SCIENTIFIC OPINION

EFSA Journal

ADOPTED: 19 January 2022

doi: 10.2903/j.efsa.2022.7126

Assessment of listing and categorisation of animal diseases within the framework of the Animal Health Law (Regulation (EU) No 2016/429): antimicrobial-resistant *Enterococcus cecorum* in poultry

EFSA Panel on Animal Health and Welfare (AHAW),
Søren Saxmose Nielsen, Dominique Joseph Bicout, Paolo Calistri, Elisabetta Canali, Julian Ashley Drewe, Bruno Garin-Bastuji, José Luis Gonzales Rojas, Christian Gortázar, Mette Herskin, Virginie Michel, Miguel Ángel Miranda Chueca, Barbara Padalino, Paolo Pasquali, Helen Clare Roberts, Hans Spoolder, Karl Ståhl, Antonio Velarde, Arvo Viltrop, Christoph Winckler, Francesca Baldinelli, Alessandro Broglia, Lisa Kohnle and Julio Alvarez

Abstract

Enterococcus cecorum (*E. cecorum*) was identified among the most relevant antimicrobial-resistant (AMR) bacteria in the EU for poultry in a previous scientific opinion. Thus, it 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 its eligibility to be listed, Annex IV for its categorisation according to disease prevention and control rules as in Article 9, and Article 8 for listing animal species related to the bacterium. The assessment has been performed following a methodology previously published. The outcome is the median of the probability ranges provided by the experts, which indicates whether each criterion is fulfilled (lower bound $\geq$ 66%) or not (upper bound $\leq$ 33%), or whether there is uncertainty about fulfilment. Reasoning points are reported for criteria with uncertain outcome. According to the assessment here performed, it is uncertain whether AMR *E. cecorum* can be considered eligible to be listed for Union intervention according to Article 5 of the AHL (33–75% probability). According to the criteria in Annex IV, for the purpose of categorisation related to the level of prevention and control as in Article 9 of the AHL, the AHAW Panel concluded that the bacterium does not meet the criteria in Sections 1, 2 and 4 (Categories A, B and D; 0–5%, 5–10% and 10–33% probability of meeting the criteria, respectively) and the AHAW Panel is uncertain whether it meets the criteria in Sections 3 and 5 (Categories C and E, 33–66% and 33–75% probability of meeting the criteria, respectively). The animal species to be listed for AMR *E. cecorum* according to Article 8 criteria are mostly birds belonging to the families of Anatidae, Columbidae and Phasianidae.

Keywords: antimicrobial resistance, *Enterococcus cecorum*, Animal Health Law, listing, categorisation, impact

Requestor: European Commission

Question number: EFSA-Q-2021-00665

Correspondence: alpha@efsa.europa.eu

Panel members: Søren Saxmose Nielsen, Julio Alvarez, Dominique Joseph Bicout, Paolo Calistri, Elisabetta Canali, Julian Ashley Drewe, Bruno Garin-Bastuji, José Luis Gonzales Rojas, Christian Gortázar, Mette Herskin, Virginie Michel, Miguel Ángel Miranda Chueca, Barbara Padalino, Paolo Pasquali, Helen Clare Roberts, Hans Spoolder, Karl Ståhl, Antonio Velarde, Arvo Viltrop and Christoph Winckler.

Declarations of interest: The declarations of interest of all scientific experts active in EFSA's work are available at https://ess.efsa.europa.eu/doi/doiweb/doisearch.

Acknowledgments: The AHAW Panel wishes to thank Peter Panduro Damborg and Ida Thøfner from the University of Copenhagen for conducting the extensive literature review under the contract OC/EFSA/ALPHA/2020/02 – LOT 1. The AHAW Panel also wishes to thank Friederike Hilbert from the University of Veterinary Medicine, Vienna, Ana R. Freitas from the University Institute of Health Sciences, Gandra, Paul McMullin from Poultry Health International, and Verena Oswaldi from EFSA for the support provided for this scientific output.

Suggested citation: EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), Nielsen SS, Bicout DJ, Calistri P, Canali E, Drewe JA, Garin-Bastuji B, Gonzales Rojas JL, Gortázar C, Herskin M, Michel V, Miranda Chueca MÁ, Padalino B, Pasquali P, Roberts HC, Spoolder H, Ståhl K, Velarde A, Viltrop A, Winckler C, Baldinelli F, Broglia A, Kohnle L and Alvarez J, 2022. Scientific Opinion on the assessment of listing and categorisation of animal diseases within the framework of the Animal Health Law (Regulation (EU) No 2016/429): antimicrobial-resistant *Enterococcus cecorum* in poultry. EFSA Journal 2022;20(2):7126, 71 pp. https://doi.org/10.2903/j.efsa.2022.7126

ISSN: 1831-4732

The EFSA Journal is a publication of the European Food Safety Authority, a European agency funded by the European Union.

Table of contents

Abstract ... 1
1. Introduction ... 5
1.1. Background and Terms of Reference as provided by the requestor ... 5
1.2. Interpretation of the Terms of Reference ... 5
2. Data and methodologies ... 5
3. Assessment ... 6
3.1. Assessment of AMR *Enterococcus cecorum* according to Article 7 criteria of the AHL ... 6
3.1.1. Article 7(a) Disease profile ... 6
3.1.1.1. Article 7(a)(i) Animal species concerned by the disease ... 6
3.1.1.2. Article 7(a)(ii) The morbidity and mortality rates of the disease in animal populations ... 7
3.1.1.3. Article 7(a)(iii) The zoonotic character of the disease ... 9
3.1.1.4. Article 7(a)(v) the persistence of the disease in animal population or the envirnoment ... 9
3.1.1.5. Article 7(a)(vi) The routes and speed of transmission of the disease between animals, and, when relevant, between animals and humans ... 11
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 ... 12
3.1.1.7. Article 7(a)(vii) The absence or presence and distribution of the disease in the Union and, where the disease is not present in the Union, the risk of its introduction into the Union ... 12
3.1.1.8. Article 7(a)(viii) The existence of diagnostic and disease control tools ... 13
3.1.2. Article 7(b) The impact of diseases ... 14
3.1.2.1. Article 7(b)(i) The impact of the disease on agricultural and aquaculture production and other parts of the economy ... 14
3.1.2.2. Article 7(b)(ii) The impact of the disease on human health ... 14
3.1.2.3. Article 7(b)(iii) The impact of the disease on animal welfare ... 15
3.1.2.4. Article 7(b)(iv) The impact of the disease on biodiversity and the environment ... 15
3.1.3. Article 7(c) Its potential to generate a crisis situation and its potential use in bioterrorism ... 16
3.1.4. Article 7(d) The feasibility, availability and effectiveness of the following disease prevention and control measures ... 16
3.1.4.1. Article 7(d)(i) Diagnostic tools and capacities ... 16
3.1.4.2. Article 7(d)(ii) Vaccination ... 16
3.1.4.3. Article 7(d)(iii) Medical treatments ... 17
3.1.4.4. Article 7(d)(iv) Biosecurity measures ... 17
3.1.4.5. Article 7(d)(v) Restrictions on the movement of animals and products ... 18
3.1.4.6. Article 7(d)(vi) Killing of animals ... 18
3.1.4.7. Article 7(d)(vii) Disposal of carcasses and other relevant animal by-products ... 19
3.1.5. Article 7(e) The impact of disease prevention and control measures ... 19
3.1.5.1. Article 7(e)(i) The direct and indirect costs for the affected sectors and the economy as a whole ... 19
3.1.5.2. Article 7(e)(ii) The societal acceptance of disease prevention and control measures ... 19
3.1.5.3. Article 7(e)(iii) The welfare of affected subpopulations of kept and wild animals ... 20
3.1.5.4. Article 7(e)(iv) The environment and biodiversity ... 20
3.2. Assessment of AMR *Enterococcus cecorum* according to Article 5 criteria of the AHL on its eligibility to be listed ... 20
3.2.1. Detailed outcome on Article 5 criteria ... 20
3.2.1.1. Reasoning for uncertain outcome on Article 5 criteria ... 22
3.2.2. Overall outcome on Article 5 criteria ... 22
3.3. Assessment of AMR *Enterococcus cecorum* according to criteria in Annex IV for the purpose of categorisation as in Article 9 of the AHL ... 23
3.3.1. Detailed outcome on Category A criteria ... 23
3.3.1.1. Reasoning for uncertain outcome on Category A criteria ... 24
3.3.2. Detailed outcome on Category B criteria ... 25
3.3.2.1. Reasoning for uncertain outcome on Category B criteria ... 26
3.3.3. Detailed outcome on Category C criteria ... 27
3.3.3.1. Reasoning for uncertain outcome on Category B criteria ... 28
3.3.4. Detailed outcome on Category D criteria ... 29
3.3.5. Detailed outcome on Category E criteria ... 29
3.3.6. Overall outcome on criteria in Annex IV for the purpose of categorisation as in Article 9 ... 29
3.4. Assessment of AMR *Enterococcus cecorum* according to Article 8 criteria of the AHL ... 31
4. Conclusions ... 32
References ... 33

Abbreviations 35
Appendix A – Criteria with certain outcome 36
Appendix B – Criteria with uncertain outcome 61

1. Introduction

The European Food Safety Authority (EFSA) received a mandate from the European Commission to investigate the global state of play as regards antimicrobial-resistant (AMR) animal pathogens that cause transmissible animal diseases (Term of Reference (ToR) 1), to identify the most relevant AMR bacteria in the European Union (EU) (first part of ToR 2), to summarise the existing or potential animal health impact of those identified bacteria in the EU (second part of ToR 2) and to perform the assessment of those bacteria to be listed and categorised according to the criteria in Article 5, Annex IV according to Article 9 and Article 8 within the Regulation (EU) No 2016/429[1] on transmissible animal diseases ('Animal Health Law') (ToR 3).

The global state of play for AMR animal pathogens that cause transmissible animal diseases (ToR 1) and the results of the assessment of the most relevant AMR bacteria in the EU (first part of ToR 2) for poultry were published in a separate EFSA scientific opinion (EFSA AHAW Panel, 2021a).

According to the results of the assessment already conducted, *Enterococcus cecorum* (*E. cecorum*) was identified among the most relevant AMR bacteria in the EU for poultry due to its increasing clinical importance in the last decades, problems associated with its treatment (often due to a late aetiological diagnosis) and its wide distribution, along with the high levels of resistance found for certain antimicrobials, which are also widely used for its treatment (lincosamides and spectinomycin) (EFSA AHAW Panel, 2021a).

This scientific opinion presents the results of the assessment on AMR *E. cecorum* in poultry on its eligibility to be listed and categorised within the AHL framework. Special focus is placed on the animal health impact of AMR *E. cecorum* in poultry in the EU, which is also summarised here as part of the assessment conducted according to the profile of the infection and its impact on animal welfare (Article 7).

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

The background and ToRs as provided by the European Commission for the present document are reported in Sections 1.1 and 1.2 of the scientific opinion on the ad hoc method to be followed for the assessment of animal diseases caused by bacteria resistant to antimicrobials within the AHL framework (EFSA AHAW Panel, 2021b).

1.2. Interpretation of the Terms of Reference

The interpretation of the ToRs is as in Sections 1.2.3 and 1.3.3 of the scientific opinion on the ad hoc method to be followed for the assessment of animal diseases caused by bacteria resistant to antimicrobials within the AHL framework (EFSA AHAW Panel, 2021b).

The present document reports the results of the assessment on AMR *E. cecorum* in poultry according to the criteria of the AHL articles as follows:

- Article 7: AMR *E. cecorum* infection profile and impacts;
- Article 5: eligibility of AMR *E. cecorum* infection to be listed;
- Article 9: categorisation of AMR *E. cecorum* infection according to disease prevention and control rules as in Annex IV;
- Article 8: list of animal species (also apart from poultry) related to AMR *E. cecorum* infection.

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 listing and categorisation of animal diseases within the AHL framework (EFSA AHAW Panel, 2017).

In order to take into account the specifics related to animal diseases caused by bacteria resistant to antimicrobials, the term 'disease' as in the AHL was interpreted in a broader sense, referring also to colonisation by commensal and potentially opportunistic bacteria, and the general presence of the identified AMR bacteria in the EU, depending on each criterion.

The following assessment was performed by the EFSA Panel on Animal Health and Welfare (AHAW) based on the information collected and compiled in form of a fact sheet as in Section 3.1 of the

[1] Regulation (EU) 2016/429 of the European Parliament and of the Council of 9 March 2016 on transmissible animal diseases and amending and repealing certain acts in the area of animal health ('Animal Health Law'). OJ L 84, 31.3.2016, p. 1–208.

present document. The outcome is the median of the probability ranges provided by the experts, which are accompanied by verbal interpretations as spelled out in Table 1.

Table 1: Approximate probability scale recommended for harmonised use in EFSA (EFSA Scientific Committee, 2018)

Probability term	Subjective probability range
Almost certain	99–100%
Extremely likely	95–99%
Very likely	90–95%
Likely	66–90%
About as likely as not	33–66%
Unlikely	10–33%
Very unlikely	5–10%
Extremely unlikely	1–5%
Almost impossible	0–1%

3. Assessment

3.1. Assessment of AMR *Enterococcus cecorum* according to Article 7 criteria of the AHL

3.1.1. Article 7(a) Disease profile

This fact sheet concerns *E. cecorum*, which is a Gram-positive coccus first described as a gut commensal in chickens (*Gallus gallus domesticus*) four decades ago (Devriese et al., 1983). Since then, as elaborated later in this fact sheet, the bacterium has been discovered in many other domestic and wild species. Hence, it appears to have a very broad host spectrum. Irrespective of the host, *E. cecorum* is an opportunistic pathogen, meaning it is a commensal bacterium causing disease only occasionally, likely during immune suppression and other yet-to-be defined circumstances.

Since 2002, *E. cecorum* has been recognised as a pathogen causing outbreaks in broiler chickens (Devriese et al., 2002). Disease typically commences as a subclinical or mild bacteraemia followed by a debilitating enterococcal spondylitis (ES) resulting in lameness (Jung et al., 2018).

Information on antimicrobial resistance in this pathogen is very limited and mostly available only for chickens. Accordingly, the fact sheet does not have a specific focus on any particular AMR phenotypes in *E. cecorum*. For more detailed information on antimicrobial resistance in poultry isolates, we refer to the recent EFSA scientific opinion on the most relevant AMR bacteria in the EU for poultry (EFSA AHAW Panel, 2021a), where this has been reviewed with tables and figures showing proportion of resistance to clinically relevant antibiotics in clinical *E. cecorum* isolates from across the world.

Whenever information in the fact sheet on carriage rate (i.e. proportion of a population colonised or carrying the bacterium somewhere in the body) is not further elaborated in terms of antimicrobial resistance, it is because the information available on carriage does not specify antimicrobial resistance.

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

Susceptible animal species

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

Pigeons (*Columba livia*) are susceptible to *E. cecorum*, and the bacterium was also isolated from the intestine of 1 of 39 northern bobwhite quail chicks (*Colinus virgianus*) in a study by McMurphy et al. (2010). The isolate was resistant to clindamycin, erythromycin and tetracycline. Using a non-culture-based approach, involving polymerase chain reaction (PCR) amplification and 16S ribosomal gene library construction, *E. cecorum* DNA has been identified in caecal samples of wild turkeys (*Meleagris gallopavo*) (Scupham et al., 2008). Also, using a non-culture-based approach, Shabbir et al. (2014) identified 16S rRNA sequences matching *E. cecorum* in the lungs of a houbara bustard (*Chlamydotis undulata*). According to the authors, this animal was more likely a reservoir host than clinically affected by this bacterium.

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

Chicken (*Gallus gallus domesticus*), Pekin duck (*Anas platyrhynchos domesticus*), turkey (*Meleagris* sp.) and domestic goose (*Anser* sp.) are susceptible.

In one of the earliest studies on *E. cecorum*, Devriese et al. (1991) isolated the bacterium from intestinal contents of pigs (*Sus scrofa domesticus*), cattle (*Bos taurus*), horses (*Equus ferus caballus*), canaries (*Serinus canaria domestica*) and a mallard duck (*Anas platyrhynchos*). A study by the same author found *E. cecorum* to constitute 5–6% of all enterococcal and streptococcal isolates from porcine faecal and intestinal samples (Devriese et al., 1994). Using a non-culture-based approach, involving PCR amplification and 16S ribosomal gene library construction, *E. cecorum* DNA has been identified in caecal samples of domestic turkeys (*Meleagris gallopavo domesticus*) (Scupham et al., 2008).

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

Unknown.

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

Experimental reproduction of ES in male broiler breeder chickens has been shown by Martin et al. (2011) upon intravenous or oral exposure to *E. cecorum*. Borst et al. (2017) also reproduced ES in broilers infected orally with *E. cecorum* and found an association between osteochondrosis in the free thoracic vertebra and ES. Thøfner and Christensen (2016) inoculated both 3-week-old broilers and adult (20- to 30-week-old) broiler breeders via the intravenous, oral and intratracheal route at two dosage rates. In breeders, only egg drop and decreased appetite were observed after high-dose intravenous exposure. High-dose intravenous exposure resulted in peracute deaths without typical lesions in broilers, whereas septicaemia, pericarditis and arthritis were observed in most broilers, given the lower dose intravenously. High-dose oral administration also induced disease in young broilers but not the adult breeders. Low-dose oral administration did not induce disease.

Infection resembling the septic phase of the infection in poultry has been induced experimentally in Pekin breeding ducks (Jung et al., 2013).

Reservoir animal species

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

E. cecorum was isolated from 28% of intestinal or faecal samples from 50 pigeons (*Columba livia domesticus*) (Baele et al., 2002). Pigeons were from different lofts.

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

E. cecorum has been isolated most frequently from poultry. The bacterium has also been isolated from various other domestic animal species as elaborated in the following. Given this broad host spectrum, it is likely that *E. cecorum* is also present (but yet to be discovered) in other animal species.

In dogs (*Canis lupis familiaris*) not suffering from enteric disease, Devriese et al. (1992a) isolated *E. cecorum* from 2% of 60 anal swabs and from 8% of 25 tonsillar swabs. The same study also isolated *E. cecorum* in cats (*Felis catus*) not suffering from enteric disease, namely from 14% of 40 anal swabs and from 12% of 26 tonsillar swabs.

In apparently healthy cattle (*Bos taurus*), Devriese et al. (1992b) found *E. cecorum* in 16% of 25 and 14% of 43 faecal samples of preruminant and ruminating calves, respectively. This species was not identified in dairy cows.

E. cecorum was isolated from 2.1% of 179 cloacal samples of healthy racing pigeons (*Columba livia domesticus*) (Dolka et al., 2020).

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

Morbidity

Parameter 1 – Prevalence/incidence

Within poultry flocks, Talebi et al. (2016) reported a morbidity of 1.5–2% among 10-week-old male broiler breeders. These birds had typical clinical signs of ES, namely sitting on their hock and tail suggestive of posterior paresis. Stalker et al. (2010) described an outbreak of the disease with onset of lameness in 4-week-old male broilers. On the first day, they reported 0.2% morbidity followed by 1% and 7% on days 2 and 3, respectively. The highest morbidity reported was 35% in broiler breeder

flocks (Borst et al., 2012). However, other causes of lameness such as bacterial chondronecrosis may contribute to these figures. That study compared antimicrobial resistance in isolates from spinal lesions, caecal content of healthy birds and caecal content of case birds (with clinical signs and gross lesions of ES). The proportion of resistance to tetracycline, oxytetracycline and erythromycin was above 70% for all broiler breeder groups, but significantly higher for isolates from spinal lesions compared to caecal isolates from case or control birds. On the contrary, the proportion of resistance to streptomycin was significantly lower for spinal isolates (12%) compared to isolates of caecal origin in case birds (20%) (Borst et al., 2012).

The recent EFSA scientific opinion on the most relevant AMR bacteria in the EU for poultry reports antimicrobial resistance data from four papers on clinical *E. cecorum* isolates from chickens. Overall, almost none (0–4%) of the 612 isolates from the three studies reporting susceptibility data for penicillins and aminopenicillins were resistant to these drugs. Similarly, the two studies reporting data on gentamicin in a total of 238 isolates showed only 0 and 2% resistance, respectively. As for the other drugs reported (lincosamides, tetracyclines, macrolides, and spiramycin), much higher levels of resistance (up to 100%) were detected (EFSA AHAW Panel, 2021a).

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

Since 2002, *E. cecorum* has been recognised as a pathogen causing outbreaks in broiler chickens (Devriese et al., 2002). Disease typically commences as a subclinical or mild bacteraemia followed by a debilitating ES resulting in lameness (Jung et al., 2018). ES is an inflammatory lesion developing in the spinal column at the level of the free thoracic vertebra and ultimately causing paralysis of affected individuals. Disease outbreaks also occur in Pekin ducks, which experience a more acute disease than chickens with signs of generalised bacteraemia but without osteomyelitis. Instead, post-mortem lesions in the liver and spleen are commonly detected (Metzner et al., 2010; Jung et al., 2012). In two recent Polish studies, few clinical isolates ($\leq$ 10 per study) have also been described in geese, turkeys and laying hens, although without further specification of disease or site of isolation (Dolka et al., 2016; Stepien-Pysniak et al., 2016).

One Polish study assessing diagnostic submissions from poultry resulting in isolation of *E. cecorum* has reported the mean age of necropsied animals as 3.6 weeks in broilers, 27.5 weeks in broiler breeders, 33.3 weeks in commercial layers, 12.9 weeks in turkeys, 3.6 weeks in ducks and 39.5 weeks in geese (Dolka et al., 2017).

It appears that colonisation patterns in poultry depend on the pathogenicity of *E. cecorum* strains. For example, one study has shown that in a broiler flock with outbreaks of ES, 60% and 90% of birds were colonised with *E. cecorum* already within 1 and 3 weeks post-hatch, respectively (Borst et al., 2017). On the contrary, in a broiler flock with no signs of spondylitis, *E. cecorum* was not even detected in birds until 3 weeks post-hatch, hence a somewhat later introduction to the intestine (Borst et al., 2017). Similar results were reported by a later study showing high early detection rates of *E. cecorum* among broilers developing spondylitis, compared to broilers unaffected by the disease (Jung et al., 2017). These results suggest that *E. cecorum* strains causing disease (i.e. pathogenic strains) are somewhat distinct from those not shown to be involved in disease (i.e. commensal strains). This is supported by the fact that isolates from lesions are genetically similar, whereas commensal isolates from the intestinal tract tend to be more genetically diverse (Jung et al., 2018). Furthermore, a general trend is that pathogenic strains have been shown to be more resistant to antibiotics than commensal strains (Boerlin et al., 2012; Borst et al., 2012), and a recent study, which is elaborated under Parameter 4 in Section 3.1.1.5, suggests that pathogenic strains also survive longer in the farm environment (Grund et al., 2021).

Different genetic traits involved in an increased adhesion, pathogenicity and control of exogenous DNA acquisition were also identified in pathogenic strains (Borst et al., 2015).

Mortality

Parameter 3 – Case-fatality rate

Overall mortality following *E. cecorum* outbreaks may vary considerably between and within studies as shown in Table 2. It should be noted that, in each study, mortality following ES outbreaks should be seen relative to typical or expected mortality of flocks without outbreaks (the baseline). For example, in the study by Borst et al. (2012), the authors reported 5.6% mortality in one flock, which had a baseline expected mortality of 3%. Most studies of Table 2 did either not report antimicrobial resistance, antimicrobial resistance was tested in a very low number of isolates, or it was not possible

to relate mortality to the proportion or type of resistance to the drugs tested. Nevertheless, two studies have reported antimicrobial resistance being more common in clinical than commensal isolates. One of these studies, elaborated under the previous parameter, showed that resistance to three of four antimicrobial drugs was more common in clinical than commensal isolates (Borst et al., 2012). These findings support those of Boerlin et al. (2012), who stated, 'While *E. cecorum* isolates from Ontario are frequently resistant to erythromycin, high-level streptomycin, tetracycline, and bacitracin in general ... the isolates recovered from clinical cases were more frequently resistant to erythromycin and streptomycin than controls. They also had more frequently elevated MICs for gentamicin and enrofloxacin than control isolates.' Importantly, the limited data available would need to be verified by others before antimicrobial resistance in *E. cecorum* can be linked with certainty to disease or death.

One experimental study on Pekin ducks showed varying mortality (6.7–100%) depending on the dose and mode of administration of *E. cecorum* isolates (Jung et al., 2013).

Table 2: Flock-level mortality in *E. cecorum* outbreaks for broiler chickens. Ranges indicate mortality in different flocks of the same study (table adapted from Jung et al. (2018))

Overall mortality (%)[(a)]	Reference
2–7[(b)]	De Herdt et al. (2008)
7.2	Jung and Rautenschlein (2014)
4.5–5.5	Borst et al. (2017)
4.1–11.7	Robbins et al. (2012)
3.1–8.1	Kense and Landman (2011)
5.61–10.66[(c)]	Borst et al. (2012)

(a): Including euthanised animals.
(b): In this study, only the mortality associated with *E. cecorum* infection was given.
(c): Up to 15% in breeders.

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

Parameter 1 – Report of zoonotic human cases (anywhere)

In case reports, *E. cecorum* has been identified as a rare cause of different infections in humans. It is generally an opportunistic pathogen and there is no argument for a general zoonotic potential. The literature reports cases of septicaemia (Greub et al., 1997; Warnke et al., 2015; Pang et al., 2016), endocarditis (Ahmed et al., 2011), peritonitis (De Baere et al., 2000; Hsueh et al., 2000) and surgical site and urinary tract infections (Delaunay et al., 2015). Infections have typically occurred in persons with severe comorbidities.

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

Enterococci are known to be intrinsically resistant to several antimicrobial agents. Whereas this has been widely investigated in other enterococcal species like *E. faecalis* and *E. faecium*, less is known for *E. cecorum*. As an example of intrinsic resistance, enterococci are known to have penicillin-binding proteins with low affinity to β-lactams. Although this may also be the case for *E. cecorum*, penicillin minimum inhibitory concentrations (MIC) are typically a bit lower for this species compared to *E. faecalis* and *E. faecium* (Jung et al., 2018). From Table 3, it is evident that resistance to penicillin is uncommon in *E. cecorum* of poultry origin with a resistance proportion of only 1.6% of 447 isolates from four different studies, whereas resistance to erythromycin (up to 89.6%) is often reported. Resistance to the last-resort antibiotic vancomycin was also uncommon with only 1.3% of 151 isolates in three studies displaying resistance, whereas nearly 100% of isolates were resistant to sulfonamides. The latter result was expected, since enterococci, unlike most other bacteria, are capable of exploiting external sources of folic acid, hence inhibition of folic acid synthesis by sulfonamides has no effect on bacteria from this genus. In a recent study, Dolka et al. (2020) tested antimicrobial susceptibility in *E. cecorum* isolates from racing pigeons, but due to the low number of isolates (n = 3), results are not mentioned here. It should be noted that susceptibility to antibiotics can be measured and interpreted in different ways. Since there are no clinical breakpoints or epidemiological cut-offs specific for *E. cecorum*, resistance proportions of any study need be interpreted carefully and comparison between studies must be done by also taking into account study design, isolate origin and prior antimicrobial

treatment. Despite the scarce cases of vancomycin resistance, for which breakpoints are not defined in *E. cecorum*, the presence of *vanA* genes in clinical isolates from poultry flocks in Poland (Dolka et al., 2016) and in retail poultry outside Europe (Harada et al., 2012) denotes that this species can acquire clinically relevant antimicrobial resistance genes from foreign bacteria.

Table 3: Antimicrobial resistance of *E. cecorum* isolated from poultry (Jung et al. (2018))

Antimicrobial class	Antimicrobial agent	References; number of resistant isolates/total number of isolates (% of resistant isolates)						Total % resistance
		Boerlin et al. (2012)	Borst et al. (2012)	Dolka et al. (2016)	Jackson et al. (2015)	Stepien-Pysniak et al. (2016)	Suyemoto et al. (2017)	
Aminocoumarins	Novobiocin	–[(a)]	70/260 (26.9)	–	–	–	–	26.9
Aminoglycosides	Gentamicin	27/73 (37.0)	35/260 (13.5)	1/82 (1.2)	1/105 (1.0)	–	0/32 (0.0)	11.6
	Kanamycin	–	–	–	14/105 (13.3)	–	2/32 (3.7)	11.7
	Neomycin	–	44/260 (17.0)	–	–	–	–	17.0
	Spectinomycin	–	45/260 (17.3)	–	–	–	–	17.3
	Streptomycin	41/73 (56.2)	32/260 (12.3)	–	8/105 (7.6)	–	2/32 (6.3)	17.7
β-lactams	Amoxicillin	–	78/260 (30.0)	–	–	0/37 (0.0)	–	26.3
	Ampicillin	–	–	1/82 (1.2)	–	–	–	1.2
	Penicillin	2/73 (2.7)	5/260 (1.9)	0/82 (0.0)	–	–	0/32 (0.0)	1.6
Glycopeptides	Teicoplanin	–	–	70/82 (85.4)	–	–	–	85.4
	Vancomycin	–	–	1/82 (1.2)	–	1/37 (2.7)	0/32 (0.0)	1.3
Glycylcyclines	Tigecycline	–	–	–	–	–	0/32 (0.0)	0.0
Lipopeptides	Daptomycin	–	–	–	–	–	0/32 (0.0)	0.0
Lincosamides	Lincomycin	–	–	–	60/105 (57.1)	–	20/32 (62.5)	58.4
Macrolides	Erythromycin	65/73 (89.0)	233/260 (89.6)	38/82 (46.3)	28/105 (26.7)	–	25/32 (78.1)	70.5
	Tylosin	–	161/260 (61.9)	–	15/105 (14.3)	19/37 (51.4)	21/32 (65.6)	49.8
Nitrofurans	Nitrofurantoin	–	–	0/82 (0.0)	–	–	0/32 (0.0)	0.0
Oxazolidinones	Linezolid	–	–	0/82 (0.0)	4/105 (3.8)	–	0/32 (0.0)	1.8
Phenicols	Chloramphenicol	–	–	0/82 (0.0)	1/105 (1.0)	–	0/32 (0.0)	0.5
	Florfenicol	12/73 (16.4)	53/260 (20.4)	–	–	4/37 (10.8)	–	18.6
Quinolones	Ciprofloxacin	–	–	–	–	–	0/32 (0.0)	0.0
	Enrofloxacin	29/73 (39.7)	56/260 (21.5)	71/82 (86.6)	–	20/37 (54.1)	–	38.9
Streptogramins	Quinupristin/ Dalfopristin	–	–	–	28/105 (26.7)	–	9/32 (28.1)	27.0

Antimicrobial class	Antimicrobial agent	References; number of resistant isolates/total number of isolates (% of resistant isolates)						Total % resistance
		Boerlin et al. (2012)	Borst et al. (2012)	Dolka et al. (2016)	Jackson et al. (2015)	Stepien-Pysniak et al. (2016)	Suyemoto et al. (2017)	
Sulfonamides	Sulfadimethoxine	–	257/260 (98.8)	–	–	–	–	98.8
	Sulfathiazole	–	243/260 (93.5)	–	–	–	–	93.5
Tetracyclines	Doxycycline	–	–	68/82 (82.9)	–	16/37 (43.2)	–	70.6
	Oxytetracycline	–	224/260 (86.2)	–	–	–	–	86.2
	Tetracycline	72/73 (98.6)	224/260 (86.2)	5/82 (6.0)	68/105 (64.7)	–	22/32 (68.8)	70.8

(a): Not done.

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

As *E. cecorum* is usually a commensal, the infectious period may in theory last from colonisation until death. This is potentially possible for all strains, as it is not yet defined if some strains cannot cause infection or if they are just less likely to cause infection than others are.

Parameter 2 – Presence and duration of latent infection period

Unknown, although as stated in the next paragraph, chickens can be silent carriers for at least a couple of weeks during bacteraemia.

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

Pathogenic strains of *E. cecorum* may colonise the intestinal tract of chickens by the age of 7 days (Borst et al., 2017) and may be found in the yolk sac or spleen earlier than 14 days of age, suggesting transfer over the intestinal barrier (Jung and Rautenschlein, 2014; Borst et al., 2017). It is unknown for how long chickens may be healthy carriers of these pathogenic strains, but at least they can be silent carriers during the first weeks of bacteraemia with no clinical signs or just a slight increase in flock mortality (Jung and Rautenschlein, 2014; Borst et al., 2017).

Environment

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

For a long time, it has been assumed that *E. cecorum* may survive in the farm environment, as farms are often struck by consecutive outbreaks of ES (De Herdt et al., 2008; Borst et al., 2017). However, only recently an experimental study tested and confirmed survival of *E. cecorum* under different environmental conditions. The study showed that *E. cecorum* can survive from 2 to 178 days depending on the combination of temperature, humidity and substrate. Survival was longest on litter (compared to dust and polyvinyl chloride), and the optimal climate conditions were 15°C and 32% relative humidity. Among four tested *E. cecorum* strains, the three pathogenic ones survived longer than the single commensal strain (Grund et al., 2021).

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)

Vertical transmission has been suspected but is yet to be proven with studies failing to show genetic similarity between strains of breeder parents and pathogenic outbreak strains in progeny flocks (Kense and Landman, 2011; Robbins et al., 2012). Horizontal transmission appears to occur rapidly in affected flocks, and the primary route of infection is believed to be faecal-oral, as intestinal infection typically develops prior to other lesions of infected chickens (Borst et al., 2017). Infection following inhalation has also been proposed (Jung and Rautenschlein, 2014; Borst et al., 2017) and even demonstrated in an experimental study that also showed infection via administration of *E. cecorum* via the intravenous and oral routes (Thøfner and Christensen, 2016). This means that infection via inhaled dust particles is theoretically possible.

It is unknown how pathogenic *E. cecorum* strains are introduced into poultry flocks, apparently not via vertical transmission as stated above. It does seem as if pathogenic strains may persist for a long period in the environment of farms experiencing multiple successive ES outbreaks.

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

There is no clear evidence of transmission from animals to humans, but there has been speculation of close contact to animals as a potential risk factor for transmission (Greub et al., 1997; Ahmed et al., 2011), as well as potential food-mediated transmission (Delaunay et al., 2015).

Speed of transmission

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

Horizontal transmission appears to occur rapidly in affected flocks, and the primary route of infection is believed to be faecal-oral, as intestinal infection typically develops prior to other lesions of infected chickens (Borst et al., 2017).

Parameter 4 – Transmission rate (β) (from R0 and infectious period) between animals and, when relevant, between animals and humans

The exact speed of transmission between animals is unknown, although outbreaks tend to occur rapidly (Borst et al., 2017). Both ingestion and/or inhalation of *E. cecorum* seem to contribute to the spread during an outbreak in a flock (Jung and Rautenschlein, 2014; Borst et al., 2017). Transmission between houses on the same farm appears to occur more seldom (Borst et al., 2017). As stated just above, nothing is known about the origin of human infection. But, in view of the few available case reports, it appears that zoonotic transmission occurs rarely.

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

Presence and distribution

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

The distribution of *E. cecorum*, and consequently disease caused by it, is endemic, as this is a ubiquitous bacterial species worldwide.

It is plausible that endemic distribution occurs both for pathogenic and commensal strains. In that regard – although some differences have been shown for colonisation patterns, genetic and genomic properties, antimicrobial resistance and environmental survival – it is important to remember that there is not yet a clear way to distinguish 'commensal' and 'pathogenic' strains. Still, the identification of different acquired antimicrobial resistance (e.g. *tet(M)*, *tet(L)*, *erm(B)*, *van(A)*) and virulence (e.g. *cyl*, *ace*, *capsule*) genes that are commonly found in clinically relevant species of *E. faecium* and *E. faecalis*, mainly in *E. cecorum* clinical cases, highlight the potential of this species to exchange DNA with other bacteria and to accumulate adaptive traits that may play a role in its pathogenicity.

Antimicrobial resistance data are only available from a few Member States; antimicrobial resistance data from clinical *E. cecorum* from poultry in France (Resapath, 2020) included resistance proportions

as follows: tetracycline (93%), spiramycin (53%), lincomycin (37%), tylosin (35%), erythromycin (32%), amoxicillin (3%) and gentamicin (2%). In addition, three Polish studies have investigated antimicrobial resistance in isolates from chicken as well as geese, turkeys and racing pigeons (Dolka et al., 2016; Stępień-Pyśniak et al., 2016; Dolka et al., 2020). Results from these studies are presented in Section 3.1.1.4.

Risk of introduction

This section is not relevant due to the ubiquitous occurrence of this bacterial species.

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

Diagnostic tools

Parameter 1 – Existence of diagnostic tools

Diagnosis in poultry is made by a combination of pathological examination of lesions and microbiological culture of sample specimens. Lesions following *E. cecorum* infection may vary, but a very typical and almost pathognomonic finding is ES and osteomyelitis at the level of the free thoracic vertebra (T6). Importantly, in the initial bacteraemic phase where lameness may be less obvious and the clinical manifestation may be minor (little increase in mortality rates), the macroscopic lesions are often few (Thøfner and Christensen, 2016). Depending on the stage in the course of the outbreak/ infection, bacterial cultivation from several of the predilection sites (joints, pericardium and bone marrow) may increase the chance for isolating *E. cecorum* (Thøfner and Christensen, 2016; Anonymous, 2021).

While confirmation of typical clinical disease by the above procedure is strong evidence of flock infection with one or more pathogenic strains of *E. cecorum*, the absence of disease does not mean that the infection is not present in other flocks.

After culturing relevant sample material from lesions, typical small enterococcal-like colonies may be identified by various well-known methods, including basic phenotypic tests, matrix-assisted laser desorption ionisation–time-of-flight mass spectrometry (MALDI-TOF MS) and PCR.

The accurate diagnosis of *E. cecorum* requires attention since this species presents uncommon phenotypic features (e.g. poor or absence of growth in enterococci selective media) and its occurrence may be overlooked.

Resistance to antibiotics can be detected in various ways, including by determination of the MIC using broth or agar dilution, or using agar diffusion, e.g. by E-test. Antimicrobial resistance can also be detected using the disk diffusion method for which zone inhibition diameters are read. Importantly, there are no breakpoints specific for *E. cecorum*, hence definition of antimicrobial resistance in this species needs be done using epidemiological cut-offs or clinical breakpoints from other enterococcal species in humans or in animals other than birds. Accordingly, the clinical relevance of *E. cecorum* susceptibility testing for guiding treatment of poultry is questionable.

Parameter 2 – Existence of control tools

There are no effective commercially available vaccines yet, but flock-specific autogenous vaccines may be applied in broiler breeder flocks. Maternal antibodies may be transferred to the offspring; however, no protection against *E. cecorum* challenge has been demonstrated, even with a vaccine composed of antigens from seven genotype groups, which induced a good opsonisation response (Borst et al., 2019a).

E. cecorum infection can be treated with antibiotics, but treatment needs to be initiated in the early (bacteraemic) stages of disease, as treatment of paralysed birds is ineffective. Penicillins are likely the most widely applied antibiotics (Jung et al., 2018), but ideally treatment should be according to antimicrobial susceptibility testing results.

It is possible that the recent discovery of long-term survival of pathogenic *E. cecorum* strains in the farm environment (Grund et al., 2021) will lead to new recommendations concerning hygiene and managerial practices.

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

The bacterium is ubiquitous, hence the disease is endemic and therefore likely present in all Member States. There is generally a lack of information on antimicrobial resistance in *E. cecorum* in Member States. The recent EFSA scientific opinion includes only data on clinical isolates from chickens in France. In addition, three Polish studies have investigated antimicrobial resistance in isolates from chickens as well as geese, turkeys and racing pigeons (Dolka et al., 2016; Stępień-Pyśniak et al., 2016; Dolka et al., 2020). The proportions of antimicrobial resistance in the French and the Polish studies are presented in Sections 3.1.1.4 and 3.1.1.7, respectively.

The loss of production due to the disease

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

Outbreaks in broilers can lead to major economic losses due to welfare-related culling, mortality, use of medicine, higher condemnation rates, etc. The exact costs are unknown, but with successive outbreaks, individual farms may be severely affected economically. As for laying hens and other domestic bird species, outbreaks appear to be rare, so even less is known about economic costs of *E. cecorum* infections in these production systems.

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

Transmissibility between animals and humans

Parameter 1 – Types of routes of transmission between animals and humans

There is no clear evidence of transmission from animals to humans, but there has been speculation of close contact to animals as a potential risk factor for transmission (Greub et al., 1997; Ahmed et al., 2011), as well as potential food-mediated transmission (Delaunay et al., 2015).

Parameter 2 – Incidence of zoonotic cases

Likely very low incidence since only a few sporadic human cases have been reported.

In case reports, *E. cecorum* has been identified as a rare cause of different infections in humans. Infections are generally opportunistic in nature and there is no argument for a zoonotic potential. The literature reports cases of septicaemia (Greub et al., 1997; Warnke et al., 2015; Pang et al., 2016), endocarditis (Ahmed et al., 2011), peritonitis (De Baere et al., 2000; Hsueh et al., 2000) and surgical site and urinary tract infections (Delaunay et al., 2015). Infections have typically occurred in immunocompromised persons with severe comorbidities.

Transmissibility between humans

Parameter 3 – Human-to-human transmission is sufficient to sustain sporadic cases or community-level outbreak

There is no evidence available on human-to-human spread, and given the rare occurrence in humans, the probability of transmission between humans appears very low. The human case studies by Pang et al. (2016), Warnke et al. (2015), Delaunay et al. (2015), Ahmed et al. (2011), De Baere et al. (2000), Hsueh et al. (2000) and Greub et al. (1997) reported full susceptibility of the clinical isolates to the antimicrobial agents tested for (β-lactams, vancomycin and other drugs depending on the study).

Parameter 4 – Sporadic, epidemic or pandemic potential

Sporadic potential appears most likely based on the few sporadic human cases reported in the literature (see Section 3.1.1.3).

The severity of human forms of the disease

Parameter 5 – Disability-adjusted life year (DALY)

Unknown.

The availability of effective prevention or medical treatment in humans

Parameter 6 – Availability of medical treatment and their effectiveness (therapeutic effect and any resistance)

The few available case studies on human disease have shown effectiveness of certain antibiotics, mainly β-lactams, e.g. ceftriaxone was effective in a human case of septicaemia (Pang et al., 2016). Vancomycin was already used, with success, for the treatment of a *E. cecorum* peritonitis human case after initial therapy with cefazolin plus gentamicin (De Baere et al., 2000). Still, the data material is too sparse to make any general statement about antibiotic effectiveness.

Parameter 7 – Availability of vaccines and their effectiveness (reduced morbidity)

No vaccines are available.

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 broilers and broiler breeders, the disease starts as a septicaemia, which is often subclinical but may lead to slight or moderately higher mortality around weeks 2–3 of age (Stalker et al., 2010; Robbins et al., 2012; Jung and Rautenschlein, 2014; Borst et al., 2017). If the disease progresses, it may develop into a skeletal infection involving the free thoracic vertebra (T6). This leads to irreversible paralysis. Affected birds are easily identifiable and would be expected to be culled on welfare grounds. The skeletal infection typically peaks at weeks 5–6 in broiler flocks and in week 13 in broiler breeders (Stalker et al., 2010; Makrai et al., 2011; Aitchison et al., 2014; Borst et al., 2017). Osteochondrosis dissecans lesions in the cartilage of the affected vertebrae have been described as a predisposing factor for ES (Borst et al., 2017). It is unknown if immune suppression or other co-morbidities predispose to the disease, although injury to the intestinal barrier due to other intestinal bacteria has been proposed as a potential factor predisposing to the initial bacteraemia. Nevertheless, a correlation between intestinal lesions and disease remains to be proven (Borst et al., 2017). Recent work attempting to document the link between intestinal damage and the condition unexpectedly demonstrated that inflammation associated with coccidial infection reduces the likelihood of tissue invasion by *E. cecorum* as well as the risk of spinal lesions developing (Borst et al., 2019b).

In Pekin ducks, a more acute disease than occurs in chickens, with signs of generalised bacteraemia, but without osteomyelitis, has been described. Post-mortem lesions in the liver and spleen are commonly detected (Metzner et al., 2010; Jung et al., 2012).

As stated above (Parameter 4 in Section 3.1.1.1), the bacterium may be isolated from a range of different lesions in poultry, suggesting that clinical signs and progress of disease may vary between cases. Concerning laying hens and other poultry species, the literature is not clear about whether *E. cecorum* is associated with specific clinical signs or pathological lesions.

One Polish study assessing diagnostic submissions from poultry resulting in isolation of *E. cecorum* has reported the mean age of necropsied animals as 3.6 weeks in broilers, 27.5 weeks in broiler breeders, 33.3 weeks in commercial layers, 12.9 weeks in turkeys, 3.6 weeks in ducks and 39.5 weeks in geese (Dolka et al., 2017). The only lesions recorded in commercial layers were arthritis (non-spinal) and ovaritis, yet only two of the 23 isolates were from these tissues (most were from heart blood).

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

E. cecorum was identified in a lung aspirate from a houbara bustard (*Chlamydotis undulata*) (Shabbir et al., 2014), which is included among the IUCN Red List of Threatened Species. According to the authors, this animal was more likely a reservoir host than clinically affected by this bacterium.

Parameter 2 – Mortality in wild species

Unknown.

Environment

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

A recent study showed that *E. cecorum* can survive from 2 to 178 days depending on the combination of temperature, humidity and substrate. Survival was longest on litter (compared to dust and polyvinyl chloride), and the optimal climate conditions were 15°C and 32% relative humidity. Among four tested *E. cecorum* strains, the three pathogenic ones survived longer than the single commensal strain (Grund et al., 2021). Therefore, it is possible that the bacterium may also persist for some time under favourable conditions on poultry farms, particularly under conditions of continuous operation, re-use of built-up litter or poor terminal cleaning and disinfection.

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

Not listed.

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

Not listed.

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

None identified.

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 tools, OIE-certified

There is no officially internationally recognised diagnostic tool; however, general practice is to evaluate clinical signs and to sample different body sites during necropsy for culture-based analysis given the wide variety of organs the bacterium may be isolated from (Thøfner and Christensen, 2016; Anonymous, 2021). Given the unusual phenotypic features of *E. cecorum* and misidentification concerns by classical methods, MALDI-TOF MS is a reliable approach to identify *E. cecorum* isolates (Delaunay et al., 2015; Warnke et al., 2015; Pang et al., 2016).

Detection of resistance is based on the previously mentioned tools (see Parameter 1 in Section 3.1.1.8), namely MIC testing or disk diffusion.

Effectiveness

Parameter 2 – Sensitivity and specificity of diagnostic tests

Unknown.

Feasibility

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

During necropsy, samples from different body sites with signs of lesions should be taken. If there is suspicion of ES due to paralysis of animals or history of this disease in the sampled farm, it would be worthwhile to sample the free thoracic vertebra for culture-based analysis.

3.1.4.2. Article 7(d)(ii) Vaccination

Availability

Parameter 1 – Types of vaccines available on the market (live, inactivated, DIVA, etc.)

None, except flock-specific autogenous vaccines for broiler breeders. Note that these are not on the market but made for specific outbreaks. Maternal antibodies may be transferred to the offspring.

Parameter 2 – Availability/production capacity (per year)

Not applicable as no vaccines are available.

Effectiveness

Parameter 3 – Field protection as reduced morbidity (as reduced susceptibility to infection and/or to disease)

No protection against *E. cecorum* challenge has been demonstrated, even with a vaccine composed of antigens from seven genotype groups which induced a good opsonisation response (Borst et al., 2019a).

Parameter 4 – Duration of protection

Not applicable as no vaccines are available.

Feasibility

Parameter 5 – Way of administration

Not applicable as no vaccines are available.

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

Availability

Parameter 1 – Types of drugs available on the market

Various antimicrobial agents can be used for treatment of *E. cecorum* infections (e.g. penicillins, amino-penicillins, macrolides and tetracyclines), but availability of registered products varies between countries.

Parameter 2 – Availability/production capacity (per year)

Antimicrobial drugs for treatment of poultry infections are widely available on the market worldwide.

Effectiveness

Parameter 3 – Therapeutic effects in the field (effectiveness)

There are no systematic assessments on efficacy of different antimicrobial regimens on *E. cecorum*-associated *disease. A recent review on E. cecorum* infections in chickens states that '… penicillin derivatives are probably the most frequently used substances to combat ES' (Jung et al., 2018). Given the overall low proportions of resistance in *E. cecorum* to penicillin and aminopenicillins (see Sections 3.1.1.4 and 3.1.1.7), this seems to be a rational choice, although the clinical relevance of susceptibility testing of *E. cecorum* is associated with uncertainty as described earlier.

Feasibility

Parameter 4 – Way of administration

Antibiotics are mostly administered orally to poultry, e.g. via drinking water.

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

Availability

Parameter 1 – Available biosecurity measures

All-in–all-out production (broilers), thorough cleaning and disinfection of poultry houses and other general biosecurity measures (e.g. pest control, personal hygiene precautions like hand washing and change of clothes and boots when entering stables) to prevent spread of pathogenic *E. cecorum* strains between flocks and, in particular, avoidance of high-dose challenge with such strains in young birds.

Effectiveness

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

Given the ubiquitous occurrence of the pathogen, its ability to remain viable for long periods, and likely occurrence of subclinical infection of potentially pathogenic strains in many asymptomatic flocks, the effectiveness is likely to depend to a large degree on that of the terminal cleaning and disinfection, as well as feed, water and house biosecurity in early life. The effectiveness of feasible biosecurity may also be affected by local degree of environmental challenge associated with the degree of multi-agedness of production, density of poultry farming operations, mixed-species farms and presence of other domestic and wildlife reservoirs.

Feasibility

Parameter 3 – Feasibility of biosecurity measures

Implementation of biosecurity measures depends on the skills of farm personnel, farm economy and workflow, and on the design of poultry farms. For example, personal hygiene precautions like hand washing and change of clothes may be simple in some farms with changing facilities and sinks, but more complex in other farms. More stringent biosecurity is possible for higher value breeding stock than production chickens. Nevertheless, the basic cleaning and disinfection approaches relevant to this disease are broadly similar to those routinely practiced for the control of notifiable diseases and zoonotic pathogens.

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

Availability

Parameter 1 – Available movement restriction measures

All-in–all-out production where broilers, and other poultry species raised for meat production, are not moved between flocks. Instead, a full production cycle takes place in a poultry house followed by transportation to the slaughterhouse, and cleaning and disinfection of the empty house before chicks for a new production cycle are allowed to enter. However, these measures are those normally advised for general disease control in poultry production.

Effectiveness

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

Given the likely occurrence of this ubiquitous commensal infection in unaffected flocks, it is unlikely that movement restrictions which go beyond normal good practice would be effective in controlling disease.

Feasibility

Parameter 3 – Feasibility of restriction of animal movement

All-in–all-out production is feasible for commercial poultry farms.

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

Availability

Parameter 1 – Available methods for killing animals

Since *E. cecorum* is not regarded a zoonotic and highly contagious agent, infected birds can be killed in slaughterhouses, and killed animals can enter human consumption if they do not show clinical signs or lesions.

Treatment of affected animals experiencing paralysis due to ES is pointless, as there is no chance of recovery. Hence, such animals should be euthanised on farm (manual neck dislocation or with the aid of an appropriate humane killer).

Effectiveness

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

Killing animals is effective for animal welfare reasons. However, euthanising paralysed birds cannot prevent the infection from spreading between animals that are subclinically affected or healthy carriers of the bacterium. Thorough cleaning and disinfection of premises is likely to be important to reduce the risk of subsequent outbreaks of ES.

Feasibility

Parameter 3 – Feasibility of killing animals

Killing of individual paralysed birds should be feasible for most farmers.

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

No special precautions should be taken concerning disposal of carcasses and animal by-products, as *E. cecorum* is not regarded a zoonotic and highly contagious agent.

Disposing carcasses of dead and euthanised animals is feasible for farmers and is necessary for general disease control. No special precautions are needed to prevent spread of infection to other farms or to humans (*E. cecorum* is not regarded a zoonotic and highly contagious agent).

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)

It has been estimated in 2012 that the total costs in Finland to keep biosecurity at an appropriate level for a batch of 75,000 broilers would be approximately €2,700 (Siekkinen et al., 2012). Likely, such costs are already budgeted in most farms; hence, additional costs to minimise the impact of *E. cecorum* on animals may not be needed. Costs for antimicrobial treatment vary depending on the drug used and the length of treatment.

Parameter 2 – Cost of eradication (culling, compensation)

Not applicable, as flocks are not culled. This is not effective in preventing spread of infection.

Parameter 3 – Cost of surveillance and monitoring

The bacterium/infection is generally not subject to surveillance or monitoring. One exception is a report from British surveillance, although without statement of economic costs (Anonymous, 2021).

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

Bans, embargoes and sanctions have not been enforced for this bacterium/disease.

The costs associated with *E. cecorum*-associated *disease arise from higher mortality and increased condemnation rates at slaughter following visual inspection. It is not possible to give a general statement about average costs for farms or at country or EU level.*

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

Unknown.

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

Not applicable, as control and preventive measures are not specific for this disease/bacterium.

There are no guidelines or recommendations for antimicrobial use for disease caused specifically by *E. cecorum*. Penicillins may work as a treatment option and should be acceptable by society, given their narrow spectrum.

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

Control measures aimed at delaying and reducing challenge with *E. cecorum* in the early life will reduce the occurrence of clinical and subclinical disease and so benefit animal welfare. Medication of affected flocks will have little or no benefit for birds already affected, but it may reduce the progression of disease in as yet subclinically affected birds to the benefit of the birds and the producer. Potentially, antibiotics used to control this or other diseases may become ineffective due to the occurrence of antimicrobial resistance, and this would reduce any animal welfare benefits.

Parameter 2 – Wildlife depopulation as control measure

Depopulation of wildlife is not a relevant control measure, as *E. cecorum* is a ubiquitous commensal in poultry and some other domestic species; hence, the presence of the bacterium in wildlife does not seem to add to the risk of poultry production.

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)

The extent of antimicrobial treatment for *E. cecorum*-associated *infections in poultry (and consequently spill-over to the environment) is unknown.*

Biodiversity

Parameter 1 – Mortality in wild species

Control measures like antimicrobial treatment and keeping biosecurity appropriate are not expected to result in mortality in wild species.

3.2. Assessment of AMR *Enterococcus cecorum* according to Article 5 criteria of the AHL on its eligibility to be listed

3.2.1. Detailed outcome on Article 5 criteria

In Table 4 and Figure 1, the results of the expert judgement on the Article 5 criteria of the AHL for AMR *E. cecorum* in poultry are presented.

The distribution of the individual answers (probability ranges) provided by each expert for each criterion is reported in Sections A.1 and A.2 of Appendix A.

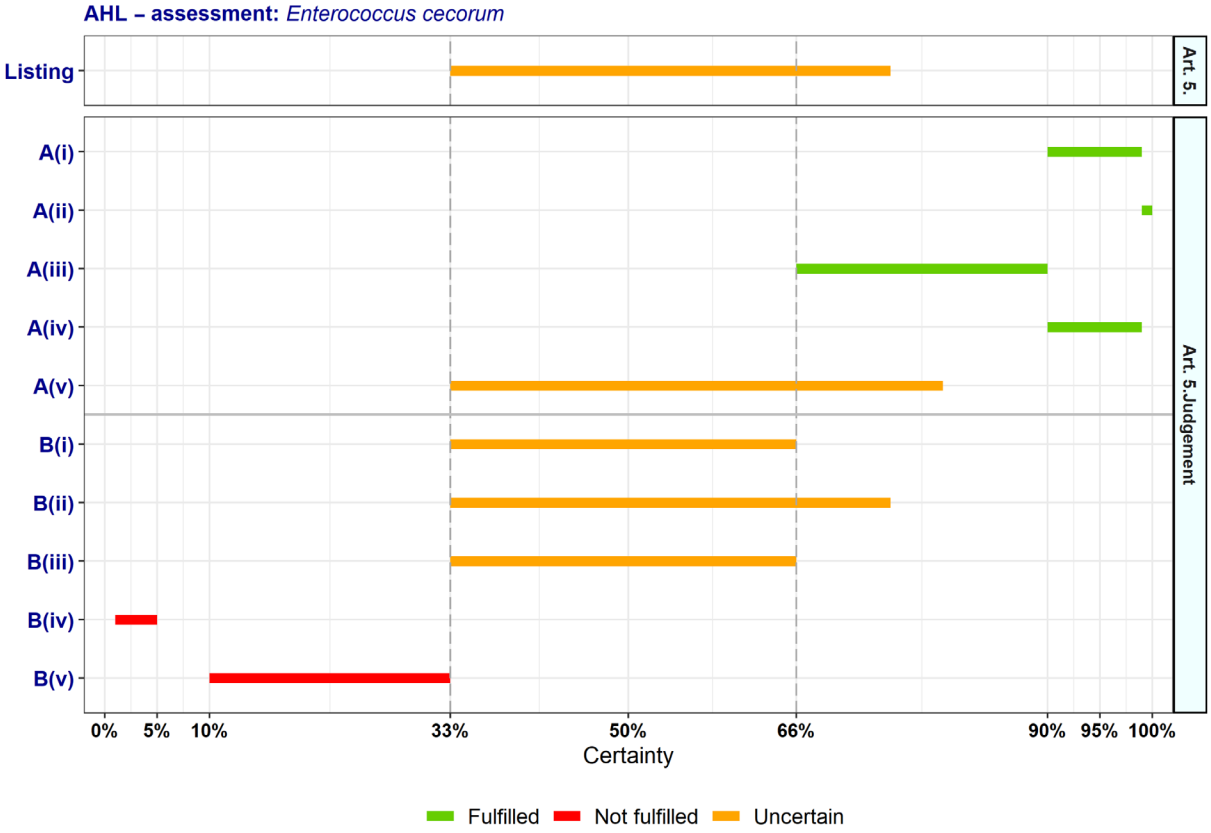
In Figure 1, the outcome of the expert judgement is graphically shown together with the estimated overall probability of the AMR bacterium meeting the criteria of Article 5 on its eligibility to be listed.

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

Criteria to be met by the disease: According to the 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		**Outcome**			
		Median range (%)	**Criterion fulfilment**	**Number of na**	**Number of experts**
A(i)	The disease is transmissible	90–99	Fulfilled	0	15
A(ii)	Animal species are either susceptible to the disease or vectors and reservoirs thereof exist in the Union	99–100	Fulfilled	0	15
A(iii)	The disease causes negative effects on animal health or poses a risk to public health due to its zoonotic character	66–90	Fulfilled	0	15
A(iv)	Diagnostic tools are available for the disease	90–99	Fulfilled	0	15
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	33–80	Uncertain	0	15

At least one criterion to be met by the disease: In addition to the criteria set out above at point 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	33–66	Uncertain	0	15
B(ii)	The disease agent has developed resistance to treatments which poses a significant danger to public and/or animal health in the Union	33–75	Uncertain	0	15
B(iii)	The disease causes or could cause a significant negative economic impact affecting agriculture or aquaculture production in the Union	33–66	Uncertain	0	15
B(iv)	The disease has the potential to generate a crisis or the disease agent could be used for the purpose of bioterrorism	1–5	Not fulfilled	0	15
B(v)	The disease has or could have a significant negative impact on the environment, including biodiversity, of the Union	10–33	Not fulfilled	0	15

na: not applicable.



Listing: the probability of the disease to be listed according to Article 5 criteria of the AHL (overall outcome).

Figure 1: Outcome of the expert judgement on Article 5 criteria and overall probability of AMR *E. cecorum* on its eligibility to be listed

3.2.1.1. Reasoning for uncertain outcome on Article 5 criteria

Criterion 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)

- Risk mitigation is primarily based on treatment using antibiotics; a prerequisite for the effective treatment can be early diagnosis, which may require frequent monitoring of uncommon phenotypic features that in turn may hamper the diagnosis.
- Treatment may fail if there is resistance against the used compound.
- Risk-mitigating measures (e.g. biosecurity, all-in–all-out) may reduce the risk of introduction, but they are not always effective.
- There is no structured or harmonised surveillance in the EU. Vaccines are not available.
- The effect of the disease is not remarkable; thus, the risk in the EU is low and risk-mitigating measures may be proportionate.
- Risks posed by AMR strains are difficult to define, since even in the case of treatment failure, this may be due to late diagnosis (treatment is provided too late) rather than due to clinical resistance.

Criterion 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):

- *E. cecorum* is an opportunistic pathogen which does not always lead to disease.
- If disease develops in poultry, it can be associated with significant morbidity, and mortality can increase to higher levels than expected.
- Disease in poultry may involve skeletal infection and lead to irreversible paralysis. Those birds would be culled on welfare grounds.
- AMR strains are usually more pathogenic than commensal ones.
- AMR *E. cecorum* is emerging in the EU.
- There is a possible mid- to long-term effect due to the dissemination of MDR strains in the environment.
- There is no significant risk to public health, as human cases are rare.

Criterion B(ii) (the disease agent has developed resistance to treatments which poses a significant danger to public and/or animal health in the Union)

- Few data are available.
- Resistance, apart from intrinsic resistance, is generally low. Resistance to critical antimicrobials seems limited.
- AMR genes can potentially be transmitted between different bacteria.
- There are several MDR strains, which are increasing and may have potential effects. This would represent a danger.

Criterion B(iii) (the disease causes or could cause a significant negative economic impact affecting agriculture or aquaculture production in the Union)

- *E. cecorum* is an opportunistic pathogen which does not always lead to disease.
- Few data are available.
- If disease develops in poultry, it can be associated with significant morbidity and mortality. This would have a significant effect on individual farms.
- There may be localised outbreaks with economic losses, especially in young chickens.
- Broiler farms may experience major economic losses due to welfare-related culling, mortality, use of antibiotics and higher condemnation rates.

3.2.2. Overall outcome on Article 5 criteria

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, a criterion is considered fulfilled when the lower bound of the median range lays above 66%.

According to the results shown in Table 4, AMR *E. cecorum* complies with four criteria of the first set (A(i)–A(iv)), but there is uncertainty on the assessment on compliance with criterion A(v) (33–80% probability). There is also uncertainty on the outcome of the assessment of another three criteria of

the second set (B(i)–B(iii)) (33–66%, 33–75% and 33–66% probability of meeting the criteria, respectively). Therefore, it is uncertain whether AMR *E. cecorum* can be considered eligible to be listed for Union intervention as laid down in Article 5 of the AHL. The estimated overall probability range for the AMR bacterium being eligible to be listed is 33–75% (Figure 1).

3.3. Assessment of AMR *Enterococcus cecorum* according to criteria in Annex IV for the purpose of categorisation as in Article 9 of the AHL

In Tables 5–9 and related graphs (Figures 2–4), the results of the expert judgement on AMR *E. cecorum* in poultry according to the criteria in Annex IV of the AHL, for the purpose of categorisation as in Article 9, are presented.

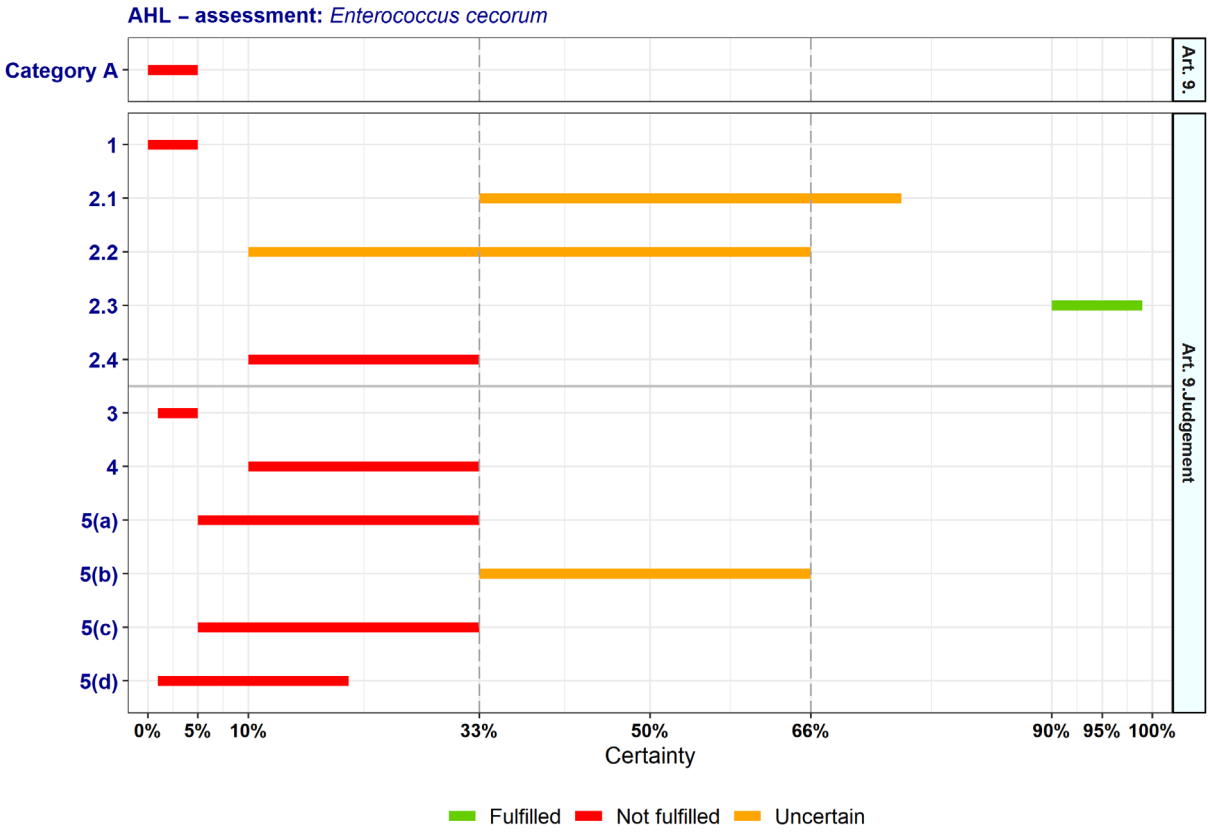
The distribution of the individual answers (probability ranges) provided by each expert for each criterion is reported in Sections B.1 and B.2 of Appendix B.

3.3.1. Detailed outcome on Category A criteria

Table 5: Outcome of the expert judgement related to the criteria of Section 1 of Annex IV (Category A of Article 9)

Criteria to be met by the disease: The disease needs to fulfil all of the following criteria		**Outcome**			
		Median range (%)	**Criterion fulfilment**	**Number of na**	**Number of experts**
1	The disease is not present in the territory of the Union or present only in exceptional cases (irregular introductions) or present in only in a very limited part of the territory of the Union	0–5	Not fulfilled	0	15
2.1	The disease is highly transmissible	33–75	Uncertain	0	15
2.2	There are possibilities of airborne or waterborne or vector-borne spread	10–66	Uncertain	0	15
2.3	The disease affects multiple species of kept and wild animals or single species of kept animals of economic importance	90–99	Fulfilled	0	15
2.4	The disease may result in high morbidity and significant mortality rates	10–33	Not fulfilled	0	15
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 for public health, including epidemic or pandemic potential or possible significant threats to food safety	1–5	Not fulfilled	0	15
4	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	10–33	Not fulfilled	0	14
5(a)	The disease has a significant impact on society, with in particular an impact on labour markets	5–33	Not fulfilled	0	14
5(b)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	33–66	Uncertain	0	14
5(c)	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	5–33	Not fulfilled	0	14
5(d)	The disease has a significant impact in the long term on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	1–20	Not fulfilled	0	14

na: not applicable.



Category A: The probability of the disease to be categorised according to Section 1 of Annex IV of the AHL (overall outcome).

Figure 2: Outcome of the expert judgement on criteria of Section 1 of Annex IV and overall probability of the AMR bacterium to be fitting in Category A of Article 9

3.3.1.1. Reasoning for uncertain outcome on Category A criteria

Criterion 2.1 (the disease is highly transmissible)

- Few data are available.
- Horizontal transmission within farms seems to occur rapidly (in case of pathogenic strains and under certain host conditions), but it is unclear whether AMR *E. cecorum* can spread between different poultry houses or farms.
- Both ingestion and inhalation contribute to transmission, and the pathogen can persist in the environment for a long time.
- Chickens can be silent carriers during the first weeks of bacteraemia.
- The pathogen in ubiquitous.

Criterion 2.2 (there are possibilities of airborne or waterborne or vector-borne spread)

- There is very little information.
- Inhalation of aerosols is possible, but this is not considered airborne spread (short distance).
- Transmission from building to building cannot be excluded.
- Faecal-oral transmission following waterborne spread may be possible.
- Vector-borne spread is very unlikely.
- The pathogen may persist in the environment for a long time (e.g. dust, litter, PVC).

Criterion 5(b) (the disease has a significant impact on animal welfare, by causing suffering of large numbers of animals)

- Large numbers of animals can be affected in individual farms. Even one broiler flock represents a large number.

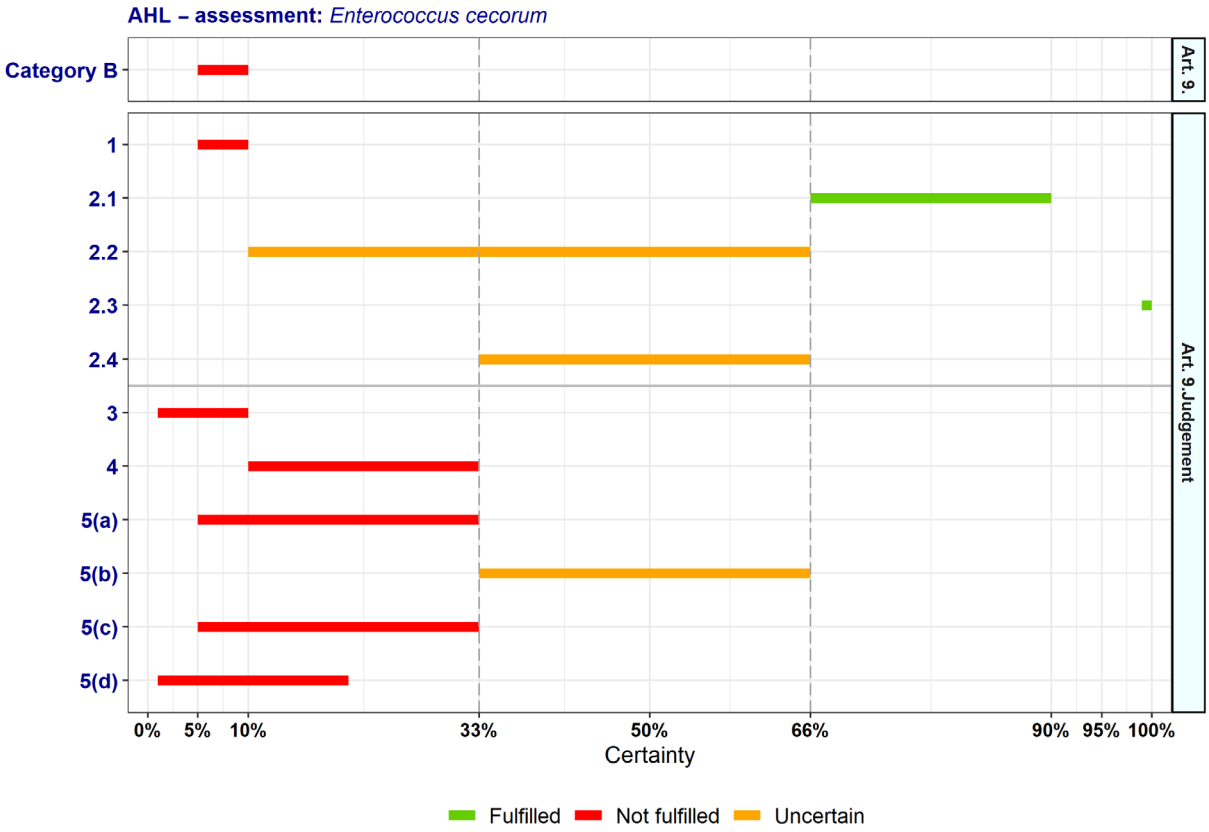
- Clinical symptoms are important for animal welfare (e.g. skeletal infection, irreversible paralysis, septicaemia) and may lead to culling on welfare grounds.
- There is only low to moderate morbidity, thus the impact is low.
- The frequency of the pathogen in the EU is unknown.
- The impact increases in case there is no treatment available.

3.3.2. Detailed outcome on Category B criteria

Table 6: Outcome of the expert judgement related to the criteria of Section 2 of Annex IV (Category B of Article 9)

Criteria to be met by the disease: The disease needs to fulfil all of the following criteria		**Outcome**			
		Median range (%)	**Criterion fulfilment**	**Number of na**	**Number of experts**
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	5–10	Not fulfilled	0	15
2.1	The disease is moderately to highly transmissible	66–90	Fulfilled	0	15
2.2	There are possibilities of airborne or waterborne or vector-borne spread	10–66	Uncertain	0	15
2.3	The disease affects single or multiple species	–	Fulfilled	0	15
2.4	The disease may result in high morbidity with in general low mortality	33–66	Uncertain	0	15
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 for public health, including epidemic potential or possible significant threats to food safety	1–10	Not fulfilled	0	15
4	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	10–33	Not fulfilled	0	14
5(a)	The disease has a significant impact on society, with in particular an impact on labour markets	5–33	Not fulfilled	0	14
5(b)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	33–66	Uncertain	0	14
5(c)	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	5–33	Not fulfilled	0	14
5(d)	The disease has a significant impact in the long term on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	1–20	Not fulfilled	0	14

na: not applicable.



Category B: The probability of the disease to be categorised according to Section 2 of Annex IV of the AHL (overall outcome).

Figure 3: Outcome of the expert judgement on criteria of Section 2 of Annex IV and overall probability of the AMR bacterium to be fitting in Category B of Article 9

3.3.2.1. Reasoning for uncertain outcome on Category B criteria

Criterion 2.2 (there are possibilities of airborne or waterborne or vector-borne spread): See above in Section 3.3.1.1.

Criterion 2.4 (the disease may result in high morbidity and in general low mortality):

- *E. cecorum* is an opportunistic pathogen which does not always lead to disease.
- Data vary a lot.
- If disease develops in poultry, it may result in high morbidity and in general low mortality.
- Significant mortality has been reported. Increases of > 5% over the baseline mortality can be considered significant.
- Morbidity seems low to moderate and mortality low.

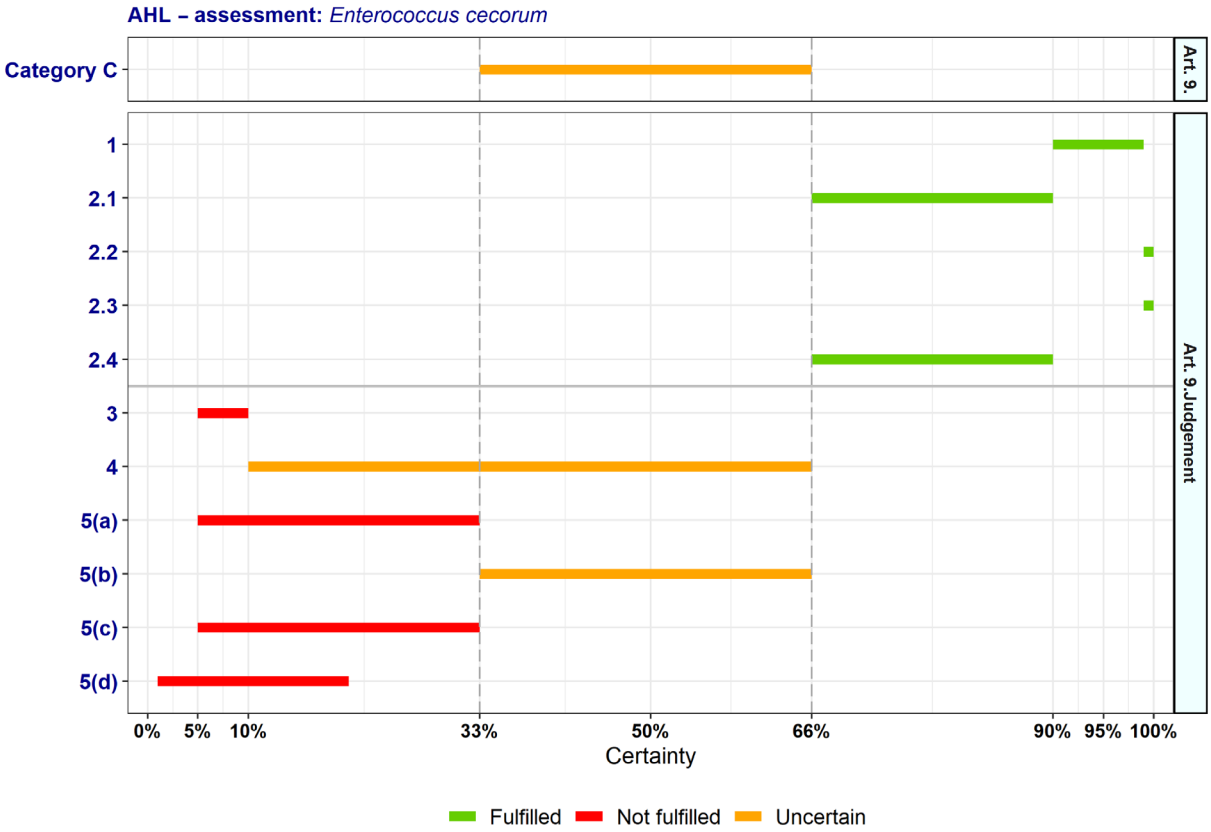
Criterion 5(b) (the disease has a significant impact on animal welfare, by causing suffering of large numbers of animals): See above in Section 3.3.1.1.

3.3.3. Detailed outcome on Category C criteria

Table 7: Outcome of the expert judgement related to the criteria of Section 3 of Annex IV (Category C of Article 9)

Criteria to be met by the disease: The disease needs to fulfil all of the following criteria		**Outcome**			
		Median range (%)	**Criterion fulfilment**	**Number of na**	**Number of experts**
1	The disease is present in the whole or part of the Union territory with an endemic character	90–99	Fulfilled	0	15
2.1	The disease is moderately to highly transmissible	66–90	Fulfilled	0	15
2.2	The disease is transmitted mainly by direct or indirect transmission	–	Fulfilled	0	15
2.3	The disease affects single or multiple species	–	Fulfilled	0	15
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	66–90	Fulfilled	0	15
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 for public health or possible significant threats to food safety	5–10	Not fulfilled	0	15
4	The disease has a significant impact on the economy of the Union, mainly related to its direct impact on certain types of animal production systems	10–66	Uncertain	0	14
5(a)	The disease has a significant impact on society, with in particular an impact on labour markets	5–33	Not fulfilled	0	14
5(b)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	33–66	Uncertain	0	14
5(c)	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	5–33	Not fulfilled	0	14
5(d)	The disease has a significant impact in the long term on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	1–20	Not fulfilled	0	14

na: not applicable.



Category C: The probability of the disease to be categorised according to Section 3 of Annex IV of the AHL (overall outcome).

Figure 4: Outcome of the expert judgement on criteria of Section 3 of Annex IV and overall probability of the AMR bacterium to be fitting in Category C of Article 9

3.3.3.1. Reasoning for uncertain outcome on Category C criteria

Criterion 4 (the disease has a significant impact on the economy of the Union, mainly related to its direct impact on certain types of animal production systems)

- Few data on economic impact are available. Exact costs are unknown.
- The frequency of the AMR pathogen in the EU is unknown.
- Commercial poultry is at bigger risk than backyard poultry due to the routes of transmission.
- Broiler farms may experience major economic losses due to welfare-related culling, mortality, use of antibiotics and higher condemnation rates. This is especially the case for successive outbreaks.
- For laying hens and other commercial poultry, outbreaks appear to be rare.
- There is only a limited animal health impact, but it could increase due to MDR strains.

Criterion 5(b) (the disease has a significant impact on animal welfare, by causing suffering of large numbers of animals): See above in Section 3.3.1.1.

3.3.4. Detailed outcome on Category D criteria

Table 8: Outcome of the expert judgement related to the criteria of Section 4 of Annex IV (Category D of Article 9)

Diseases in Category D **need to fulfil criteria of Section 1, 2, 3 or 5 of Annex IV** of the AHL **and the following**:		Outcome			
		Median range (%)	**Criterion fulfilment**	**Number of na**	**Number of experts**
D	The risk posed by the disease can be effectively and proportionately mitigated by measures concerning movements of animals and products in order to prevent or limit its occurrence and spread	10–33	Not fulfilled	0	14

na: not applicable.

3.3.5. Detailed outcome on Category E criteria

Table 9: Outcome of the expert judgement related to the criteria of Section 5 of Annex IV (Category E of Article 9)

Diseases in Category E **need to fulfil criteria of Section 1, 2 or 3 of Annex IV** of the AHL **and/or the following**:		Outcome	
		Median range (%)	**Fulfilment**
E	Surveillance of the disease is necessary for reasons related 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.)	33–75	Uncertain

3.3.6. Overall outcome on criteria in Annex IV for the purpose of categorisation as in Article 9

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 points (a) to (e) of Article 9(1) of the AHL) if it 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 5–9. According to the assessment methodology, a criterion is considered fulfilled when the lower bound of the median range lays above 66%.

The overall outcome of the assessment on criteria in Annex IV of the AHL, for the purpose of categorisation of AMR *E. cecorum* as in Article 9, is presented in Table 10 and Figure 5.

Table 10: Outcome of the assessment on criteria in Annex IV of the AHL for the purpose of categorisation as in Article 9

Category	**Article 9 criteria**										
	1° set of criteria					**2° set of criteria**					
	1	**2.1**	**2.2**	**2.3**	**2.4**	**3**	**4**	**5(a)**	**5(b)**	**5(c)**	**5(d)**
	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	0–5	33–75	10–66	90–99	10–33	1–5	10–33	5–33	33–66	5–33	1–20
B	5–10	66–90	10–66	–	33–66	1–10	10–33	5–33	33–66	5–33	1–20
C	90–99	66–90	–	–	66–90	5–10	10–66	5–33	33–66	5–33	1–20
D	10–33										
E	33–75										

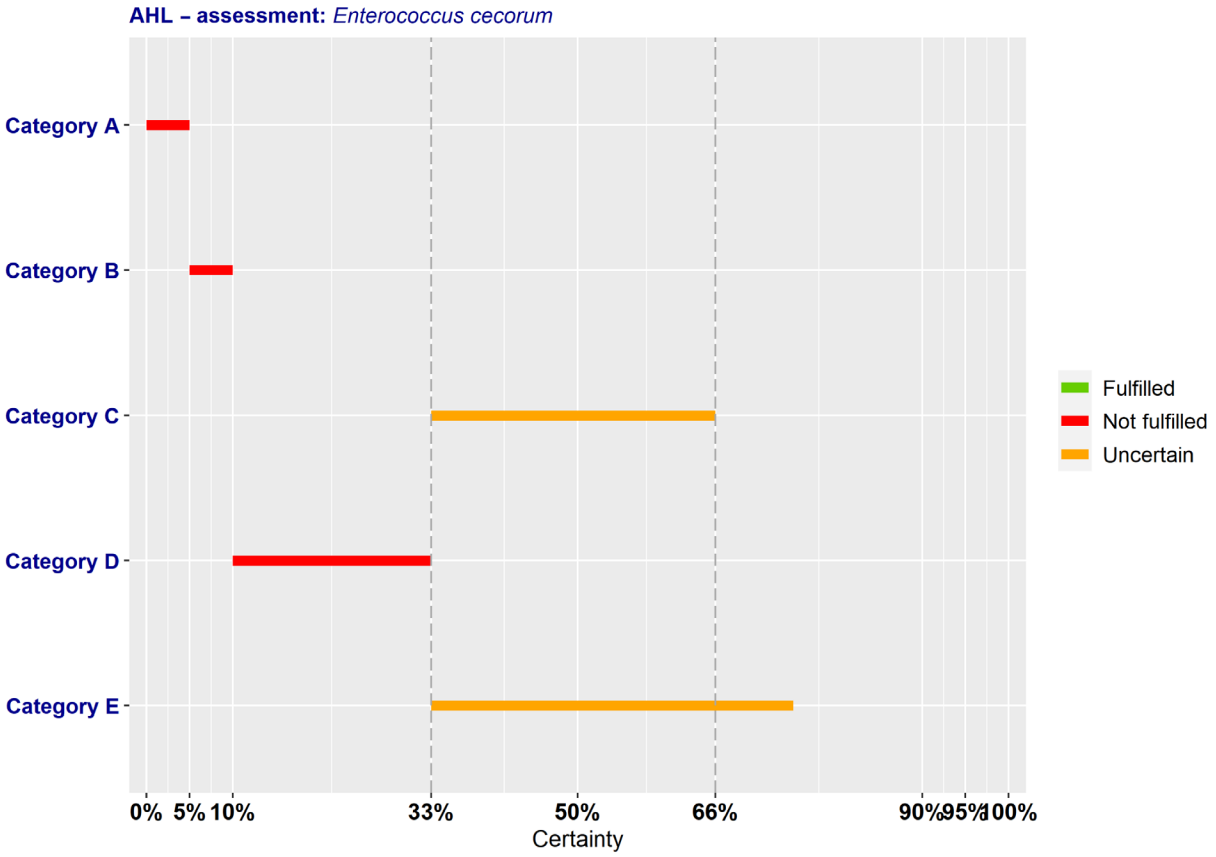


Figure 5: Outcome of the expert judgement on criteria in Annex IV and overall probabilities for categorisation of the AMR bacterium in accordance with Article 9

Probability ranges (% certainty) (green: fulfilled; red: not fulfilled; orange: uncertain).

According to the assessment here performed, AMR *E. cecorum* complies with the following criteria of Sections 1–5 of Annex IV of the AHL for the application of the disease prevention and control rules referred to in points (a)–(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, AMR *E. cecorum* complies only with criterion 2.3 (90–99% probability). The assessment was inconclusive on compliance with criteria 2.1 (33–75% probability) and 2.2 (10–66% probability). To be eligible for Category A, a disease needs to comply additionally with one of the criteria of the second set (3, 4, 5(a)–(d)) and AMR *E. cecorum* does not comply with any apart from criterion 5(b), for which the assessment was inconclusive (33–66% probability). Overall, it was assessed with 0–5% probability that AMR *E. cecorum* may be assigned to Category A according to criteria in Section 1 of Annex IV for the purpose of categorisation as in Article 9 of the AHL.
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, AMR *E. cecorum* complies only with criteria 2.1 (66–90% probability) and 2.3. The assessment was inconclusive on compliance with criteria 2.2 (10–66% probability) and 2.4 (33–66% probability). To be eligible for Category B, a disease needs to comply additionally with one of the criteria of the second set (3, 4, 5(a)–(d)) and AMR *E. cecorum* does not comply with any apart from criterion 5(b), for which the assessment was inconclusive (33–66% probability). Overall, it was assessed with 5–10% probability that AMR *E. cecorum* may be assigned to Category B according to criteria in Section 2 of Annex IV for the purpose of categorisation as in Article 9 of the AHL.
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, AMR *E. cecorum* 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, 5(a)–(d)) and AMR *E. cecorum* does not comply with any apart from criteria 4 (10–66% probability) and 5(b) (33–66% probability), for which the assessment

was inconclusive. Overall, it was assessed with 33–66% probability that AMR *E. cecorum* may be assigned to Category C according to criteria in Section 3 of Annex IV for the purpose of categorisation as in Article 9 of the AHL.

4) To be assigned to Category D, a disease needs to comply with criteria of Section 1, 2, 3 or 5 of Annex IV of the AHL and with the specific criterion D of Section 4, with which AMR *E. cecorum* does not comply (10–33% probability).
5) To be assigned to Category E, a disease needs to comply with criteria of Section 1, 2 or 3 of Annex IV of the AHL, and/or the surveillance of the disease is necessary for reasons related 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, for which the assessment is inconclusive (33–75% probability of fulfilling the criteria).

3.4. Assessment of AMR *Enterococcus cecorum* according to Article 8 criteria of the AHL

In this section, the results of the assessment on the criteria of Article 8(3) of the AHL for AMR *E. cecorum* are presented. 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 the list if they are affected or if they pose a risk for the spread of a specific listed disease because:

a) they are susceptible to 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 the 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 animal species to be listed for AMR *E. cecorum* according to the criteria of Article 8(3) of the AHL are as displayed in Table 11 (elaborated from information reported in Section 3.1.1.1 of the present document).

Table 11: Animal species to be listed for AMR *E. cecorum* according to the criteria of Article 8

	Class/Order	Family	Genus/Species
Susceptible	Anseriformes	Anatidae	Duck (*Anas platyrhynchos domesticus*)
			Goose (*Anser* sp.)
	Columbiformes	Columbidae	Pigeon (*Columba livia domesticus*)
	Galliformes	Odontophoridae	Bobwhite quail (*Colinus virgianus*)
		Phasianidae	Chicken (*Gallus gallus domesticus*)
			Turkey (*Meleagris* sp.)
	Otidiformes	Otididae	Houbara bustard (*Chlamydotis undulata*)
	Passeriformes	Fringillidae	Canary (*Serinus canaria domestica*)
	Artiodactyla	Suidae	Pig (*Sus scrofa domesticus*)
	Perissodactyla	Bovidae	Cattle (*Bos taurus*)
		Equidae	Horse (*Equus caballus ferus*)
Reservoir	Birds		
	Carnivora	Canidae	Dog (*Canis lupus familiaris*)
		Felidae	Cat (*Felis catus*)
	Perissodactyla	Bovidae	Cattle (*Bos taurus*)
Vector	None		

[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.

The table contains all animal species in which AMR *E. cecorum* has been described, but also those animal species from which only the bacterium itself has been isolated. The latter makes susceptibility to AMR clones likely.

4. Conclusions

The AHAW Panel emphasises that the assessment of impacts, as well as prevention and control measures, related to AMR bacteria using the criteria as laid down in Articles 5 and 9 of the AHL is particularly challenging for opportunistic pathogens that can also be found as commensal bacteria in healthy animals.

Generally, there is high level of uncertainty around the occurrence, frequency and distribution of antimicrobial resistance in *E. cecorum*. Since there is no structured data collection or surveillance in place in the EU, it is unclear whether the sporadic reports on the detrimental effects of infection due to AMR *E. cecorum* strains may be representative of the full damage caused by this AMR pathogen. Estimates of prevalence, incidence, morbidity and mortality are difficult to interpret due to the opportunistic nature of *E. cecorum* and disease development being multifactorial (i.e. depending on host and other risk factors, co-infections with other pathogens). Furthermore, assessment of the clinical significance of antimicrobial resistance is difficult due to the lack of poultry-specific clinical breakpoints. Clinical importance, economic impact and zoonotic implications of this bacterial species need further investigation. However, AMR *E. cecorum* (and AMR enterococci in general) are recognised as an emerging problem in poultry industry and their role is yet to be fully understood.

TOR 1: *For each of those identified AMR bacteria considered most relevant in the EU, following the criteria laid down in Article 7 of the AHL, an assessment on its eligibility to be listed for Union intervention as laid down in Article 5(3) of the AHL*;

- It is uncertain (33–75% probability, from 'as likely as not' to 'likely') whether AMR *E. cecorum* can be considered eligible to be listed for Union intervention as laid down in Article 5 of the AHL.

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

- The AHAW Panel considered with 0–5% probability (from 'almost impossible' to 'extremely unlikely') that AMR *E. cecorum* meets the criteria as in Section 1 of Annex IV of the AHL, for the application of the disease prevention and control rules referred to in point (a) of Article 9 (1) of the AHL.
- The AHAW Panel considered with 5–10% probability ('very unlikely') that AMR *E. cecorum* meets the criteria as in Section 2 of Annex IV of the AHL, for the application of the disease prevention and control rules referred to in point (b) of Article 9(1) of the AHL.
- The AHAW Panel was uncertain (33–66% probability, 'as likely as not') whether AMR *E. cecorum* meets the criteria as in Section 3 of Annex IV of the AHL, for the application of the disease prevention and control rules referred to in point (c) of Article 9(1) of the AHL.
- The AHAW Panel considered with 10–33% probability ('unlikely') that AMR *E. cecorum* meets the criteria as in Section 4 of Annex IV of the AHL, for the application of the disease prevention and control rules referred to in point (d) of Article 9(1) of the AHL.
- The AHAW Panel was uncertain (33–75% probability, from 'as likely as not' to 'likely') whether AMR *E. cecorum* meets the criteria as in Section 5 of Annex IV of the AHL, for the application of the disease prevention and control rules referred to in point (e) of Article 9(1) of the AHL.

TOR 3: *For each of the AMR bacteria 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;*

- The animal species that can be considered to be listed for AMR *E. cecorum* according to Article 8(3) of the AHL are mostly birds belonging to the families of Anatidae, Columbidae and Phasianidae, as reported in Table 11 in Section 3.4 of the present document.

The AHAW Panel highlights that monitoring of antimicrobial resistance in opportunistic pathogens could help to assess their impacts. Therefore, even though the assessment on AMR *E. cecorum* is inconclusive on its eligibility to be listed for Union intervention, specific initiatives (e.g. monitoring or

applied research) into various aspects of AMR *E. cecorum* can be useful to better understand its distribution and to assess its impact on animal health and welfare in the EU.

References

Ahmed FZ, Baig MW, Gascoyne-Binzi D and Sandoe JAT, 2011. *Enterococcus cecorum* aortic valve endocarditis. Diagnostic Microbiology and Infectious Disease, 70, 525–527. https://doi.org/10.1016/j.diagmicrobio.2011.04.001

Aitchison H, Poolman P, Coetzer M, Griffiths C, Jacobs J, Meyer M and Bisschop S, 2014. Enterococcal-related vertebral osteoarthritis in South African broiler breeders: a case report. Journal of the South African Veterinary Association, 85, 1077. https://doi.org/10.4102/jsava.v85i1.1077

Anonymous, 2021. Disease surveillance in England and Wales, April 2017. Veterinary Record, 180, 440–443. https://doi.org/10.1002/vetr.476

Baele M, Devriese LA, Butaye P and Haesebrouck F, 2002. Composition of enterococcal and streptococcal flora from pigeon intestines. Journal of Applied Microbiology, 92, 348–351. https://doi.org/10.1046/j.1365-2672.2002.01537.x

Boerlin P, Nicholson V, Brash M, Slavic D, Boyen F, Sanei B and Butaye P, 2012. Diversity of *Enterococcus cecorum* from chickens. Veterinary Microbiology, 157, 405–411. https://doi.org/10.1016/j.vetmic.2012.01.001

Borst LB, Suyemoto MM, Robbins KM, Lyman RL, Martin MP and Barnes HJ, 2012. Molecular epidemiology of *Enterococcus cecorum* isolates recovered from enterococcal spondylitis outbreaks in the southeastern United States. Avian Pathology, 41, 479–485. https://doi.org/10.1080/03079457.2012.718070

Borst LB, Suyemoto MM, Scholl EH, Fuller FJ and Barnes HJ, 2015. Comparative genomic analysis identifies divergent genomic features of pathogenic *Enterococcus cecorum* including a type IC CRISPR-cas system, a Capsule Locus, an *epa*-Like Locus, and putative host tissue binding proteins. PLoS One, 10, e0121294. https://doi.org/10.1371/journal.pone.0121294

Borst LB, Suyemoto MM, Sarsour AH, Harris MC, Martin MP, Strickland JD, Oviedo EO and Barnes HJ, 2017. Pathogenesis of Enterococcal Spondylitis caused by *Enterococcus cecorum* in Broiler Chickens. Veterinary Pathology, 54, 61–73. https://doi.org/10.1177/0300985816658098

Borst LB, Suyemoto MM, Chen LR and Barnes HJ, 2019a. Vaccination of breeder hens with a polyvalent killed vaccine for pathogenic *Enterococcus cecorum* does not protect offspring from enterococcal spondylitis. Avian Pathology, 48, 17–24. https://doi.org/10.1080/03079457.2018.1536819

Borst LB, McLamb KA, Suyemoto MM, Chen LR, Levy MG, Sarsour AH, Cordova HA, Barnes HJ and Oviedo-Rondón EO, 2019b. Coinfection with *Eimeria* spp. decreases bacteremia and spinal lesions caused by pathogenic *Enterococcus cecorum*. Animal Feed Science and Technology, 250, 59–68. https://doi.org/10.1016/j.anifeedsci.2018.09.014

De Baere T, Claeys G, Verschraegen G, Devriese LA, Baele M, Van Vlem B, Vanholder R, Dequidt C and Vaneechoutte M, 2000. Continuous ambulatory peritoneal dialysis peritonitis due to *Enterococcus cecorum*. Journal of Clinical Microbiology, 38, 3511–3512. https://doi.org/10.1128/JCM.38.9.3511-3512.2000

De Herdt P, Defoort P, Van Steelant J, Swam H, Tanghe L, Van Goethem S and Vanrobaeys M, 2008. *Enterococcus cecorum* osteomyelitis and arthritis in broiler chickens. Vlaams Diergeneeskundig Tijdschrift, 78, 44–48.

Delaunay E, Abat C and Rolain J-M, 2015. *Enterococcus cecorum* human infection, France. New Microbes and New Infections, 7, 50–51. https://doi.org/10.1016/j.nmni.2015.06.004

Devriese LA, Cauwerts K, Hermans K and Wood AM, 2002. *Enterococcus cecorum* septicemia as a cause of bone and joint lesions resulting in lameness in broiler chickens. Vlaams Diergeneeskundig Tijdschrift, 71, 219–221.

Devriese LA, Dutta GN, Farrow JAE, Van de Kerckhove A and Phillips BA, 1983. *Streptococcus cecorum*, a new species isolated from chickens. International Journal of Systematic and Evolutionary Microbiology, 33, 772–776. https://doi.org/10.1099/00207713-33-4-772

Devriese LA, Ceyssens K and Haesebrouck F, 1991. Characteristics of *Enterococcus cecorum* strains from different animal species. Letters in Applied Microbiology, 12, 137–139. https://doi.org/10.1111/j.1472-765X.1991.tb00524.x

Devriese LA, Cruz Colque JI, De Herdt P and Haesebrouck F, 1992a. Identification and composition of the tonsillar and anal enterococcal and streptococcal flora of dogs and cats. Journal of Applied Bacteriology, 73, 421–425. https://doi.org/10.1111/j.1365-2672.1992.tb04998.x

Devriese LA, Laurier L, De Herdt P and Haesebrouck F, 1992b. Enterococcal and streptococcal species isolated from faeces of calves, young cattle and dairy cows. Journal of Applied Bacteriology, 72, 29–31. https://doi.org/10.1111/j.1365-2672.1992.tb04877.x

Devriese LA, Hommez J, Pot B and Haesebrouck F, 1994. Identification and composition of the streptococcal and enterococcal flora of tonsils, intestines and faeces of pigs. Journal of Applied Bacteriology, 77, 31–36. https://doi.org/10.1111/j.1365-2672.1994.tb03040.x

Dolka B, Chrobak-Chmiel D, Makrai L and Szeleszczuk P, 2016. Phenotypic and genotypic characterization of *Enterococcus cecorum* strains associated with infections in poultry. BMC Veterinary Research, 12, 129. https://doi.org/10.1186/s12917-016-0761-1

Dolka B, Czopowicz M, Chrobak-Chmiel D, Ledwoń A and Szeleszczuk P, 2020. Prevalence, antibiotic susceptibility and virulence factors of *Enterococcus* species in racing pigeons (*Columba livia f. domestica*). BMC Veterinary Research, 16, 7. https://doi.org/10.1186/s12917-019-2200-6

Dolka B, Golebiewska-Kosakowska M, Krajewski K, Kwiecinski P, Nowak T, Szubstarski J, Wilczynski J and Szeleszczuk P, 2017. Occurrence of *Enterococcus* spp. in poultry in Poland based on 2014–2015 data. Medycyna Weterynaryjna, 73, 220–224. https://doi.org/10.21521/mw.5680

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), More S, Bøtner A, Butterworth A, Calistri P, Depner K, Edwards S, Garin-Bastuji B, Good M, Gortázar Schmidt C, Michel V, Miranda MA, Nielsen SS, Raj M, Sihvonen L, Spoolder H, Stegeman JA, Thulke H-H, Velarde A, Willeberg P, Winckler C, Baldinelli F, Broglia A, Candiani D, Gervelmeyer A, Zancanaro G, Kohnle L, Morgado J and Bicout D, 2017. Scientific opinion on an ad hoc method for the assessment on listing and categorisation of animal diseases within the framework of the Animal Health Law. EFSA Journal 2017;15(7):4783, 42 pp. https://doi.org/10.2903/j.efsa.2017.4783

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), Nielsen SS, Bicout DJ, Calistri P, Canali E, Drewe JA, Garin-Bastuji B, Gonzales Rojas JL, Gortázar Schmidt C, Herskin M, Michel V, Miranda Chueca MA, Padalino B, Pasquali P, Roberts HC, Spoolder H, Ståhl K, Velarde A, Viltrop A, Winckler C, Dewulf J, Guardabassi L, Hilbert F, Mader R, Baldinelli F and Alvarez J, 2021a. Scientific Opinion on the assessment of animal diseases caused by bacteria resistant to antimicrobials: Poultry. EFSA Journal 2021;19(12):7114, 47 pp. https://doi.org/10.2903/j.efsa.2021.7114

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), Nielsen SS, Bicout DJ, Calistri P, Canali E, Drewe JA, Garin-Bastuji B, Gonzales Rojas JL, Gortázar Schmidt C, Herskin M, Michel V, Miranda Chueca MA, Padalino B, Pasquali P, Roberts HC, Sihvonen LH, Spoolder H, Ståhl K, Velarde A, Viltrop A, Winckler C, Guardabassi L, Hilbert F, Mader R, Smith P, Aznar I, Muñoz Guajardo I, Baldinelli F and Alvarez J, 2021b. Scientific Opinion on the ad hoc method for the assessment of animal diseases caused by bacteria resistant to antimicrobials. EFSA Journal 2021;19(6):6645, 29 pp. https://doi.org/10.2903/j.efsa.2021.6645

EFSA Scientific Committee, Benford D, Halldorsson T, Jeger MJ, Knutsen HK, More S, Naegeli H, Noteborn H, Ockleford C, Ricci A, Rychen G, Schlatter JR, Silano V, Solecki R, Turck D, Younes M, Craig P, Hart A, Von Goetz N, Koutsoumanis K, Mortensen A, Ossendorp B, Martino L, Merten C, Mosbach-Schulz O and Hardy A, 2018. Guidance on Uncertainty Analysis in Scientific Assessments. EFSA Journal 2018;16(1):5123, 39 pp. https://doi.org/10.2903/j.efsa.2018.5123

Greub G, Devriese LA, Pot B, Dominguez J and Bille J, 1997. *Enterococcus cecorum* septicemia in a malnourished adult patient. European Journal of Clinical Microbiology and Infectious Diseases, 16, 594–598. https://doi.org/10.1007/BF02447923

Grund A, Rautenschlein S and Jung A, 2021. Tenacity of *Enterococcus cecorum* at different environmental conditions. Journal of Applied Microbiology, 130, 1494–1507. https://doi.org/10.1111/jam.14899

Harada T, Kawahara R, Kanki M, Taguchi M and Kumeda Y, 2012. Isolation and characterization of *vanA* genotype vancomycin-resistant *Enterococcus cecorum* from retail poultry in Japan. International Journal of Food Microbiology, 153, 372–377. https://doi.org/10.1016/j.ijfoodmicro.2011.11.029

Hsueh P-R, Teng L-J, Chen Y-C, Yang P-C, Ho S-W and Luh K-T, 2000. Recurrent bacteremic peritonitis caused by *Enterococcus cecorum* in a patient with liver cirrhosis. Journal of Clinical Microbiology, 38, 2450–2452.

Jackson CR, Kariyawasam S, Borst LB, Frye JG, Barrett JB, Hiott LM and Woodley TA, 2015. Antimicrobial resistance, virulence determinants and genetic profiles of clinical and nonclinical *Enterococcus cecorum* from poultry. Letters in Applied Microbiology, 60, 111–119. https://doi.org/10.1111/lam.12374

Jung A, Chen LR, Suyemoto MM, Barnes HJ and Borst LB, 2018. A review of *Enterococcus cecorum* infection in poultry. Avian Diseases, 62, 261–271. https://doi.org/10.1637/11825-030618-Review.1

Jung A, Metzner M, Köhler-Repp D and Rautenschlein S, 2013. Experimental reproduction of an *Enterococcus cecorum* infection in Pekin ducks. Avian Pathology, 42, 552–556. https://doi.org/10.1080/03079457.2013.850151

Jung A, Petersen H, Teske L and Rautenschlein S, 2017. Colonization patterns of *Enterococcus cecorum* in two different broiler production cycles detected with a newly developed quantitative real-time PCR. BMC Microbiology, 17, 106. https://doi.org/10.1186/s12866-017-1021-7

Jung A and Rautenschlein S, 2014. Comprehensive report of an *Enterococcus cecorum* infection in a broiler flock in Northern Germany. BMC Veterinary Research, 10, 311. https://doi.org/10.1186/s12917-014-0311-7

Jung A, Ryll M and Rautenschlein S, 2012. Relevance and diagnostics of selected bacterial pathogens of poultry. Tierärztliche Praxis. Ausgabe G, Grosstiere/Nutztiere, 40, 94–100.

Kense MJ and Landman WJM, 2011. *Enterococcus cecorum* infections in broiler breeders and their offspring: molecular epidemiology. Avian Pathology, 40, 603–612. https://doi.org/10.1080/03079457.2011.619165

Makrai L, Nemes C, Simon A, Ivanics E, Dudás Z, Fodor L and Glávits R, 2011. Association of *Enterococcus cecorum* with vertebral osteomyelitis and spondylolisthesis in broiler parent chicks. Acta Veterinaria Hungarica, 59, 11–21. https://doi.org/10.1556/AVet.59.2011.1.2

Martin LT, Martin MP and Barnes HJ, 2011. Experimental reproduction of enterococcal spondylitis in male broiler breeder chickens. Avian Diseases, 55, 273–278. https://doi.org/10.1637/9614-121410-Reg.1

McMurphy MA, Applegate D and Crupper SS, 2010. *Enterococcus* species isolated from Northern Bobwhite (*Colinus virginianus*) Chicks: Species distribution and antibiotic resistance. International Journal of Poultry Science, 9, 43–47. https://doi.org/10.3923/ijps.2010.43.47

Metzner M, Köhler-Repp D and Köhler B, 2010. Neue bakterielle Infektionserreger des Geflügels? Enterococcus cecorum, Helcococcus kunzii und andere. In: DVG (ed.). 79. DVG-Fachgespräch Geflügelkrankheiten. Hannover, Germany. pp. 39–47.

Pang KW, Coorevits L, Van Acker J and Pauwels W, 2016. *Enterococcus cecorum* sepsis in a patient with liver cirrhosis, successfully treated with ceftriaxone. Acta Clinica Belgica, 71, 347–348. https://doi.org/10.1080/17843286.2016.1147674

Resapath, 2020. French surveillance network for antimicrobial resistance in bacteria from diseased animals. 2018 annual report. Available online: https://www.anses.fr/fr/system/files/LABO-Ra-Resapath2018EN.pdf

Robbins KM, Suyemoto MM, Lyman RL, Martin MP, Barnes HJ and Borst LB, 2012. An outbreak and source investigation of enterococcal spondylitis in broilers caused by *Enterococcus cecorum*. Avian Diseases, 56, 768–773. https://doi.org/10.1637/10253-052412-Case.1

Scupham AJ, Patton TG, Bent E and Bayles DO, 2008. Comparison of the cecal microbiota of domestic and wild turkeys. Microbial Ecology, 56, 322–331. https://doi.org/10.1007/s00248-007-9349-4

Shabbir MZ, Park J, Muhammad K, Rabbani M, Rana MY and Harvill ET, 2014. Culture independent analysis of respiratory microbiome of houbara bustard (*Chlamydotis undulata*) revealed organisms of public health significance. International Journal of Agriculture and Biology, 16, 222–226.

Siekkinen KM, Heikkilä J, Tammiranta N and Rosengren H, 2012. Measuring the costs of biosecurity on poultry farms: a case study in broiler production in Finland. Acta Veterinaria Scandinavica, 54, 12.

Stalker MJ, Brash ML, Weisz A, Ouckama RM and Slavic D, 2010. Arthritis and osteomyelitis associated with *Enterococcus cecorum* infection in broiler and broiler breeder chickens in Ontario, Canada. Journal of Veterinary Diagnostic Investigation, 22, 643–645. https://doi.org/10.1177/104063871002200426

Stępień-Pyśniak D, Marek A, Banach T, Adaszek Ł, Pyzik E, Wilczyński J and Winiarczyk S, 2016. Prevalence and antibiotic resistance of *Enterococcus* strains isolated from poultry. Acta Veterinaria Hungarica, 64, 148–163. https://doi.org/10.1556/004.2016.016

Suyemoto MM, Barnes HJ and Borst LB, 2017. Culture methods impact recovery of antibiotic-resistant enterococci including *Enterococcus cecorum* from pre- and postharvest chicken. Letters in Applied Microbiology, 64, 210–216. https://doi.org/10.1111/lam.12705

Talebi A, Taifebagherlu J, Sharifi A and Delkhosh-Kasmaie F, 2016. Spondylitis in broiler breeder farms in West-Azerbaijan province, Iran: clinical report. Veterinary Research Forum, 7, 353–355.

Thøfner I and Christensen JP, 2016. Investigation of the pathogenesis of *Enterococcus cecorum* after intravenous, intratracheal or oral experimental infections of broilers and broiler breeders. Poster session presented at VETPATH 2016, Prato, Italy.

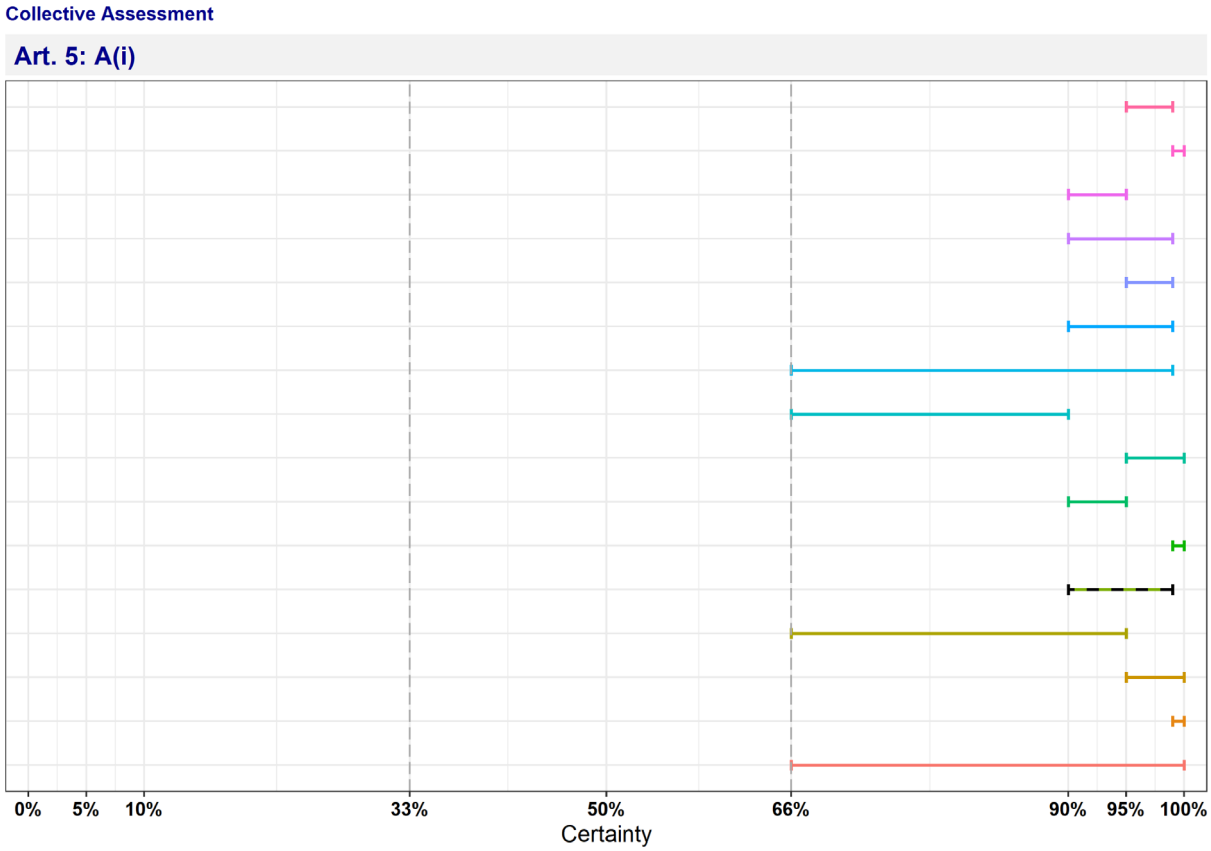
Warnke P, Köller T, Stoll P and Podbielski A, 2015. Nosocomial infection due to *Enterococcus cecorum* identified by MALDI-TOF MS and Vitek 2 from a blood culture of a septic patient. European Journal of Microbiology and Immunology, 5, 177–179. https://doi.org/10.1556/1886.2015.00008

Abbreviations

AHAW	Animal Health and Welfare
AHL	Animal Health Law
AMR	Antimicrobial-resistant
CFSPH	Center for Food Security and Public Health
CI	Current impact
CITES	Convention on International Trade in Endangered Species
DALY	Disability-adjusted life year
DIVA	Differentiation of infected from vaccinated animals
ES	Enterococcal spondylitis
IUCN	International Union for Conservation of Nature
MALDI-TOF MS	Matrix-assisted laser desorption ionisation–time-of-flight mass spectrometry
MIC	Minimum inhibitory concentration
MS	Member State
OIE	Office International des Épizooties (World Organisation for Animal Health)
PCR	Polymerase chain reaction
PI	Potential impact
ToR	Term of Reference

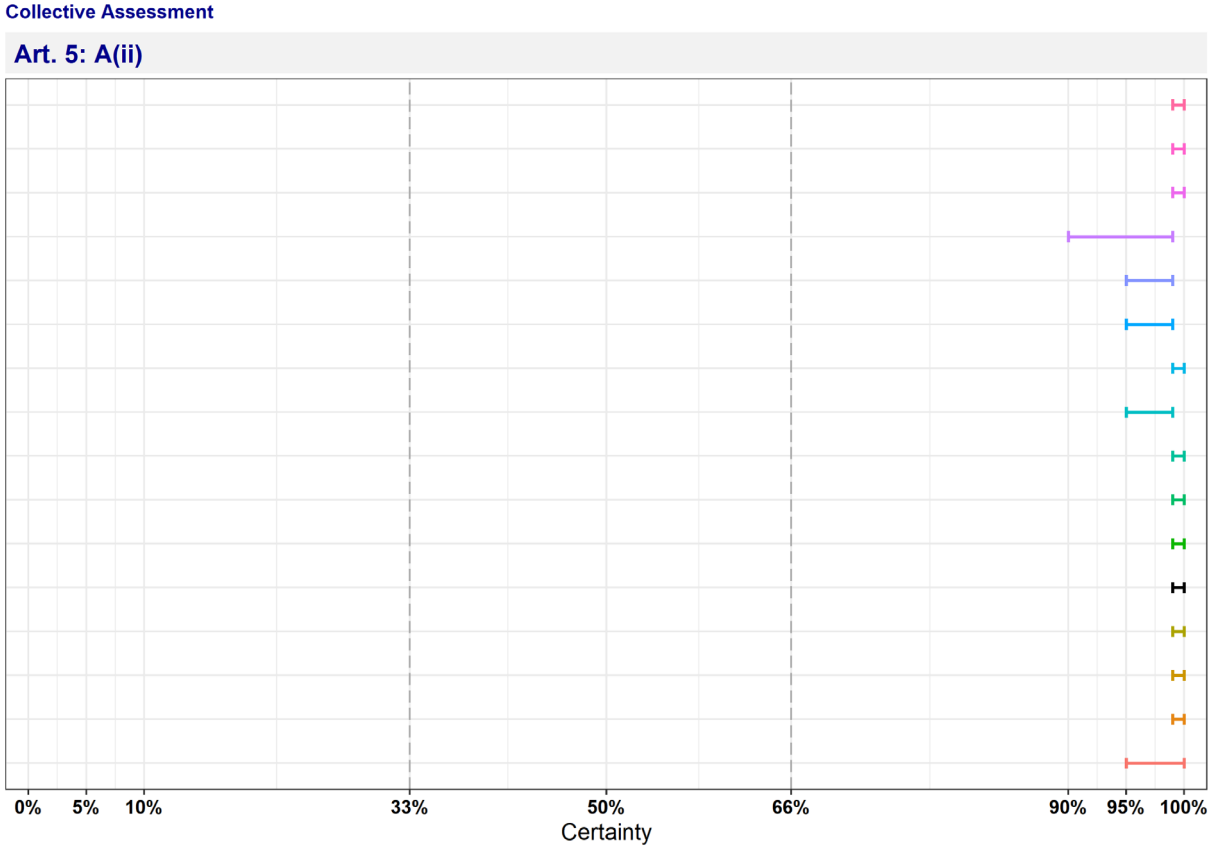
Appendix A – Criteria with certain outcome

A.1. Article 5 criteria



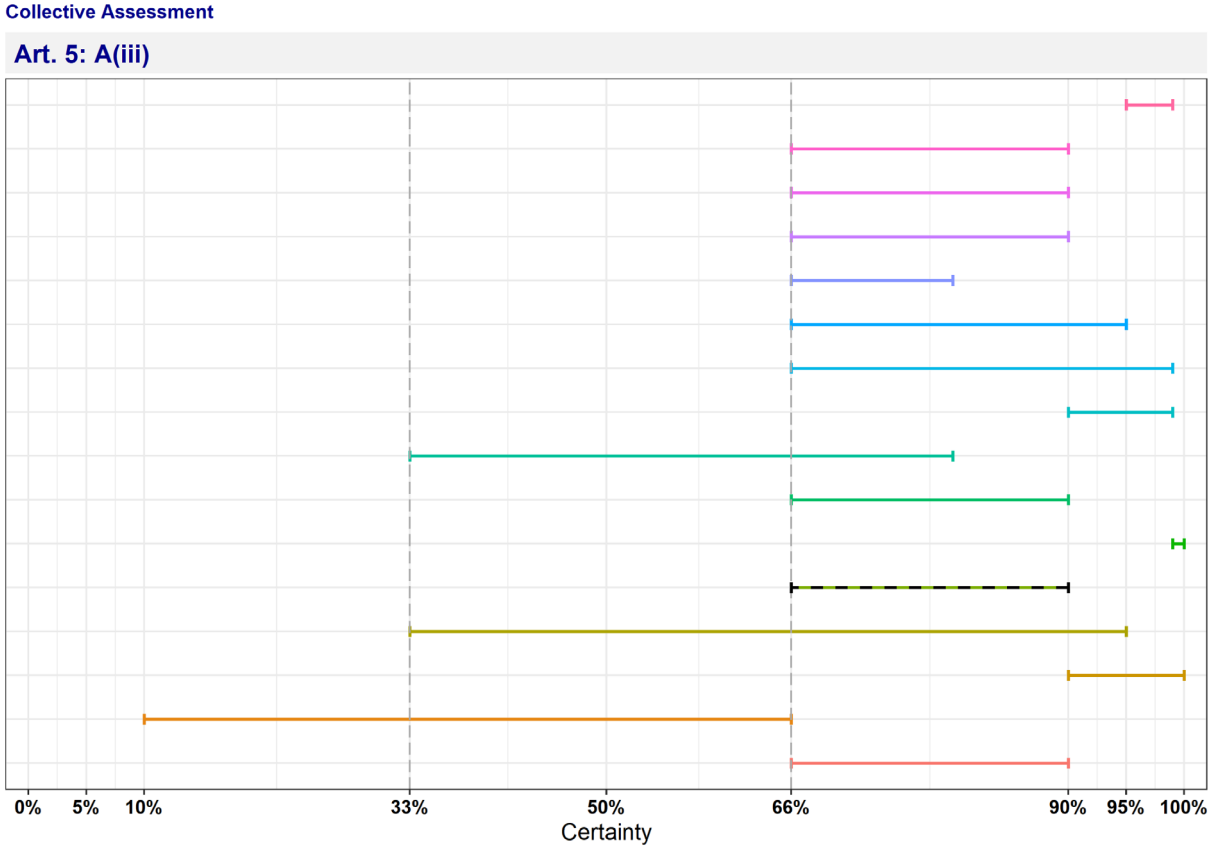
The median range is displayed as a dashed line.

Figure A.1: Individual probability ranges reflecting fulfilment of criterion A(i) (the disease is transmissible) after the collective judgement



The median range is displayed as a dashed line.

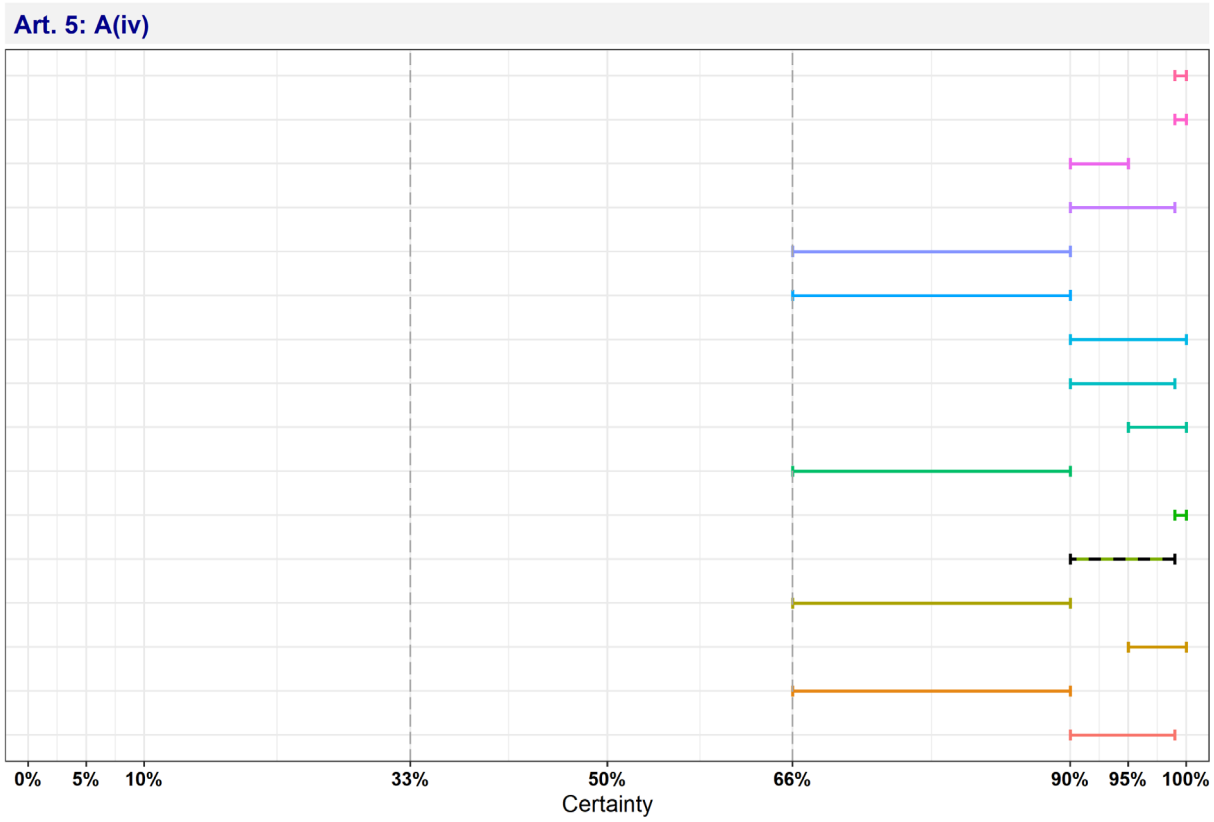
Figure A.2: Individual probability ranges reflecting fulfilment of criterion A(ii) (animal species are either susceptible to the disease or vectors and reservoirs thereof exist in the Union) after the collective judgement



The median range is displayed as a dashed line.

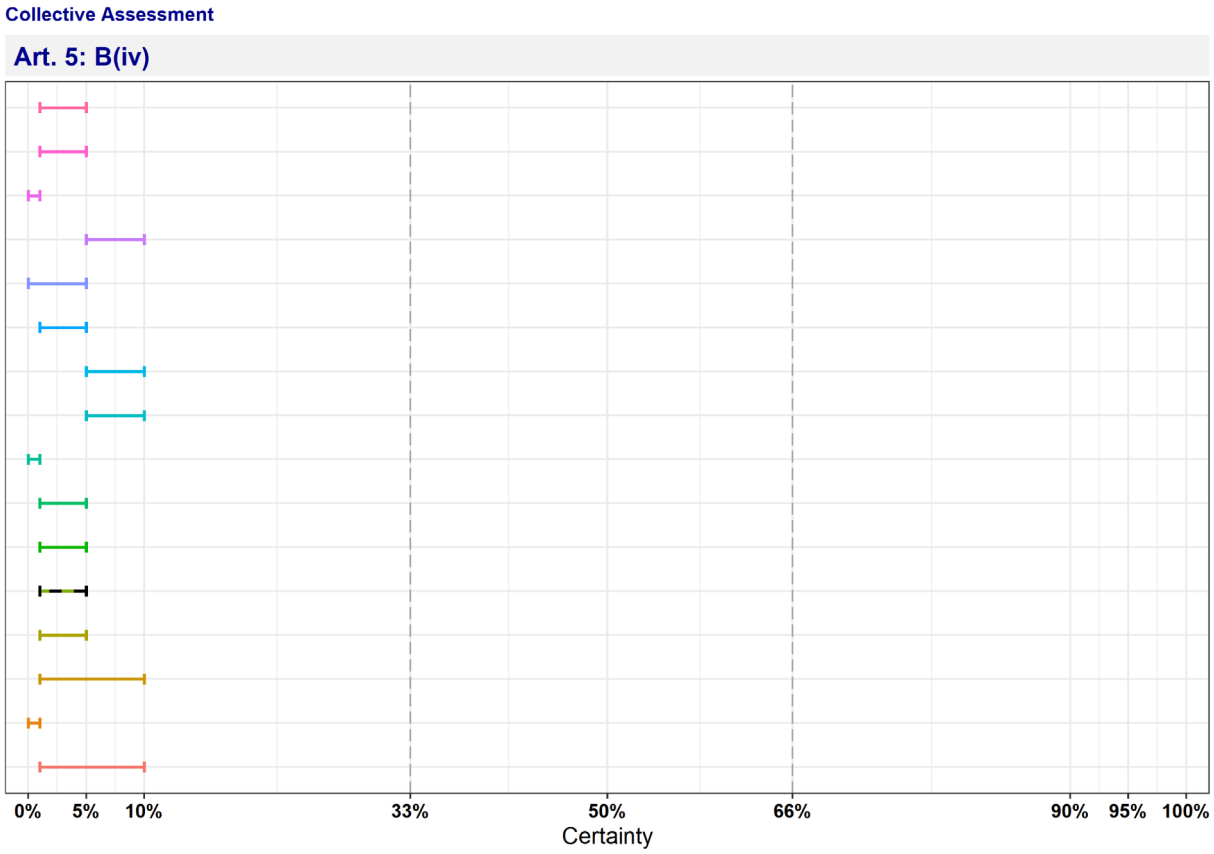
Figure A.3: Individual probability ranges reflecting fulfilment of criterion A(iii) (the disease causes negative effects on animal health or poses a risk to public health due to its zoonotic character) after the collective judgement

Collective Assessment



The median range is displayed as a dashed line.

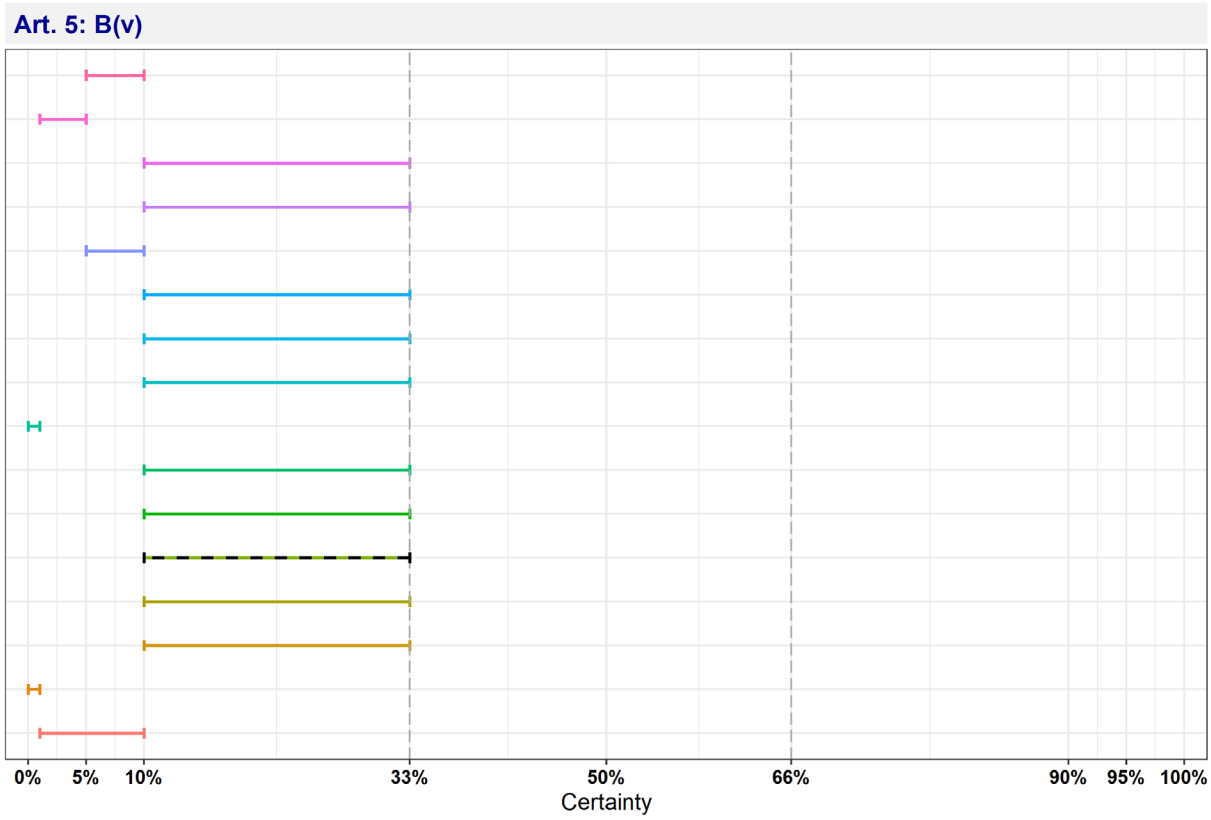
Figure A.4: Individual probability ranges reflecting fulfilment of criterion A(iv) (diagnostic tools are available for the disease) after the collective judgement



The median range is displayed as a dashed line.

Figure A.5: Individual probability ranges reflecting non-fulfilment of criterion B(iv) (the disease has the potential to generate a crisis or the disease agent could be used for the purpose of bioterrorism) after the collective judgement

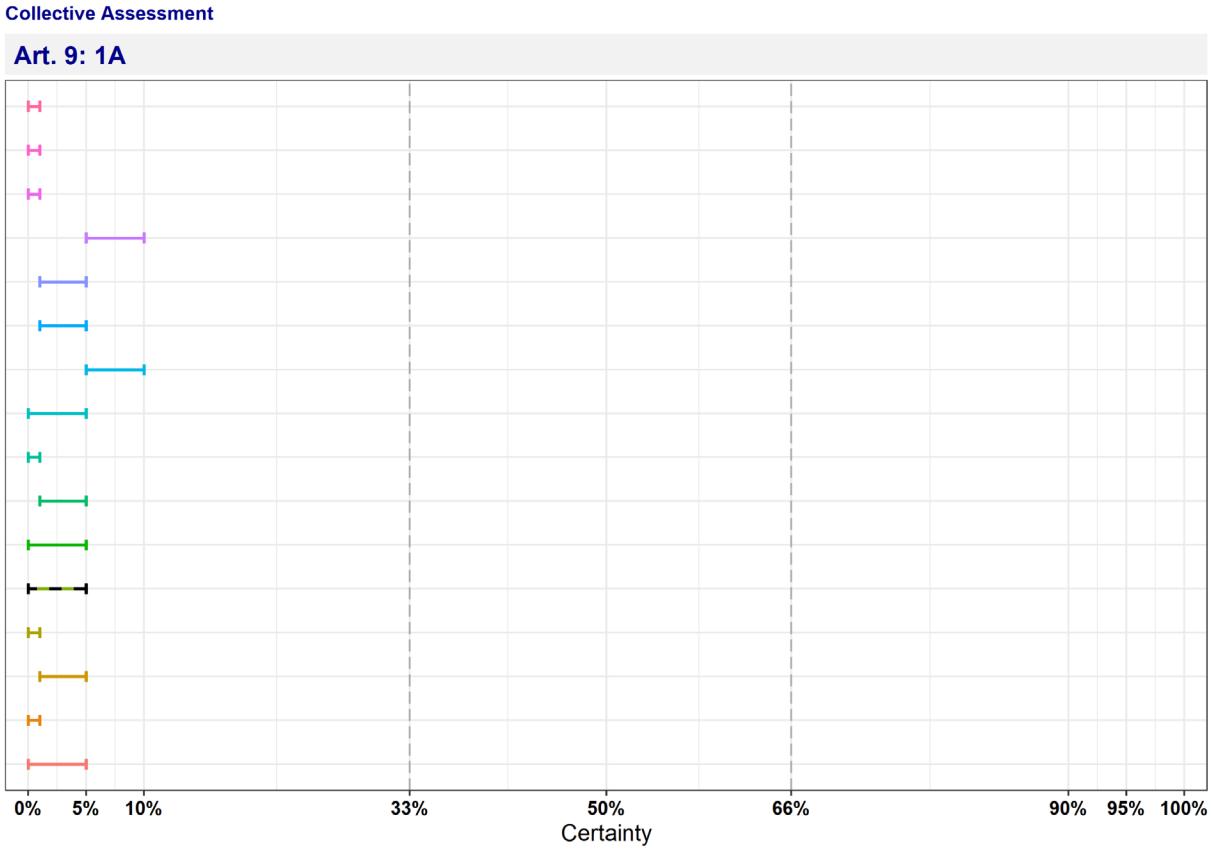
Collective Assessment



The median range is displayed as a dashed line.

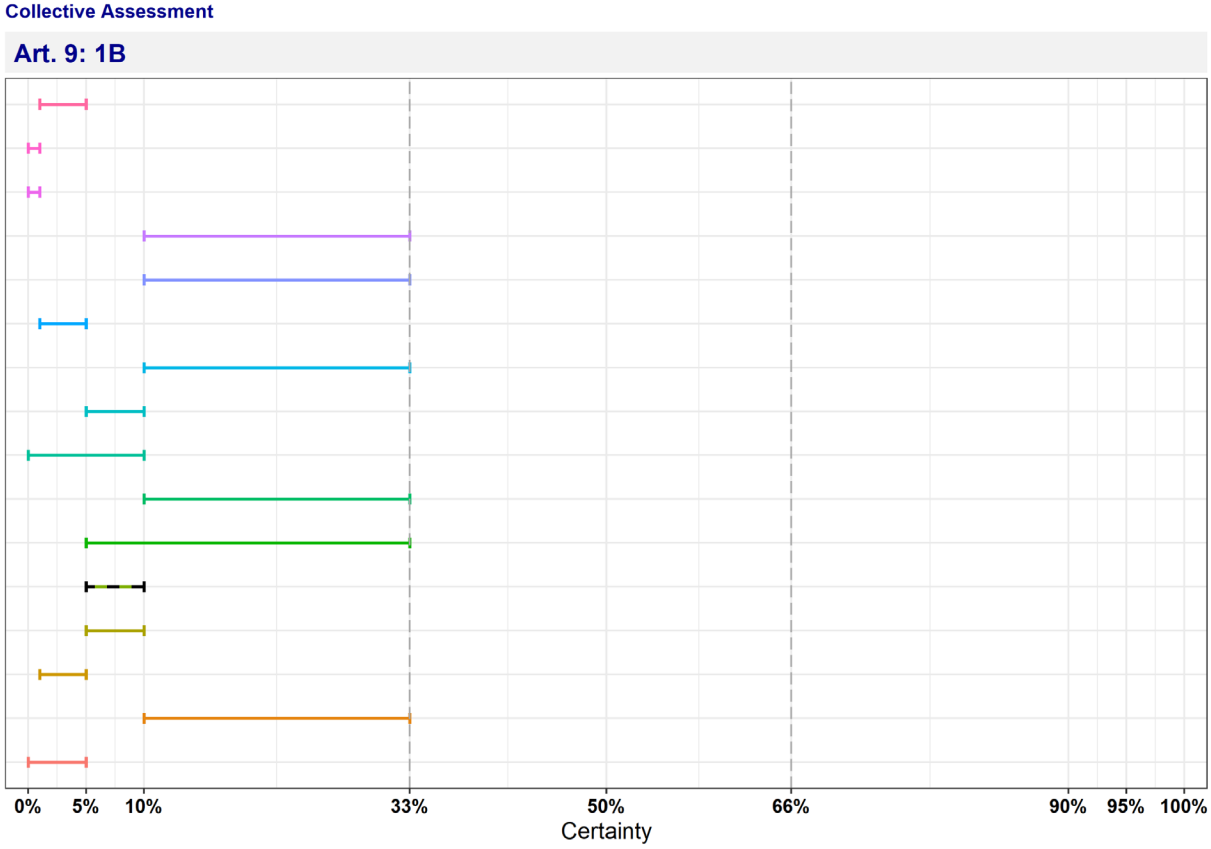
Figure A.6: Individual probability ranges reflecting non-fulfilment of criterion B(v) (the disease has or could have a significant negative impact on the environment, including biodiversity, of the Union) after the collective judgement

A.2. Article 9 criteria



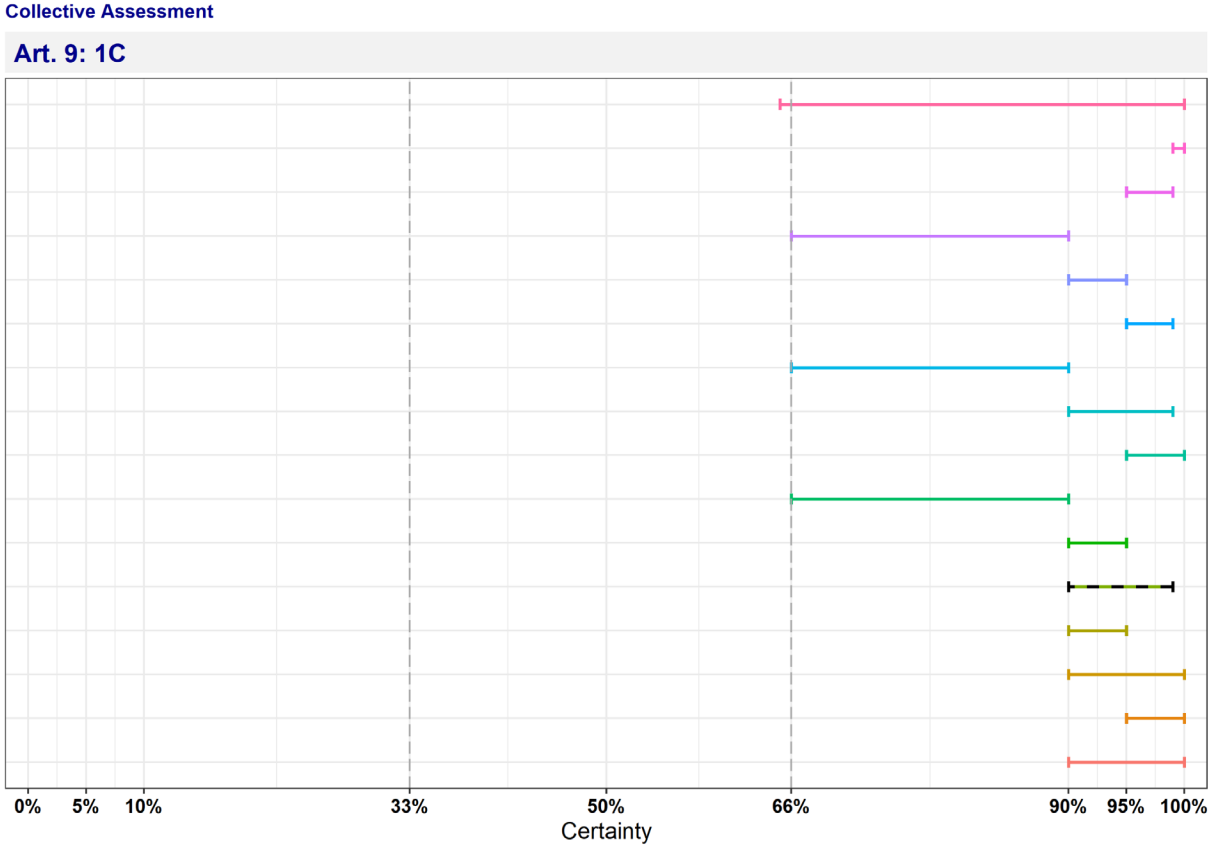
The median range is displayed as a dashed line.

Figure A.7: Individual probability ranges reflecting non-fulfilment of criterion 1A (the disease is not present in the territory of the Union or present only in exceptional cases (irregular introductions) or present in only in a very limited part of the territory of the Union) after the collective judgement



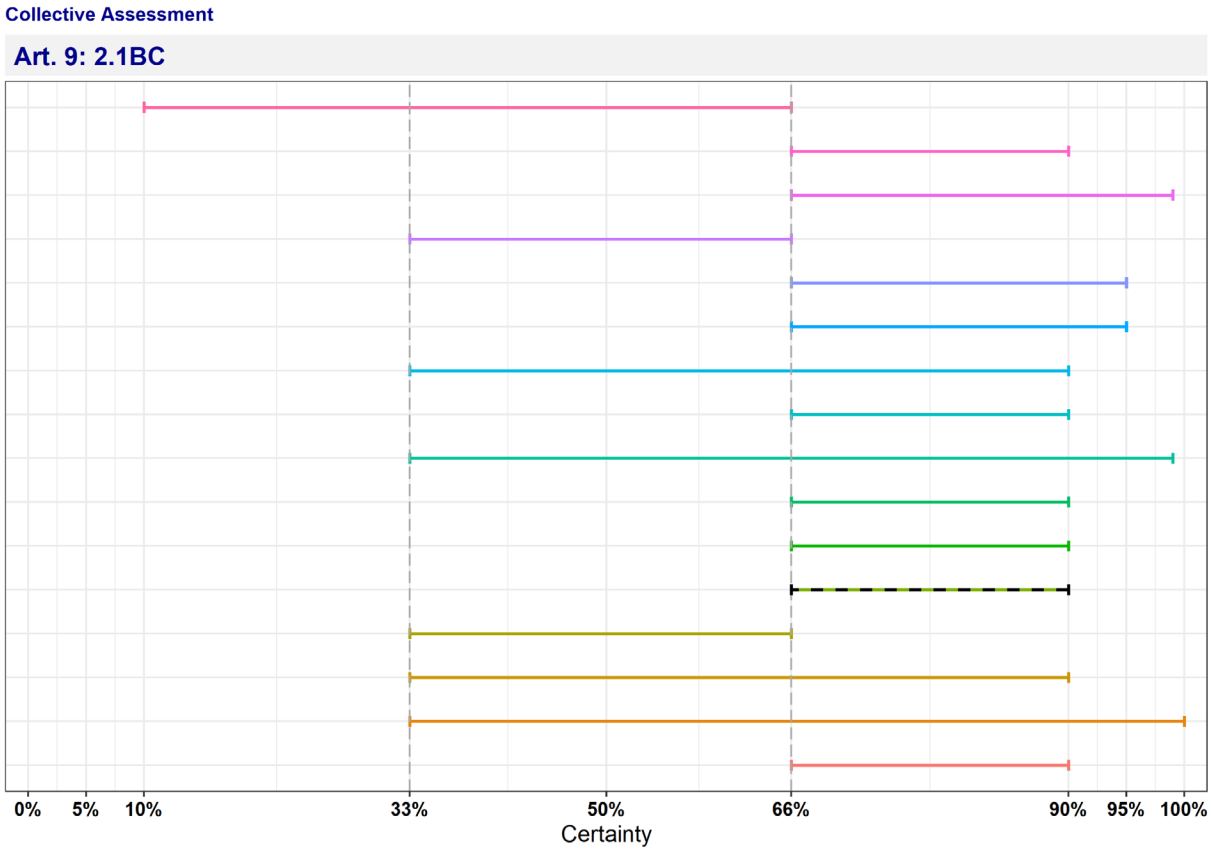
The median range is displayed as a dashed line.

Figure A.8: Individual probability ranges reflecting non-fulfilment of criterion 1B (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) after the collective judgement



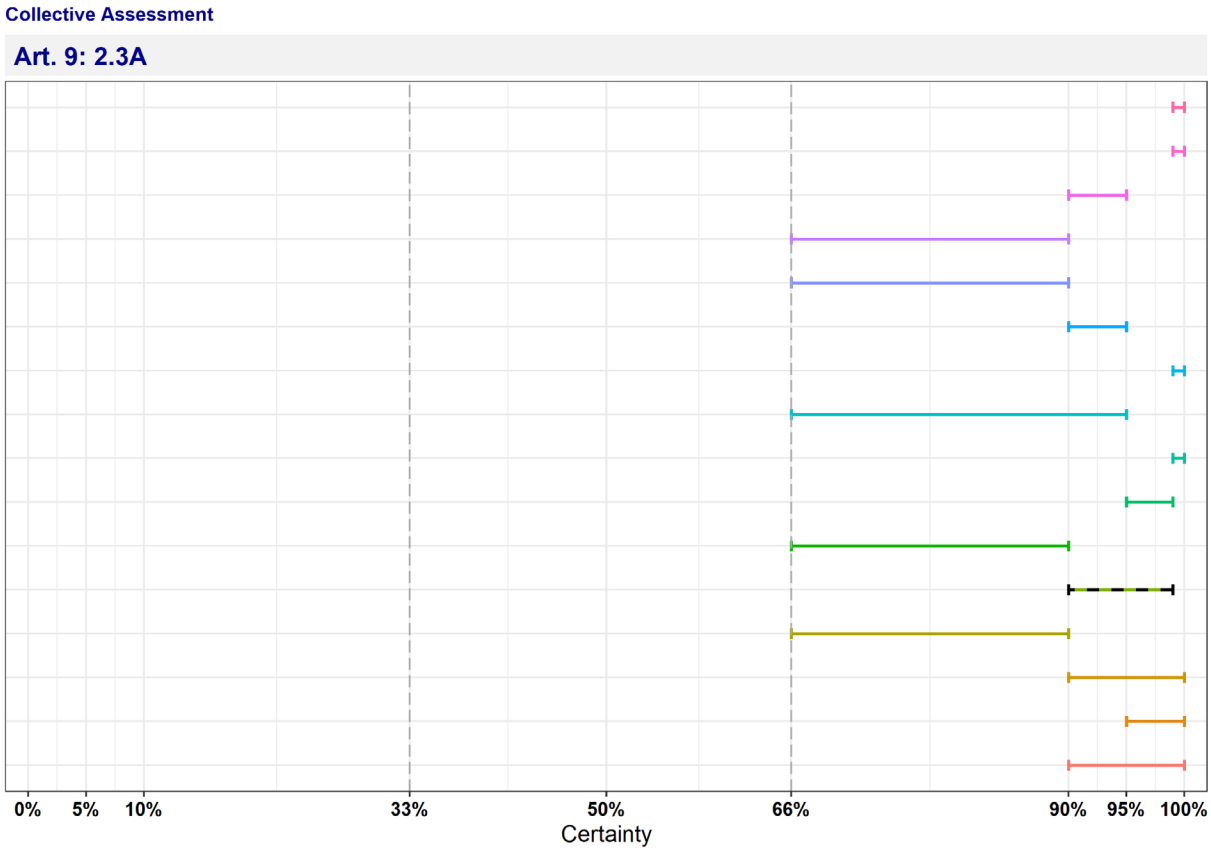
The median range is displayed as a dashed line.

Figure A.9: Individual probability ranges reflecting fulfilment of criterion 1C (the disease is present in the whole or part of the Union territory with an endemic character) after the collective judgement



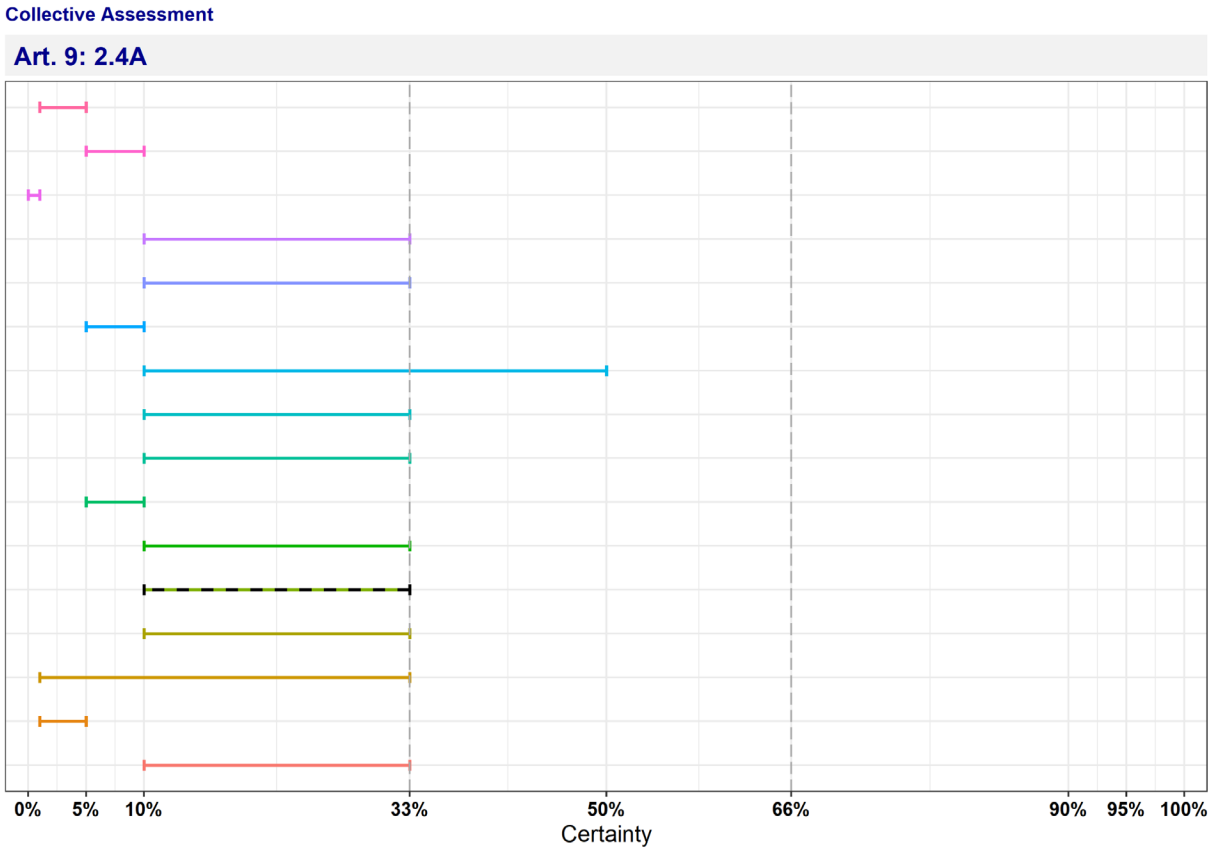
The median range is displayed as a dashed line.

Figure A.10: Individual probability ranges reflecting fulfilment of criterion 2.1BC (the disease is moderately to highly transmissible) after the collective judgement



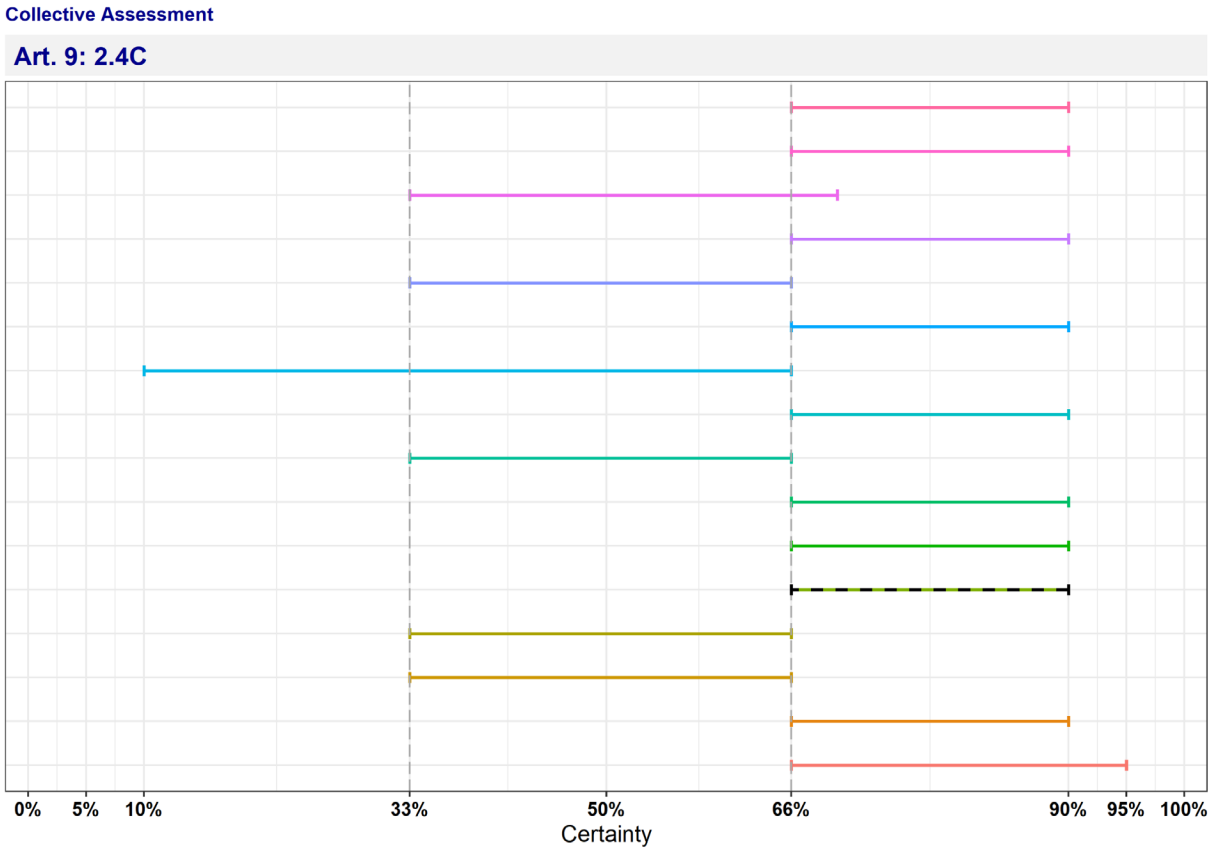
The median range is displayed as a dashed line.

Figure A.11: Individual probability ranges reflecting fulfilment of criterion 2.3A (the disease affects multiple species of kept and wild animals or single species of kept animals of economic importance) after the collective judgement



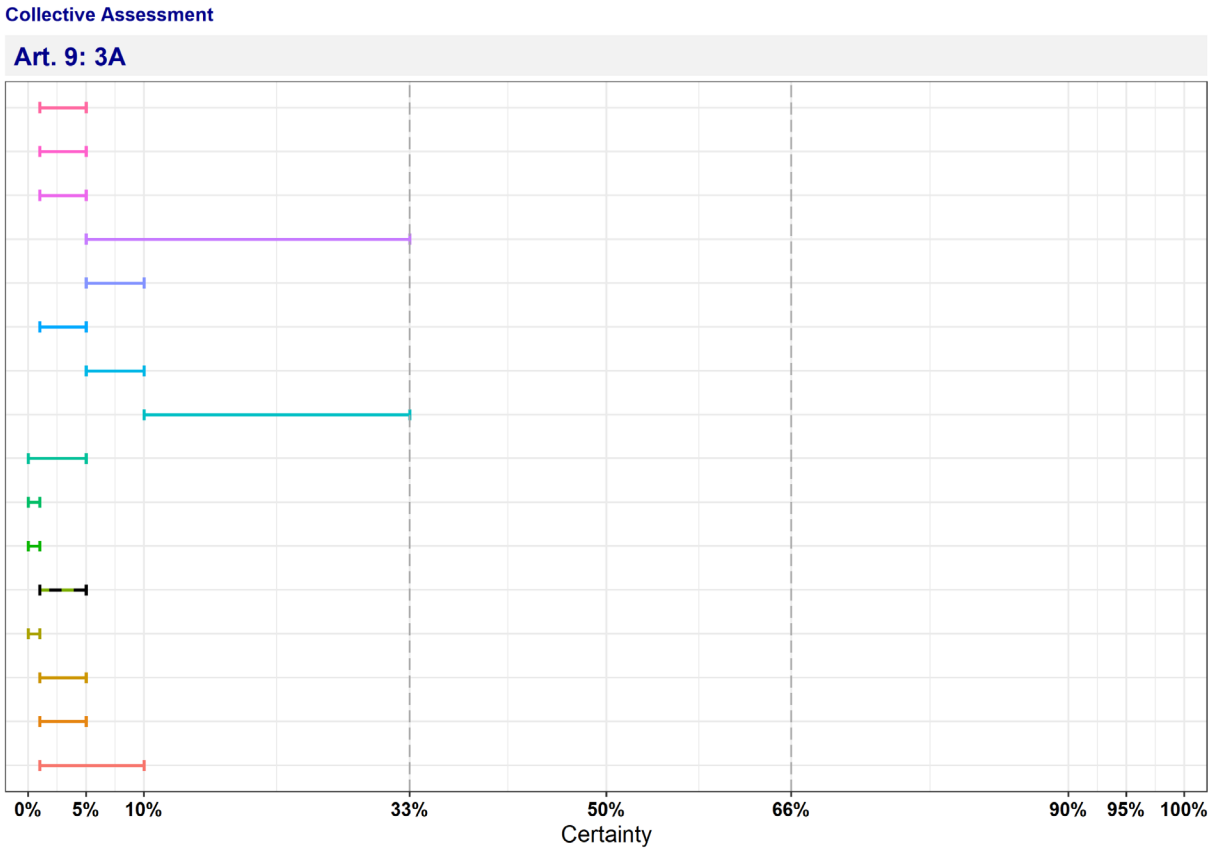
The median range is displayed as a dashed line.

Figure A.12: Individual probability ranges reflecting non-fulfilment of criterion 2.4A (the disease may result in high morbidity and significant mortality rates) after the collective judgement



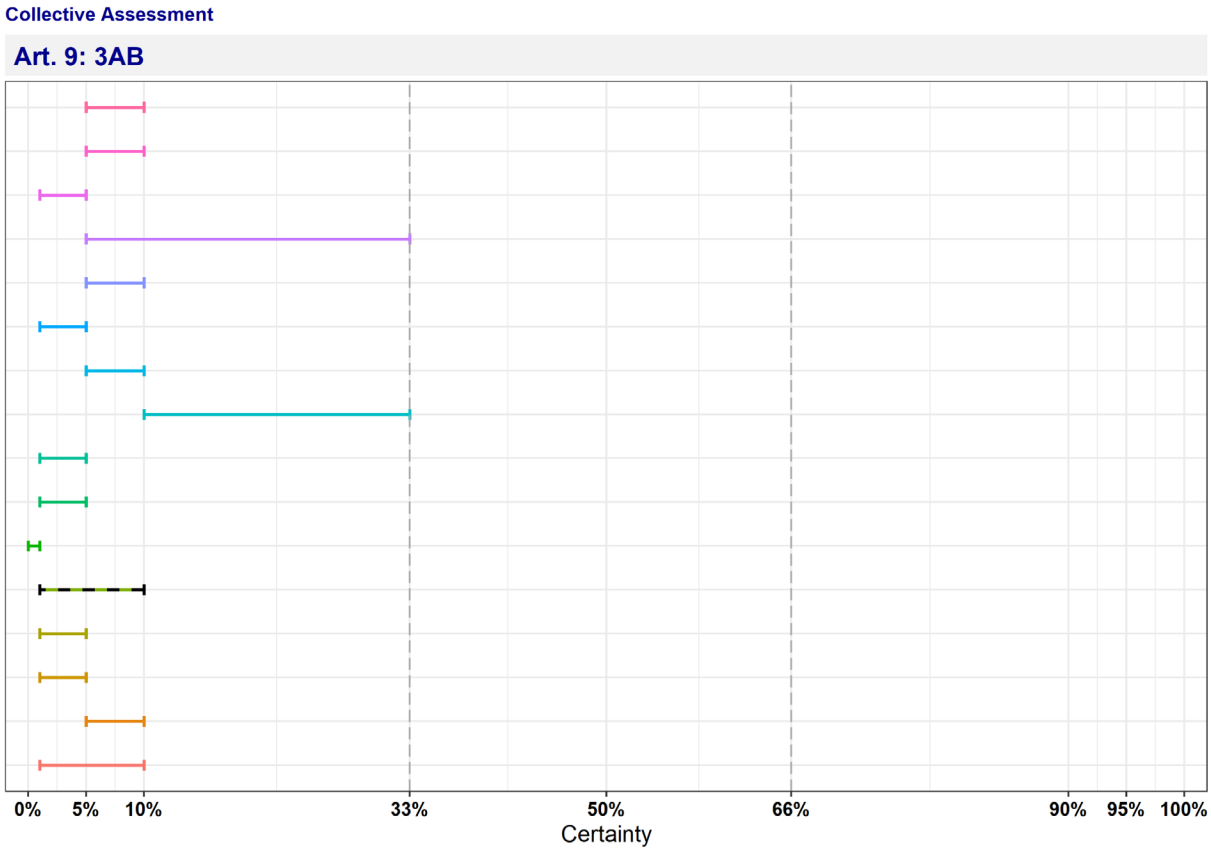
The median range is displayed as a dashed line.

Figure A.13: Individual probability ranges reflecting fulfilment of criterion 2.4C (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) after the collective judgement



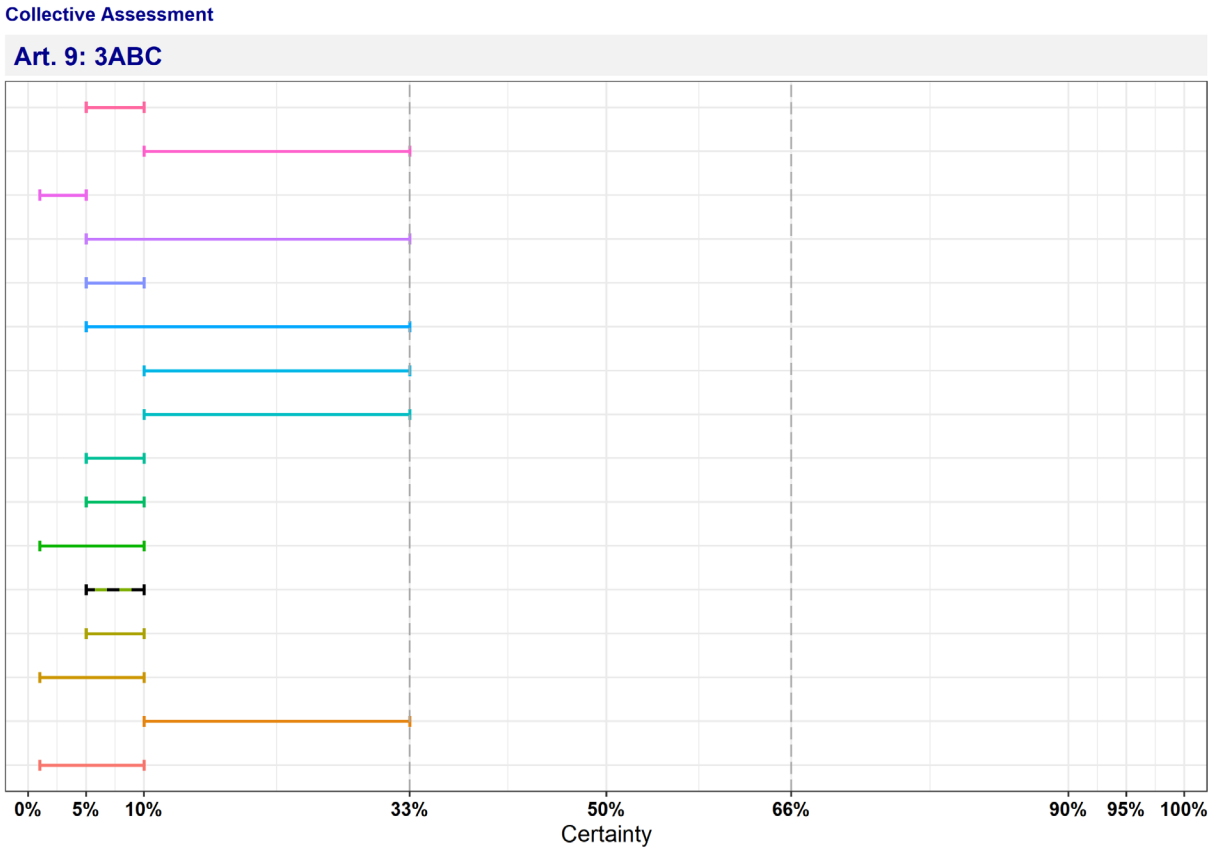
The median range is displayed as a dashed line.

Figure A.14: Individual probability ranges reflecting non-fulfilment of criterion 3A (the disease has a zoonotic potential with significant consequences for public health, including epidemic or pandemic potential or possible significant threats to food safety) after the collective judgement



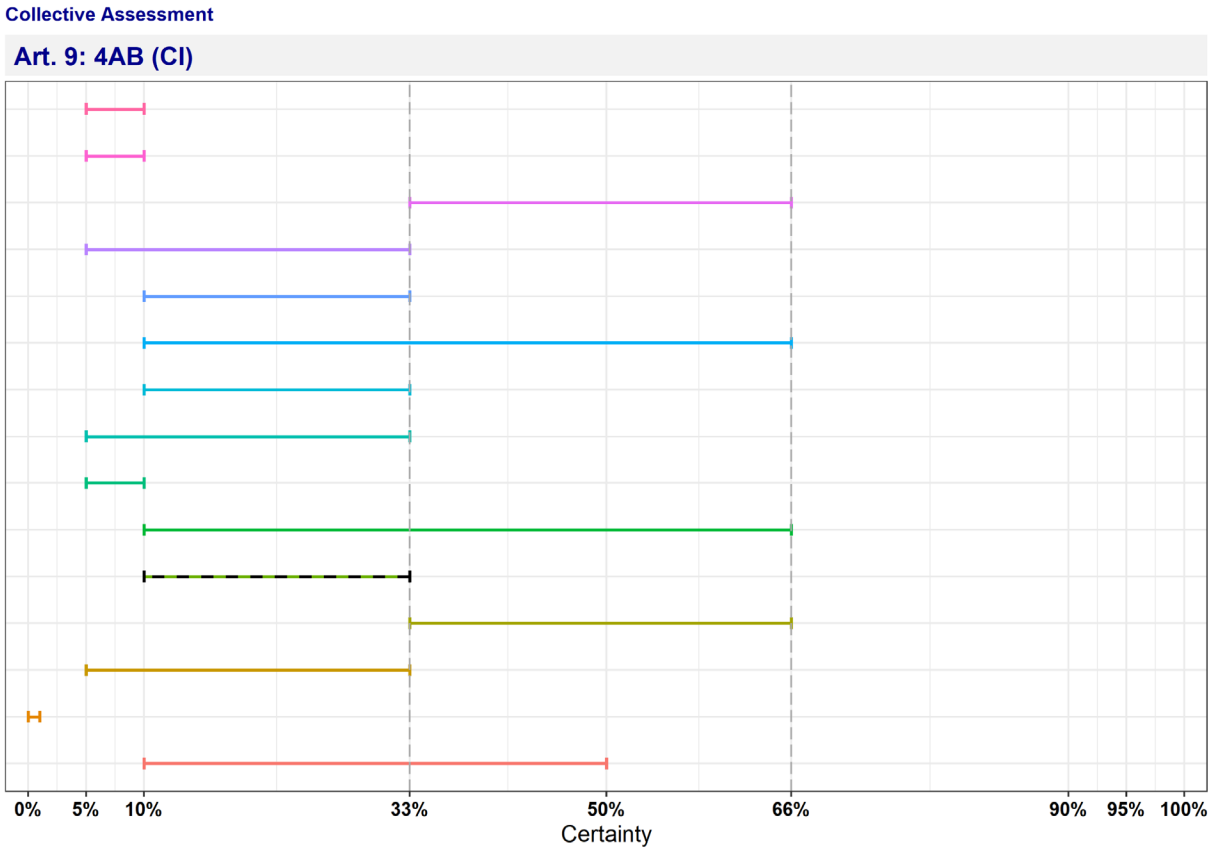
The median range is displayed as a dashed line.

Figure A.15: Individual probability ranges reflecting non-fulfilment of criterion 3AB (the disease has a zoonotic potential with significant consequences for public health, including epidemic potential or possible significant threats to food safety) after the collective judgement



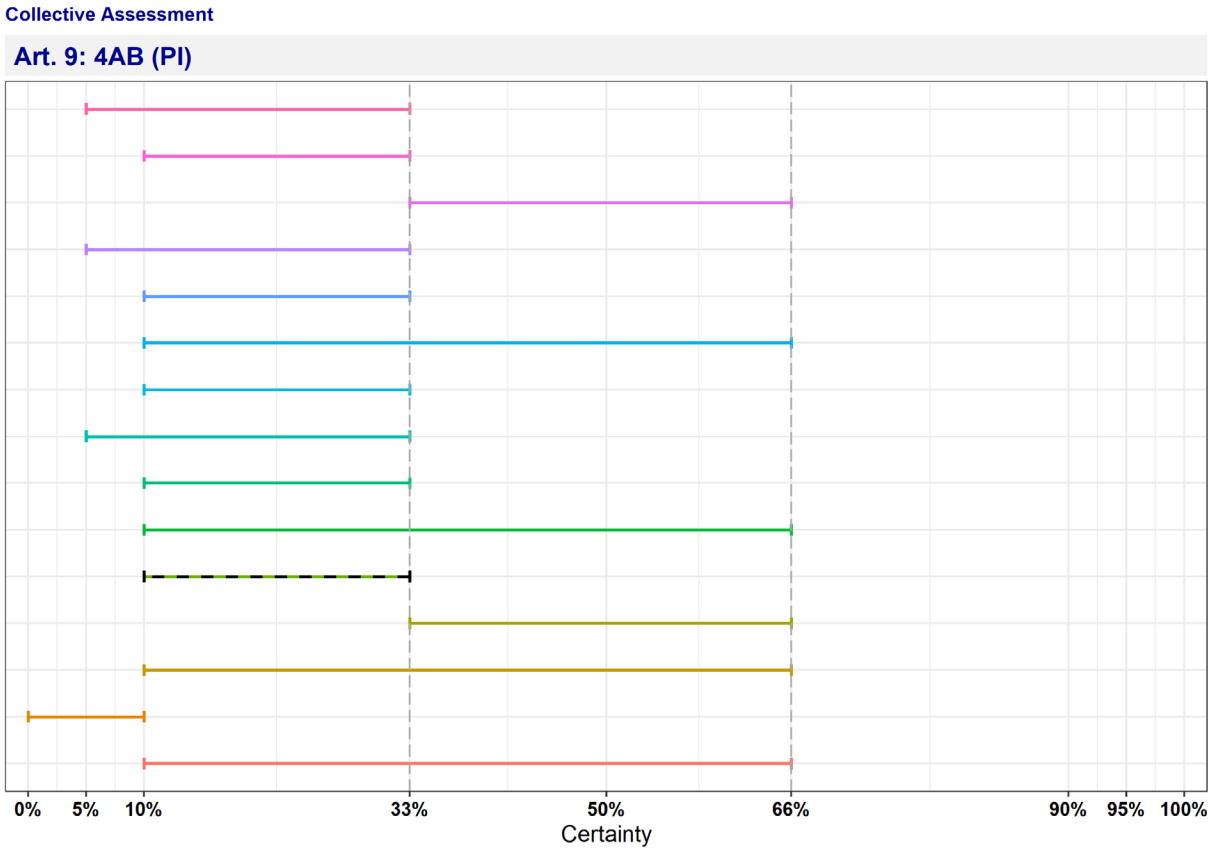
The median range is displayed as a dashed line.

Figure A.16: Individual probability ranges reflecting non-fulfilment of criterion 3ABC (the disease has a zoonotic potential with significant consequences for public health or possible significant threats to food safety) after the collective judgement



CI: current impact.
The median range is displayed as a dashed line.

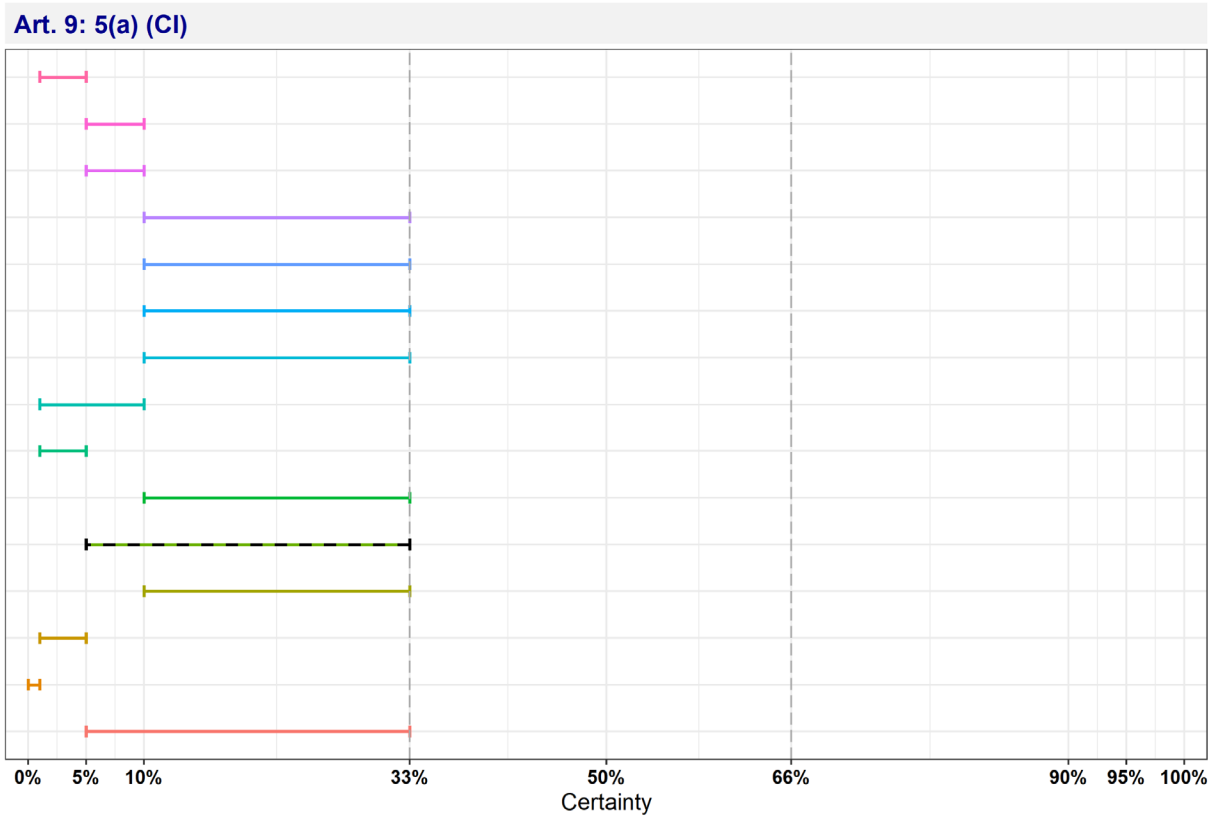
Figure A.17: Individual probability ranges reflecting non-fulfilment of criterion 4AB (current impact) (the disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals) after the collective judgement



PI: potential impact.
The median range is displayed as a dashed line.

Figure A.18: Individual probability ranges reflecting non-fulfilment of criterion 4AB (potential impact) (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) after the collective judgement

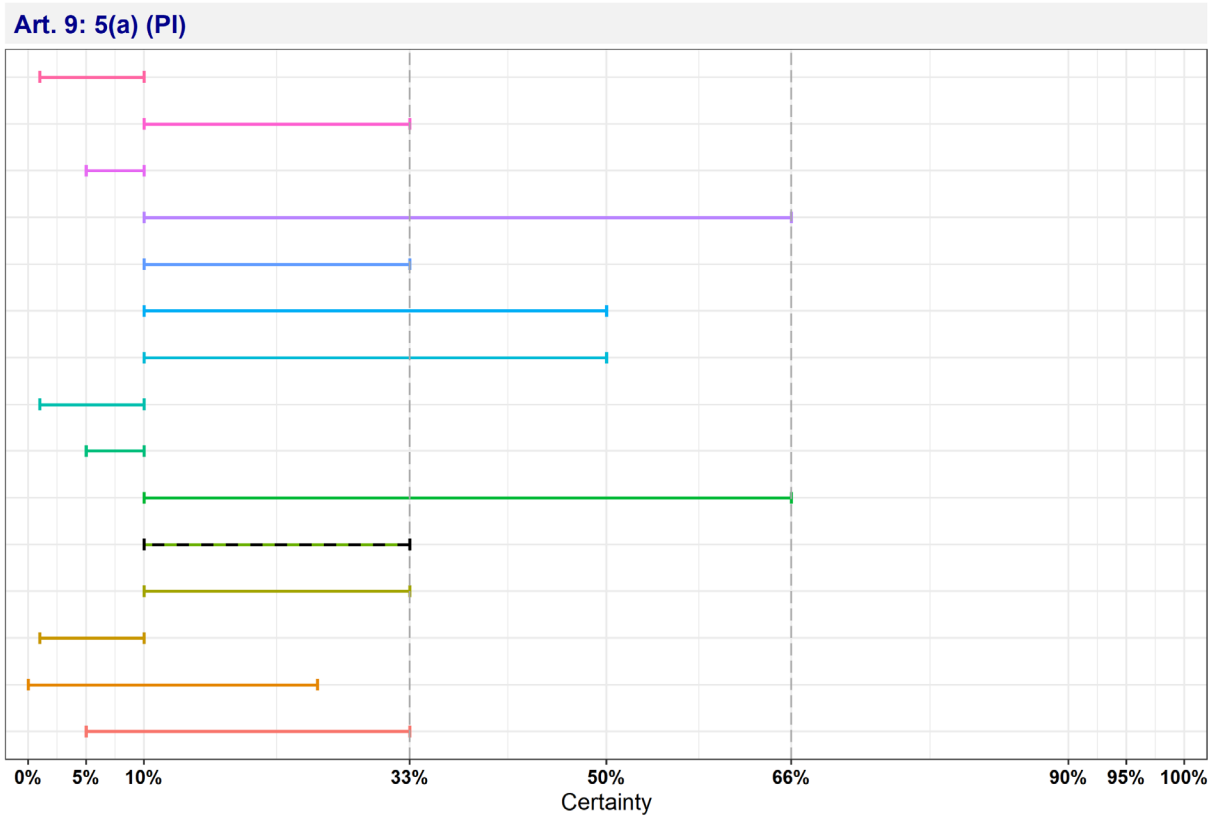
Collective Assessment



CI: current impact.
The median range is displayed as a dashed line.

Figure A.19: Individual probability ranges reflecting non-fulfilment of criterion 5(a) (current impact) (the disease has a significant impact on society, with in particular an impact on labour markets) after the collective judgement

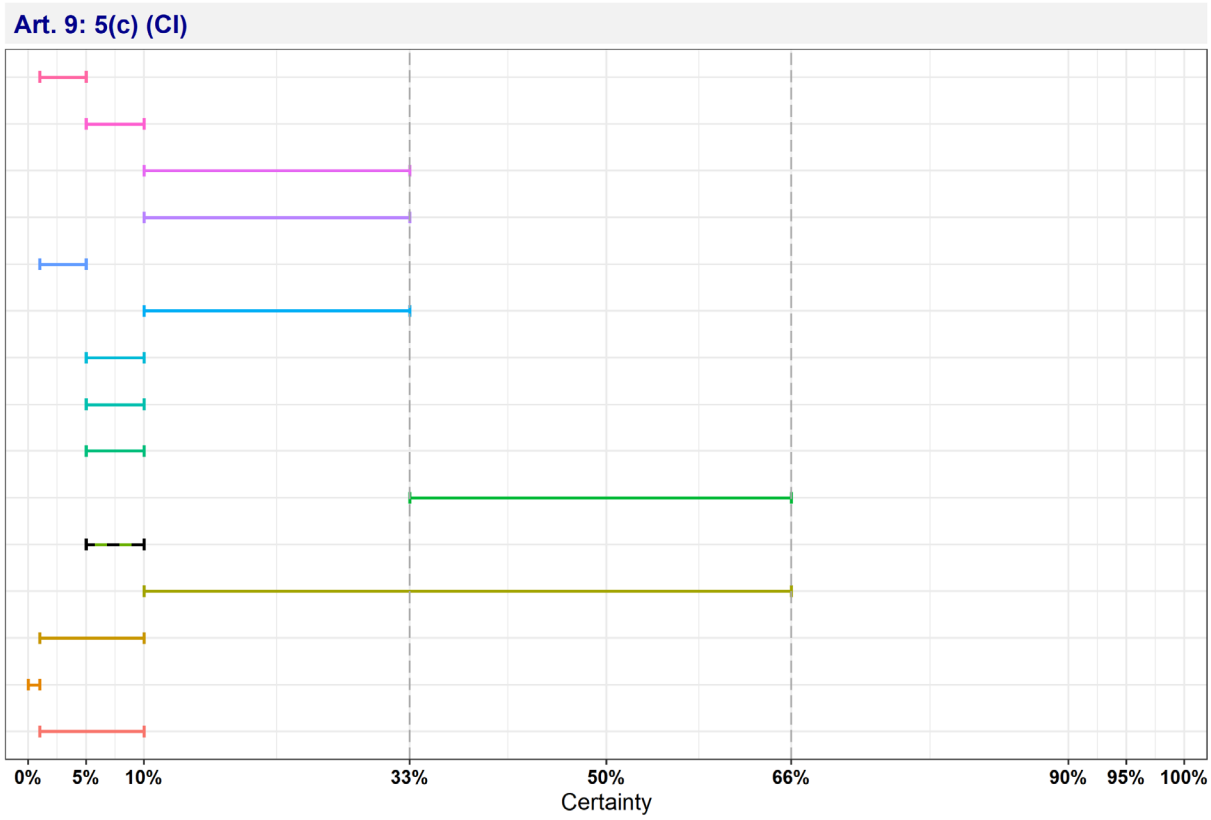
Collective Assessment



PI: potential impact.
The median range is displayed as a dashed line.

Figure A.20: Individual probability ranges reflecting non-fulfilment of criterion 5(a) (potential impact) (the disease has a significant impact on society, with in particular an impact on labour markets) after the collective judgement

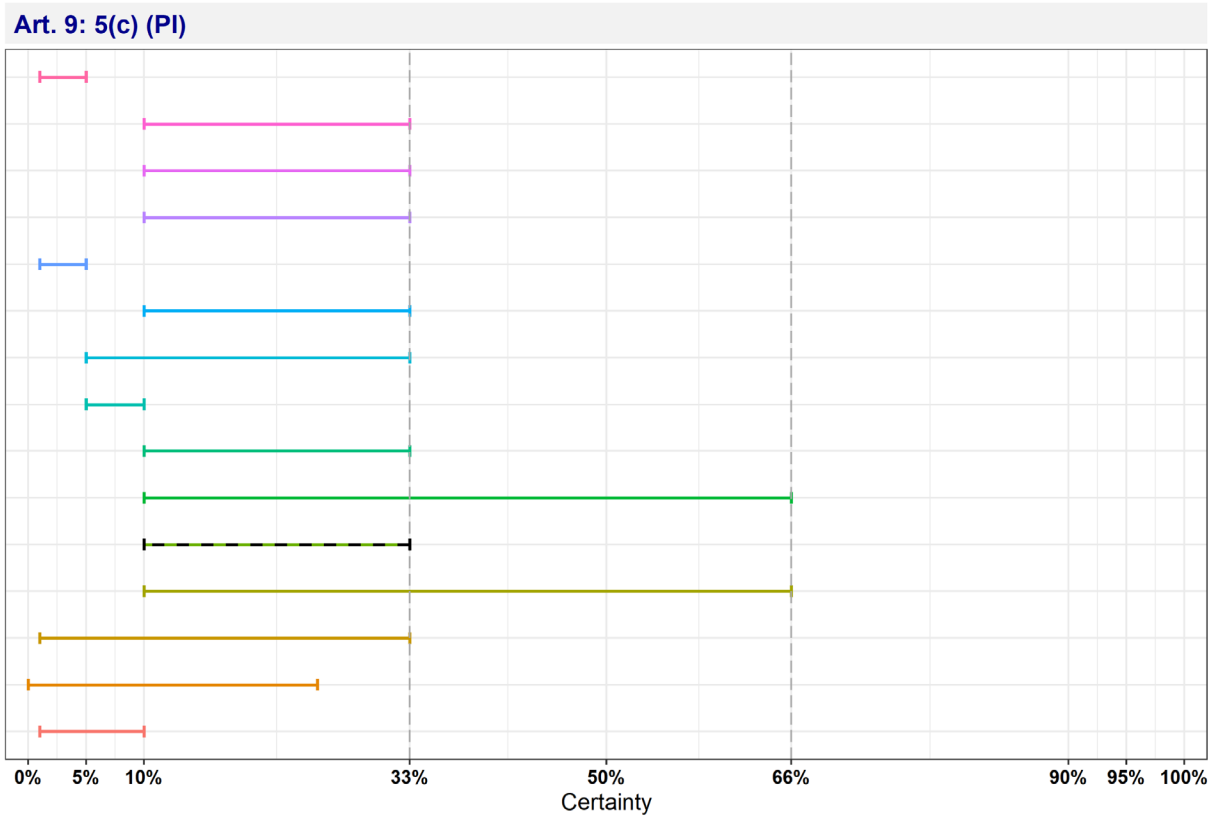
Collective Assessment



CI: current impact.
The median range is displayed as a dashed line.

Figure A.21: Individual probability ranges reflecting non-fulfilment of criterion 5(c) (current impact) (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) after the collective judgement

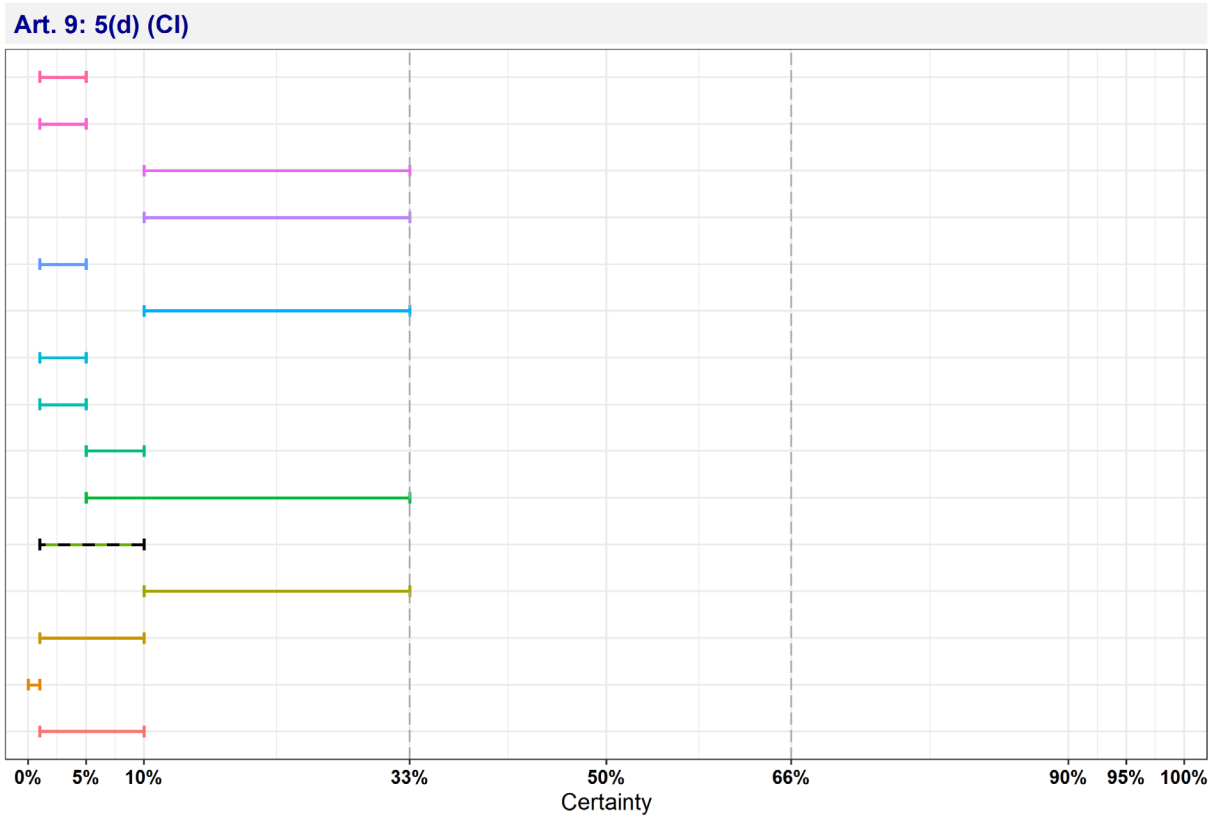
Collective Assessment



PI: potential impact.
The median range is displayed as a dashed line.

Figure A.22: Individual probability ranges reflecting non-fulfilment of criterion 5(c) (potential impact) (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) after the collective judgement

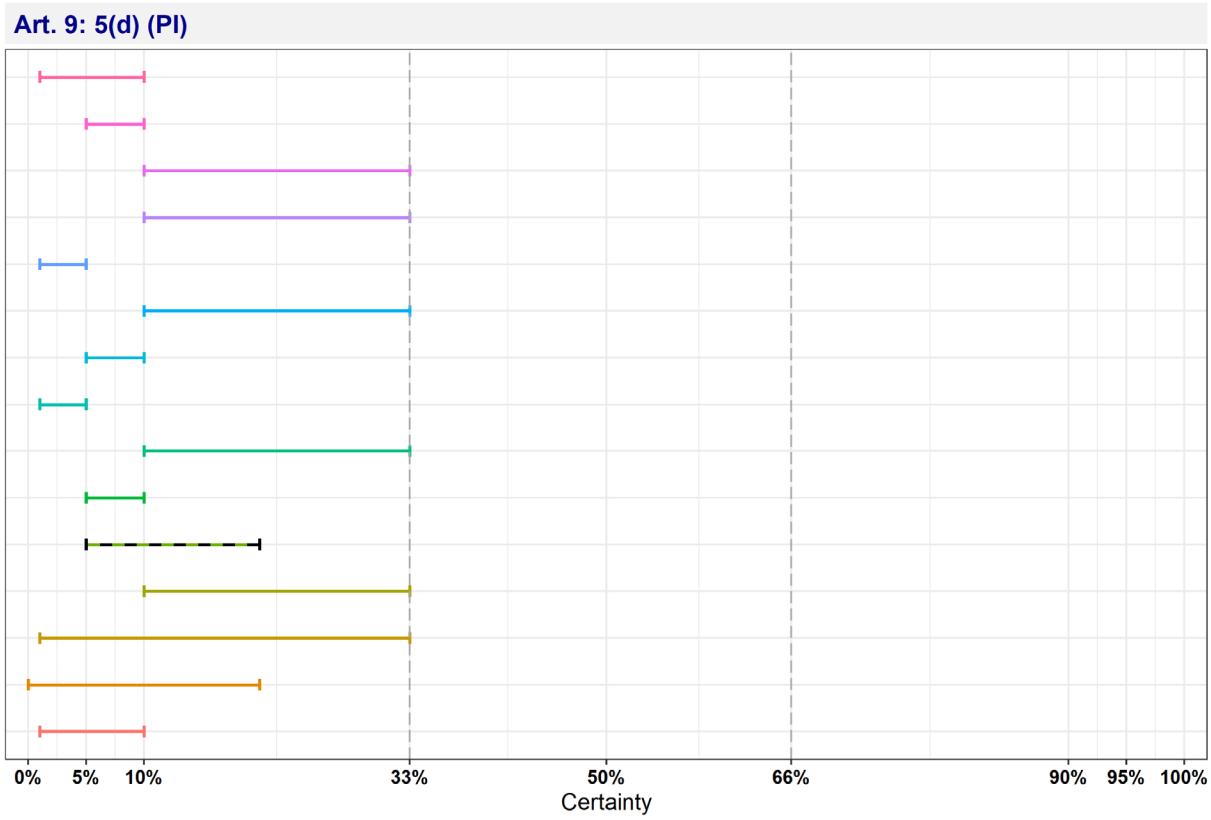
Collective Assessment



CI: current impact.
The median range is displayed as a dashed line.

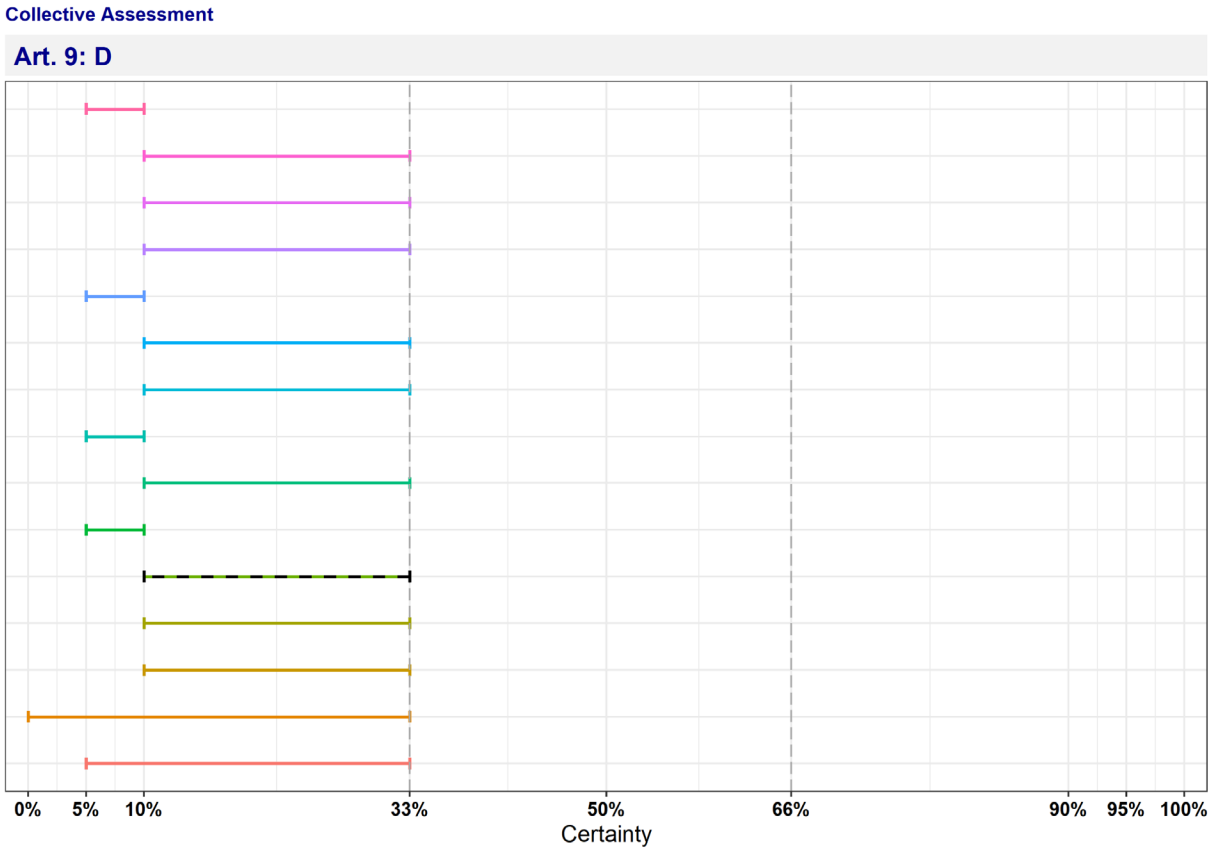
Figure A.23: Individual probability ranges reflecting non-fulfilment of criterion 5(d) (current impact) (the disease has a significant impact in the long term on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds) after the collective judgement

Collective Assessment



PI: potential impact
The median range is displayed as a dashed line.

Figure A.24: Individual probability ranges reflecting non-fulfilment of criterion 5(d) (potential impact) (the disease has a significant impact in the long term on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds) after the collective judgement

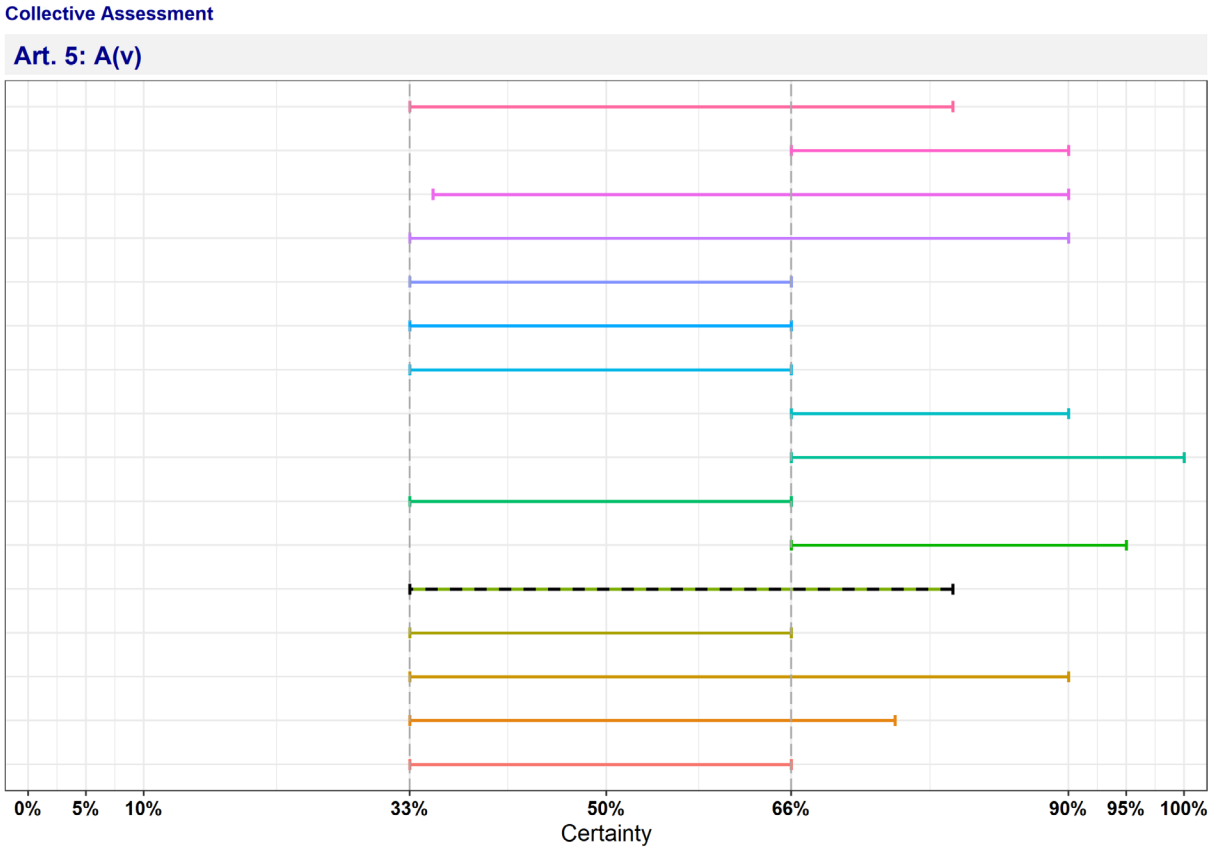


The median range is displayed as a dashed line.

Figure A.25: Individual probability ranges reflecting non-fulfilment of criterion D (the risk posed by the disease can be effectively and proportionately mitigated by measures concerning movements of animals and products in order to prevent or limit its occurrence and spread) after the collective judgement

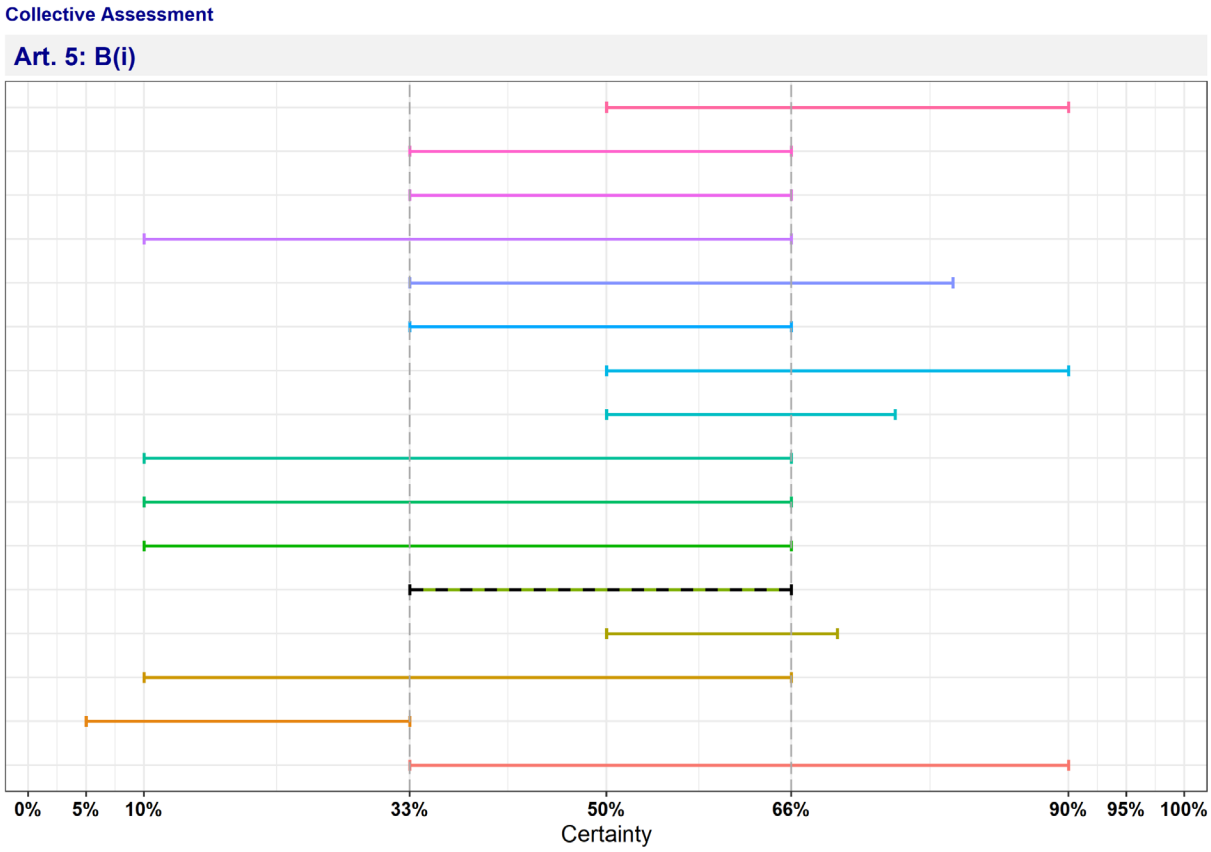
Appendix B – Criteria with uncertain outcome

B.1. Article 5 criteria



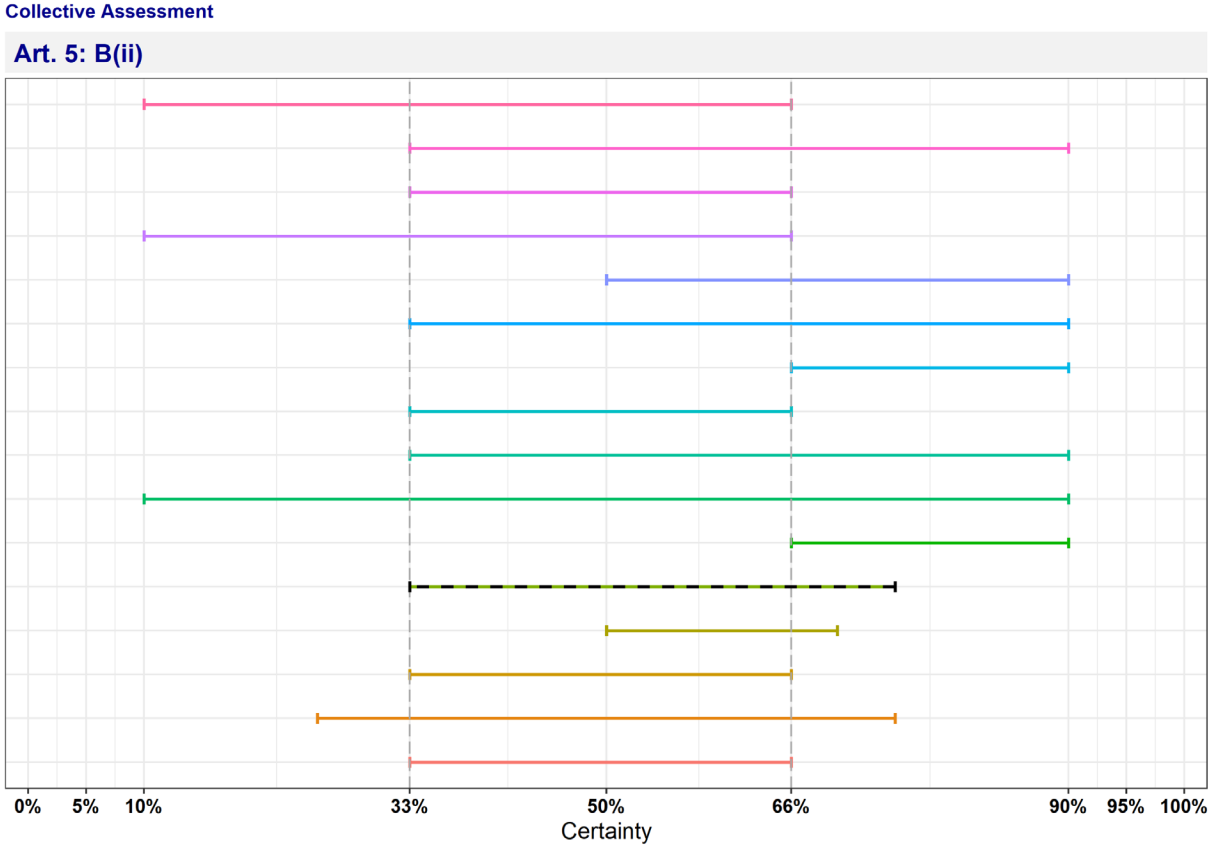
The median range is displayed as a dashed line.

Figure B.1: Individual probability ranges reflecting uncertain outcome on criterion 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) after the collective judgement



The median range is displayed as a dashed line.

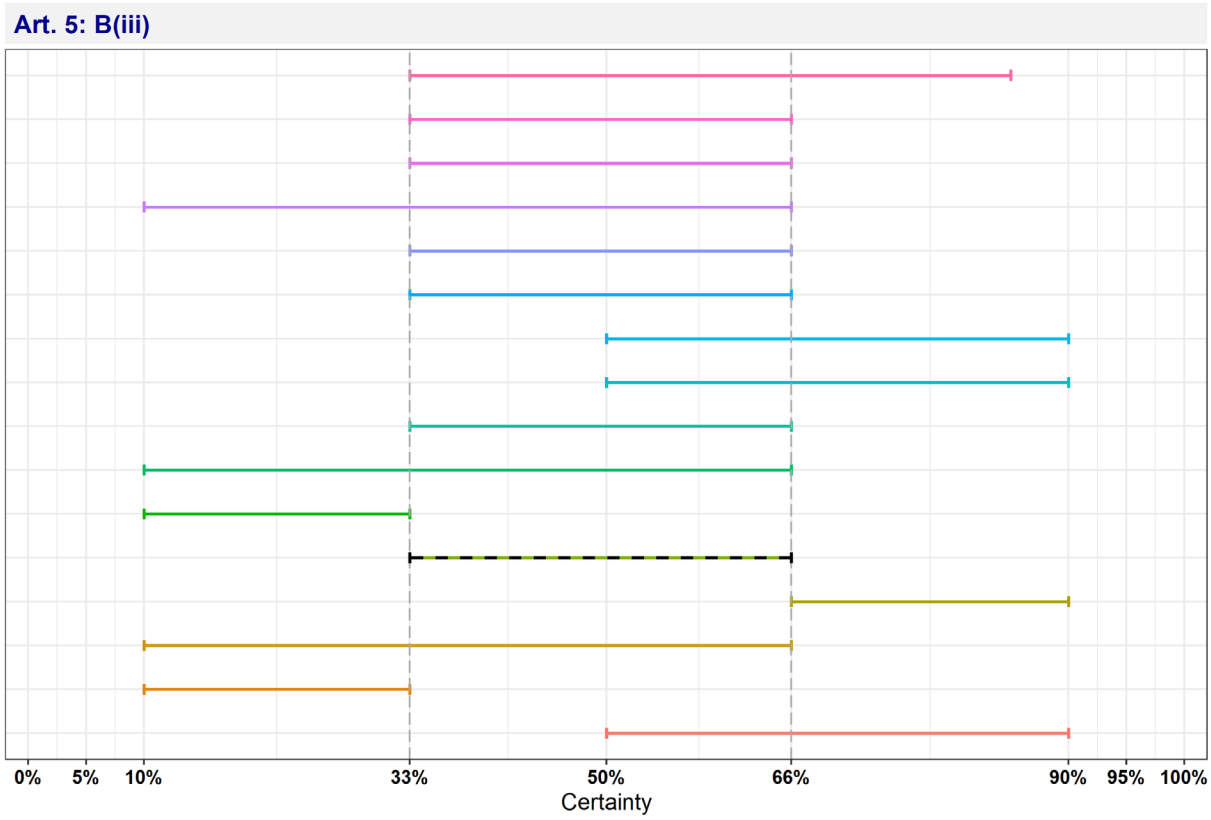
Figure B.2: Individual probability ranges reflecting uncertain outcome on criterion B(i) (the disease causes or could cause significant negative effects in the Union on animal health, or poses or could pose a significant risk to public health due to its zoonotic character) after the collective judgement



The median range is displayed as a dashed line.

Figure B.3: Individual probability ranges reflecting uncertain outcome on criterion B(ii) (the disease agent has developed resistance to treatments which poses a significant danger to public and/or animal health in the Union) after the collective judgement

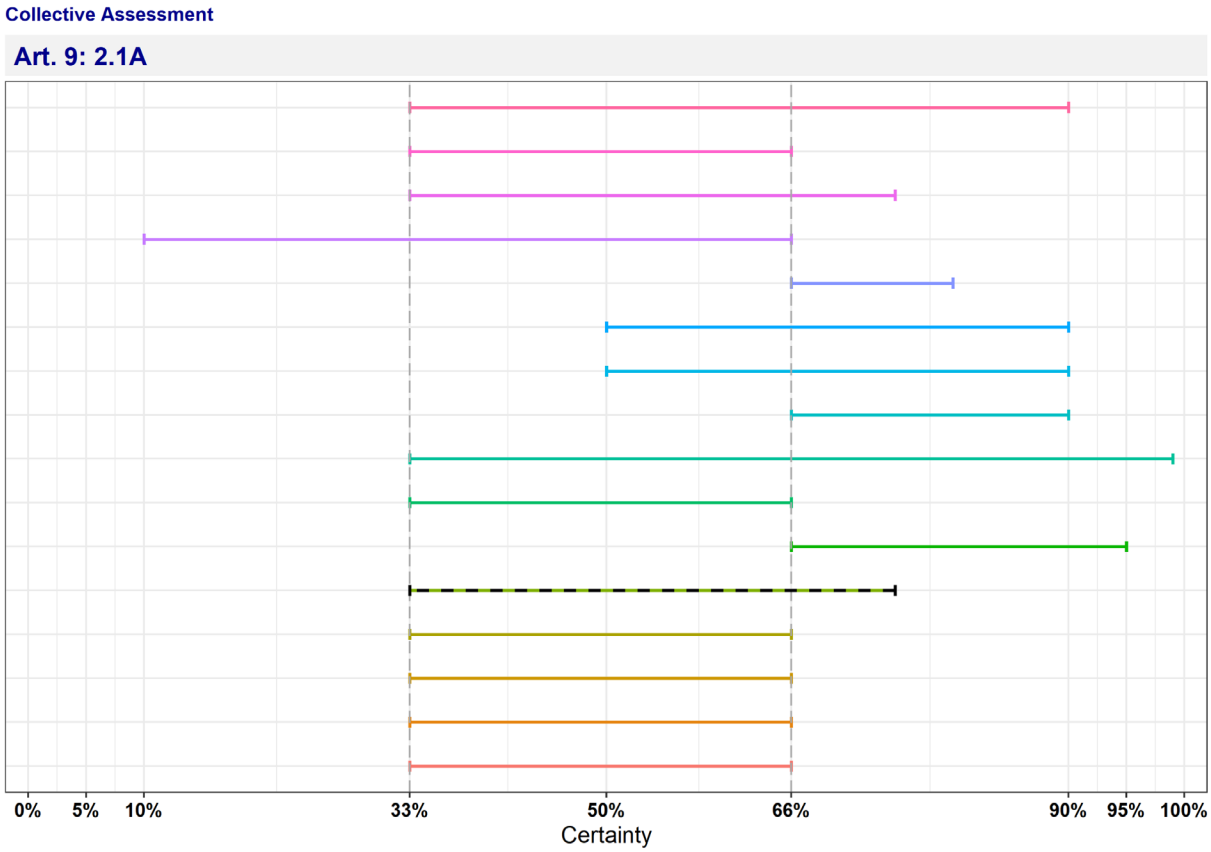
Collective Assessment



The median range is displayed as a dashed line.

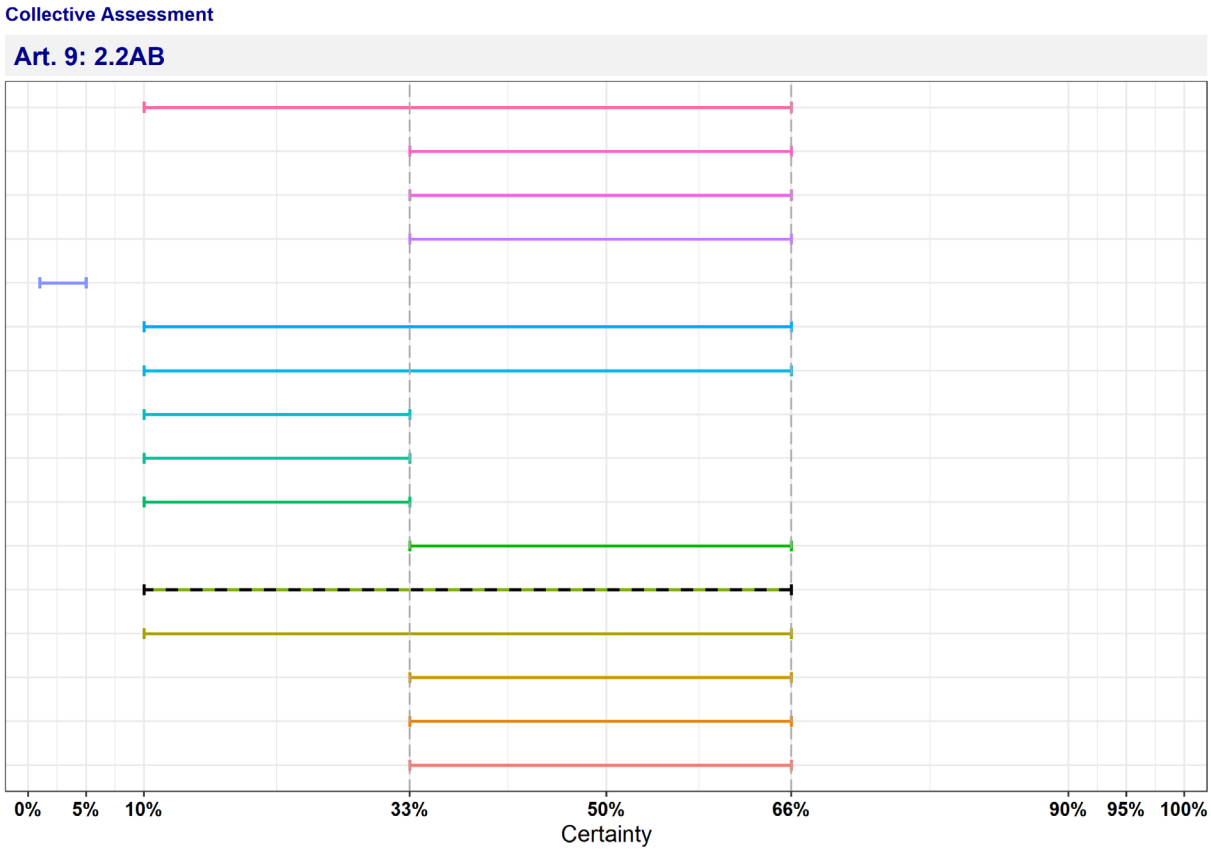
Figure B.4: Individual probability ranges reflecting uncertain outcome on criterion B(iii) (the disease causes or could cause a significant negative economic impact affecting agriculture or aquaculture production in the Union) after the collective judgement

B.2. Article 9 criteria



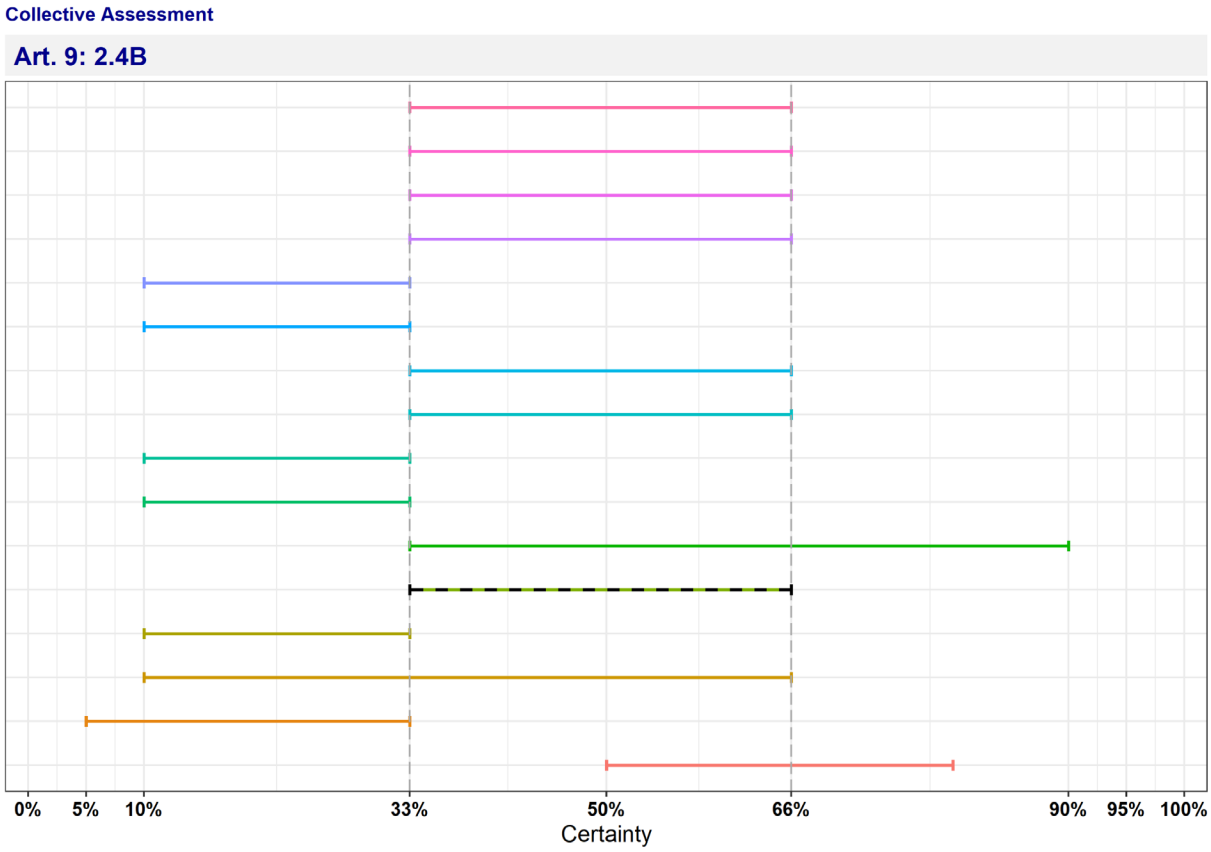
The median range is displayed as a dashed line.

Figure B.5: Individual probability ranges reflecting uncertain outcome on criterion 2.1A (the disease is highly transmissible) after the collective judgement



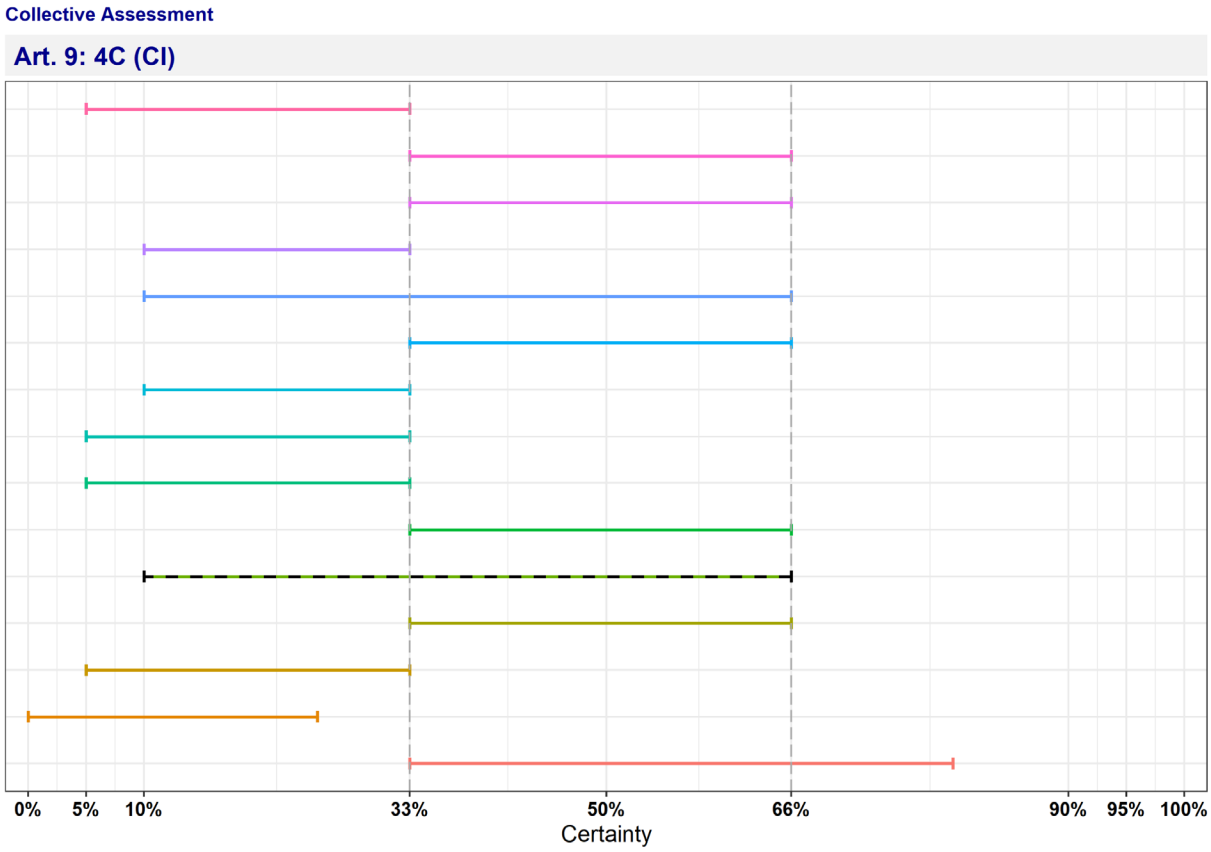
The median range is displayed as a dashed line.

Figure B.6: Individual probability ranges reflecting uncertain outcome on criterion 2.2AB (there are possibilities of airborne or waterborne or vector-borne spread) after the collective judgement



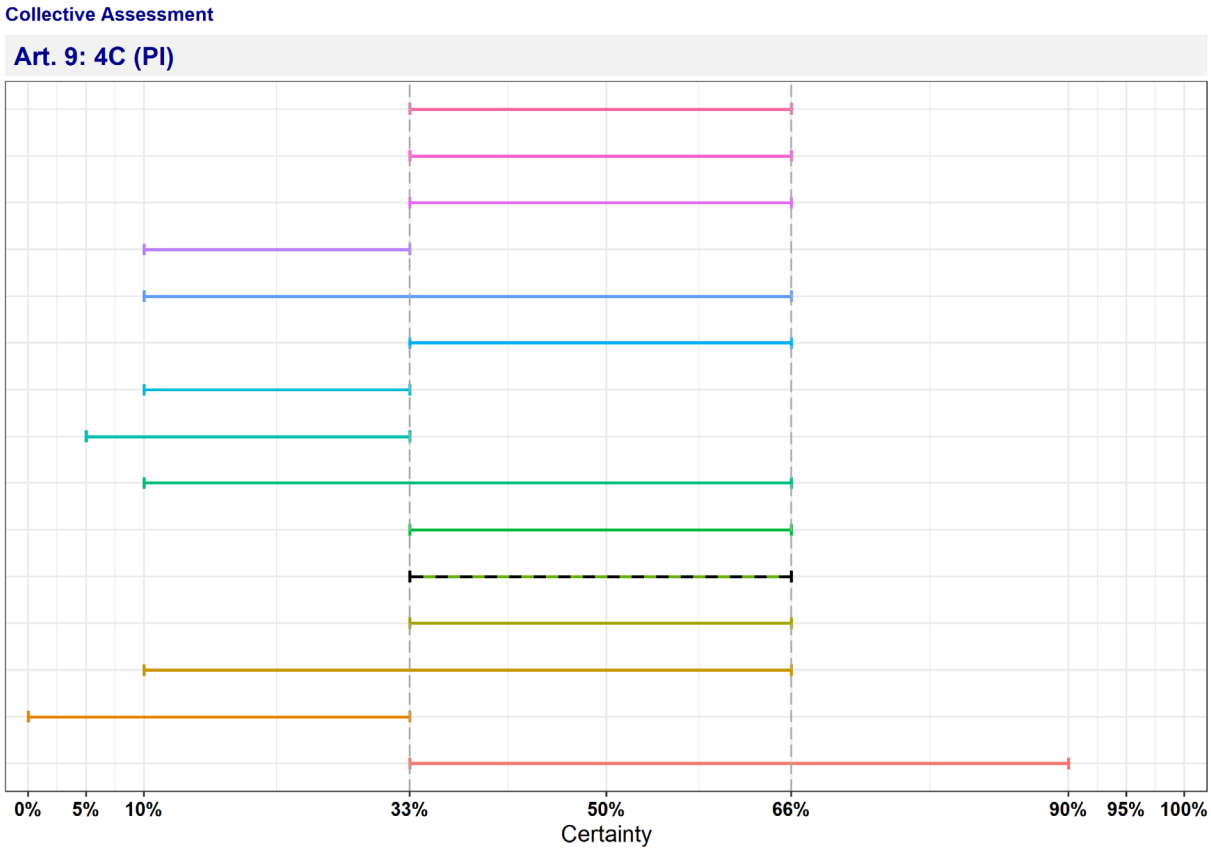
The median range is displayed as a dashed line.

Figure B.7: Individual probability ranges reflecting uncertain outcome on criterion 2.4B (the disease may result in high morbidity with in general low mortality) after the collective judgement



CI: current impact.
The median range is displayed as a dashed line.

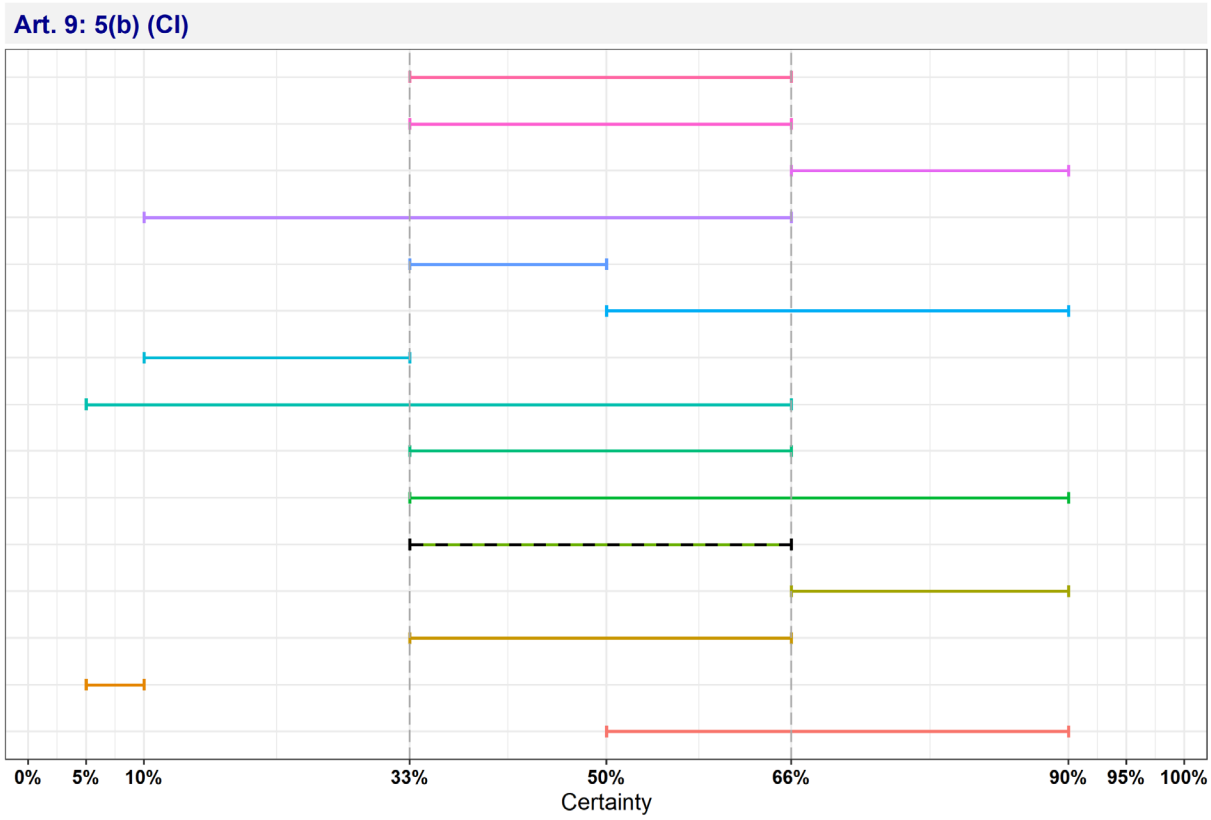
Figure B.8: Individual probability ranges reflecting uncertain outcome on criterion 4C (current impact) (the disease has a significant impact on the economy of the Union, mainly related to its direct impact on certain types of animal production systems) after the collective judgement



PI: potential impact.
The median range is displayed as a dashed line.

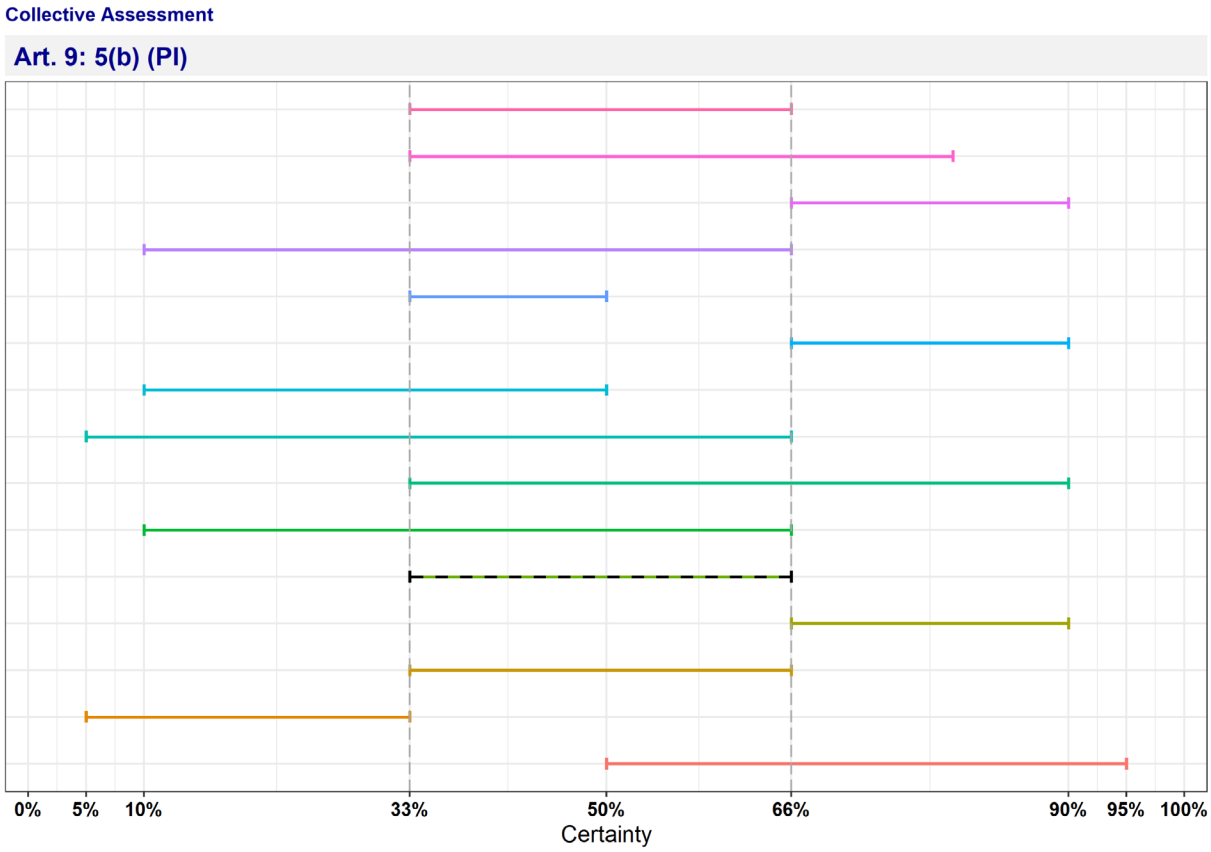
Figure B.9: Individual probability ranges reflecting uncertain outcome on criterion 4C (potential impact) (the disease has a significant impact on the economy of the Union, mainly related to its direct impact on certain types of animal production systems) after the collective judgement

Collective Assessment



CI: current impact.
The median range is displayed as a dashed line.

Figure B.10: Individual probability ranges reflecting uncertain outcome on criterion 5(b) (current impact) (the disease has a significant impact on animal welfare, by causing suffering of large numbers of animals) after the collective judgement



PI: potential impact.
The median range is displayed as a dashed line.

Figure B.11: Individual probability ranges reflecting uncertain outcome on criterion 5(b) (potential impact) (the disease has a significant impact on animal welfare, by causing suffering of large numbers of animals) after the collective judgement