimed at reducing biosecurity risks to a very low level, but not to zero'.

The beef review noted that lumpy skin disease (LSD) was not present in the applicant countries, so a full risk assessment was not conducted for that disease. It concluded: "There is scientific evidence that [lumpy skin disease virus (LSDV)] may be present in and/or transmitted via fresh beef or beef products. There is no evidence that [LSDV] is present in Japan, the Netherlands, New Zealand, the United States and Vanuatu. Therefore, further risk assessment is not required; however, risk management is necessary. Certification of country freedom from LSD is considered sufficient, reasonable and practical to address the risk of importation of [LSDV] in fresh beef and beef products from Japan, the Netherlands, New Zealand, the United States and Vanuatu".

1.1 Purpose of this addendum

LSD has never been reported in any of the applicant countries and remains a nationally notifiable or reportable disease in these jurisdictions. However, there have been significant changes in the global distribution of LSD since the beef review was published, further developments in scientific research, and relevant changes to the WOAH Terrestrial Code. Consequently, the department has conducted this analysis of risks of LSDV transmission through fresh bovine skeletal muscle meat.

This addendum provides an updated review of the biosecurity risks of LSD associated with fresh bovine skeletal muscle meat (as defined in Section 1.2) that is imported for human consumption into Australia from applicant countries. This addendum should be read in conjunction with the beef review. Unless otherwise stated, the definitions and methods used in this addendum are consistent with those of the beef review.

1.2 Scope and commodity definition

This document is an addendum to the beef review but has a narrower scope. It assesses the potential LSD risk associated with fresh (chilled or frozen) meat flesh[4] derived exclusively from bovine[5] skeletal muscle (fresh bovine skeletal muscle meat).

This addendum does not evaluate risks associated with carcase components other than fresh bovine skeletal muscle prepared as meat for human consumption, such as bone and offal. There was insufficient evidence to consider other carcase components as equivalent to fresh bovine skeletal muscle meat from a biosecurity risk perspective.

[4] Meat flesh is defined as "skeletal muscle of any slaughtered animal, and any attached rind, fat, connective tissue, nerve, blood and blood vessels".
[5] Bovines are defined as domesticated American bison (*Bison bison*), buffalo (*Bubalus bubalis*—water buffalo or domestic Asian water buffalo), or cattle (*Bos taurus* and *Bos indicus*).

2 Background

LSD is an infectious viral disease that often occurs in epidemic form. Clinical disease is characterised by fever and the eruption of nodules in the skin, internal lesions and sometimes death.

LSDV belongs to the genus *Capripoxvirus* of the family *Poxviridae* (Skinner et al. 2011).

LSD mainly affects cattle, with occasional cases in Asian water buffalo (*Bubalis bubalis*). The role of species, other than cattle and buffalo, in the epidemiology of the disease is considered insignificant.

Before 2012, the distribution of LSD was limited to Africa and parts of the Middle East. LSD then spread throughout the Middle East, the Republic of Türkiye, Cyprus, eastern Europe, the Balkans and the Russian Federation. Since 2019, LSD has spread throughout the Asian continent, ranging from India to China, as well as extending through southern Asia where it has been reported in Bangladesh, Taiwan, Vietnam, Bhutan, Hong Kong, Nepal and Myanmar. In 2021, LSD spread further into Cambodia, Thailand and Malaysia. In 2022, cases were reported in Indonesia, Singapore and Pakistan. The disease may continue to spread globally, including throughout South-East Asian countries (Department of Agriculture 2022; Tuppurainen, Alexandrov & Beltrán-Alcrudo 2017).

LSD is a longstanding WOAH-listed disease of international significance in the trade of animals and animal products (WOAH 2022b). Infection due to LSDV has never occurred in Australia (AHA 2022b). In Australia, LSD is nationally notifiable and is currently classified as a Category 3 disease in the Emergency Animal Disease Response Agreement (EADRA), which are diseases with the potential to cause significant national socio-economic consequences through impacts on international trade, market disruptions involving two or more states and severe production losses to affected industries. Category 3 diseases have minimal or no effect on human health or the environment (AHA 2022a).

3 Method

The method used in this addendum followed the approach used in the beef review for hazards requiring risk assessment. Briefly, this risk assessment evaluated the likelihood and the biological and economic consequences of entry, establishment and spread of LSDV. This involved an evaluation of:

- the likelihood of LSDV entering Australia via imported bovine skeletal muscle meat (entry assessment)
- the likelihood of susceptible animals being exposed to and infected with LSDV via imported bovine skeletal muscle meat (exposure assessment)
- the likelihood of significant outbreaks occurring due to exposure (part of the consequence assessment)
- the potential impacts of any significant outbreaks (part of the consequence assessment).

3.1 Entry assessment

The entry assessment describes the biological pathways necessary for importation to introduce pathogenic agents into the importing country and estimates the probability of that complete process occurring. It considers biological factors of LSDV and the species of origin; country factors including prevalence and animal health systems in the country of export; and commodity factors such as the quantity to be imported, testing, treatment and/or processing.

The minimum requirement for the entry assessment was considered to be equivalent to Australian standards and legislation for sourcing of domesticated bison, buffalo or cattle, the production of beef and beef products for human consumption and their storage and transportation, including the:

- Australian Standard for the Hygienic Production and Transportation of Meat and Meat Products for Human Consumption (2007) (Australian Meat Standard) (FRSC 2007).
- Bovine spongiform encephalopathy (BSE) requirements for the importation of beef and beef products for human consumption–effective 1 March 2010 (Australian BSE requirements) (FSANZ 2010).
- Imported Food Control Act 1992 which requires imported food to comply with the Australia New Zealand Food Standards Code and not pose a risk to human health.

A qualitative likelihood was assigned to describe the likelihood of LSDV entering Australia in fresh bovine skeletal muscle meat imported for human consumption.

3.2 Exposure assessment

The exposure assessment describes the biological pathways necessary for exposure of susceptible animals to the hazard from the imported product and estimates the probability of the exposure occurring. It considers biological factors of LSDV; importing country factors such as the presence of competent vectors, human and animal demographics; geographical and environmental characteristics; and commodity factors such as quantity to be imported, end use and disposal practices. In this addendum, the exposure assessment estimated the qualitative likelihood of susceptible animals in Australia being directly exposed to and infected with the disease agent introduced via contaminated fresh bovine skeletal muscle meat.

The method for exposure assessment in the beef review considered the possibility of susceptible animals being exposed to contaminated waste products derived from beef or beef products. As LSD can be transmitted mechanically through insect vectors, this addendum also considered the possibility of transmission through insects becoming contaminated through contact with contaminated waste products, and then exposing at least one susceptible animal. Exposure groups considered were domestic and feral cattle and buffalo.

3.3 Estimation of the likelihood of entry and exposure

The likelihood of entry and exposure of LSDV was estimated by combining the likelihood of entry and the corresponding likelihood of exposure using the matrix shown in Figure 1.

Figure 1 Matrix for combining qualitative likelihoods

Likelihood of entry						
High	Negligible	Extremely low	Very low	Low	Moderate	High
Moderate	Negligible	Extremely low	Very low	Low	Low	Moderate
Low	Negligible	Extremely low	Very low	Very low	Low	Low
Very low	Negligible	Extremely low	Extremely low	Very low	Very low	Very low
Extremely low	Negligible	Negligible	Extremely low	Extremely low	Extremely low	Extremely low
Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
	Negligible	*Extremely low*	*Very low*	*Low*	*Moderate*	*High*

Likelihood of exposure

3.4 Consequence assessment

3.4.1 Likelihood of establishment and/or spread

The consequence assessment describes the relationship between exposures to the identified hazard and the consequences of those exposures. It assesses the likelihood of establishment and/or spread of LSDV and the potential impacts/effects of the disease (that is, the outbreak scenario).

The likelihood of significant outbreaks occurring following cases of LSD (the likelihood of establishment and/or spread) was assessed qualitatively. Factors relevant to this assessment included pathogen factors, exposure group factors, demographic and environmental factors, and disease control factors.

Consequences attributable to the outbreaks were assessed qualitatively in terms of direct and indirect effects on human, animal and plant life and health on a national scale, including adverse health, environmental and socioeconomic effects.

The likely consequences of establishment and/or spread of the disease agent were then estimated by combining the likelihood of establishment and/or spread with the overall effect of establishment and/or spread using the matrix shown in Figure 2.

Figure 2 Likely consequences matrix

Likelihood of establishment and/or spread						
High	Negligible	Very low	Low	Moderate	High	Extreme
Moderate	Negligible	Very low	Low	Moderate	High	Extreme
Low	Negligible	Negligible	Very low	Low	Moderate	High
Very low	Negligible	Negligible	Negligible	Very low	Low	Moderate
Extremely low	Negligible	Negligible	Negligible	Negligible	Very low	Low
Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Very low
	Negligible	*Very low*	*Low*	*Moderate*	*High*	*Extreme*

Overall effect of establishment and/or spread

3.5 Risk estimation

The overall likelihood of entry and exposure was combined with the likely consequences using Figure 3 to produce the risk estimate for LSD in imported bovine skeletal muscle meat.

Figure 3 Risk estimation matrix

Likelihood of entry and exposure						
High	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Moderate	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Low	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk	High risk
Very low	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk
Extremely low	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk
Negligible	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk
	Negligible	*Very low*	*Low*	*Moderate*	*High*	*Extreme*

Likely consequences of establishment and/or spread

4 Technical information

4.1 Agent properties

LSDV can remain viable for many months in the environment, especially in dark environmental conditions such as contaminated animal sheds. It can survive in necrotic skin nodules for longer than 33 days, desiccated crusts for up to 35 days and air-dried hides for at least 18 days (WOAH 2017).

4.2 Epidemiology

Biting insects have been shown to be the primary route for transmitting the disease under field circumstances (Magori-Cohen et al. 2012). Ticks have also been implicated (Lubinga et al. 2015; Lubinga et al. 2013; Tuppurainen & Oura 2012). Outbreaks have been associated with *Stomoxys calcitrans* (stable fly) carrying LSDV over 80 km, and possibly over 200 km by wind in Israel (Yeruham et al. 1995). Experimentally, it was shown that *S. calcitrans* can transmit capripox viruses between sheep, (Kitching & Mellor 1986) and *Aedes aegypti* can transmit LSDV from infected cattle to susceptible cattle (Chihota et al. 2001).

The incubation period of LSD ranges from 1 to 4 weeks and can be as early as 4 days in experimentally infected animals (CFSPH 2017). The incubation period of LSD in the WOAH Terrestrial Code is 28 days (WOAH 2021).

LSD is a highly infectious transboundary disease. The primary mode of transmission of LSDV is mechanical through biting arthropod vectors such as mosquitoes *A. aegypti*, *Anopheles stephensi* and *Culex quinquefasciatus*, *S. calcitrans* and the biting midge *Culicoides nubeculosus*. The virus does not replicate in these arthropods (Klement 2018; Tuppurainen et al. 2013a). Frequency of disease is higher in warm and humid weather conditions when there are high population densities of biting arthropods (Machado et al. 2019).

Ticks are also competent vectors of LSDV and may act as reservoirs. Transstadial and mechanical transmission have been demonstrated in several species of ticks including *Amblyomma hebraeum* and *Rhipicephalus appendiculatus*, and transovarial transmission has been shown in *Rhipicephalus decoloratus* ticks (Lubinga et al. 2015; Lubinga et al. 2013; Tuppurainen et al. 2013a; Tuppurainen et al. 2013b). However, an understanding of the role of ticks in transmission of the virus requires further investigation (Klement 2018).

A high proportion of animals infected with LSDV (up to 50%) have sub-clinical or mild infection but are still viraemic and capable of transmitting the disease via vectors (Osuagwuh et al. 2007; Tuppurainen, Alexandrov & Beltrán-Alcrudo 2017; Tuppurainen, Venter & Coetzer 2005). However, uptake of LSDV by biting vectors is most efficient from clinically affected animals. Insects (*A. aegypti*, *C. quinquefasciatus*, *S. calcitrans*, and *C. nubeculosus*) that feed on sub-clinical animals were found to be 97% less likely to acquire LSDV than insects feeding on a clinical animal (Sanz-Bernardo et al. 2021). This suggests that the viral load in sub-clinical animals is lower than in clinically affected animals. The same study found that sub-clinically infected cattle are significantly less likely to transmit LSDV compared with clinically infected cattle.

Although transmission may occur by ingestion of feed and water contaminated with infected saliva (WOAH 2013), LSDV is not readily spread by direct contact (cutaneous lesions, saliva, respiratory secretions, milk and semen) or iatrogenically through the use of contaminated needles (Carn & Kitching 1995; Kitching & Taylor 1985). Experimental infection has occurred following subcutaneous, intramuscular and intravenous injection with LSDV.

Direct contact transmission of LSDV in the absence of vectors is generally considered to be inefficient (Sprygin et al. 2019; Weiss 1968). However, a 2020 study suggests that recombination of LSDV could be producing strains that may be more capable of transmission in the absence of vectors (Kononov et al. 2019a; Kononov et al. 2020).

The recombinant strain involved, LSDV RUSSIA/Saratov/2017, was isolated from a field case of LSD following widespread vaccination of cattle in an adjacent country with a live attenuated LSD vaccine (Sprygin et al. 2018). Infection following direct transmission of LSDV RUSSIA/Saratov/2017 showed a distinct pattern of initial lesion development focused on the head and neck and is likely the result of initial infection in the lungs or mucosa; however, generalised lesions eventually developed in the in-contact animals. In-contact animals in the absence of vectors developed similar or lower viral titres in blood, ocular and nasal secretions by comparison with intravenously infected animals to which they were exposed (Kononov et al. 2020).

4.3 Pathogenesis

After biting insects have transmitted LSDV to the susceptible host, replication initially occurs in the skin. Viraemia is usually detectable after 6 days and lasts for approximately 9 days. LSDV continues to be shed from nasal, oral and conjunctival secretions for at least 1 week post viraemia (Babiuk 2018). LSDV genome has been detected up to 42 days from skin lesions in infected cattle and viral isolation was successful up to 15 days post infection (Babiuk et al. 2008).

LSD causes systemic disease in cattle and buffalo, with fever, generalised skin nodules, lesions in the mucous membranes and internal organs, emaciation, enlarged lymph nodes and cutaneous oedema. Pox lesions can be seen on mucous membranes of the eyes, mouth, nose, pharynx, epiglottis, trachea; on the ruminal and abomasal mucosae; on the muzzle, nares, prepuce, testicles, udder and teats; in the vulva and under the tail (WOAH 2013).

Mortality rates of between 1% and 5%, and morbidity rates of between 10% and 20% are expected for LSD in cattle (WOAH 2022b).

4.4 Transmission in skeletal muscle meat

As mentioned above, LSDV is transmitted primarily by biting insects and is not readily spread by direct contact. However, poxvirus nodules might be present in the muscles of infected animals and the virus is resistant to environmental degradation. In addition, LSDV persists for a prolonged period within the skin of infected animals (Tuppurainen, Venter & Coetzer 2005). Thus, it is theoretically possible that meat or other carcase parts, particularly skin, may introduce LSDV into a region where it can then spread, due to viral persistence in these tissues.

Several papers have stated that LSD lesions may be present in meat and/or musculature. Some masses (lumps) may be detected in the subcutaneous tissues and are often distributed throughout the connective tissue and muscle in the body (Diesel 1949). Nodules may be found in the subcutaneous tissue, muscle fascia, muscle and internal organs (Davies 1991; Mulatu & Feyisa 2018). Clinical signs of LSD in cattle are mild to severe; characterised by fever, multiple skin nodules covering the neck, back, perineum, tail, limbs, genital organs, mucous membranes, and the lesions may also involve subcutaneous tissues and sometimes musculature and internal organs. Histopathological examination of affected cattle during an LSD outbreak in Egypt found marked coagulative necrosis of subcutaneous muscle (Neamat-Allah 2015). Histopathology of gross lesions (nodules) from affected cattle in an Egyptian abattoir over 12 months revealed that the nodules involved all layers of the skin and occasionally the adjacent muscle (Ahmed & Dessouki 2013).

However, at the time of the beef review, the only observational studies to mention LSD in bovine muscle described pathology associated with LSD in subcutaneous muscle and not skeletal muscle (Ahmed & Dessouki 2013; Neamat-Allah 2015; Young, Basson & Weiss 1970).

Kononov et al. (2019b) is the only peer-reviewed study that examines the likelihood of skeletal muscle becoming contaminated with LSDV. In that study, 12 bulls were inoculated intravenously with a dose of 2×10^5 median tissue culture infectious doses ($TCID_{50}$) of LSDV. At 21 days post-inoculation, no infectious LSDV nor LSDV RNA was detected in apparently healthy skeletal muscle tissue harvested from all animals (8 clinically and 4 sub-clinically infected cattle). LSDV was only recovered from muscle tissues physically connected to overlying skin lesions in 4 of the experimentally inoculated animals with clinical signs of disease.

Kononov et al. (2019b) concluded that the likelihood of transmission through skeletal meat not connected to adjacent skin lesions was minimal and stated that "… this is the first scientific confirmation that skeletal meat of cattle infected with a virulent LSDV strain can be considered a commodity with a very low risk".

The WOAH Terrestrial Code (Article 11.9.2) now recommends that skeletal meat should not require any LSD-related conditions regardless of the status of the animal population of the exporting country and has nominated skeletal muscle as a "safe commodity"[6] (WOAH 2022b). This article states that when authorising import or transit, Veterinary Authorities should not require any LSD-related conditions regardless of the status of the animal population of the exporting country for skeletal muscle, casings, gelatine and collagen, tallow, hooves and horns. However, it is important to note the WOAH Terrestrial Code requires that the production of meat is undertaken in accord with applicable international standards.

The department notes that since the beef review was published, the Ministry for Primary Industries Biosecurity New Zealand released *Technical Advice Risk of lumpy skin disease via import of cattle and buffalo meat and meat products for human and animal consumption* (Ministry for Primary Industries 2022). This concluded that "risk management measures are not justified for LSDV when cattle and

[6] The WOAH Terrestrial Code defines a safe commodity as "a commodity that can be traded without the need for risk mitigation measures specifically directed against a particular listed disease, infection or infestation and regardless of the status of the country or zone of origin for that disease, infection or infestation".

buffalo meat and meat products intended for human and animal consumption are imported into New Zealand”.

There are no reports in the scientific literature which implicate meat from LSD infected animals in the transmission of LSDV.

4.5 Current biosecurity measures

LSD is a WOAH-listed disease (WOAH 2022a). As for other animal diseases with significant adverse impacts, the implications of WOAH listing are broad ranging, extending beyond that described below.

The Australian Government’s 2017 beef review noted that LSD was accepted by Australia as not present in the applicant countries (Japan, the Netherlands, New Zealand, the United States and Vanuatu), so a full risk assessment was not conducted (Department of Agriculture and Water Resources 2017). As mentioned earlier, current import conditions for the import of beef and beef products for human consumption from applicant countries require country freedom from LSD. Countries at the present time need to be acceptable to Australia as free from LSD (as well as meeting all other requirements) to be eligible to supply fresh (chilled or frozen) beef or beef products to Australia.

Should an applicant country experience an incursion of LSD, the expectation is that regulatory programs and relevant legislation would come into immediate effect to notify trading partners and WOAH of the detection, as well as specify what affected product may be in transit and contain the outbreak with the objective of eradication if possible. Article 2.1.4.1b in the WOAH Terrestrial Code refers to evaluation of veterinary services of the exporting country as an important input to the entry assessment (WOAH 2022b).

5 Risk Assessment

5.1 Entry assessment

The following factors were considered relevant to an estimate of the likelihood of LSDV being present in fresh bovine skeletal muscle meat imported for human consumption from applicant countries:

- LSD has an expanding global distribution and presents a significant ongoing animal disease threat.
  - As mentioned in Section 2, LSD was originally limited to Africa but has spread throughout the Asian continent. It is now present in South East Asia including Vietnam, Thailand, Malaysia and Indonesia.
- The likelihood of LSDV entering Australia in fresh bovine skeletal muscle meat is reduced by general entry requirements and the notification requirements in applicant countries, should there be an incursion. The sourcing of fresh beef and beef products from animals that have undergone suitable ante- and post-mortem inspection in establishments under the control of the Competent Authority of countries approved to export to Australia ensures that only healthy animals will be slaughtered for human consumption.
- Should any clinically affected animals not be detected before transport to the abattoir in the source country, or develop clinical signs of LSD during transport, they are highly likely to be identified during the specified ante- and post-mortem inspection with the source country's controls coming into immediate effect.
- It is possible that sub-clinically affected animals may enter an abattoir for processing. However, current research suggests that the viral load in sub-clinical animals is lower than in clinically affected animals. There is evidence that sub-clinically infected cattle are significantly less likely to transmit LSDV compared with clinically infected cattle (Sanz-Bernardo et al. 2021).
- Kononov et al. (2019b) attempted to isolate infectious LSDV in clinically and sub-clinically infected cattle 21 days after inoculation with LSDV.
  - No infectious LSDV was detected in apparently healthy skeletal muscle tissue (that was not underlying skin lesions) from the 8 clinically affected animals. LSDV was only recovered from skeletal muscle tissue that was physically connected to overlying skin lesions in 4 of the clinically affected animals.
  - No infectious LSDV was detected in apparently healthy skeletal muscle tissue harvested from the 4 sub-clinically infected animals. LSDV was only detected in enlarged lymph nodes and testicles of these animals. It is important to note that lymph nodes are not included in the definition of bovine skeletal muscle meat (see Section 1.2).
  - This study demonstrates that skeletal muscle meat of cattle infected with a virulent strain of LSDV is highly unlikely to be infectious regardless of the clinical presentation, as long as the skeletal muscle tissue is not connected to underlying lesions.

  - Article 11.9.2. of the WOAH Terrestrial Code (WOAH 2022b) advises that, for the purposes of international trade, bovine skeletal muscle meat is a safe commodity regardless of the LSD status of the animal population in the exporting country.
- During the viraemic phase of infection, LSDV is present in an animal's blood, raising the possibility of infectious blood being retained in fresh bovine skeletal muscle meat. While blood is retained in a carcase following slaughter and exsanguination, it is largely retained in the viscera rather than the skeletal muscle.
  - The residual blood content of lean meat was found to be 2–9 mL/kg muscle in studies. There is no evidence that this amount is affected by different slaughter methods or that large amounts of residual blood influence the microbiology of meat (Warriss 1984).

Based on these factors, the entry assessment for LSDV via fresh bovine skeletal muscle meat derived exclusively from bovines concludes there is a **very low** likelihood of entry of this disease via fresh bovine skeletal muscle meat when sourcing and official inspection requirements for import are fulfilled in applicant countries.

5.2 Exposure assessment

The following factors were considered relevant to an estimate of the likelihood of susceptible animals being exposed to LSDV in fresh bovine skeletal muscle meat imported for human consumption from applicant countries:

- Biting flies in Australia that may be able to feed on bovine skeletal muscle meat have an extremely low to negligible likelihood of ingesting LSDV (Sanz-Bernardo et al. 2021) and being able to pass it on to cattle or buffalo.
- All states and territories in Australia prohibit the feeding of Restricted Animal Material (RAM) to all ruminants. RAM is defined as any material taken from a vertebrate animal other than tallow, gelatin, milk products or oils. It includes meat, rendered products, such as blood meal, meat meal, meat and bone meal, fish meal, poultry meal, eggs, feather meal, and compounded feeds made from these products.
- There are no reports in the scientific literature which implicate meat from LSD infected animals in the transmission of LSD.

The likelihood that biting insects feeding on fresh bovine skeletal muscle meat could become contaminated with LSDV and spread the disease to susceptible cattle or buffalo within Australia is estimated to be **extremely low**.

The likelihood of exposure of susceptible cattle or buffalo to infection through oral exposure to fresh bovine skeletal muscle meat is estimated to be **extremely low**.

5.3 Estimate of the likelihood of entry and exposure

The likelihood of entry of LSDV was estimated to be **very low**, and the likelihood of exposure to LSDV was estimated to be **extremely low**. Using Figure 1, the likelihood of entry and exposure for LSDV was estimated to be **extremely low**.

5.4 Consequence assessment

5.4.1 Identification of an outbreak scenario and likelihood of establishment and/or spread associated with the outbreak scenario

The most likely outbreak scenario following exposure of susceptible animals to LSDV in imported fresh bovine skeletal muscle was considered to be establishment in the directly exposed population and spread to other populations of susceptible animals across multiple states or territories.

The following factors were considered relevant to an estimate of the likelihood of the identified outbreak scenario occurring:

- Transmission of LSDV is primarily via biting arthropod vectors. Spread of disease is usually influenced by synoptic systems, geography and climate. The virus could spread quickly and be difficult to control in a country or region that has an abundance of competent vectors and favourable conditions for vector survival, such as Australia.
- Movement of infected animals is the main pathway for long-distance dispersal of LSD. Animal movements between states and territories occurs frequently.
- Clinical signs of LSD may not be evident for several weeks after infection. However, on a newly affected farm it is likely that some animals would display clinical signs of disease within the first or second week of infection.

Based on these considerations, the likelihood of establishment and/or spread of LSDV associated with the identified outbreak scenario was estimated to be **moderate**.

5.4.2 Determination of overall effect of establishment and/or spread associated with outbreak scenario

Factors considered relevant to the effect on the life or health (including production effects) of susceptible animals were:

- Mortality of between 1% and 5% is expected for LSD.
- Animals affected by LSD may have permanent loss of milk production, infertility problems and permanent damage to hides.

The effect on the living environment, including life and health of wildlife, and any effects on the non-living environment of LSD is not considered to be negligible.

The effect on new or modified eradication, control, monitoring or surveillance and compensation strategies or programs include that:

- If LSD was identified in Australia, the response strategy as outlined in the AUSVETPLAN Response Strategy for LSD is eradication in the shortest possible time using stamping out. This would be supported by a combination of strategies including sanitary disposal of destroyed animals and contaminated animal products, quarantine and movement controls, decontamination of fomites, control of vectors, tracing and surveillance, zoning and/or compartmentalisation, vaccination if available, and an awareness campaign (AHA 2022b).
- LSD is scheduled as Category 3 under Australia’s Emergency Animal Disease Response Agreement (EADRA) for cost-sharing arrangements. Should it be activated, EADRA states that

direct costs of the response would be shared by Australian governments and relevant industries by contributions of 50% each (AHA 2022a).

The effect on domestic trade or industry, including changes in consumer demand and effects on other industries supplying inputs to, or using outputs from, directly affected industries include that:

- Following a detection of LSD, domestic movement restrictions would disrupt domestic markets.
- Along with affected livestock producers, associated industries in affected regions would suffer losses, such as transporters, stockfeed manufacturers and processors of animal products.
- With export market disruptions, relevant animal products destined for export would be redirected to the domestic market and domestic prices may fall. As a result, revenue for affected and associated industries would decrease.
- Domestic consumers may be concerned about the safety of animal products. This could reduce sales of products derived from relevant species. An awareness campaign may be needed to educate consumers that LSD does not affect food safety.

The effect on international trade, including loss of markets, meeting new technical requirements to enter or maintain markets and changes in international consumer demand include that:

- An outbreak of LSD in Australia would significantly disrupt exports of relevant animals and animal products from Australia. Resumption of trade would depend on renegotiations with importing countries and additional biosecurity measures may need to be met.
- Under the WOAH Terrestrial Code, freedom from LSD can only be claimed after a minimum of 14 months following the stamping out of the last vaccinated or infected animal (WOAH 2021).
- In 2021, Australian beef exports were valued at $9.2 billion (MLA 2022).
- Australian dairy product exports are forecast to be $3.4 billion in the 2022–23 financial year (Department of Agriculture, Fisheries and Forestry 2023).
- If LSD became established, zoning could be used to maintain or regain access to international markets. However, export markets for relevant commodities from affected zones may be lost or restricted, and access to new export markets could be affected.

The effect on the environment, including biodiversity, endangered species and the integrity of ecosystems include that:

- Disposal of destroyed animals and animal products, and increased use of disinfectants, may have effects on the environment.
- Increased use of insecticides for insect control could impact a range of insect species and disrupt food sources of wildlife, lead to environmental contamination (including water sources) and resistance to insecticides.

The effect on communities, including reduced tourism, reduced rural and regional economic viability and loss of social amenity, and any ‘side effects’ of control measures include that:

- Psychological distress could occur due to implementation of control and eradication measures, such as for owners of animals that are destroyed as part of disease control measures.

- Ongoing financial distress could occur for owners of affected premises if the disease situation prevents timely restocking.
- Where the relevant species were important to the local economy, if LSD became established, the economic viability of communities within affected regions may be compromised due to effects on directly affected and associated industries.
- Disruption of events due to movement controls could have social consequences for people involved.

Based on the geographic level and magnitude of effects, the overall effect of establishment and/or spread of LSDV associated with the identified outbreak scenario was estimated to be **high**. The effect is likely to be significant at the national level and highly significant within affected zones. This implies that the effect would be of national concern. However, serious effects on economic stability, societal values or social well-being would be limited to a given zone.

5.4.3 Derivation of likely consequences

The likelihood of establishment and/or spread of LSDV was estimated to be **moderate**. The overall effect of establishment and/or spread for LSDV was estimated to be **high**. Using Figure 2, the likely consequences of establishment and/or spread of LSDV were estimated to be **high**.

5.5 Risk estimation

The likelihood of entry and exposure of LSDV was estimated to be **extremely low**. The likely consequences of establishment and/or spread of LSDV was estimated to be **high**. Using Figure 3, the unrestricted risk of LSDV was estimated to be **very low**. Further risk management is therefore not required to meet Australia's ALOP.

6 Conclusion and recommendations

The overall biosecurity risk of LSD associated with the importation of fresh bovine skeletal muscle meat derived from bovines in applicant countries that have been approved for the importation of fresh beef and beef products into Australia is assessed as **very low** when all sourcing and processing requirements specified in the beef review are met. Under those conditions of trade Australia's ALOP with respect to animal biosecurity risks will have been achieved and additional biosecurity measures for LSDV are not required. This finding is consistent with the New Zealand risk assessment which concluded that risk management measures were not justified for imported cattle and buffalo meat and meat products for human consumption (Ministry for Primary Industries 2022).

It is recommended that the requirement for country freedom from LSD for the export of fresh bovine skeletal muscle to Australia from approved source countries be removed from Australia's published import conditions for imported fresh bovine skeletal muscle meat.

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