SCIENTIFIC OPINION

Assessment of listing and categorisation of animal diseases within the framework of the Animal Health Law (Regulation (EU) No 2016/429): Border disease

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Abstract

Border disease has been assessed according to the criteria of the Animal Health Law (AHL), in particular criteria of Article 7 on disease profile and impacts, Article 5 on the eligibility of Border disease to be listed, Article 9 for the categorisation of Border disease according to disease prevention and control rules as in Annex IV and Article 8 on the list of animal species concerned by Border disease. The assessment has been performed following a methodology composed of information collection and compilation, expert judgement on each criterion at individual and, if no consensus was reached before, also at collective level. The output is composed of the categorical answer, and for the questions where no consensus was reached, the different supporting views are reported. Details on the methodology used for this assessment are explained in a separate opinion. According to the assessment performed, Border disease can be considered eligible to be listed for Union intervention as laid down in Article 5(3) of the AHL. The disease would comply with the criteria as in Sections 3, 4 and 5 of Annex IV of the AHL, for the application of the disease prevention and control rules referred to in points (c), (d) and (e) of Article 9(1). The animal species to be listed for Border disease according to Article 8(3) criteria are mainly sheep and other species of the family Bovidae as susceptible and reservoirs.

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1.   Introduction

1.1.   Background and Terms of Reference as provided by the requestor

The background and Terms of Reference (ToR) as provided by the European Commission for the present document are reported in Section 1.2 of the scientific opinion on the ad hoc methodology followed for the assessment of the disease to be listed and categorised according to the criteria of Article 5, Annex IV according to Article 9, and 8 within the Animal Health Law (AHL) framework (EFSA AHAW Panel, 2017).

1.2.   Interpretation of the Terms of Reference

The interpretation of the ToR is as in Section 1.2 of the scientific opinion on the ad hoc methodology followed for the assessment of the disease to be listed and categorised according to the criteria of Article 5, Annex IV according to Article 9, and 8 within the AHL framework (EFSA AHAW Panel, 2017).

The present document reports the results of assessment on Border disease (BD) according to the criteria of the AHL articles as follows:

- Article 7: Border disease profile and impacts
- Article 5: eligibility of Border disease to be listed
- Article 9: categorisation of Border disease according to disease prevention and control rules as in Annex IV
- Article 8: list of animal species related to Border disease.

2.   Data and methodologies

The methodology applied in this opinion is described in detail in a dedicated document about the ad hoc method developed for assessing any animal disease for the listing and categorisation of diseases within the AHL framework (EFSA AHAW Panel, 2017).

3.   Assessment

3.1.   Assessment according to Article 7 criteria

This section presents the assessment of BD according to the Article 7 criteria of the AHL and related parameters (see Table 2 of the opinion on methodology (EFSA AHAW Panel, 2017)), based on the information contained in the fact-sheet as drafted by the selected disease scientist (see Section 2.1 of the scientific opinion on the ad hoc methodology) and amended by the AHAW Panel.

3.1.1.   Article 7(a) Disease Profile

Border disease is a pestivirus disease of mainly sheep and occasionally goats caused by border disease virus (BDV): family Flaviviridae, genus *Pestivirus* (Nettleton et al., 1998; OIE, 2017). Like all pestiviruses, BDV can infect a wide range of host species but was initially described as a pathogen of sheep. Infection of immunocompetent animals generally leads to mild symptoms followed by seroconversion. However, occasional isolates may cause more serious disease (Chappius et al., 1984; OIE, 2017). Infection of females during pregnancy can lead to abortion, stillbirth, birth defects and the birth of congenitally infected progeny. In goats, abortion is the main outcome but occasional persistently infected (PI) kids can be born. PI lambs or kids are seronegative, tolerant of the virus and shed it in all secretions and excretions throughout their lives, making them a major driver of BD epidemiology. They can have fleece abnormalities in addition to musculoskeletal and nervous signs. Classical appearance is the 'hairy shaker' lamb where the coat is noticeably longer and finer than normal and the young has tremors that can range from mild to severe. PI lambs may be born smaller than normal and exhibit poorer growth rates and health. They may also succumb to disease similar in appearance to mucosal disease in cattle caused by the related pestivirus bovine viral diarrhoea virus (BVDV), characterised by the presence of cytopathic versions of the initial infecting virus (OIE, 2017). Infection at later stages in pregnancy (after the onset of fetal immunocompetence) generally results in birth of virus-free offspring that are seropositive and otherwise normal, although some weak lambs may die early in life (Barlow and Patterson, 1982; OIE, 2017).

There is no effective vaccine for BDV, although a killed vaccine has been produced (Brun et al., 1993). Disease control is achieved by flock management and biosecurity, particularly with respect to pregnant ewes.

National eradication programmes for the related pestivirus BVDV may be influenced by BDV infection. Although BDV infects cattle infrequently, BVDV infection of sheep is more frequent and causes disease identical to BD. This makes appropriate diagnosis and biosecurity for BD important, especially where it could compromise the BVDV status of in-contact cattle.

3.1.1.1. Article 7(a)(i) Animal species concerned by the disease

Susceptible animal species

It is likely that pestiviruses including BDV can infect a wide range of even-toed ungulates. This group includes domesticated species including sheep, goats, cattle and pigs, plus wild animals such as antelopes, camels, deer, giraffes, hippopotamuses, llamas and alpacas. BDV infection has been demonstrated by serology or virus detection in several of these species.

Parameter 1 – Naturally susceptible wildlife species (or family/orders)

- Reindeer (*Rangifer tarandus*) (Becher et al., 1999, 2003; Avalos-Ramirez et al., 2001)
- Chamois (*Rupicapra rupicapra*) (Riekerink et al., 2005)
- Pyrenean chamois (*Rupicapra pyrenaica pyrenaica*) (Arnal et al., 2004)
- Mouflon (*Ovis musimon*) (Hemmatzadeh et al., 2016)
- European hare (*Lepus europaeus*) (Colom-Cadena et al., 2016)
- Alpine ibex (*Capra ibex*) (Fernández-Aguilar et al., 2016)

Parameter 2 – Naturally susceptible domestic species (or family/orders)

- Sheep (*Ovis aries*) (Barlow and Patterson, 1982)
- Cattle (*Bos taurus/indicus*) (Becher et al., 1997)
- Goats (*Capra hircus*) (Nettleton et al., 1998)
- Pig (*Sus scrofa*) (Vilcek and Belák, 1996)
- Alpaca (*Vicugna pacos*) (Danuser et al., 2009)
- Llama (*Lama glama*) (Danuser et al., 2009)

Parameter 3 – Experimentally susceptible wildlife species (or family/orders)

There is little information on experimental infection, although evidence from BVDV suggests that pestiviruses can infect a wide range of species.

- Pyrenean chamois (*Rupicapra pyrenaica*) (Martin et al., 2013)

Parameter 4 – Experimentally susceptible domestic species (or family/orders)

- Sheep (Nettleton et al., 1992)
- Goats (Løken et al., 1991)
- Cattle (Braun et al., 2015)
- Pigs (Cabezón et al., 2010a)

Reservoir animal species

Parameter 5 – Wild reservoir species (or family/orders)

No specific information is available.

Parameter 6 – Domestic reservoir species (or family/orders)

Sheep, cattle, goats and pigs can all produce PI offspring that shed virus and can act as a persistent source of infection to in-contact animals, thus acting as reservoir species.

3.1.1.2. Article 7(a)(ii) The morbidity and mortality rates of the disease in animal populations

Morbidity

Parameter 1 – Prevalence/Incidence

BD has a world-wide distribution with seroprevalence estimated to vary from 5% to 50% (OIE, 2017). However, relatively few prevalence studies have been done in recent years and cross-reactivity

of serological assays between BDV and BVDV complicates analyses. Reports from Spain (Berriatua et al., 2006; Valdazo-González et al., 2006) suggested flock prevalence of 68% and 100%; while 68% of sheep on communal alpine pastures in Austria were BD-positive (Krametter-Froetscher et al., 2007). The number of PI animals driving these high seroprevalence figures appears to be no more than 1% of the at-risk population (Krametter-Froetscher et al., 2010; Schweizer and Peterhans, 2014). Similarly high prevalence has also been reported in Pyrenean chamois (Fernández-Sirera et al., 2012a).

While antigenic cross-reactivity with BVDV causes problems for assay specificity, the ability of sheep to be infected with BVDV, inducing symptoms identical to BD, means that any BD analysis requires either molecular confirmation based on PI animals derived from the same outbreak, or the use of monoclonal antibodies or virus neutralisation assays that can distinguish between BDV and BVDV infection (Kaiser et al., 2017).

In goats, a study conducted in Italy in two herds where abortion, stillbirth and weak live kids were caused by BDV, pestivirus antibodies were detected in 61/67 and in 38/169 goats, respectively, for the two herds. In addition, a PI goat was found in one herd (Rosamilia et al., 2014).

Parameter 2 – Case-morbidity rate (% clinically diseased animals out of infected ones)

Experimental and natural infection of immunocompetent sheep has generally been reported to cause inapparent or little overt disease (Nettleton et al., 1998), with a very low case-morbidity rate. Symptoms include mild fever and inflammatory response followed by induction of virus-neutralising antibodies (Barlow and Patterson, 1982). Experimental infection with different BDV strains also showed mild clinical signs and similar weight gain (Thabti et al., 2002). However, a recent feedlot study showed that about 55% of 36 lambs tested were infected with BDV and had 2.1 times higher risk of showing gastrointestinal and respiratory signs of disease and a 20% reduction in growth rate compared to uninfected lambs (González et al., 2014). Infection of pregnant ewes results in BD-affected offspring with the outcome of infection depending on the timing of infection and the strain of virus. Infection before the onset of fetal immunocompetence causes approximately 50% fetal death, with surviving lambs being PI and tolerant to the virus. PI lambs can be underweight and weak and many die at or around weaning time and in distinctive cases show tremor and abnormal body conformation and hairy fleeces (Nettleton, online). However, a small proportion of PI sheep appears normal and can survive to breeding age, giving birth to lambs that are always PI (Nettleton et al., 1992, 1998).

Infection occurring around mid-gestation can result in lambs showing severe nervous and skeletal symptoms of BD (Nettleton et al., 1998). Lambs infected in late gestation can appear normal and healthy, are born with BDV antibody and free of virus. Some of such lambs, however, can be stillborn or weak and many die in early life (Nettleton et al., 1998).

BD can also occur in goats and, although disease in goats is rare, reproductive failure (barrenness, abortion, stillbirth) is the main outcome of infection during pregnancy, found in over 80% of cases (Løken et al., 1991). In two eastern China provinces, BDV infection was confirmed in goat herds suffering intractable diarrhoea by virus isolation with morbidity and mortality of about 28–37% and 10–15%, respectively (Li et al., 2013).

Mortality

Parameter 3 – Case-fatality rate

While infection of immunocompetent hosts has generally been reported to cause little overt disease, mortality in the offspring of infected pregnant females depends on the timing of infection, virulence of the infecting strain and the species/breed of the infected host. Case-fatality rates among the offspring of infected pregnant ewes have been reported to be around 50% (Barlow and Patterson, 1982). There have also been reports of more severe forms of BD, with the Aveyron virus, for example, producing outbreaks with mortality of 70% or more in sheep (Chappius et al., 1984; Vega et al., 2015) or in Pyrenean chamois (Fernández-Sirera et al., 2012a).

Congenitally infected lambs can grow slowly and many may die at or around weaning. Others may survive to adulthood but deaths due to late onset disease, with apparent similarities to mucosal disease in cattle, can also be seen. This fatal disease is associated with the appearance of a cytopathic BDV variant, apparently derived from the infecting virus (Barlow et al., 1983; Gardiner et al., 1983; Monies et al., 2004; Hilbe et al., 2009).

In Pyrenean chamois, infection with one BDV strain has been associated with population crashes observed in this species since 2001 (Arnal et al., 2004). Experimental infection with this strain of virus demonstrated almost 100% mortality in naïve infected chamois, confirming this link (Cabezón et al., 2010a; Fernández-Sirera et al., 2012a; Martin et al., 2013; Beaunée et al., 2015).

3.1.1.3. Article 7(a)(iii) The zoonotic character of the disease

Presence

Parameter 1 – Report of zoonotic human cases (anywhere)

There is no evidence of human infection with BDV.

3.1.1.4. Article 7(a)(iv) The resistance to treatments, including antimicrobial resistance

Parameter 1 – Resistant strain to any treatment even at laboratory level

No treatments against BDV infection are usually applied thus resistance to treatment is not relevant.

3.1.1.5. Article 7(a)(v) The persistence of the disease in an animal population or the environment

Animal population

Parameter 1 – Duration of infectious period in animals

Animals that are not previously infected *in utero* are viraemic for a short period (1–2 weeks) post-infection during which time they may present a risk of infection to naïve in-contact animals. However, the greatest risk of infection comes from surviving animals PI *in utero*. These PI animals are tolerant of the virus, have ongoing viraemia and excrete virus in all bodily secretions. As such they are the main source of infection for uninfected susceptible in-contact animals. Within-herd rates of infection of over 50% are common.

Parameter 2 – Presence and duration of latent infection period

There is no formal period of latent infection. Transiently infected animals have viraemia from about day 4 after infection for about 1 week. However, PI animals, being born tolerant of the virus, are antibody negative and virus positive and may therefore appear uninfected by serological analysis. In addition, in PI lambs that take colostrum containing anti-BDV antibodies, the viraemia may not be apparent for up to 2 months (OIE, 2017).

Parameter 3 – Presence and duration of the pathogen in healthy carriers

The only healthy carriers are a proportion of PI lambs that may appear healthy but carry and excrete BDV for life (Nettleton et al., 1998; OIE, 2017).

Environment

Parameter 4 – Length of survival (dpi) of the agent and/or detection of DNA in selected matrices (soil, water, air) from the environment (scenarios: high and low T)

BDV does not survive for long outside its host. As an enveloped virus, it is easily inactivated by heat, drying, detergents and UV light. Recent studies suggest that enveloped viruses may survive up to 5 days in dry environments (Firquet et al., 2015). However, where there is moisture in the environment and temperatures are moderate (less than 15°C, for example) BDV may survive for longer periods in agricultural environments. Direct transmission from PI to uninfected animals is considered the main route and housing will contribute to a higher rate on infection. Spread among unhoused grazing animals is considered to be slow (Nettleton et al., 1998), although some spread of disease within and between species on communal alpine pasture has been reported (Krametter-Froetscher et al., 2007; Braun et al., 2013).

3.1.1.6. Article 7(a)(vi) The routes and speed of transmission of the disease between animals, and, when relevant, between animals and humans

Routes of transmission

Parameter 1 – Types of routes of transmission from animal to animal (horizontal, vertical)

The main mode of transmission of BDV is horizontal, via nose-to-nose contact and potentially also via aerosols. Infection of susceptible animals in shared accommodation is highly effective compared with open grazing (Nettleton et al., 1998; Fernández-Sirera et al., 2012b; Nettleton, online).

PI animals that survive to breeding age will always produce PI offspring by congenital infection of the fetus. Vertical transmission is therefore an important factor in the epidemiology of BD because virus shed by PI animals is the main source of infection for uninfected susceptible animals.

Parameter 2 – Types of routes of transmission between animals and humans (direct, indirect, including food-borne)

Not applicable, since not zoonotic.

Speed of transmission

Parameter 3 – Incidence between animals and, when relevant, between animals and humans

The purchase of PI replacement females is the commonest way of introducing infection in a flock, then the transmission of BDV within flocks is highly dependent on husbandry of the animals as it is driven by the presence of PI animals and the opportunity for sheep-to-sheep contact to facilitate infection. Spread within sheep flocks that are grazed extensively is slow, potentially taking years, due to the fragility of the virus in the environment. Spread may be much faster within housed flocks or flocks sharing feeding troughs where nose-to-nose contact can occur. Sheep housed together during early pregnancy may suffer high rates of abortion or losses due to BD at lambing (Nettleton et al., 1998).

Parameter 4 – Transmission rate (beta) (from R_0 and infectious period) between animals and, when relevant, between animals and humans

The transmission rate for BDV has not been determined. However, it is likely to be similar to that for BVDV due similarities in their routes of infection. In experimental infection of calves, the basic reproduction ratio (R_0) was estimated to be 0.49 (95% CI 0.06; 2.99), suggesting a limited viral spread using the BVDV-2c strain. This suggests that this BVDV-2 infection in transiently infected (TI) animals resulted in limited transmission to other animals (Sarrazin et al., 2014).

In a previous study on a transmission model of BVD, R_0 for BVDV, estimated in dairy cattle herds without PI animals, ranged from 1.2 to 3.04, whereas this can increase up to 35.0, in the presence of PI animals (Cherry et al., 1998). This large range reflects different modes of pestivirus transmission. Vertical transmission from a PI cow is essentially 100% efficient, as is contact-mediated horizontal transmission from a PI animal. In contrast, transmission via fomites or from transiently infected animals is less efficient (Lindberg and Houe, 2005).

Transmission of BDV is driven by the presence of PI animals, which shed virus continuously for life, and the rate of infection of other animals depends on the degree of contact possible. Thus, the housing of pregnant naïve sheep with one or more PI sheep may lead to a high frequency of stillbirth, abortion and other losses at or around lambing due to BDV infection (Nettleton et al., 1998).

3.1.1.7. Article 7(a)(vii) The absence or presence and distribution of the disease in the Union, where the disease is not present in the Union, the risk of its introduction into the Union

Presence and distribution

Border disease has world-wide distribution.

Parameter 1 – Map where the disease is present in EU

The Member States (MSs) were BDV infection was reported to date are Austria (Krametter-Froetscher et al., 2007), Denmark (Tegtmeier et al., 2000), France (Dubois et al., 2008), Germany (Becher et al., 2003), Ireland (O'Neill et al., 2004), Italy (Fernández-Sirera et al., 2011, 2012b), the Netherlands (Orsel et al., 2009), Slovakia (Lešková et al., 2013), Spain (Berriatua et al., 2004), Sweden (Kautto et al., 2012) and the UK (Barlow and Patterson, 1982; Nettleton et al., 1998). Moreover, BDV infection has been reported in Turkey (Gur, 2009), Montenegro, and Switzerland (Schaller et al., 2000; Braun et al., 2013).

BDV has also been reported outside Europe, including Australia, Japan, New Zealand, USA (Giangaspero, 2011), China (Li et al., 2013), India (Mishra et al., 2012) and Iran (Hemmatzadeh et al., 2016).

Parameter 2 – Type of epidemiological occurrence (sporadic, epidemic, endemic) at MS level

From published reports, BD has been detected in 11 EU MSs, but it is likely to be present in all MSs where the size and density of the small ruminant population is sufficient to allow maintenance of disease circulation. Outbreaks of disease (reproductive failure, abortion, deaths of young animals) may also occur on a seasonal basis and relate to BDV infection of pregnant animals in a previously uninfected flock.

Risk of introduction

BDV infection is already present in EU.

3.1.1.8. Article 7(a)(viii) The existence of diagnostic and disease control tools

Diagnostic tools

Parameter 1 − Existence of diagnostic tools

There is no designated OIE Reference Laboratory for BDV but most Member State laboratories that provide pestivirus (BVDV, CSFV) testing are likely to perform BDV testing for differential diagnosis. One of the most sensitive proven methods for identifying BDV remains virus isolation. Direct immunofluorescence or other immunohistochemical techniques on frozen tissue sections as well as antigen-detecting enzyme-linked immunosorbent assay (ELISA) (Entrican et al., 1995) and conventional and real-time reverse-transcription polymerase chain reaction (RT-PCR) are also valuable methods for identifying BDV-infected animals.

Serological techniques, to identify BDV-specific antibody responses, include ELISA and virus-neutralisation assays. Protocols for both assays are provided in the OIE chapter on BD (OIE, 2017), while ELISA assay kits are available from a number of manufacturers, including (Table 1):

Table 1: ELISA kits for detection of BDV antibodies in sheep/goats

Company	Base	Test
LSI	France	LSIVet™ Ruminant BVD/BD p80 Serum/Milk ELISA Kit
Svanova Biotech AB	Sweden	SVANOVIR BDV-Ab kit
IDvet	France	ID Screen® BVD p80 Antibody One-Step
		ID Screen® BVD p80 Antibody Competition
Hipra	Spain	CIVTEST BOVIS BVD/BD P80

Some ELISA approaches, such as those specific for the p80 (E2) or Erns glycoproteins of BVDV may have broad pestivirus specificity and may be unsuitable for the specific diagnosis of BD in sheep.

Virus-neutralisation assays provide an opportunity to control against misidentification of BVDV-infected animals by testing cross-neutralising of different strains or species of pestivirus. BDV-specific sera should have a greater ability to neutralise BDV strains (a higher neutralising titre) than BVDV strains (Dekker et al., 1995; Paton et al., 1995; Nettleton et al., 1998).

RT-PCR is now widely used for detection of pestivirus nucleic acid. While pan-pestivirus primers may be used, they are not species-specific and a number of assays have been developed for specific recognition of BD viruses (Fulton et al., 1999; McGoldrick et al., 1999; Vilbek and Paton, 2000). A more recent multicolour real-time RT-PCR assay allows simultaneous detection and discrimination of BDV and BVDV types 1 and 2 (Willoughby et al., 2006).

Control tools

Parameter 2 − Existence of control tools

With no commercially available and effective vaccine, disease outbreaks are generally controlled by husbandry, with biosecurity measures similar to those in use for BVDV eradication (Nettleton, online). In consultation with the veterinary surgeon, a flock management programme should aim to remove all PI animals from the flock and prevent contact with or introduction of BDV-infected animals from outside − particularly aimed at preventing infection of pregnant ewes. Testing should be an integral part of this programme. Antibody ELISA on serum samples can be used to ascertain flock status, as flocks containing congenitally infected animals will contain seropositive animals.

Importantly, seropositive animals are likely to be immune to further infection (with the same or related virus strains (Dekker et al., 1995; Nettleton et al., 1998)). In contrast, BDV PI animals will be antibody-negative but virus-positive and can be rapidly identified by antigen ELISA or PCR-based testing (apart from about 2 months after colostrum with BDV-antibodies has been taken). Any virus antigen-positive animals should be re-tested after at least 2 weeks to confirm that the positive result was not due to transient infection with BDV.

Important considerations for BDV control include:

- Maintenance of a closed flock will help prevent disease as introduction of new stock is the usual route of infection.
- Purchase only from flocks free of BD and test all replacements for presence of virus.
- Isolate all newly purchased animals until they can be tested free of BDV. If testing is not done, then this should include the separate mating of ewes and maintenance of separation until lambing.
- If it is impractical to remove all PI sheep from the flock, an alternative strategy would be to deliberately expose the breeding stock to PI animals well in advance of the breeding season to increase the level of flock immunity. Indoor exposure for a period of weeks would be required for increased infection levels (Nettleton, online).

Note that contact with BVDV-infected cattle could increase the possibility of infection with BVDV, which can cause disease identical to BDV in sheep and goats and which can persist in a flock or herd in the same way. The converse is also true and BDV PI sheep or goats will present a risk of infection to in-contact cattle (Sandvik, 2014).

An inactivated, combined vaccine against BDV and BVDV has been described (Brun et al., 1993) but there is little evidence of its use or efficacy in sheep, although BDV-specific neutralising antibodies were demonstrated in cattle (Oguzoglu et al., 2003).

While there is clear need for a vaccine to prevent infection of pregnant susceptible sheep and goats, the market for a BDV vaccine may not be sufficient to support its development on economic grounds. However, some diagnostic tests – both for antigen and antibody – do not clearly distinguish between BVDV and BDV. Sheep and goats therefore could constitute a BDV reservoir such that BDV infection of in-contact cattle may interfere with BVD status during eradication. Thus, the need to prevent BDV infection interfering with BVDV eradication in cattle may provide further support for development of a BDV vaccine (Sandvik, 2014).

3.1.2. Article 7(b) The impact of diseases

3.1.2.1. Article 7(b)(i) The impact of the disease on agricultural and aquaculture production and other parts of the economy

The level of presence of the disease in the Union

Parameter 1 – Number of MSs where the disease is present

BDV infection has been reported in 11 MSs, although it is likely to be present in others MSs with sufficient numbers of sheep or goats that support the circulation of virus in the population. The seroprevalence of infection can vary between countries and regions but may be in the range of 5-50% among adult sheep (Nettleton et al., 1998; OIE, 2017). Published prevalence figures include 3% of Austrian flocks, with higher frequencies among animals on shared alpine pastures (Krametter-Froetscher et al., 2007, 2010), 8% of Danish flocks, 40–60% in alpine and Pyrenean chamois and mouflon (Marco et al., 2009; Fernández-Sirera et al., 2011, 2012a; Martin et al., 2011; Beaunée et al., 2015), 46% of sheep flocks in Ireland (O'Neill et al., 2004), about 27% of sheep and goat flocks in the Netherlands (Orsel et al., 2009), 30% of sheep flocks in Northern Ireland (Graham et al., 2001), and 25–100% of Spanish sheep flocks (Berriatua et al., 2004, 2006; García-Pérez et al., 2010; González et al., 2014; Fernández-Aguilar et al., 2016).

The loss of production due to the disease

Parameter 2 – Proportion of production losses (%) by epidemic/endemic situation

Infection of adult susceptible species with BDV usually leads to relatively mild symptoms, including mild fever and leukopenia with a brief viraemia between days 4 and 11 post-infection, followed by seroconversion producing virus neutralising antibodies that provide immunity to later infection with similar strains of virus. However, one study has suggested that BDV infection causes economic losses due to the increase in digestive and respiratory signs, together with the drop in growth rate and the delayed slaughter in commercial conditions (González et al., 2014).

Different strains of virus and infection of different hosts may also lead to different disease outcomes, such as the large losses due to the Aveyron strain of BDV in sheep (Chappius et al., 1984) and in outbreaks of BD in Pyrenean chamois (Marco et al., 2007).

Infection of pregnant animals with BDV, particularly before the fetus becomes immunocompetent at about day 85 of pregnancy, is an important cause of infertility in sheep, causing embryonic and fetal death. Surviving lambs may be weak and have congenital abnormalities – especially of the nervous system and coat. In goats, abortion is the most frequent outcome following infection of pregnant females. In all susceptible species, the congenitally infected offspring that survive infection *in utero* are the major source of infectious virus, which is shed from all secretions and excretions for the life of the animal. Congenitally infected offspring may also be smaller and have poorer growth than uninfected animals and have a shortened lifespan due to the activation of a cytopathic derivative of their infecting virus.

The economic losses due to BDV are mainly the results of losses associated with increased barrenness, abortion, stillbirth and neonatal death in the flock. There are little data on the economic impact but publications on losses in the UK (Sweasey et al., 1979; Sharp and Rawson, 1986) suggested that losses due to BDV infection of pregnant ewes were due to both the reduction in the number of surviving lambs and the reduced growth of surviving lambs, producing estimated losses of 20% and 45%, respectively, in the value of the lamb crop. The observed reduction on weight gain of 20% in a feedlot affected by transient BDV infection (González et al., 2014) suggests that production losses should not be attributed solely to infection of lambs *in utero*.

3.1.2.2. Article 7(b)(ii) The impact of the disease on human health

Not applicable – humans are not susceptible to infection with BDV.

3.1.2.3. Article 7(b)(iii) The impact of the disease on animal welfare

Parameter 1 – Severity of clinical signs at case level and related level and duration of impairment

In general, transient infection of sheep or goats with BDV is inapparent or leads to mild clinical signs including fever, which are resolved within a few weeks. The main welfare issues associated with BDV infection follow the infection of pregnant females, where a range of negative outcomes are possible. These include resorption of pregnancy, abortion, stillbirth, and the birth of weak and PI offspring. The main effect of BDV in goats is abortion, while PI sheep may show congenital abnormalities, especially of the nervous system and coat.

However, more severe disease with increased morbidity and mortality has been observed in outbreaks caused by specific BDV strains such as the Aveyron strain in sheep (Chappius et al., 1984; Vega et al., 2015). Specific host–virus interactions may also have severe outcomes, including the deaths among Pyrenean Chamois apparently caused by a BDV type 4 strain (Arnal et al., 2004; Marco et al., 2007; Luzzago et al., 2016). In addition, it is possible that rearing conditions may impact on the losses due to BD. A feedlot study of natural BDV infection showed more than half of the lambs tested had BDV infection and these animals showed a 20% reduction in growth rate compared with uninfected lambs at 3 months of age (González et al., 2014).

In addition, congenitally PI lambs, born live, may also be smaller and have poorer growth than uninfected animals and have a shortened lifespan, i.e. many may die at or around weaning and in distinctive cases show tremor and abnormal body conformation and hairy fleeces (Nettleton, online). Those that survive to adulthood may die due to late onset of disease, with apparent similarities to mucosal disease in cattle due to the activation of a cytopathic derivative of their infecting virus (Barlow et al., 1983; Gardiner et al., 1983; Monies et al., 2004; Hilbe et al., 2009).

3.1.2.4. Article 7(b)(iv) The impact of the disease on biodiversity and the environment

Biodiversity

Parameter 1 – Endangered wild species affected: listed species as in CITES and/or IUCN list

It is likely that pestiviruses including BDV can infect a wide range of even-toed ungulates. This group includes wild animals such as antelopes, camels, deer, giraffes, hippopotamuses, llamas and alpacas. BDV infection has been demonstrated by serology or virus detection in several of these species: Reindeer (Becher et al., 1999, 2003; Avalos-Ramirez et al., 2001), chamois (Arnal et al., 2004), Pyrenean chamois, mouflon (Hemmatzadeh et al., 2016), alpaca and llama (Danuser et al., 2009).

Therefore, endangered potential hosts within Europe are those species classified in CITES Appendix I (most endangered among CITES-listed animals) or II (potentially under threat), and classed as potential BDV hosts on the basis of their species and geographic range (Table 2).

Table 2: List of endangered potential hosts for Border disease infection

Full Name	English Names	CITES Appendix
Bos mutus	Wild yak	I
Dama dama mesopotamica	Mesopotamian fallow deer, Persian fallow deer	I
Naemorhedus caudatus	Chinese goral, long-tailed goral	I
Oryx leucoryx	Arabian oryx, white oryx	I
Ovis aries ophion	Cyprian wild sheep, Cyprus mouflon	I
Ovis ammon	Argali, Asian wild sheep, Marco Polo sheep	I/II
Ovis aries	Mouflon, red sheep, shapo, shapu, urial	I/II
Ammotragus lervia	Aoudad, barbary sheep, uaddan	II
Capra caucasica	West Caucasian tur	II
Lama guanicoe	Guanaco	II
Moschus moschiferus	Siberian musk deer	II
Pecari tajacu	Collared peccary	II
Rupicapra pyrenaica ornata	Abruzzo chamois, Apennine chamois	II
Saiga tatarica	Saiga, saiga antelope	II
Tayassu pecari	White-lipped peccary	II
Saiga borealis	Mongolian saiga	II

Parameter 2 − Mortality in wild species

A number of wildlife species are potential hosts of BDV, as described above. The morbidity and mortality among these species may be more severe than in domesticated hosts infected under experimental conditions as a result of limited nutrition and concurrent infection (Arnal et al., 2004; Fernández-Sirera et al., 2012a). Indeed, among sheep, acute (transient) infection with BDV under commercial feedlot conditions appeared to reduce growth rates (González et al., 2014) compared with experimental infection (Cabezón et al., 2010b).

Among those wildlife species that are known to be BDV hosts, mortality has only been described for a few. In Pyrenean chamois, infection with BDV has been associated with significant mortality (Arnal et al., 2004) with potential influence on the population dynamics of this species (Cabezón et al., 2011; Fernández-Sirera et al., 2012a; Beaunée et al., 2015).

Environment

Parameter 3 − Capacity of the pathogen to persist in the environment and cause mortality in wildlife

BDV is rapidly inactivated by heat, drying, detergents and UV light. Recent studies suggest that enveloped viruses may survive up to 5 days in dry environments (Firquet et al., 2015). Direct transmission from PI to uninfected animals is considered the main route, so that spread within herds of gathering animals may be more rapid than among solitary animal or between herds.

3.1.3. Article 7(c) Its potential to generate a crisis situation and its potential use in bioterrorism

Parameter 1 − Listed in OIE/CFSPH classification of pathogens

No − BDV is not listed among the 'OIE-Listed diseases, infections and infestations in force in 2017'. Further, it is not included in the Centre for Food Security and Public Health (CFSPH) list of Bioterrorism and High Consequence Pathogen (CFSPH, 2017).

Parameter 2 − Listed in the Encyclopaedia of Bioterrorism Defence of Australia Group

No − BDV is not listed in the Australia Group List of Human and Animal Pathogens and Toxins for Export Control (The Australia Group, 2017).

Parameter 3 − Included in any other list of potential bio- agro-terrorism agents

BDV is not included in the UK Approved List of biological agents produced by the Advisory Committee on Dangerous Pathogens (HSE, 2013).

3.1.4. Article 7(d) The feasibility, availability and effectiveness of the following disease prevention and control measures

3.1.4.1. Article 7(d)(i) Diagnostic tools and capacities

Availability

Parameter 1 – Officially/internationally recognised diagnostic tool, OIE certified

The OIE Terrestrial Manual chapter on BD (OIE, 2017) lists the following tests for the detection of BDV: virus isolation, immunohistochemistry for virus antigen, virus antigen ELISA, virus-specific RT-PCR; and for detection of antibodies against BDV: virus-neutralisation test (VNT), ELISA and agar gel immunodiffusion test. However, the choice of method will depend on the status of the animal to be tested. PI animals will generally be virus-positive and antibody-negative throughout their lifetime. In contrast, transiently infected animals will show a short viraemia for 1–2 weeks after BDV infection, and will become BDV antibody-positive. The appropriate test for diagnosis will therefore depend on the test aims (individual or herd status testing; identification of PI animals) and the number and age of animals to be tested.

Effectiveness

Parameter 2 – Se and Sp of diagnostic test

These data are not recorded for the tests listed in the IOE chapter on BDV (OIE, 2017) but some commercial kits have recorded specificity and sensitivity data such as: Se 94% sheep, 100% goats; Sp 94% sheep, 100% goats (compared with VNT, SVANOVIR® BDV- Ab).

However, diagnostic specificity of many tests, both antibody and virus detection, may be compromised by cross-reactivity between BDV and BVDV. Both antibody ELISA and PCR based testing may include reagents that do not distinguish between these related viruses and care should be taken to ensure that methods specific to BD are part of the diagnostic process. These include comparative VNT (Nettleton et al., 1998) and multiplex RT-PCR (Willoughby et al., 2006).

Feasibility

Parameter 3 – Type of sample matrix to be tested (blood, tissue, etc.) (Table 3)

Table 3: Types of sample matrix for different diagnostic tests

Test	Suitable tissue(s)
Virus isolation	Fresh blood or tissue
Immunohistochemistry for virus antigen	Fixed/frozen tissue
Virus antigen ELISA	Blood, fresh or fixed tissue
Virus-specific RT-PCR	Blood, fresh or fixed tissue
Virus neutralisation test	Blood serum or plasma
ELISA	Blood serum or plasma
Agar gel immunodiffusion test	Blood serum or plasma

ELISA: enzyme-linked immunosorbent assay; RT-PCR: reverse-transcription polymerase chain reaction.

3.1.4.2. Article 7(d)(ii) Vaccination

There is no commercial vaccine for BDV, although some experimental work with an inactivated, combined vaccine against BDV and BVDV has been described (Brun et al., 1993). Use of this vaccine in sheep has not been reported but immunised cattle developed BDV-specific neutralising antibodies (Oguzoglu et al., 2003). Vaccination of pregnant ewes with live and inactivated virus preparations appeared to confer protection against subsequent challenge and reduced rates of infection in the lambs being carried (Vantsis et al., 1980), suggesting that a BDV-specific vaccine for sheep is possible. BVD eradication campaigns in several MSs may drive demand for a BDV vaccine to protect BVD-negative cattle herds (Sandvik, 2014).

3.1.4.3. Article 7(d)(iii) Medical treatments

Not applicable – no specific drugs for treatment of BD are available.

3.1.4.4. Article 7(d)(iv) Biosecurity measures

Availability

Parameter 1 − Available biosecurity measures

Biosecurity for BD should be aimed at preventing infection, particularly of pregnant animals, by the operation of a closed flock with appropriate testing and separation of bought-in stock.

Important considerations for BDV control include:

- A major risk of infection comes from the movement or purchase of animals that may be shedding BDV due to transient or persistent infection. Care should therefore be taken following the purchase of new stock or the return of animals from communal grazing or other events.
- All new stock or animals which have been away from the farm should be quarantined until they can be tested.
- Appropriate diagnostic tests for BDV infection should be performed on all quarantined animals to demonstrate freedom from BDV before mixing with other stock. Detection of BDV nucleic acid or antigen will identify infected animals and two positive tests, separated by at least 4 weeks, will identify PI animals that should be culled. A positive serological test result shows that an animal has been transiently infected and is unlikely to be shedding virus (except for lambs of less than 2 months old which may have maternally derived antibodies).
- Infectious material can be carried on bedding, clothes, boots and equipment. Practise good hygiene, including the use of effective disinfectants, particularly when moving between quarantined animals and other stock.
- Consult with a veterinary surgeon on a herd/flock health plan in order to minimise infection.

Effectiveness

Parameter 2 − Effectiveness of biosecurity measures in preventing the pathogen introduction

As the most important source of BDV for uninfected farms is the introduction of PI animals, properly executed biosecurity should be highly effective. The virus spreads best in enclosed spaces such as shared accommodation and has also been documented to spread on communal pastures, so the enforcement of appropriate biosecurity should remove the opportunity for susceptible animals to mix with potentially infected individuals.

Feasibility

Parameter 3 − Feasibility of biosecurity measures

This depends of the individual business and its ability to operate without mixing its stock with new purchases or animals from other farms. Ideally, this approach to disease prevention should be feasible and simple to adopt.

3.1.4.5. Article 7(d)(v) Restrictions on the movement of animals and products

Availability

Parameter 1 − Available movement restriction measures

BDV is not controlled at EU level, so there are no formal movement restriction measures in place. While eradication of the related BVDV is complete in Scandinavia and Switzerland, national or regional BVD eradication programmes are in place in Austria, the Netherlands, Germany, Scotland, Ireland, and regions of France and Italy, with herd-based schemes in England, France, Italy Spain and Portugal (BVDzero, 2017). In those EU MSs which become free of BVDV, the problems of diagnostic cross-reactivity with BD infection could be a reason for introduction of controls (Braun et al., 2013; Sandvik, 2014; Kaiser et al., 2017).

Effectiveness

Parameter 2 − Effectiveness of restriction of animal movement in preventing the between farm spread

The main mode of infection appears to be through close contact, with a lower component of spread via aerosols or fomites (Nettleton et al., 1998; Krametter-Froetscher et al., 2007; Braun et al., 2013; OIE, 2017). It is therefore likely that the restrictions on the movement of PI animals off farms would be an effective means of reducing spread of BDV in the same manner as this, coupled with effective diagnostic testing, has been demonstrated effective for BVDV control.

Feasibility

Parameter 3 – Feasibility of restriction of animal movement

Effective restriction would need to be applied only to PI animals, which would be virus-positive in two tests separated by at least 4 weeks. Therefore, any application of movement restriction would need to be accompanied by suitable screening to identify the animals that were the source of infection in the same manner as this has been demonstrated effective for BVDV control.

3.1.4.6. Article 7(d)(vi) Killing of animals

Availability

Parameter 1 – Available methods for killing animals

EU MSs are required to have animal killing capability as part of measures for control of exotic disease incursions. Available measures and associated procedures to assure animal protection are detailed in Council Regulation (EC) No 1099/2009[1].

Effectiveness

Parameter 2 – Effectiveness of killing animals (at farm level or within the farm) for reducing/stopping spread of the disease

The identification and slaughter of PI animals at an early age would be the single most effective measure for the eradication of BDV from MSs. However, the lack of clear clinical signs in infected animals means that sensitive and specific diagnosis of BDV infection would be required.

Feasibility

Parameter 3 – Feasibility of killing animals

The number of PI animals in any outbreak of BDV appears to be 1% or less of the total at-risk population (Krametter-Froetscher et al., 2010; Schweizer and Peterhans, 2014). Removal of this number of animals is therefore feasible within the context of a national/international testing and disease eradication scheme.

3.1.4.7. Article 7(d)(vii) Disposal of carcasses and other relevant animal by-products

Availability

Parameter 1 – Available disposal option

Disposal options for sheep and goat carcases and associated wastes are: commercial fixed plant incineration; rendering; commercial landfill sites (with appropriate approval).

Effectiveness

Parameter 2 – Effectiveness of disposal option

Incineration and rendering would effectively inactivate BDV. Use of landfill may also be effective as BDV is likely to be inactivated rapidly.

Feasibility

Parameter 3 – Feasibility of disposal option

Given the relatively small numbers involved, carcase disposal is likely to be feasible.

3.1.5. Article 7(e) The impact of disease prevention and control measures

3.1.5.1. Article 7(e)(i) The direct and indirect costs for the affected sectors and the economy as a whole

Parameter 1 – Cost of control (e.g. treatment/vaccine, biosecurity)

Vaccine to prevent the infection of pregnant ewes would be desirable but may not be perceived as cost-effective by the vaccine developing industry. In the absence of licensed treatments or vaccines for

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[1] Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing. J L 303, 18.11.2009, p. 1–30.

BDV infection, appropriate biosecurity to prevent infection by external contacts such as newly purchased or returning animals remains the most important means. This includes the identification of infected flocks where BDV is circulating and then identification and removal of all PI animals. The cost-effectiveness of this measure would be greater in higher than in lower prevalence countries and would depend on the structure of the industry relevant to biosecurity. The main aim of such measures should be to avoid infection of pregnant ewes and the prompt removal of PI animals. Diagnostic testing should be an integral part of this programme.

As no organised plans for testing sheep for BDV seem to have been presented with the aim to reduce the prevalence of the infection, an estimate of the costs of such measures is difficult to separate from the costs of eradication (below) as the same approaches would be used. However, the recognition that BD viruses in sheep and cattle can potentially interfere with national plans to eradicate BVDV in cattle has stimulated renewed interest in BD and its control (Sandvik, 2014).

Parameter 2 – Cost of eradication (culling, compensation)

An estimate of the costs of such measures is difficult to separate from the costs of control as the same approaches would be used (see Parameter 1 above).

Across EU MSs, the numbers of sheep and goats total over 85 and 12 millions, respectively. If we estimate the range of prevalence to be 5–50% (OIE, 2017) and the presence of PI animals at 1% of affected animals (Schweizer and Peterhans, 2014), then the estimated numbers of PI animals in EU MSs will be 42,000–420,000 sheep and 6,250–62,500 goats, with estimated values of EUR 2–20 M (sheep) and EUR 0.15–1.5 M (goats) (Eurostat, 2017).

It is likely that these costs (EUR 25–250,000 per million sheep and EUR 12.5000–125,000 per million goats) provide a reasonable estimate of potential culling and compensation costs to remove PI animals from all MSs.

Parameter 3 – Cost of surveillance and monitoring

These costs are harder to estimate as it is likely that all flocks and herds would need to be initially screened to determine what herds had circulating BDV in the herd causing BDV-specific antibody levels in the most recent lamb crop (bulk testing for BDV-specific antibody), followed by sampling of all animals in positive flocks including testing of individual seronegative animals for the presence of antigen (antigen ELISA or RT-PCR), suggesting that the costs could be high depending on the BDV herd prevalence.

Parameter 4 – Trade loss (bans, embargoes, sanctions) by animal product

BDV is not notifiable and there are no official controls at EU level. However, it is possible that MSs with BVDV eradication programmes may implement controls to protect BVDV-free cattle herds from BDV.

Parameter 5 – Importance of the disease for the affected sector (% loss or € lost compared to business amount of the sector)

BD often goes unnoticed as its effects are mainly on fertility, rather than morbidity in older animals, and poor scanning rates for pregnancy and losses due to abortion, stillbirth, or neonatal deaths may not immediately be ascribed to BD. Indeed, among sheep, BDV is not perceived as a major cause of abortion (Mearns, 2007). However, its impact may be underestimated.

3.1.5.2. Article 7(e)(ii) The societal acceptance of disease prevention and control measures

There are no specific studies on BDV. It is anticipated that any improvement in the BDV status of sheep and goats will be socially well received as the immediate results of eradication would be a reduction in the numbers of lambs/kids lost due to this disease, improving animal welfare and industry profitability.

3.1.5.3. Article 7(e)(iii) The welfare of affected subpopulations of kept and wild animals

Parameter 1 – Welfare impact of control measures on domestic animals

Imposing movement restrictions on infected premises, pending the identification and removal of all PIs, would have an impact on the industry through an inability to sell stock, particularly if restrictions coincide with annual lamb sales. However, there are unlikely to be specific welfare consequences of such restrictions. Compulsory culling of PI animals would have negative welfare impact on the

proportion of such animals being culled that would otherwise survive healthy and not succumb to BDV, due to the activation of a cytopathic derivative of their infecting virus, but the potential reduction in morbidity associated with transient infection would have welfare benefits for uninfected flocks.

Parameter 2 – Wildlife depopulation as control measure

There are few species that carry BDV at a sufficiently high frequency to justify such measures. The contacts between domestic sheep and goats are more likely to lead to infection of the wildlife species and would only be an issue at late stages in BDV eradication, where potential reservoirs of infection in wildlife may need to be considered.

3.1.5.4. Article 7(e)(iv) The environment and biodiversity

Environment

Parameter 1 – Use and potential residuals of biocides or medical drugs in environmental compartments (soil, water, feed, manure)

There are currently no biocides or medical drugs available for use with BDV.

Biodiversity

Parameter 2 – Mortality in wild species

A few reports have suggested that wildlife species such as the Pyrenean chamois suffer considerable mortality as a consequence of BDV infection (Arnal et al., 2004; Marco et al., 2015; Serrano et al., 2015). Morbidity and mortality were replicated in an experimental infection of chamois (Cabezón et al., 2011), but not of sheep (Cabezón et al., 2010b) or pigs (Cabezón et al., 2010a). It is therefore possible that morbidity and mortality resulting from BDV infection of wildlife species may depend on either circulation of species-specific strains or the movement of novel virus strains into a susceptible population by interspecies infection. Further research is therefore required to study the distribution of BDV strains in wildlife species.

3.2. Assessment according to Article 5 criteria

This section presents the results of the expert judgement on the criteria of Article 5 of the AHL about BD (Table 4). The expert judgement was based on Individual and Collective Behavioural Aggregation (ICBA) approach described in detail in the opinion on the methodology (EFSA AHAW Panel, 2017). Experts have been provided with information of the disease fact-sheet mapped into Article 5 criteria (see supporting information, Annex A), based on that the experts indicate their Y/N or 'na' judgement on each criterion of Article 5, and the reasoning supporting their judgement.

The minimum number of judges in the judgement was 12. The expert judgement was conducted as described in the methodological opinion (EFSA AHAW Panel, 2017). For details on the interpretation of the questions, see Appendix B of the methodological opinion (EFSA AHAW Panel, 2017).

Table 4: Outcome of the expert judgement on the Article 5 criteria for Border disease

Criteria to be met by the disease: According to AHL, a disease shall be included in the list referred to in point (b) of paragraph 1 of Article 5 if it has been assessed in accordance with Article 7 and meets all of the following criteria		Final outcome
A(i)	The disease is transmissible	Y
A(ii)	Animal species are either susceptible to the disease or vectors and reservoirs thereof exist in the Union	Y
A(iii)	The disease causes negative effects on animal health or poses a risk to public health due to its zoonotic character	Y
A(iv)	Diagnostic tools are available for the disease	Y
A(v)	Risk-mitigating measures and, where relevant, surveillance of the disease are effective and proportionate to the risks posed by the disease in the Union	Y

At least one criterion to be met by the disease:

In addition to the criteria set out above at points A(i)–A(v), the disease needs to fulfil at least one of the following criteria

B(i)	The disease causes or could cause significant negative effects in the Union on animal health, or poses or could pose a significant risk to public health due to its zoonotic character	Y
B(ii)	The disease agent has developed resistance to treatments and poses a significant danger to public and/or animal health in the Union	na
B(iii)	The disease causes or could cause a significant negative economic impact affecting agriculture or aquaculture production in the Union	NC
B(iv)	The disease has the potential to generate a crisis or the disease agent could be used for the purpose of bioterrorism	N
B(v)	The disease has or could have a significant negative impact on the environment, including biodiversity, of the Union	NC

Colour code: green = consensus (Yes/No), yellow = non-consensus (NC), red = not applicable (na), i.e. insufficient evidence or irrelevant to judge.

3.2.1. Non-consensus questions

This section displays the assessment related to each criterion of Article 5 where no consensus was achieved in form of tables (Tables 5 and 6). The proportion of Y, N or na answers is reported, followed by the list of different supporting views for each answer.

Table 5: Outcome of the expert judgement related to criterion 5 B(iii)

Question		Final outcome	Response		
			Y (%)	N (%)	na (%)
B(iii)	The disease causes or could cause a significant negative economic impact affecting agriculture or aquaculture production in the Union	NC	92	0	8

NC: non-consensus; number of judges: 12.

Reasoning supporting the judgement

Supporting Yes:

- An experimental study showed that a large proportion (55%) of BDV-infected lambs had 2.1 times higher risk of showing gastrointestinal and respiratory signs of disease and showed a 20% reduction in growth rate compared to uninfected lambs (González et al., 2014). Infection before the onset of fetal immunocompetence causes approximately 50% fetal death, with surviving lambs being congenitally infected. In addition, more severe forms of the disease in the case of highly pathogenic strains of BDV could occur, e.g. Aveyron strain producing outbreaks with mortality of 70% or more in sheep and production loss (20–45%) in UK. BDV infection has been reported in 11 MSs.
- BDV infection is similar to the infection caused by BVDV. Limited data are available compared to BVD, nonetheless reports do indicate that the infection could cause significant losses.

Supporting na:

- Data on economic impact in natural infections are scarce.

Table 6: Outcome of the expert judgement related to criterion 5 B(v)

Question		Final outcome	Response		
			Y (%)	N (%)	na (%)
B(v)	The disease has or could have a significant negative impact on the environment, including biodiversity, of the Union	NC	67	33	0

NC: non-consensus; number of judges: 12.

Reasoning supporting the judgement

Supporting Yes:

- EU wildlife species such as the Pyrenean chamois (not endangered) and, at a lesser degree, Cyprus mouflon, Apennine chamois and mouflon (endangered) are concerned by BDV infection and could suffer with considerable level of mortality as a consequence of BDV infection. In Pyrenean chamois, infection with BDV has been associated with significant mortality (Arnal et al., 2004) with potential influence on the population dynamics of this species (Cabezón et al., 2011; Fernández-Sirera et al., 2012a; Beaunée et al., 2015).

Supporting No:

- The disease has been reported to cause significant mortality in chamois, but at the same time many infected populations of chamois remain unaffected.
- The infection has been detected in wild ruminant populations and in no case after introduction of BDV has there been a description of total population collapse.

3.2.2. Outcome of the assessment of Border disease according to criteria of Article 5(3) of the AHL on its eligibility to be listed

As from the legal text of the AHL, a disease is considered eligible to be listed as laid down in Article 5 if it fulfils all criteria of the first set from A(i) to A(v) and at least one of the second set of criteria from B(i) to B(v). According to the assessment methodology (EFSA AHAW Panel, 2017), a criterion is considered fulfilled when the outcome is 'Yes'. According to the results shown in Table 4, BD disease complies with all criteria of the first set and with one criterion of the second set, therefore it is considered eligible to be listed for Union intervention as laid down in Article 5(3) of the AHL.

3.3. Assessment according to Article 9 criteria

This section presents the results of the expert judgement on the criteria of Annex IV referring to categories as in Article 9 of the AHL about BD (Tables 7, 8, 9, 10 and 11). The expert judgement was based on ICBA approach described in detail in the opinion on the methodology. Experts have been provided with information of the disease fact-sheet mapped into Article 9 criteria (see supporting information, Annex A), based on that the experts indicate their Y/N or 'na' judgement on each criterion of Article 9, and the reasoning supporting their judgement.

The minimum number of judges in the judgement was 12. The expert judgement was conducted as described in the methodological opinion (EFSA AHAW Panel, 2017). For details on the interpretation of the questions see Appendix B of the methodological opinion (EFSA AHAW Panel, 2017).

Table 7: Outcome of the expert judgement related to the criteria of Section 1 of Annex IV (category A of Article 9) for Border disease (CI: current impact; PI: potential impact)

Criteria to be met by the disease: The disease needs to fulfil all of the following criteria		Final outcome
1	The disease is not present in the territory of the Union OR present only in exceptional cases (irregular introductions) OR present only in a very limited part of the territory of the Union	N
2.1	The disease is highly transmissible	N
2.2	There are possibilities of airborne or waterborne or vector-borne spread	N
2.3	The disease affects multiple species of kept and wild animals OR single species of kept animals of economic importance	Y
2.4	The disease may result in high morbidity and significant mortality rates	NC
At least one criterion to be met by the disease: In addition to the criteria set out above at points 1–2.4, the disease needs to fulfil at least one of the following criteria		
3	The disease has a zoonotic potential with significant consequences on public health, including epidemic or pandemic potential OR possible significant threats to food safety	N
4(CI)	The disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals	NC

4(PI)	The disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals	Y
5(a)(CI)	The disease has a significant impact on society, with in particular an impact on labour markets	N
5(a)(PI)	The disease has a significant impact on society, with in particular an impact on labour markets	N
5(b)(CI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	NC
5(b)(PI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	Y
5(c)(CI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	N
5(c)(PI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	Y
5(d)(CI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	N
5(d)(PI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	Y

Colour code: green = consensus (Yes/No), yellow = non-consensus (NC).

Table 8: Outcome of the expert judgement related to the criteria of Section 2 of Annex IV (category B of Article 9) for Border disease (CI: current impact; PI: potential impact)

Criteria to be met by the disease: The disease needs to fulfil all of the following criteria		**Final outcome**
1	The disease is present in the whole OR part of the Union territory with an endemic character AND (at the same time) several Member States or zones of the Union are free of the disease	N
2.1	The disease is moderately to highly transmissible	Y
2.2	There are possibilities of airborne or waterborne or vector-borne spread	N
2.3	The disease affects single or multiple species	Y
2.4	**The disease may result in high morbidity with in general low mortality**	NC
At least one criterion to be met by the disease: In addition to the criteria set out above at points 1–2.4, the disease needs to fulfil at least one of the following criteria		
3	The disease has a zoonotic potential with significant consequences on public health, including epidemic potential OR possible significant threats to food safety	N
4(CI)	The disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals	NC
4(PI)	The disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals	Y
5(a)(CI)	The disease has a significant impact on society, with in particular an impact on labour markets	N
5(a)(PI)	The disease has a significant impact on society, with in particular an impact on labour markets	N
5(b)(CI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	NC
5(b)(PI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	Y
5(c)(CI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	N
5(c)(PI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	Y
5(d)(CI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	N
5(d)(PI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	Y

Colour code: green = consensus (Yes/No), yellow = non-consensus (NC).

Table 9: Outcome of the expert judgement related to the criteria of Section 3 of Annex IV (category C of Article 9) for Border disease (CI: current impact; PI: potential impact)

Criteria to be met by the disease: The disease needs to fulfil all of the following criteria		Final outcome
1	The disease is present in the whole OR part of the Union territory with an endemic character	Y
2.1	The disease is moderately to highly transmissible	Y
2.2	The disease is transmitted mainly by direct or indirect transmission	Y
2.3	The disease affects single or multiple species	Y
2.4	The disease usually does not result in high morbidity and has negligible or no mortality AND often the most observed effect of the disease is production loss	Y
At least one criterion to be met by the disease: In addition to the criteria set out above at points 1–2.4, the disease needs to fulfil at least one of the following criteria		
3	The disease has a zoonotic potential with significant consequences on public health, or possible significant threats to food safety	N
4(CI)	The disease has a significant impact on the economy of parts of the Union, mainly related to its direct impact on certain types of animal production systems	NC
4(PI)	The disease has a significant impact on the economy of parts of the Union, mainly related to its direct impact on certain types of animal production systems	N
5(a)(CI)	The disease has a significant impact on society, with in particular an impact on labour markets	N
5(a)(PI)	The disease has a significant impact on society, with in particular an impact on labour markets	N
5(b)(CI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	NC
5(b)(PI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	Y
5(c)(CI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	N
5(c)(PI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	Y
5(d)(CI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	N
5(d)(PI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	Y

Colour code: green = consensus (Yes/No), yellow = non-consensus (NC).

Table 10: Outcome of the expert judgement related to the criteria of Section 4 of Annex IV (category D of Article 9) for Border disease

Criteria to be met by the disease: The disease needs to fulfil all of the following criteria		Final outcome
D	The risk posed by the disease in question can be effectively and proportionately mitigated by measures concerning movements of animals and products in order to prevent or limit its occurrence and spread	Y
The disease fulfils criteria of Sections 1, 2, 3 or 5 of Annex IV of AHL		Y

Colour code: green = consensus (Yes/No).

Table 11: Outcome of the expert judgement related to the criteria of Section 5 of Annex IV (category E of Article 9) for Border disease

Diseases in category E **need to fulfil criteria of Sections 1, 2 or 3 of Annex IV of AHL** and/or the following:		Final outcome
E	Surveillance of the disease is necessary for reasons relating to animal health, animal welfare, human health, the economy, society or the environment (If a disease fulfils the criteria as in Article 5, thus being eligible to be listed, consequently category E would apply.)	Y

Colour code: green = consensus (Yes/No).

3.3.1. Non-consensus questions

This section displays the assessment related to each criterion of Annex IV referring to the categories of Article 9 of the AHL where no consensus was achieved in form of tables (Tables 12, 13 and 14). The proportion of Y, N or 'na' answers are reported, followed by the list of different supporting views for each answer.

Table 12: Outcome of the expert judgement related to criterion 2.4 of Article 9

Question		Final outcome	Response		
			Y (%)	N (%)	na (%)
2.4 (cat. A)	The disease may result in high morbidity and significant mortality rates	NC	67	33	0
2.4 (cat. B)	The disease may result in high morbidity with in general low mortality	NC	83	17	0

NC: non-consensus; number of judges: 12.

Reasoning supporting the judgement

Supporting Yes for 2.4 (cat. A):

- Highly pathogenic strain (e.g. Aveyron) causes severe forms with high morbidity and high mortality.
- Overall individual seroprevalence can vary between 5% and 50%. There may be high mortality if impact on offspring (e.g. in PI) is considered and high morbidity in surviving lambs, whereas mortality in adults is generally low.
- There could be either high or low mortality, depending on if infected and immunocompetent (mostly with short and unapparent disease) are included among the morbid animals.
- Depending on how fetal mortality is characterised, i.e. mortality (cat. A) or production loss (cat. C) can apply.

Supporting Yes for 2.4 (cat. B):

- Depending on husbandry and other factors there may be high morbidity with generally low mortality.
- Prevalence can be up to 100%, but mortality rates remain low.

Table 13: Outcome of the expert judgement related to criterion 4(CI) of Article 9

Question		Final outcome	Response		
			Y (%)	N (%)	na (%)
4 (cat. A, B)	The disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals	NC	0	83	17
4 (cat. C)	The disease has a significant impact on the economy of parts of the Union, mainly related to its direct impact on certain types of animal production systems	NC	0	92	8

NC: non-consensus; number of judges: 12.

Reasoning supporting the judgement

Supporting No for 4 (cat. A, B):

- Although the impact at farm level might be significant, there are no reports documenting the impact at country level and no current control programme suggesting that the disease currently does have a significant impact on the economy of the Union.

Supporting na for 4 (cat. A, B):

- It depends on the strain. Solid data on the economic impact of BDV in MSs are very limited, no effective vaccines and no control programmes have been developed suggesting that the economic impact is probably perceived as quite limited. Sheep production contributes differently to the economy in different countries. No information is available about impact or distribution.

Supporting No for 4 (cat. C):

- Although the impact of BD is likely greater in intensive sheep production, there is not any particular production system affected.
- There are consequences in animal health and production, but not to a level that impacts the economy of the Union.

Supporting na for 4 (cat. C):

- Data on economic impact are very limited.

Table 14: Outcome of the expert judgement related to criterion 5(b)(CI) of Article 9

Question		Final outcome	Response		
			Y (%)	N (%)	na (%)
5b	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	NC	42	33	25

NC: non-consensus; number of judges: 12.

Reasoning supporting the judgement

Supporting Yes:

- Lambs born with BDV congenital infection can be underweight and weak. In distinctive cases lambs show tremor, abnormal body conformation and hairy fleeces (Nettleton, online).
- The welfare of PI would be greatly comprised: 1% PI of at-risk animals represents a large number.

Supporting No:

- Abortions and production loss are not considered per se as welfare impairment, and if present clinical signs in the dam are weak.

Supporting na:

- There are insufficient data quantifying the numbers with welfare effects caused by BDV.

3.3.2. Outcome of the assessment of criteria in Annex IV for Border disease for the purpose of categorisation as in Article 9 of the AHL

As from the legal text of the AHL, a disease is considered fitting in a certain category (A, B, C, D or E corresponding to point (a) to point (e) of Article 9(1) of the AHL) if it is eligible to be listed for Union intervention as laid down in Article 5(3) and fulfils all criteria of the first set from 1 to 2.4 and at least one of the second set of criteria from 3 to 5(d) as shown in Tables 7–11. According to the assessment methodology (EFSA AHAW Panel, 2017), a criterion is considered fulfilled when the outcome is 'Yes'. With respect to different type of impact where the assessment is divided into current and potential impact, a criterion will be considered fulfilled if at least one of the two outcomes is 'Y' and, in case of no 'Y', the assessment is inconclusive if at least one outcome is 'NC'.

A description of the outcome of the assessment of criteria in Annex IV for BD for the purpose of categorisation as in Article 9 of the AHL is presented in Table 15.

Table 15: Outcome of the assessment of criteria in Annex IV for Border disease for the purpose of categorisation as in Article 9 of the AHL

Category	Article 9 criteria										
	1° set of criteria					2° set of criteria					
	1	**2.1**	**2.2**	**2.3**	**2.4**	**3**	**4**	**5a**	**5b**	**5c**	**5d**
	Geographical distribution	Transmissibility	Routes of transmission	Multiple species	Morbidity and mortality	Zoonotic potential	Impact on economy	Impact on society	Impact on animal welfare	Impact on environment	Impact on biodiversity
A	N	N	N	Y	NC	N	Y	N	Y	Y	Y
B	N	Y	N	Y	NC	N	Y	N	Y	Y	Y
C	Y	Y	Y	Y	Y	N	NC	N	Y	Y	Y
D						Y					
E						Y					

According to the assessment here performed, BD complies with the following criteria of the Sections 1 to 5 of Annex IV of the AHL for the application of the disease prevention and control rules referred to in points (a) to (e) of Article 9(1):

1) To be assigned to category A, a disease needs to comply with all criteria of the first set (1, 2.1–2.4) and according to the assessment BD complies with criterion 2.3, but not with criteria 1, 2.1 and 2.2 and the assessment is inconclusive on compliance with criterion 2.4. To be eligible for category A, a disease needs to comply additionally with one of the criteria of the second set (3, 4, 5a–d) and BD complies with criteria 4, 5b, 5c and 5d, but not with criteria 3 and 5a.

2) To be assigned to category B, a disease needs to comply with all criteria of the first set (1, 2.1–2.4) and according to the assessment BD complies with criteria 2.1 and 2.3, but not with criteria 1 and 2.2 and the assessment is inconclusive on compliance with criterion 2.4. To be eligible for category B, a disease needs to comply additionally with one of the criteria of the second set (3, 4, 5a–d) and BD complies with criteria 4, 5b, 5c and 5d, but not with criteria 3 and 5a.

3) To be assigned to category C, a disease needs to comply with all criteria of the first set (1, 2.1–2.4) and according to the assessment BD complies with all of them. To be eligible for category C, a disease needs to comply additionally with one of the criteria of the second set (3, 4, 5a–d) and BD complies with criteria 5b, 5c and 5d, but not with criteria 3 and 5a and the assessment is inconclusive on compliance with criterion 4.

4) To be assigned to category D, a disease needs to comply with criteria of Sections 1, 2, 3 or 5 of Annex IV of the AHL and with the specific criterion D of Section 4, with which BD complies.

5) To be assigned to category E, a disease needs to comply with criteria of Sections 1, 2 or 3 of Annex IV of the AHL and/or the surveillance of the disease is necessary for reasons relating to animal health, animal welfare, human health, the economy, society or the environment. The latter is applicable if a disease fulfils the criteria as in Article 5, with which BD complies.

3.4. Assessment of Article 8

This section presents the results of the assessment on the criteria of Article 8(3) of the AHL about BD. The Article 8(3) criteria are about animal species to be listed, as it reads below:

'3. Animal species or groups of animal species shall be added to this list if they are affected or if they pose a risk for the spread of a specific listed disease because:

a) they are susceptible for a specific listed disease or scientific evidence indicates that such susceptibility is likely; or

b) they are vector species or reservoirs for that disease, or scientific evidence indicates that such role is likely'.

For this reason, the assessment on Article 8 criteria is based on the evidence as extrapolated from the relevant criteria of Article 7, i.e. the ones related to susceptible and reservoir species or routes of transmission, which cover also possible role of biological or mechanical vectors.[2] According to the mapping, as presented in Table 5, Section 3.2 of the scientific opinion on the ad hoc methodology (EFSA AHAW Panel, 2017), the main animal species to be listed for BD according to the criteria of Article 8(3) of the AHL are as displayed in Table 16.

Table 16: Main animal species to be listed for Border disease according to criteria of Article 8 (source: data reported in Section 3.1.1.1)

	Class	Order	Family	Genus/Species
Susceptible	Mammalia	Artiodactyla	Bovidae	Sheep (*Ovis aries*), cattle (*Bos taurus*, *Bos indicus*), goats (*Capra hircus*), chamois (*Rupicapra rupicapra*), Pyrenean chamois (*Rupicapra pyrenaica pyrenaica*), mouflon (*Ovis orientalis*), Alpine ibex (*Capra ibex*), antelopes (not specified)
			Suidae	Pig (*Sus scrofa*)
			Camelidae	Alpaca (*Vicugna pacos*), llama (*Lama glama*)
			Cervidae	Reindeer (*Rangifer tarandus*)
			Giraffidae	not specified
			Hippopotamidae	not specified
		Lagomorpha	Leporidae	European hare (*Lepus europaeus*)
Reservoir	Mammalia	Artiodactyla	Bovidae	Sheep (*Ovis aries*), cattle (*Bos taurus*, *Bos indicus*), goats (*Capra hircus*)
			Suidae	Pig (*Sus scrofa*)
Vectors	none			

4. Conclusions

TOR 1: *for each of those diseases an assessment, following the criteria laid down in Article 7 of the AHL, on its eligibility of being listed for Union intervention as laid down in Article 5(3) of the AHL;*

- According to the assessment here performed, BD complies with all criteria of the first set and with one criterion of the second set and therefore can be considered eligible to be listed for Union intervention as laid down in Article 5(3) of the AHL.

TOR 2a: *for each of the diseases which was found eligible to be listed for Union intervention, an assessment of its compliance with each of the criteria in Annex IV to the AHL for the purpose of categorisation of diseases in accordance with Article 9 of the AHL;*

- According to the assessment here performed, BD meets the criteria as in Sections 3, 4 and 5 of Annex IV of the AHL, for the application of the disease prevention and control rules referred to in points (c), (d) and (e) of Article 9(1) of the AHL.

TOR 2b: *for each of the diseases which was found eligible to be listed for Union intervention, a list of animal species that should be considered candidates for listing in accordance with Article 8 of the AHL.*

- According to the assessment here performed, the animal species that can be considered to be listed for BD according to Article 8(3) of the AHL are mainly sheep and other species of the family Bovidae as susceptible and reservoirs, as reported in Table 16 in Section 3.4 of the present document.

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[2] A vector is a living organism that transmits an infectious agent from an infected animal to a human or another animal. Vectors are frequently arthropods. Biological vectors may carry pathogens that can multiply within their bodies and be delivered to new hosts, usually by biting. In mechanical vectors, the pathogens do not multiply within the vector, which usually remains infected for shorter time than in biological vectors.

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Abbreviations

AHAW	EFSA Panel on Animal Health and Welfare
AHL	Animal Health Law
BD	Border disease
BDV	Border disease virus
BVDV	bovine viral diarrhoea virus
CFSPH	Centre for Food Security and Public Health
CSFV	classical swine fever virus
ELISA	enzyme-linked immunosorbent assay
ICBA	Individual and Collective Behavioural Aggregation
MS	Member State
OIE	World Organization for Animal Health
PI	persistently infected
RT-PCR	reverse-transcription polymerase chain reaction
TI	transiently infected
ToR	Terms of Reference
UV	ultraviolet
VNT	virus-neutralisation test

Annex A – Mapped fact-sheet used in the individual judgement on Border disease

Annex A can be found in the online version of this output ('Supporting information' section): https://doi.org/10.2903/j.efsa.2017.4993