Animal & Plant Health Agency

Risk assessment for bluetongue virus (BTV-3 and BTV-8): Risk assessment of entry into Great Britain

Qualitative Risk Assessment

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Summary

This document is an update of the risk assessment of the likely incursion of BTV-8 into Great Britain (England, Scotland and Wales) produced in 2017. On 5 September 2023, BTV-3 was reported in the Netherlands, it rapidly spread to Belgium and Germany, then was later detected in south-east England. Furthermore, in August 2023, a 'new strain' of BTV-8 was identified in France and quickly spread across the south of France. The risk question being assessed here is "What is the risk of BTV overwintering or being introduced into Great Britain from northern Europe and infecting livestock at least once in 2024?".

It looks at the pattern of BTV spread in both the 'new strain' of BTV-8 and BTV-3 from September 2023 to April 2024. It also considers the endemic strain of BTV-8 which re-emerged in France in 2015, although not much is known about the current level of circulation. Finally, it looks at the pathogenicity, the impact and the likely introduction of BTV into Great Britain in 2024 from infected midges or infected animals.

The results are summarised in the table below.

Summary of risks of entry of bluetongue virus in Great Britain such that at least one livestock animal is infected in 2024.

Hazard	Route	Probability that at least one livestock animal is infected in Great Britain in 2024	Uncertainty
BTV-3	Overwintering in midges in Great Britain	Low to medium	High
BTV-3	Entering Great Britain from northern Europe through windborne incursion of infected midges	Very high	High

Hazard	Route	Probability that at least one livestock animal is infected in Great Britain in 2024	Uncertainty
BTV-8	Entering Great Britain from northern France through windborne incursion of infected midges	Medium	High
BTV-3 and BTV-8	Imported live animals	Very low	Low
BTV-3 and BTV-8	Transplacental	Very low	Low
BTV-3	Overwintering in livestock (bloodmeal and testes)	Very low	Low

Bluetongue virus serotype 3 (BTV-3) was reported for the first time in northern Europe in 2023. On 5 September 2023, BTV was confirmed through clinical signs on 4 sheep farms and samples were taken for sequencing. Analysis confirmed it to be BTV-3 (House of Representatives of the Netherlands 2023). Following this, BTV-3 rapidly spread across the entire of the Netherlands. On 10 October 2023 BTV-3 was reported in Belgium and on 13 October, it was also reported in Germany. On 10 November 2023 BTV-3 was also identified in Great Britain. As of 15 April 2024, there have been 6001 reported detections in the Netherlands (NVWA 2024), 7 in Belgium (Sciesano 2024) and 56 in Germany (TSIS 2024). These cases are primarily in sheep and cattle (mainly subclinical in cattle) but there have also been a number of detections in alpacas and other ruminant species (PAFF Netherlands 2023). Unlike for BTV-8, there is no vaccine available in Europe for BTV-3 at this time.

Bluetongue virus serotype 8 (BTV-8) re-emerged in 2015 in central France, despite being undetected in mainland EU for at least 5 years prior to this. Since then, BTV-8 has become endemic in France and is still circulating. As of June 2021, BTV-8 was confirmed to be present in the north of France but since then there have not been any updates (WAHIS). In August 2023 a number of severe clinical cases, uncharacteristic of the previously reported strain of BTV-8, were identified in cattle and sheep in Aveyron. This prompted sequencing of the viral genome, which confirmed it to be an exotic strain of BTV-8, different from the strain of BTV-8 endemic in France since 2015 (ESA September 2023). The origin of this 'new strain' is not currently known. By December 2023, France had reported 1,300 detections of the 'new strain', across 23 departments in mainland France, but the French authorities have confirmed that the vaccine for BTV-8 is still effective against the new strain (ESA December 2023). This is to be expected, as the naming of strains is based on the gene responsible for the immune response and as the ribonucleic acid (RNA) segments in BTV can reassort, the rest of the genome may give the virus different virulence characteristics but in terms of immunity the vaccines are still appropriate. Since then, there has been no further update and it is not known how far the 'new strain' of BTV-8 has spread, but the French authorities have communicated that an update may be made in the event of a significant change in the epidemiological situation (ESA April 2024). Bluetongue is a category C+D+E disease under EU Regulation (EU) 2018/1882 meaning that in Europe, eradication is optional, but surveillance is required as well as additional trade requirements to prevent spread to disease free member states. France is required to provide update reports every 6 months to the World Organization for Animal Health (WOAH).

The risk assessment also considers the number of cattle and sheep found to be infected with BTV-3 in south-east England at the end of 2023. This raises the question of whether BTV-3 could have successfully overwintered in Great Britain such that it is already here in 2024, mainly in infected midges which might have survived the winter. It is argued here that the risks of overwintering in infected cattle either from transplacental transmission or from rare cases in livestock where infections last longer than 60 days are lower than through infected adult midges. Data from Met Office show that temperatures in England in the winter of 2023 to 2024 were generally higher than monthly temperatures in England in the winter of 2006 to 2007 when BTV-8 successfully overwintered in northern Europe. Although the temperature was not suitable for BTV replication in midges over the winter of 2023 to 2024 (requires a mean temperature of 15°C, but replication has been recorded at temperatures as low as 12°C, albeit at a much slower rate), this may explain why the seasonal vector low period was not confirmed until January 2024 (APHA 2023).

BTV-8 previously overwintered in northern Europe in 2006 to 2007.When comparing data for January 2007 and 2024, England in 2024 was 2.2°C colder than England, Maastricht and the Netherlands, in 2007. This was also true for January 2024 in Maastricht which was 3.5°C lower than that for January 2007. Maastricht in the Netherlands was selected due to its proximity to Belgium and Germany, which are also affected by BTV-3. Thus, the relatively cold January in England and in northern Europe for 2024 may offer some protective effect against overwintering. But it should be noted that mean temperatures in Maastricht were higher in December, February and March in 2023 to 2024 compared to 2006 to 2007 indicating a relatively mild winter.

The probability that BTV-3 has overwintered in Great Britain, such that at least one livestock animal is infected in 2024 is low to medium with high uncertainty. This takes into account the number of cases (119 cases) reported in south-east England. However, given the relatively mild winter in 2023 to 2024 together with the very large number of livestock cases in 2023 in the Netherlands, it is considered that the aggregated probability of BTV-3 overwintering in northern Europe such that at least one livestock is infected is very high. The probability of midges being infected and then blown over into Great Britain at some point during 2024, based on risk predictions and events from 2023, is also very high.

Overall, it was concluded that even if BTV-3 does not overwinter in Great Britain there is a very high probability of introduction of BTV-3 into livestock through midges at least once in 2024 from northern Europe. This contrasts to the 2017 risk assessment when the risk for BTV-8 was considered medium (DEFRA 2017), The original risk assessment was based on confirmation of a small number of cases in northern France and the effective use of a vaccine for trade purposes.

There is high uncertainty in the estimated very high risk of introduction of BTV-3 from the Continent in 2024. Firstly, it predicts large numbers of cases in livestock in northern Europe in the summer of 2024, so that there is potential for large numbers of infected midges to be blown over into Great Britain. Second there is uncertainty in the level of herd immunity in livestock in northern Europe. The relatively high numbers of cases of BTV-3 in 2023 in livestock in the Netherlands, Belgium and northern Germany compared to Great Britain, may influence the levels of herd immunity to the virus in the livestock population on the Continent in 2024 (69). However, “replacement” livestock less than a year old may have lower, if any, natural immunity or residual maternally derived immunity and will contribute a new pool of susceptible hosts. The level of disease on the Continent in the summer 2024 is difficult to predict due to variable daily temperatures on the Continent, unknown livestock movements, unknown levels of herd immunity in livestock and high numbers of midge vectors.

The risk of importing infected livestock with BTV-3 or BTV-8 is very low. All imports of susceptible livestock from BTV affected counties are required to comply with the health certificate requirements including the appropriate vaccination. Countries affected with BTV-3 (Belgium, Germany and the Netherlands) are unable to comply with the Great Britain health certificate due to no vaccine being available in Europe. Although there is a vaccine available for BTV-8, France also has epizootic haemorrhagic disease virus (EHDV) present, preventing it from meeting the requirements for importing. There is a small possibility of BTV-3 being brought into Great Britain through the importation of infected cattle, if BTV-3 is able to spread to countries undetected. At this time, in northern Europe the only country trading live susceptible animals with Great Britain is Denmark. Although importation is allowed from other countries if livestock do not transit a BTV-3 region during the season. Germinal products are not included in this assessment as they are considered lower risk, due to the strict requirements for importing, highlighted in the health certificates (Great Britain HC003E and Great Britain HC009E).

It should be noted that the risk assessment here predicts the probability of at least one livestock animal being infected in Great Britain in 2024. It does not give any information on the number or frequency of livestock animals infected. While just a single livestock animal being infected in Great Britain may not have a high probability per se of onward spread to other livestock through midges, the more livestock animals that are infected through midges either overwintering in Great Britain or windborne from northern Europe, then the higher the probability of transmission to other livestock and subsequent spread in the vector season.

Introduction

Bluetongue (BT) is a notifiable disease of ruminants, most commonly associated with clinical disease in sheep but can also affect cattle. It is caused by infection with the bluetongue virus (BTV), an orbivirus of the Reoviridae family (1). There are 29 known serotypes (2-4, 52) and these viruses are usually transmitted in Europe via the bites of infected Culicoides midges.

The virus is often found in southern Europe, BTV serotypes 1, 2, 3, 4 , 9 and 16 have all been identified in the Mediterranean basin (5). Until recently only BTV serotypes 1, 8 and 25 and three vaccine strains of BTV-6, BTV-11 and BTV-14 had previously been identified in northern Europe; BTV-8, BTV-1 and BTV-14 are known to have circulated efficiently in Culicoides (6, 7). The BTV-8 virus reached Great Britain during 2007, the second year of the epizootic in northwest Europe when infection rates were very high in Continental Europe and BTV-1 reached northern France (8-10).

The identification of BTV-3 in the Netherlands in September 2023 has led to concerns that an epizootic across north Europe may develop again this year with the potential for significant losses of livestock. BTV-3 rapidly spread from the Netherlands to Belgium and Germany and was later detected in Great Britain. At this time, there is no vaccine available for BTV-3 in Europe. This means that there is a substantially naïve livestock population present in northern Europe with very limited immunity. It should also be noted that BTV vaccines do not provide cross protection for other serotypes. Controls are limited for BTV-3 and are focused mainly on the movement of livestock in and from affected areas. This document considers the risks of an incursion of BTV-3 in Great Britain in 2024, primarily through windborne spread of infected Culicoides from northern Europe.

In addition to this, there was an emergence of a ‘new strain’ of BTV-8 in France in August 2023, but little data is published about how far it has spread. It was identified due to uncharacteristically causing severe clinical cases in unvaccinated sheep and cattle. Genetic analyses of the virus have shown that it is different to the previous northern European strain of BTV-8, but vaccines were identified to still be effective. As a vector borne disease, vaccination is the best control option which is highlighted in the Great Britain control strategy for Bluetongue.

Risk question

Within this QRA, we review the risk of BTV-3 or BTV-8 entry to Great Britain during 2024, via infected midges as the primary route together with overwintering and also via infected imported animals. As such, the specific risk question is:

“What is the risk of BTV overwintering or being introduced into Great Britain (Great Britain) from northern Europe and at least once affecting livestock in 2024?”.

It should be noted that the risk assessment here predicts the likelihood of at least one livestock animal being infected in Great Britain in 2024. It does not give any information on the number or frequency of livestock animals infected. While just a single livestock animal being infected in Great Britain may not have a high probability per se of onward spread to other livestock through midges, the more livestock animals that are infected through midges either overwintering in Great Britain or windborne from northern Europe, then the higher the probability of transmission to other livestock and subsequent spread in the vector season.

Hazard identification

The hazard is bluetongue virus. There are 2 serotypes considered, namely serotype 8 (BTV-8) and serotype 3 (BTV-3).

BTV-3

On 5 September 2023, BTV was confirmed on 4 sheep farms in the Netherlands following reports on clinical suspicion by private veterinarians. Sequencing was conducted by Wageningen Bioveterinary Research and it was confirmed as BTV-3 by the EU Reference Laboratory in Madrid (House of Representatives of the Netherlands 2023). Since then, there have been 6001 reports across the entire of the Netherlands, at this time it is not clear what the effects are on mortality or morbidity but the prevalence within herds is currently being analysed to provide more insight (NVWA 2024).

In December 2023, the NVWA highlighted that a variety of ruminants were found to be infected with BTV-3 which included sheep, goats, cows, alpacas, lamas, mouflon, water buffalo, wisent and yak (PAFF Netherlands 2023). On 10 October 2023, BTV-3 was reported in Belgium (Sciesano 2024) and on the 13 October 2023, it was also reported in Germany (TSIS 2024). As of 15 April 2024, there have been 7 outbreaks of BTV-3 in Belgium and 53 outbreaks in Germany. Boender et al (68) have concluded that in addition to short-distance dispersal of infected midges, other transmission routes such as livestock transports probably played an important role in the Netherlands in 2024.

On 10 November 2023, it was confirmed that 1 cow on a farm in Kent, England tested positive for BTV-3 after samples were taken as part of annual bluetongue surveillance, no clinical signs were observed. As of 15 April 2024, the total number of reported cases of BTV-3 in England is 126 (7 sheep and 119 cattle) across 73 locations in 4 counties (Kent, Norfolk, Suffolk and Surrey) (GOV 2024). The locations are shown in Figure 1.

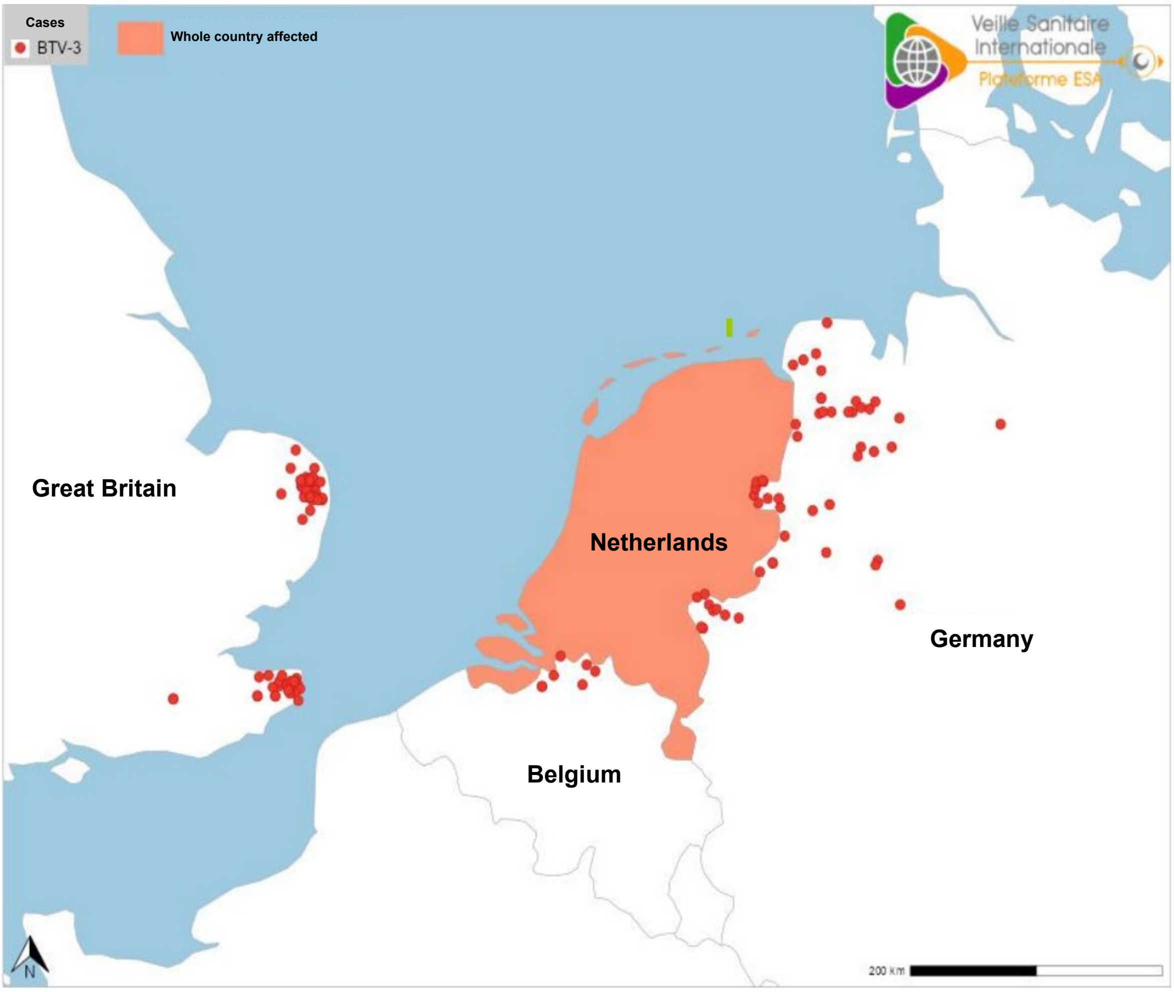

Figure 1: The locations of BTV-3 cases (red dots) in Great Britain, Belgium, Germany and the Netherlands where the whole country is affected (Source: Plateforme ESA, accessed on 15 April 2024).

BTV-8

In 2015 a ram located in central France was clinically diagnosed with BTV, but none of the other animals in the herd showed any clinical signs. Genetic sequencing identified the virus to be closely related to the BTV-8 strain that circulated in 2006 – 2008. Although the origin of the outbreak is unclear, it is thought that BTV-8 was likely circulating at very low levels from the time it first emerged in 2006 (Sailleau et al., 2017).

Since then, this strain of BTV-8 has become endemic in France. However, a 'new strain' of BTV-8 was first reported in the country in August 2023. The cases were unusual given the severity of clinical signs; namely, pyrexia, mouth ulcers and coughing, leading to authorities to sequence the viral genome. This confirmed it to be an exotic strain of BTV-8, different from the strain of BTV-8 which has been endemic in France since 2015 but the existing vaccines against serotype 8 remain effective against this ‘new strain’ (ESA September 2023). By November 2023, the newly identified strain had been implicated in 1,300 reports (1000 in cattle and 300 in sheep), spread across 25 departments in France (ESA December 2023) (Figure 2). However, since November 2023 there have been no further updates reported. The French authorities have communicated that due to a lack of consolidated data the extent of the spread of the ‘new strain’ of BTV-8 will not be regularly updated, but an update may be made if a significant change in the epidemiological situation occurs (ESA April 2024).

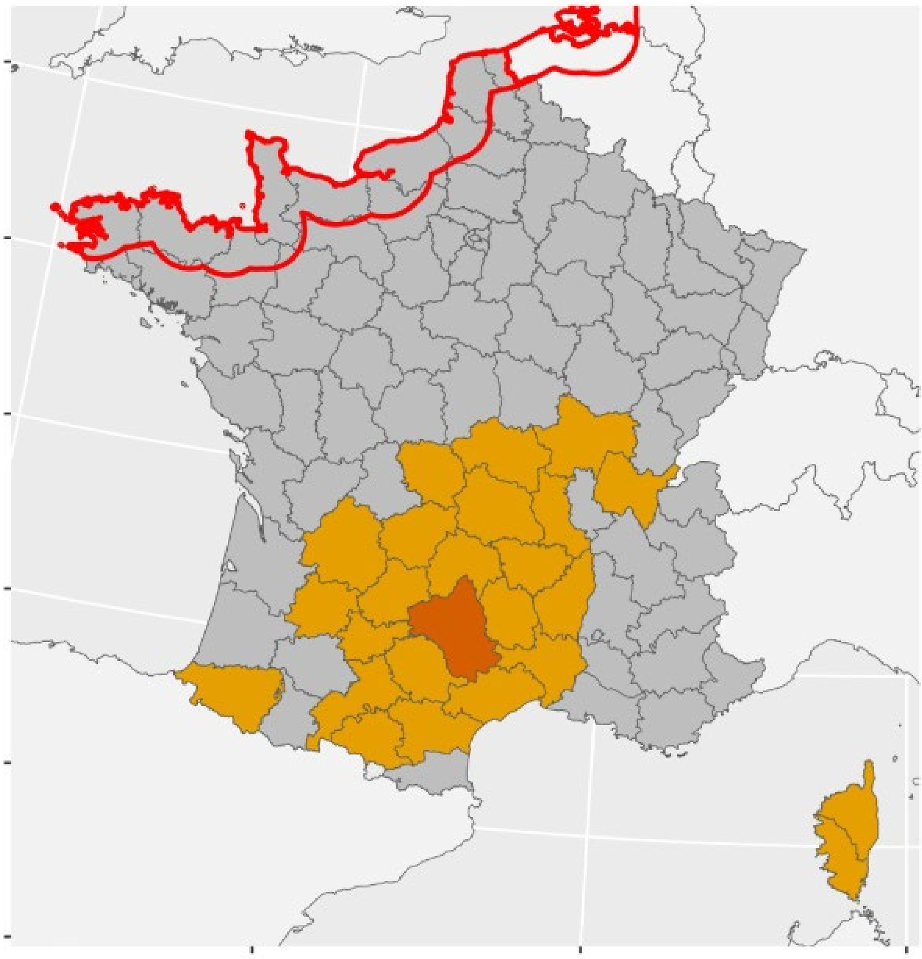

Figure 2: The initial report of the ‘new strain’, of BTV-8 in the department of Aveyron (represented as dark orange). Subsequent detections in other departments (represented as light orange) and the 50km coastal area where windborne incursion to Great Britain would be possible (represented as red lines), (This map was created from data published by Platform ESA 28 November 2023 accessed 10 April 2024).

Source of infection in Europe

The source of infection is still not fully understood. Possible factors include:

1. A new introduction through imported animals, germinal products or infected midges.

2. Wildlife reservoirs. Wildlife are not vaccinated and therefore could act as reservoirs for disease. In Spain, red deer have been found to test positive (PCR) for BTV in areas where there were there were no clinical cases in livestock. However, viral RNA can still be present many months after infection which may explain these findings. Wildlife reservoirs are not thought to be a major factor in disease transmission. In North America, bluetongue cycles every 1 to 3 years in deer populations in endemic areas and every 8 to 10 years in epidemic areas, but outbreaks in livestock would be expected given the co-habiting ranges of the animals in Europe (45).

3. Undetected infection in vaccinated animals (BTV-8). The vaccination programme in France was mandatory between 2008 and 2010 and then became voluntary in 2010, but there is no information on how many farmers continued with it. Instead, only animals moving out of France are required to be vaccinated before transportation as the entire of France is considered an affected area and there are no restrictions zones for internal movements. The majority of animals in France are beef cattle and are replaced less frequently than dairy animals, there may be animals present which have been vaccinated. New infection with BTV-8 will therefore act as a “booster” so mild clinical signs could be missed when the ‘new strain’ of BTV-8 first appeared.

4. Transplacental spread. BTV-8 is capable of being transmitted transplacentally but vaccinated (inactivated vaccine) animals are not capable of harbouring the virus in lymph nodes so transplacental transmission is not likely. For non-vaccinated animals if transplacental transmission takes place then not all calves born to viraemic dams would survive and not all would be virus positive (Van der Sluijs et al., 2016) . For BTV-3 there was a case of transplacental transmission identified in England in 2023 and another reported in the Netherlands for BTV-3, suggesting that BTV-3 may also be capable of this. However, there is a lack of evidence surrounding BTV-3. It is assumed that the dam was infected while pregnant, but there is also a possibility of germplasm spreading the disease.

5. Other countries outside of northern Europe. During 2006 the first outbreak of Bluetongue ever recorded in northern Europe started in Belgium and the

Netherlands, spreading to Luxemburg, Germany and north-east France. The virus overwintered (2006 to 2007) re-appearing during May to June 2007 with greatly increased severity in affected areas. It then spread further into Germany and France, reaching Denmark, Switzerland, the Czech Republic and Great Britain. The origin was never discovered but sequencing revealed that the virus was related to strains from sub-Saharan Africa. It is uncertain how it originally arrived in northern Europe. Therefore, it is not possible to rule out that a similar incursion event occurred in central France in 2023 or may happen again.

At this time, the origin of this strain of BTV-3 in the Netherlands is unknown. Analysis has identified that the strain is similar to the BTV-3 strain first reported in Tunisia in 2016, which subsequently spread to Sardinia where it is now endemic. However, there are some notable differences in the sequence making it difficult to determine the origin (APHA 2023). It is noteworthy that the sites in the Netherlands first found to be infected were approximately 20km from Schiphol airport which is a major international hub.

Clinical impact of BTV

Given BTV is a seasonal disease in northern Europe with a history of re-emerging, it would not be surprising if we saw incidents of BTV-3 and BTV-8 being reported in northern Europe this year.

Endemic BTV-8 in France

In the previous epizootics of BTV-8 in 2006 to 2007, there were distinct patterns which could be drawn from the epidemiology of disease (50). Five phases can be seen: firstly, in a naïve population, the disease may not be detected as there are so few infected animals. In phase 2 the prevalence rises rapidly until phase 3 when prevalence plateaus. In phase 4, which can last several years, endemicity is reached or disease prevalence may drop again and phase 5 is where there is disease freedom, but still a history of disease can be found (Figure 3). But, it is dependent on a number of factors including, the surveillance system sensitivity ,vaccine effectiveness (where applicable) and environmental conditions. The duration of the phases depends on the circulation of the virus and therefore in winter, phase 4 may start but as there are still naïve animals present, phase 5 is not reached, and the increase continues in the following year. While it was widely reported in 2006 to 2007 to have had a devastating effect on sheep and cattle populations, it was very variable and clearly depended on the weight of infection in the midge population. Experimental infection of sheep with BTV-8 has shown only mild clinical signs (53), while some retrospective work on French cattle and the incidence of early calving also shows only slight increase above what is expected (54).

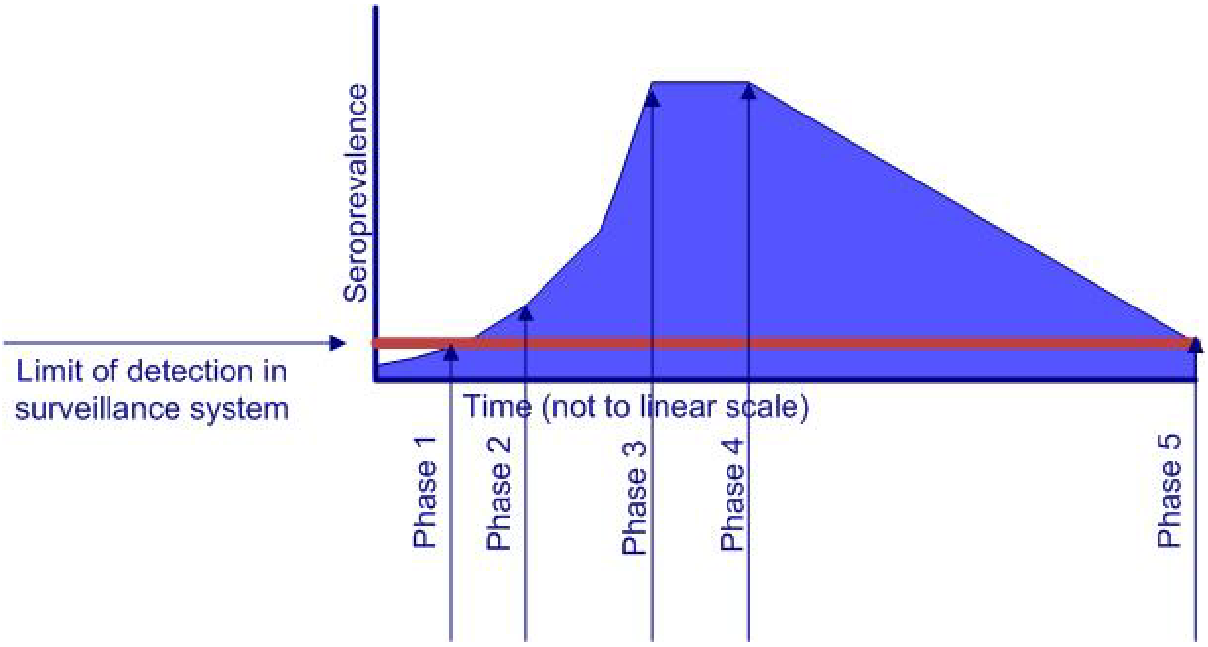

Figure 3: Different phases of seroprevalence in animal populations based on the epizootics of BTV-8 in 2006 to 2007 (Source DEFRA 2017).

After France regained BTV free status in 2012, vaccination of livestock was no longer enforced, and a surveillance programme was implemented. Several years later in 2015 BTV-8 re-emerged (60). It was speculated that it likely circulated in low levels throughout this period but was undetected due to a significant number of the livestock population having immunity from either the vaccine or from natural immunity from the previous outbreak that started in 2006 (60). As the proportion of susceptible young unvaccinated animals increased there was likely a greater opportunity for BTV-8 transmission (60). Another possibility was the use of stored infected germinal products, as there was so little strain variation from the 2007 virus (60).

BTV-3

As with other serotypes of BTV, sheep have shown the most severe clinical signs. There have been similar numbers of sheep and cattle infected with BTV-3 in the Netherlands, however cattle were less likely to show clinical signs. Moreover, there have been reports of cases in goats, alpacas, llamas, mouflon, water buffalo, wisent and yak. There has also been a case of transplacental transmission of BTV-3 in Great Britain and another case was reported in the Netherlands in cattle. Since the emergence of BTV-3 in northern Europe in 2023, it is estimated that 0.2% of the Dutch cattle population have died as well as 3.9% of the sheep population (no data on the specific mortality rate) (NFU 2024). As BTV-3 is new to northern Europe, there is potential for it to have a significant effect on livestock population as many will be naïve and there is no vaccine. Natural immunity provides protection against BTV-8 for life (60), this is thought to be similar for BTV-3 so previously infected livestock will likely have resistance, but this is a relatively low number of the total livestock populations in northern Europe.

‘New strain’ of BTV-8 in France

In unvaccinated or naïve cattle and sheep, the ‘new strain’ of BTV-8 appears to cause severe clinical signs including pyrexia, locomotion difficulties, mouth ulcers and cough, this is uncharacteristic of the strain of BTV-8 which is endemic in France. However, the full clinical impact of this ‘new strain’ is difficult to assess as it is still emerging and there is a lack of consolidated data.

Risk assessment terminology

In this qualitative risk assessment, the likelihood of entry and exposure, levels of uncertainty and outcome of the consequence assessment are described using the established terminology defined in Tables 1 to 3.

It should be noted that these European Food Safety Authority (EFSA) definitions merely give an indication of relative risk with respect to each other for the reader and the use of terms such as “regularly” and “very often” for medium and high respectively reflect a generic time frame. It should be stressed in this risk assessment that, although the risk question specifies “per year”, the predicted qualitative risks give no indication of the number of times in 2024 that BTV infection may occur in Great Britain livestock. The qualitative risks merely indicate the relative magnitude of the probability of at least one infection in Great Britain cattle per year as specified in the risk question.

Table 1: Terminology and definitions used to describe likelihood of entry and exposure (EFSA, 2006)

Probability	EFSA definition
Negligible	Event is so rare that it does not merit consideration
Very low	Event is very rare but cannot be excluded
Low	Event is rare but does occur

Probability	EFSA definition
Medium	Event occurs regularly
High	Event occurs very often
Very high	Event occurs almost certainly

Table 2: Terminology used to describe the level of uncertainty in the entry, exposure and consequence assessment (EFSA, 2006, Spiegelhalter and Riesch, 2011)

Uncertainty category and definition	Type of information – evidence to support uncertainty category
Low Further research is very unlikely to change our confidence in the assessed risk	Solid and complete data available (For example long-term monitoring results) Peer-reviewed published studies where design and analysis reduce bias (For example systematic reviews, randomised control trials, outbreak reports using analytical epidemiology) Complementary evidence provided in multiple references Expert group risk assessments, specialised expert knowledge, consensus opinion of experts Established surveillance systems by recognised authoritative institutions Authors report similar conclusions
Medium Further research is likely to have an important impact on our confidence in the risk estimate	Some but no complete data available Non peer-reviewed published studies - reports Observational studies - surveillance reports - outbreak reports Individual (expert) opinion Evidence provided in a small number of references

Uncertainty category and definition	Type of information – evidence to support uncertainty category
	Authors report conclusions that vary from one another
High Further research is very likely to have an important impact on our confidence in the risk estimate	Scarce or no data available No published scientific studies available Evidence is provided in grey literature (unpublished reports, observations, personal communication) Individual (non-expert) opinion Authors report conclusions that vary considerably between them

Table 3: Terminology used to describe the outcome of the consequence assessment (Food and Agriculture (FAO) and World Health Organisation (WHO), 2021)

Term	Definition
Insignificant	Insignificant impact, little disruption to normal operation, low increase in normal operation costs
Minor	Minor impact for small population, some manageable operation disruption, some increase in operating costs
Moderate	Minor impact for large population, significant modification to normal operation but manageable, operation costs increased, increased monitoring
Major	Major impact for small population, systems significantly compromised and abnormal operation, if at all, high level of monitoring required
Catastrophic	Major impact for large population or complete failure of systems

Entry assessment

The presence of BTV in livestock in Great Britain may result from:

- overwintering of BTV-3 through survival of infected midges over winter 2023 to 2024 in southeast England
- overwintering of BTV-3 in the ruminant population over winter 2023 to 2024 in south-east England
- overwintering of BTV-3 by transplacental transmission or in the testes in ruminants over winter 2023 to 2024 in south-east England
- an infected or infectious vector reaching Great Britain and then infecting susceptible host
- entry via import of infected livestock
- use of infected germinal products

Spread will depend upon the presence of vectors when the susceptible host (typically sheep or cattle) arrives or becomes infected and whether the susceptible host is or becomes viraemic. Not every midge arriving from northern Europe will be infectious; not every infected vector will lead to an infected susceptible host, and it is possible more than one susceptible host is infected when many midges arrive in a single period.

The risk pathway for the entry of BTV into Great Britain is shown in Figure 8 and Figure 12. The pathways highlight the 2 key routes of entry, namely, the windborne spread of infected midges or, the importation of infected animals. Germinal products are not included in the pathway as it they are considered lower risk, due to strict requirements for importing highlighted in the health certificates (Great Britain HC003E and Great Britain HC009E).

It is also important to note that we define disease entry as the presence of a BTV positive livestock animal in the Great Britain, as opposed to the presence of an infected vector. This is based on the assumption that a cloud of vectors arriving from an affected area to Great Britain has potential to include infected individuals, but not all will be infectious or lead to transmission. Disease will be declared if there is onward transmission to susceptible livestock within Great Britain. The likelihood of transmission via midges to susceptible hosts depends on the immune status and the time of year.

Transmission of bluetongue virus in northern Europe

The cycle of BTV transmission has been well documented, with transmission occurring during peak vector activity periods with appropriate temperatures, ceasing during the winter before re-emerging at the start of the next vector period (16). In northern Europe, transmission is therefore temperature dependent.

At temperatures below 15°C, the virus replication rate decreases but replication will still occur down to 12°C albeit at a much slower rate (66, 67), though the longevity of midges may increase from 3 weeks to up to 90 days in colder conditions (17). A mild winter, however, could increase the duration of suitable conditions for vector activity, longevity, and virus replication. The time of year at which the disease may reappear varies. This was estimated to be between April and May during the 2007 to 2008 outbreak of BTV-8, when the first new infections were detected in ruminants but this will depend upon temperatures and vector feeding behaviour (18). The seasonal vector low period (SVLP) is informed by findings of Culicoides traps placed across England. As a blood meal is needed for egg production, only female Culicoides feed on animals. Following egg production, these vectors will change their pigmentation – with pigmented individuals therefore serving as a proxy for previous biting activity. The start of the SVLP is declared when fewer than 5 pigmented Culicoides are found in a single night's trapping from any trap over 2 consecutive weeks (communication from The Pirbright Institute, 2024), and ends when more than 5 are identified. In England the SVLP usually ends around April to May.

Figure 4 shows the basic reproduction number (R_0) for bluetongue as a function of temperature. R_0 represents the number of secondary infections arising from an infected susceptible during the infectious period. The plot was generated using the uncertainty analysis presented in (Burgin et al. (2012) but using updated distributions for the underlying epidemiological parameters. From Figure 4, R_0 exceeds one between 15°C and 33°C, with a peak R0=3.3 at 22°C.

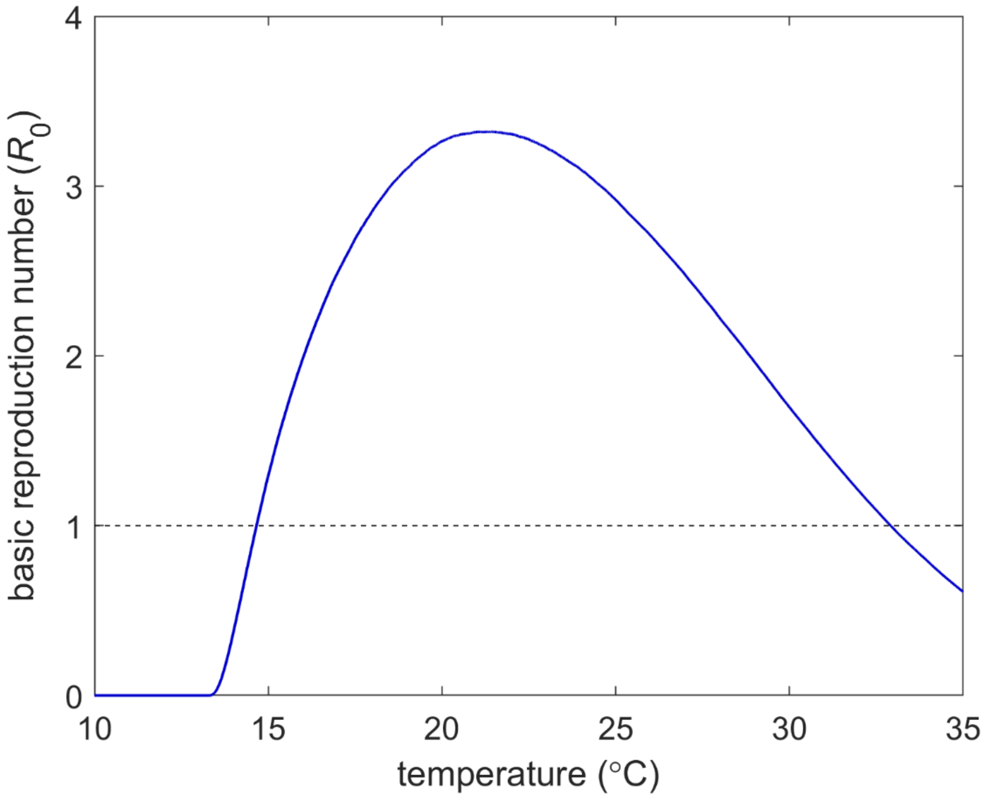

Figure 4: Basic reproduction number (R0) for BTV as a function of daily average temperature. The blue line shows the mean for the uncertainty analysis used to calculate R0 (allowing for uncertainty in the underlying epidemiological parameters), while the black dotted line indicates the threshold at R0 = 1 (from Simon Gubbins, The Pirbright Institute April 2024).

Overwintering of BTV-3 in 2023 to 2024 in south-east England

Overwintering of BTV could potentially occur due to virus persistence in either long-lived vectors or through horizontal or vertical transmission amongst animal hosts (16), but the frequency of overwintering remains largely unknown. BTV-8 is known to cause transplacental transmission in pregnant heifers (40, 41), and a case of transplacental transmission of BTV-3 has been recently recorded in Great Britain (APHA 2024). Overwintering of vectors in livestock accommodation is a possible mechanism for maintaining disease transmission from year to year (13). An EFSA opinion has described these mechanisms in more detail, but the conclusion was that the infection clearly overwinters successfully, and that disease eradication using vaccination would require several years of repeated vaccination of suspect animals, but the current surveillance levels required in EU legislation are not sensitive enough to detect low levels of circulation in Europe (51).

Wilson and Mellor (18) write “In many temperate regions classical BTV transmission is almost completely interrupted for several months of the year by cold weather, but outbreaks often resume after interruptions far longer than the typical lifespan (3 weeks) of an adult vector or the normal period of host infectiousness, a phenomenon termed ‘overwintering’”.

In this risk assessment we are looking at a scenario where we assess whether BTV has successfully overwintered in England and in northern Europe. Here only overwintering in adult midges (rather than egg, larval or pupal stages) are considered. Since BTV is not transmitted transovarially in midges, the mechanism is survival of the infected adult midge over the winter period, and eggs or larval stages do not need to be considered (unlike some mosquito-borne viruses). Two other routes are considered by Wilson and Mellor (18), these are overwintering of the virus in the infected ruminant population, and transplacental transmission in the ruminant and are now discussed.

Overwintering in the ruminant population

Infectious BTV can be isolated from the blood of cattle for much longer than from sheep and goats, and although the vast majority of active infections in cattle endure for less 60 days, a fraction last for much longer (Wilson et al. (16). EFSA (15) estimated that 99% of viraemia in cattle ceases by 9 weeks (63 days), suggesting just 1% are still viraemic after 9 weeks. Given the small number of cases detected in ruminants in Great Britain in autumn and winter 2023, the number of cattle remaining infectious for longer than 60 days would be small. Since midge numbers and midge activity are both decreased in the winter, the number of bites each cow receives is much lower than in summer. Furthermore, while a single midge bite is sufficient to infect a cow, the probability of transmission from cow to midge is less efficient such that a large number of bites are required to infect at least one midge. The overwintering of BTV-3 in the ruminant population in Great Britain is therefore not considered further here.

Overwintering by transplacental transmission

The gestational period of a cow is 9 months. The high-risk period for infection in 2023 was from August to November. Any cows infected in the first trimester would have likely aborted. Cows infected in the second trimester would have given birth between February and April and would have been tested at birth if present in the temporary control zone (TCZ) or in a traced premises. Cows infected in the third trimester have already calved and would have been tested in the TCZ. The gestational period for sheep is 5 months, therefore pregnant sheep infected during the high-risk period have already given birth.

Overwintering through persistence in the testes of ruminants

BTV-8 is characterised as being transmissible though semen and the presence of live, virulent BTV-8 in extended semen from naturally infected bulls has been clearly demonstrated (71). Due to the limited amount of evidence, it is not known if this could also be the case for BTV-3. As with all susceptible livestock, any entire males within the TCZ were tested for BTV-3 and if they were found positive outside of the SVLP, were culled for disease control purposes. Those that were found in the SVLP were placed under movement restrictions, and will have to be tested again as part of the disease control exit strategy.

Overwintering in adult midges

Overwintering of the virus in adult midges is central to the qualitative risk assessment. The overwintering of BTV-3 either in south-east England (Figure 5) or more likely in northern Europe (Figure 7) is possible on the basis that BTV-8 successfully overwintered in northern Europe in 2006 to 2007. This was attributed to the very mild winter in terms of recorded temperatures. BTV-8 was not present in Great Britain in the winter of 2006 to 2007, although it entered Great Britain from Europe in 2007.

Monthly temperatures for the winters of 2006 to 2007 and 2023 to 2024 in England were compared in Table 4 using Met Office data (62, 63, 64). Although these are average temperatures across England rather than the south-east of England, they give an indication of relative temperatures during each month. It should be noted that the mean temperature of 7.5°C in February 2024 is the highest mean temperature for February recorded since 1884 according to Met Office data (64). The mean temperature for the winter of 2024 is the second highest on record at 6.2°C (the highest being winter 2016 of 6.5°C) while the mean winter temperature for 2007 was the third highest temperature at 6.2°C according to Met Office data (63). Mean temperatures in December 2023, February 2024 and March 2024 were higher than those in the corresponding 2006 to 2007 period (Table 4). In terms of whether BTV-3 has overwintered in south-east England in 2023 to 2024 it would be more reassuring if temperatures were lower than those in 2006 to 2007 across all months. This is not the case. It is concluded that the higher temperatures in England in 2023 to 2024 compared to 2006 to 2007 would not allow us to rule out overwintering of BTV-3 in south-east England.

Table 4: Comparison of mean temperatures (°C) and temperature ranges (monthly average minimum to monthly average maximum) in England for the winter of 2006 to 2007 and the winter of 2023 to 2024. Data from the Met Office (62, 63, 64).

Month	2006 to 2007 temperature (°C)	2023 to 2024 temperature (°C)	Difference in mean temperature (°C)
November	7.9 (4.3 to 10.6)	7.3 (4.3 to 10.3)	–0.6
December	6.1 (3.5 to 7.8)	6.8 (4.3 to 9.4)	+0.7
January	6.6 (3.8 to 9.5)	4.4 (1.6 to 7.3)	–2.2
February	5.8 (2.7 to 8.9)	7.5 (4.5 to 10.5)	+1.7
March	6.9 (2.9 to 11.0)	7.8 (4.4 to 11.1)	+0.9

Table 5 shows a comparison of the temperatures in England over the 2023 to 2024 winter months and those in Maastricht over the same months in 2006 to 2007, where BTV-8 overwintered. While December and February mean temperatures are higher for England 2023 to 2024 the temperature of January 2024 is 2.2°C lower than that in Maastricht for 2007. Thus, the relatively cold January in England in 2024 may offer some protective effect against overwintering this season.

Table 5: Comparison of mean temperatures (°C) and temperature ranges (monthly average minimum to monthly average maximum) in Maastricht (south-east Netherlands) and England for the winter of 2006 to 2007 (65).

Month	Maastricht 2006 to 2007 temperature (°C)	England 2023 to2024 temperature (°C)	Difference in mean temperature (°C)
November	9.1 (3.4 to 15.7)	7.3 (4.3 to 10.3)	-1.7
December	6.0 (0.0 to 13.3)	6.8 (4.3 to 9.4)	+0.8
January	6.6 (-2.9 to 12.7)	4.4 (1.6 to 7.3)	-2.2
February	6.4 (-0.7 to 9.9)	7.5 (4.5 to 10.5)	+1.1
March	7.8 (2.7 to 11.4)	7.8 (4.4 to 11.1)	0.0

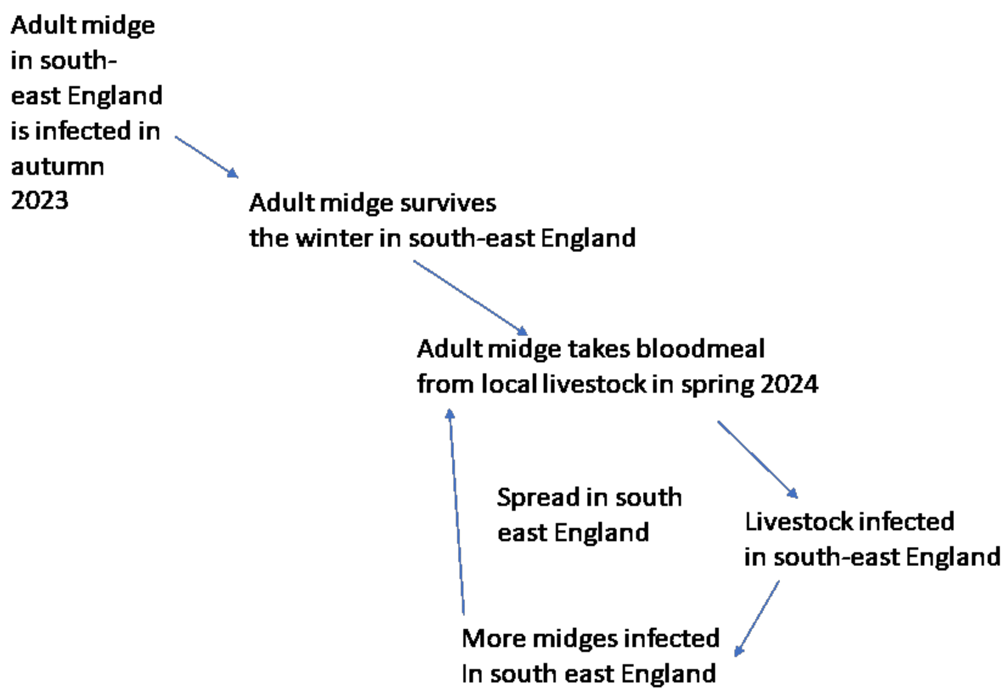

Figure 5: Overwintering of BTV-3 in adult midges in Great Britain, in a scenario where an infected adult female midge is able to survive the winter, then later bite a susceptible host causing infection in the livestock, providing an opportunity for other previously uninfected midges to feed and become infected, continuing the cycle.

The lifetime of the midge may be extended by mild winter conditions with individual Culicoides sonorensis surviving up to 3 months at 10°C. Thus, according to Lysyk and Danyk (59) the maximum longevity of Alberta females (Culicoides sonorensis) increased from 28 days at 30°C to 84 days at 10°C, and US females of C. sonorensis survived from 25 to 91 days at the same temperatures. Median longevity was 12 days to 19 days at 10°C, so 50% survived for almost 3 weeks at 10°C. Wilson et al. (16) noted that the winter of 2006 to 2007 was the mildest on record in Europe and small numbers of adult Culicoides were caught throughout the winter period. Wilson et al (16) adds that in mild winters such as 2006 to 2007 it is possible that a small fraction of the infected adult Culicoides population might survive long enough to bridge the gap between transmission seasons. Adult Culicoides may also be sheltered from the worst conditions of winter to some degree by their choice of resting place. Studies during the 2006 to 2007 outbreak in Europe suggested small numbers may move indoors when outdoor temperatures begin to drop. It should be noted that cattle are often housed in northern Europe and the heat from the cattle would prevent low temperatures. Napp et al. (61) calculate probabilities of 1.6×10^{-4} to 1.4×10^{-3} per midge of indoor midges surviving both the long enough to become infected and to take another bloodmeal in January and November, respectively while outdoor midges had a zero probability of surviving.

The probability that an autumn midge in south-east England infects a livestock animal the following spring in south-east England is calculated as negligible (although at the end of negligible that is near to the very low risk level) per “autumn” midge in Table 6. The uncertainty in this negligible estimate is medium reflecting the uncertainty that a midge in south-east England is infected in the autumn together with the uncertainty that the midge survives the winter (Table 6). One area of uncertainty is whether an animal is more infectious to others if it is bitten repeatedly over time by many infectious midges and one bite per one animal does not lead to onward infection.

Table 6: Calculation of the probability that an infected midge in the autumn 2023 manages to infect a livestock animal in the following spring 2024 in southeast England. The units are "per autumn midge".

Pathway step from Figure 5	Qualitative probability	Uncertainty
Adult midge is infected in autumn in south-east England	Very low – this probability takes into account the relatively small number of infected livestock in south-east England in autumn 2023. Were there to be more infected animals as in northern Europe (Table 6) then this probability would be low.	Medium – probability is higher than negligible, but not likely to be as high as low in Great Britain.
Adult midge survives the winter in south-east England	Low - only a small proportion will survive, hence low, however this is not very low or negligible.	Medium – probability is somewhere in the very low to low region based on data.
Adult midge takes bloodmeal from local livestock in spring in south-east England	Medium – based on possibility that midge may bite wild mammals rather than livestock	Medium – depends on ratio of livestock to wildlife in area
Livestock is infected after bite	Medium to high (BTV infected midge likely to be near livestock)	Low – this depends on the immune status of the livestock in south-east England. Due to the small number of livestock cases herd immunity is likely to be low.

Pathway step from Figure 5	Qualitative probability	Uncertainty
Overall probability that at least one livestock animal is infected in the spring 2024 in south-east England per autumn midge	Negligible (calculated as combination of probabilities above such that low x very low = negligible), although at the end of negligible that is near to the very low risk level. Note that although there are 2 “high” risks, that very low x high = very low.	Medium – based on the medium uncertainties for the probabilities for the key steps namely probability midge is infected and probability that midge survives the winter.

To calculate the aggregated probability that at least one livestock animal is infected in spring 2024 in south-east England requires a quantitative estimate of the number of autumn midges in south-east England. While this number is unknown, it is undoubtedly huge, such that the aggregated probability that at least one livestock animal is infected in spring in the south-east is low to medium. Thus, a value of n = 10^8 to 10^9 midges in the autumn in south-east England would give a low to medium aggregated probability with an individual probability, p, “at the end of negligible that is near to the very low risk level” in Figure 6. The uncertainty in this estimate is medium.

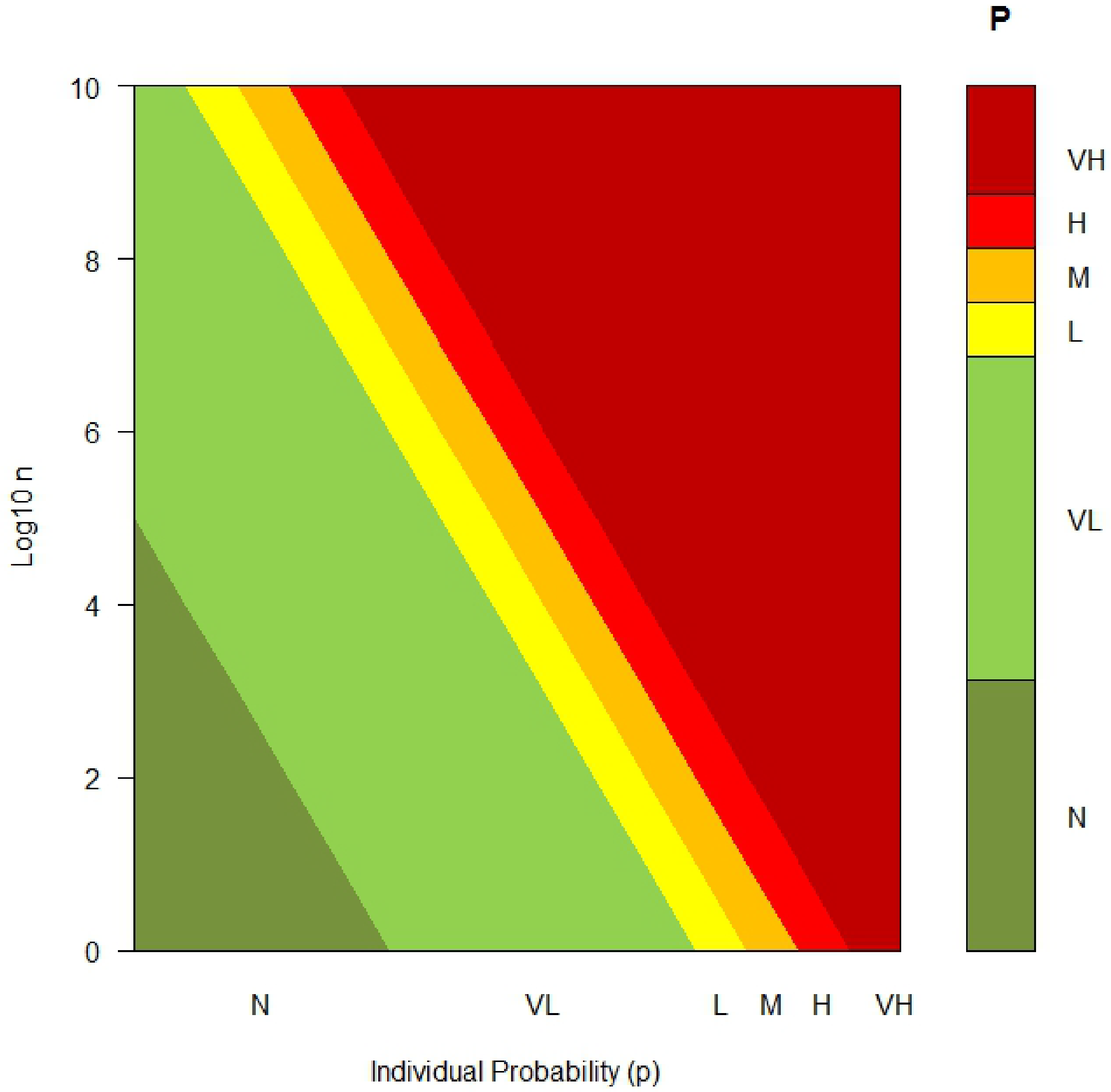

Figure 6: Contour plot, showing on the x axis individual probability (p) including negligible (N, dark green), very low (VL, light green), low (L, yellow), Medium (M, orange), high (H, light red) and very high (VH, dark red). On the y axis is the Log10 value which increases based on the number of samples. The x and y are multiplied to get aggregated probability scores. (Adapted from Kelly et al. 2018).

Infectious vector reaching Great Britain and infecting an animal

Survival and entry of BTV-infected midges from northern Europe into south-east England

The main route of BTV transmission is via infected midges (2), notably the C. obsoletus complex for Great Britain (5). In order for infected midges to reach Great Britain, a number of events must occur, such as successful overwintering of the virus in northern Europe and initial travel of infected midges over land to the coast, culminating in travel over the English Channel. Such long-distance travel is assisted by the wind, although active movement from the midge is required to stay airborne (22).

Specifically, we were interested in the suitability of weather conditions in France, Belgium, the Netherlands, Germany and Denmark, as well as the suitability in southern England, the wind direction and humidity. The estimates for temperature suitability for Great Britain, France, Belgium, Netherlands, Germany and Denmark during the 2023 vector period are set out in Table 7. Estimates were very high every fortnight from August through to October suggesting that temperatures during this period would have been optimal for BTV transmission.

Table 77: Qualitative risk estimates for temperature suitability for each country in Europe and Great Britain during the 2023.

Date	Suitability of temperature in France	Suitability of temperature in Belgium	Suitability of temperature in Netherlands	Suitability of temperature in Germany	Suitability of temperature in Denmark	Suitability of temperature in Great Britain
02 August 2023	Very high	Very high	Very high	Very high	Very high	High
16 August 2023	Very high	Very high	Very high	Very high	Very high	High
30 August 2023	Very high	Very high	Very high	Very high	Very high	High

Date	Suitability of temperature in France	Suitability of temperature in Belgium	Suitability of temperature in Netherlands	Suitability of temperature in Germany	Suitability of temperature in Denmark	Suitability of temperature in Great Britain
08 September 2023	Very high	Very high	Very high	Very high	Very high	High
13 September 2023	Very high	Very high	Very high	Very high	Very high	Very high
27 September 2023	Very high	Very high	Very high	Very high	Very high	Medium
11 October 2023	Very high	Very high	Very high	Very high	Very high	Medium
25 October 2023	Medium	Medium	Medium	Medium	Low	Low
08 November 2023	Low	Low	Low	Low	Very low	Low
22 November 2023	Low	Low	Low	Low	Very low	Very low
06 December 2023	Very low	Very low	Very low	Very low	Negligible	Very low

Date	Suitability of temperature in France	Suitability of temperature in Belgium	Suitability of temperature in Netherlands	Suitability of temperature in Germany	Suitability of temperature in Denmark	Suitability of temperature in Great Britain
20 December 2023	Low	Low	Low	Very low	Negligible	Low
03 January 2024	Low	Low	Low	Very low	Negligible	Low
17 January 2024	Very low	Very low	Very low	Negligible	Negligible	Very low
Overall, calculated as highest or sum	Very high	Very high	Very high	Very high	Very high	Very high

The risk of a windborne midge incursion will increase during the vector activity season – as the season progresses due to the increased likelihood of viraemic hosts in coastal areas of continental Europe. During an outbreak, the number of infected (and therefore viraemic) hosts increases and, as a consequence, the number of infected midges also increases and similarly the likelihood that one will be carried by the wind as they will be close enough to the coast. It will also depend on there being present a high density of susceptible (naïve) animals in areas where infected midges arrive.

The pathway for entry of infected midges into Great Britain from northern Europe is set out in Figure 7. and requires the infected adult midge to overwinter in northern Europe.

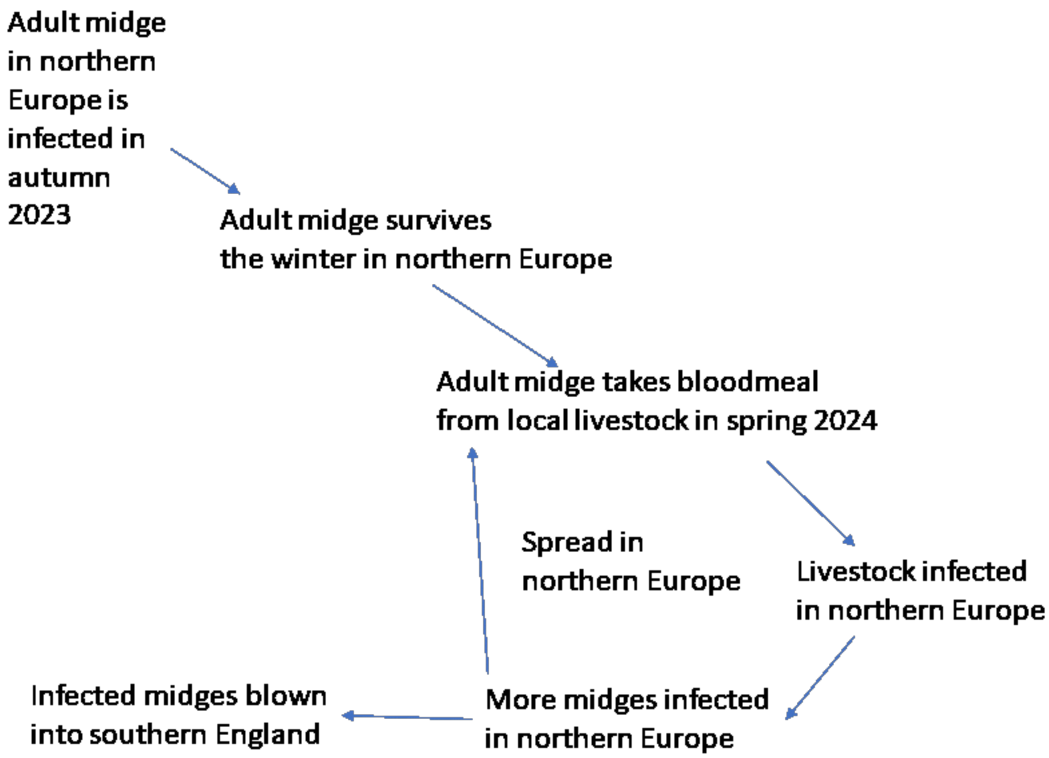

Figure 7: Entry of BTV-3 into Great Britain from northern Europe in 2024, in a scenario where an infected adult female midge is able to survive the winter, then later bite a susceptible host causing infection in the livestock, providing an opportunity for other previously uninfected midges to feed and become infected, continuing the cycle, then some infected midges are carried over to England by the wind.

BTV-3 from northern Europe

During 2023, there were large numbers of incidents of BTV-3 in livestock in the Netherlands (6,001 incidents), as well as some reports in Belgium and Germany. If BTV-3 is able to successfully overwinter in these countries such that disease spreads within the livestock population in northern Europe in 2024, then there is a very high likelihood, based on 2023 and January 2024 predictions in Table 7, that BTV-3 infected Culicoides midges will reach Great Britain at some stage. BTV-8 reached northern Europe for the first time in 2006 affecting 2,000 holdings before reports ceased in January 2007. The outbreak then re-emerged months later and spread to a further 45,000 holdings by the end of 2007 (Wilson et al 2008). Thus, BTV-8 overwintered in the Netherlands in 2006 to 2007. Table 5 compares the mean temperatures in Maastricht in south-east Netherlands in the winter 2006 to 2007 with those of 2023 to 2024. While mean temperatures in Maastricht were higher in December, February and March in 2023 to 2024 compared to 2006 to 2007 the mean temperature for January 2024 was 3.5°C lower than that for January 2007. It could be the cold January of 2024 that has a major impact of preventing overwintering of BTV-3 in northern Europe in 2023 to 2024.

Table 88: Comparison of mean temperatures (°C) and ranges (monthly average minimum to monthly average maximum) in Maastricht (south-east Netherlands) for the winter of 2006 to 2007 and the winter of 2023 to 2024 (65).

Month	Maastricht 2006 to 2007 temperature (°C)	Maastricht 2023 to 2024 temperature (°C)	Difference in mean temperature (°C)
November	9.1 (3.4 to 15.7)	7.5 (0.8 to 12.1)	–1.6
December	6.0 (0.0 to 13.3)	6.5 (–1.5 to 10.8)	+0.5
January	6.6 (–2.9 to 12.7)	3.1 (–5.6 to 10.7)	–3.5
February	6.4 (–0.7 to 9.9)	8.0 (3.7 to 13.3)	+1.6
March	7.8 (2.7 to 11.4)	9.2 (5.7 to 12.8)	+1.4

There have been repeated outbreaks of BTV each year in locations such as Sardinia where BTV-3 has been endemic since 2017 although the climate in Sardinia is warmer than that in northern Europe and sees incidents all year round (IZS 2024). In countries with a similar climate to Great Britain there is some evidence that BTV will overwinter. Since the re-emergence of BTV-8 in 2015 in France BTV-8 has become endemic and there are reports of cases seasonally, although it is not clear whether this is in those parts of France with similar climates to Great Britain. Moreover, in the 2006 outbreak in northern Europe we saw a re-emergence in the Netherlands and Germany (60). As we leave the seasonal vector low period, temperature conditions will become much more suitable for BTV transmission and vector populations will also increase.

Table 9: Calculation of the probability that an infected midge in the autumn 2023 manages to infect a livestock animal in the following spring 2024 in northern Europe..

Pathway step from Figure 7	Qualitative probability	Uncertainty
Adult midge is infected in autumn in northern Europe	Low – this probability takes into account the large number of infected livestock in northern Europe (mainly the Netherlands) in autumn 2023. Were there to be fewer infected animals as in Great Britain (Table 3) then this probability would be very low.	Medium - probability is higher than the very low in Great Britain, but not likely to be as high as medium.
Adult midge survives the winter in northern Europe	Low - only a small proportion will survive, hence low, however this is not very low or negligible. It should be noted that cattle are often housed in northern Europe and the heat from the cattle would prevent low temperatures.	Medium - probability is somewhere in the very low to low region based on data.
Adult midge takes bloodmeal from local livestock in spring in northern Europe	Medium	Medium - depends on ratio of livestock to wildlife in area
Livestock is infected after bite	High	High – this depends on the immune status of the livestock in northern Europe

Pathway step from Figure 7	Qualitative probability	Uncertainty
Overall probability that at least one livestock animal is infected in the spring 2024 in northern Europe per autumn midge	Very low (calculated as combination of probabilities above such that low x low = very low)	High based on uncertainty in immune status of livestock in northern Europe

The probability that an autumn midge in northern Europe infects a livestock animal with BTV-3 the following spring in northern Europe is calculated as very low per midge in Table 9. Modelling by Napp et al. (61) for Germany indicated that overwintering was only possible for vectors infected during the period of low vector activity (PLVA) that infected the host after this period finished, and only by vectors that emerged after January with mean probabilities (per midge) increasing from 0 per midge in December and January to 5.9×10^{-8} per midge in February, 9.2×10^{-8} per midge in March and 1.1×10^{-7} per midge in April. While these transmission probabilities are qualitatively more in the negligible range per midge, much lower than the very low probabilities per midge predicted here in Table 9, it should be stressed that they only apply to vectors that emerged in the given month rather than overwintering from the previous vector season. Also, Napp et al. (61) do not appear to take into account that midges may survive up to 3 months at 10°C according to Lysyk and Danyk (59).

To calculate the aggregated probability that at least one livestock animal is infected with BTV-3 in spring 2024 in northern Europe requires a quantitative estimate of the number of autumn midges in northern Europe. While this number is unknown, it is undoubtedly huge, such that the aggregated probability that at least one livestock animal is infected with BTV-3 in spring in northern Europe is very high. The uncertainty is high reflecting lack of information on the number of autumn midges in northern Europe and the level of herd immunity in livestock in northern Europe. There is a proposed study (69) in the Netherlands to determine the percentage of sheep and cattle in 2024 with antibodies to BTV-3.

Combining the probabilities of windborne incursions of midges into Great Britain from northern Europe based on fortnightly data for 2023 (Table 7) and the probability that more midges are infected with BTV-3 in northern Europe in 2024 (Table 9), it is estimated in Table 10. that the probability of BTV-3 infected midges entering Great Britain from northern Europe in 2024 is very high. The uncertainty is high, based on the uncertainty that BTV-3 overwinters together with the lack of knowledge of the immune status of livestock in northern Europe during 2024 after high exposures in 2023.

Table 1010: Calculation of probability that BTV-3 infected midges enter Great Britain in 2024 from northern Europe. Northern Europe is defined as the 50km buffer zone used for airborne assessments (Figure 8).

Pathway step from Figure 8	Qualitative probability	Uncertainty
Probability that at least one livestock animal is infected with BTV-3 in the spring 2024 in northern Europe	Very high - calculated as aggregated probability that the risk per midge is very low (Table 9) but the number of midges is huge.	High
Probability more midges infected in northern Europe	Very high – assumes spread within livestock in northern Europe	High - based on uncertainty in immune status of livestock in northern Europe
Probability midges blown on wind from northern Europe into southern England taking into account temperature conditions for BTV transmission in northern Europe	Very high – taken as the sums for France, Belgium, Netherlands, Germany, and Denmark from Table 7 based on 2023 data.	Low based on observations from 2023
Overall probability the BTV-3 infected midges enter Great Britain from northern Europe in 2024	Very high – calculated as combination of risks above	High – based on uncertainty that that BTV-3 overwinters in northern Europe and lack of knowledge on the herd immunity status of livestock in northern Europe

BTV-8 from France

For BTV-8 the annual likelihood of BTV entry into Great Britain via windborne incursion is considered to be medium. The uncertainty is high primarily due to the lack of consolidated data in France and the uncertainty around the monthly surveillance being carried out in France in sentinel herds. There is a potential time lag in reporting new cases of either BTV-8 or the 'new strain' of BTV-8 further north. Additionally, the extent of the spread of the 'new strain' of BTV-8 is unknown. Viraemic animals from the affected areas in central France could move quite legally to other premises in the north. It should be noted that although BTV-8 has been in France since 2015, Great Britain has remained BTV free, suggesting that there have been no windborne incursions of infected midges resulting in infected livestock. However, the 'new strain' of BTV-8 has spread rapidly through the south of France and presents a possibility of increased infection pressure. This may lead to new foci of BTV, which would increase the likelihood of infected midges arriving along the south coast of England.

Initial location of an infectious vector

When France first reported BTV-8 in 2015, the Met Office carried out modelling of the likely wind-borne distribution of midges from the area of the outbreak in the days leading up to reporting. During the vector-active season, Met Office Numerical Atmospheric-dispersion Modelling Environment (NAME) model is used to conduct regular risk assessments of the potential for windborne incursion of BTV-infected midges into Great Britain from continental Europe (in the 2023 to 2024 season, these were generally held fortnightly except for a period of weekly assessments following the emergence of BTV-3 in the Netherlands; whereas they are currently being held weekly) (Nelson et al., 2022). The NAME model relies on a combination of current meteorological data and known relationships between midge population data and meteorological conditions to predict the windborne movement of midges from coastal areas of continental Europe across the English Channel and North Sea. Although the NAME model does not consider overland movement of vectors, it is considered plausible that infected livestock within 50km of the northern coast of France, Belgium, the Netherlands, or Germany, or the western coast of Denmark, could give rise to infected vectors able to be blown into Great Britain (Sedda et al., 2012, Sumner et al., 2017) (Figure 8).

In the event of disease overwintering successfully, the risk of incursion from windborne vector movement will be retrospectively estimated on a regular basis using such modelling. At present, we cannot predict the risk of incursion in advance as the average daily temperature and wind direction cannot be determined so far in advance.

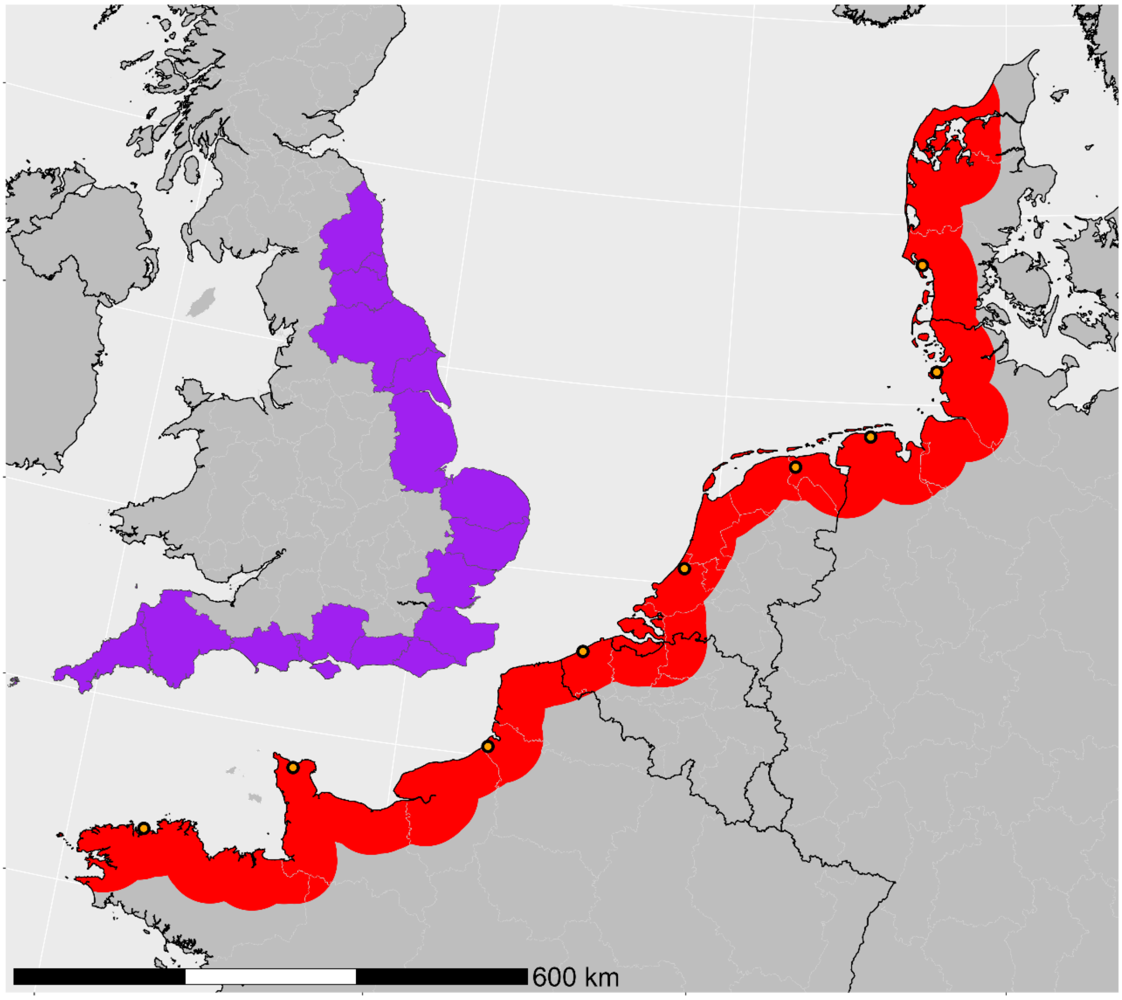

Figure 8: The counties in the south, south-east and north-east of England at risk of windborne incursion determined by NAME model outputs (shown in purple) and a 50km wide area of northern coast of France, Belgium, the Netherlands, Germany and the west coast of Denmark considered to be most likely to lead to windborne incursion of Culicoides in Great Britain (shown in red).

It is important to note that while BTV-8 was able to reach Great Britain during the 2007 to 2008 outbreak, and the point of entry was Suffolk to Essex (although it is likely that there were at least 2 separate incursions) (31). A similar event occurred in 2023 with BTV-3. In this scenario BTV-3 was first discovered in Kent then shortly after in Norfolk and Suffolk. On the other hand, when we looked at the likely incursion of Schmallenberg virus into Great Britain using similar modelling and given the disease distribution across France, Belgium and Netherlands in 2010 (42) the whole south coast of England was at risk. Data for 2023 highlighted that Kent, East Sussex, Essex and Suffolk had the greatest number of meteorological events suitable for bringing over Culicoides (Figure 9). It is difficult to extrapolate if there will be similar meteorological conditions in 2024, but if this is the case then we would expect both the south coast and east coast to be at risk.

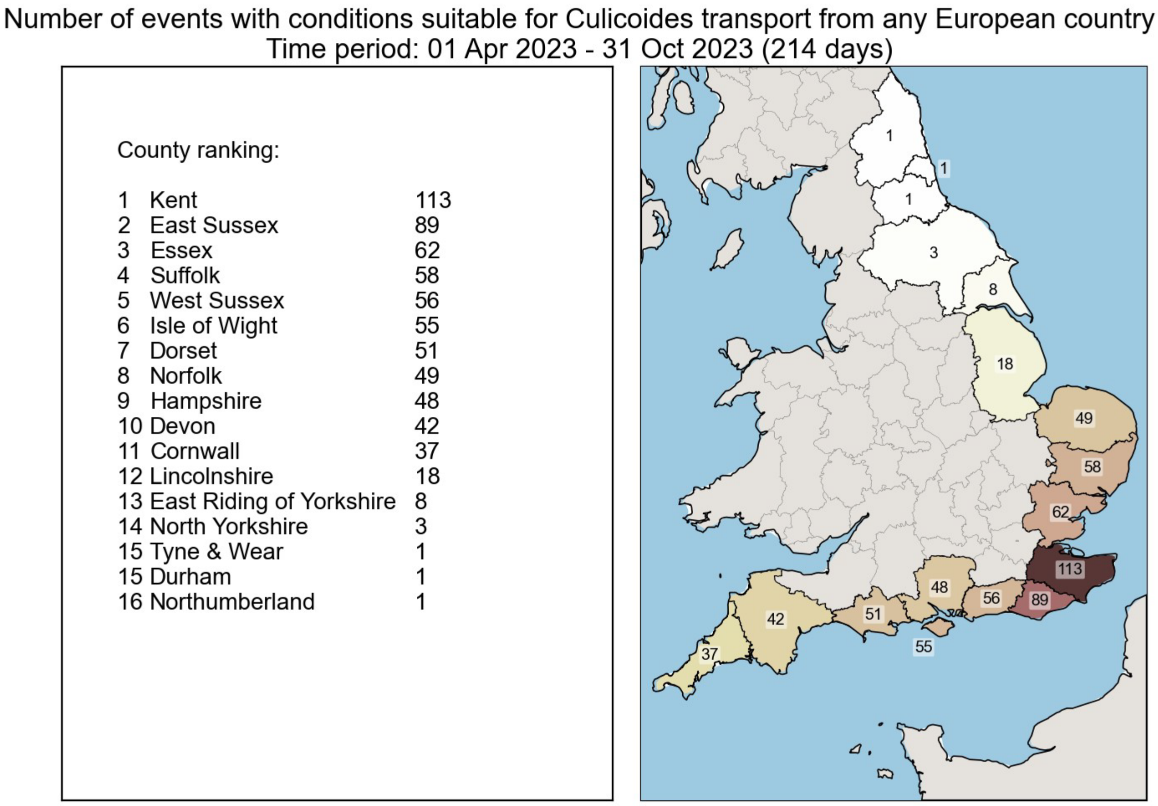

Figure 9: The counties in the south, south-east and north-east of England at risk of windborne incursion determined by NAME model outputs ranked in order of the number of meteorological events that occurred, which were capable of transporting Culicoides to Great Britain, between April and October in 2023.

Culicoides midges can be blown long distances over sea by the wind (EFSA AHAW Panel, 2009). This is believed to have been responsible for the entry of BTV into Great Britain across the English Channel in 2007 from continental Europe (Nelson et al., 2022). This is also speculated to be a potential route that BTV-3 was able to enter Great Britain in 2023. The maximum possible distance postulated for Culicoides dispersal is 700km over sea, or 150km over land (Mellor, Boorman and Baylis, 2000, Hendrick et al., 2008, Mintiens et al., 2008, Nelson et al., 2022). At this time, it is not known which parts of France are affected by the new strain of BTV-8 or the endemic strain of BTV-8, but the north coast of France is within this postulated dispersal distance. There is a lot of uncertainty regarding the location of the BTV-8 in France and uncertainty surrounding the level of surveillance being carried out.

Regarding BTV-3, in the 2023 vector season, there were numerous cases that were previously in the 50km high likelihood areas in Belgium, the Netherlands and Germany. If BTV-3 successfully overwinters in these areas, there will be a **very high** risk of windborne incursions happening in 2024. The presence of cases of BTV-3 in England in the previous season highlights the large geographic jumps that can be made by the virus. At this time, it is not known how BTV-3 was able to enter Great Britain, though wind borne movement of infected midges is suspected. If BTV infected Culicoides are able to reach Great Britain and infect livestock, south-east of England will be most suitable for BTV infection as this is the warmest region of Great Britain (Figure 10).

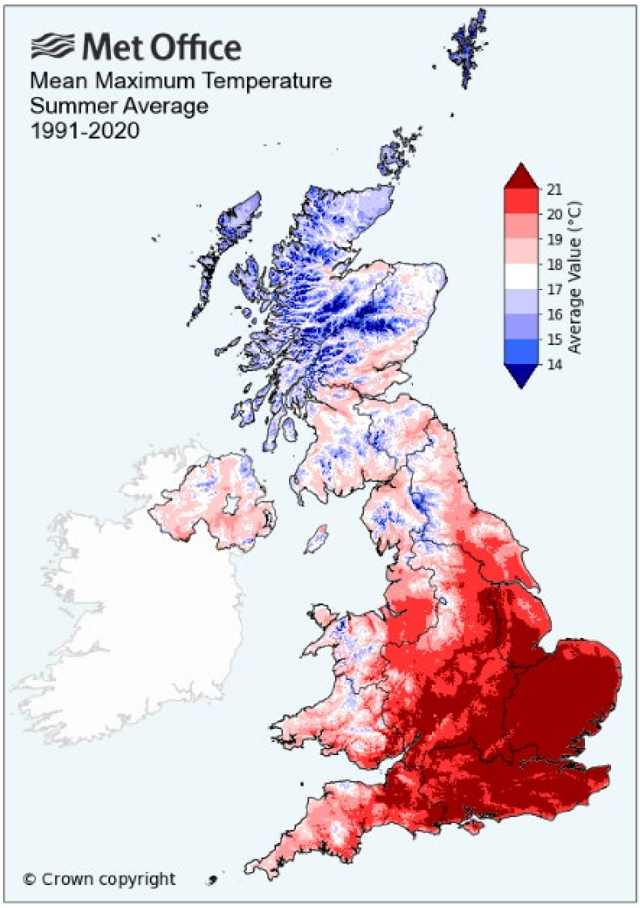

Figure 10: Weather data for the United Kingdom between 1991 to 2020, highlighting that south has warmer mean maximum temperatures than the north, with south-east England being the warmest at 21°C (dark red), and Scotland being the least warm with a maximum mean of 14°C (dark blue) (Met Office, no date).

Time period of risk

Meteorological events with conditions suitable for Culicoides movements to Great Britain in 2023 are highlighted below (Table 11). This data looks at the areas in which incursions were predicted for 2023. It is difficult to determine from 2023 data if there will be a similar pattern in 2024 and it should also be noted that the vector populations are highest between June to September. When vector populations are high there is a greater risk of incursions, assuming that meteorological events are suitable. Therefore, there is a strong correlation between the vector population and the greatest number of suitable meteorological events for 2023 occurring between June to September (Table 11). Additionally, midges will not fly in strong wind or heavy rain (28). Previous studies, looking at various sources, showed the south and south-east coast of Great Britain to be more exposed to wind patterns that would be sufficient for vector movement (29).

Table 11: Number of events with meteorological conditions suitable for potential incursions into Great Britain coastal counties each month during 2023 vector season. Note that there can be a maximum of 2 incursion events per day, one for sunrise Culicoides activity and one for sunset activity.

County	April	May	June	July	August	September	October
Cornwall	1	4	5	2	4	12	9
Devon	2	3	5	8	4	17	3
Dorset	4	4	11	9	5	15	3
Hampshire	3	4	9	10	5	11	6
Isle of Wight	5	3	10	8	7	13	9
West Sussex	4	4	14	9	6	14	5
East Sussex	8	11	20	12	12	21	5
Kent	9	14	26	12	15	27	10
Essex	6	6	19	3	5	16	7
Suffolk	4	4	21	5	4	16	4
Norfolk	2	3	18	4	4	15	3
Lincolnshire	0	2	10	2	0	1	3
East Riding of Yorkshire	0	0	7	1	0	0	0
North Yorkshire	0	0	2	1	0	0	0

The time of year at which virus transmission re-occurs in northern Europe and then the time of year at which it spreads are both likely to play crucial roles in the likelihood of BTV entry to the Great Britain. Assuming that the virus is present, transmission would be expected to resume in northern Europe from around April to May onwards, depending on the average daily temperature (Figure 5) as well as the population of infected midges and naïve animals. Generally, in Europe, BTV is reported over the winter months in the southerly latitudes, where endemic disease is less seasonal.

The mean temperatures over the past 140 years across the whole of the UK are plotted below (Figure 11). Assuming a mean minimum temperature for virus replication of 12ºC to 15ºC (Carpenter et al., 2011), in an average year, temperatures would be high enough for BTV to replicate within a vector between May and September.

11

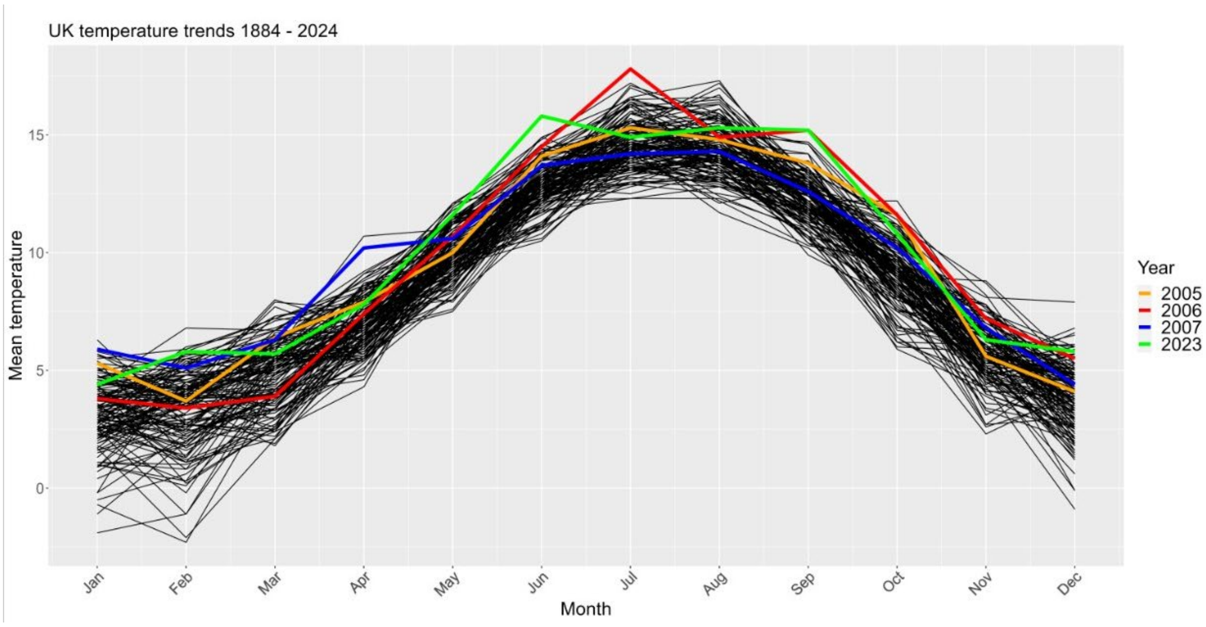

Figure 11: Daily mean temperatures within the UK for each year from 1884 to 2024, showing that the mean temperatures are greatest between May and October, and highlighting 2005 which had a cold February, 2006 which had the highest peak temperature (red), 2007 which had a much warmer April (blue) and 2023 temperatures which is most recent (green).

Incursion through imported live animals

Under the conditions of the health certificate requirements, live ruminants imported from EU countries must have been resident within holdings since birth or within 40 days prior to export, in an area where there have been no BTV cases within a 150km radius within the previous 60 days (WOAH, 2021). Animals imported from EU countries which have not been free from BTV in the past 24 months and are not seasonally disease-free must also have been isolated before export and they must have received the appropriate vaccine.

If the animal originates from a country affected by BTV, the animals are banned from entering Great Britain, unless the animal is vaccinated against the correct serotype or is naturally immune. Currently, as there is no approved vaccine for BTV-3, countries affected with BTV-3 are unable to comply with the health certificate requirements. This means that at this time, Belgium, Germany and the Netherlands are unable to send livestock to Great Britain. Additionally, France is currently also affected by epizootic haemorrhagic disease virus serotype 8 (EHDV-8) a similar disease to BTV for which there is no vaccine. Therefore, livestock from France cannot meet the health certificate requirements at this time. Further details on how bluetongue in Europe is affecting imports is published on GOV.UK: Imports, exports and EU trade of animals and animal products: topical issues. Due to testing requirements of livestock entering Great Britain and surveillance it is highly unlikely that moves would be permitted. The uncertainty is low.

The overall risk of importing livestock infected with BTV into Great Britain from Europe is Very low with low uncertainty. It should be noted that it is possible that undetected spread to neighbouring countries could occur. Currently only Denmark is able to transport livestock to Great Britain. There is a small risk of BTV-3 reaching Demark without being detected and in this scenario, it is plausible that an infected animal may be sent to Great Britain (Figure 12). Complete vector control is difficult to achieve (Carpenter, Mellor and Torr, 2008), therefore, animals may still become infected with BTV during pre or post movement isolation. Partly for this reason, the animals need to have tested negative on 2 separate occasions. The first test must have been conducted at the point of isolation and the second test at least 28 days later, but within 10 days of export.

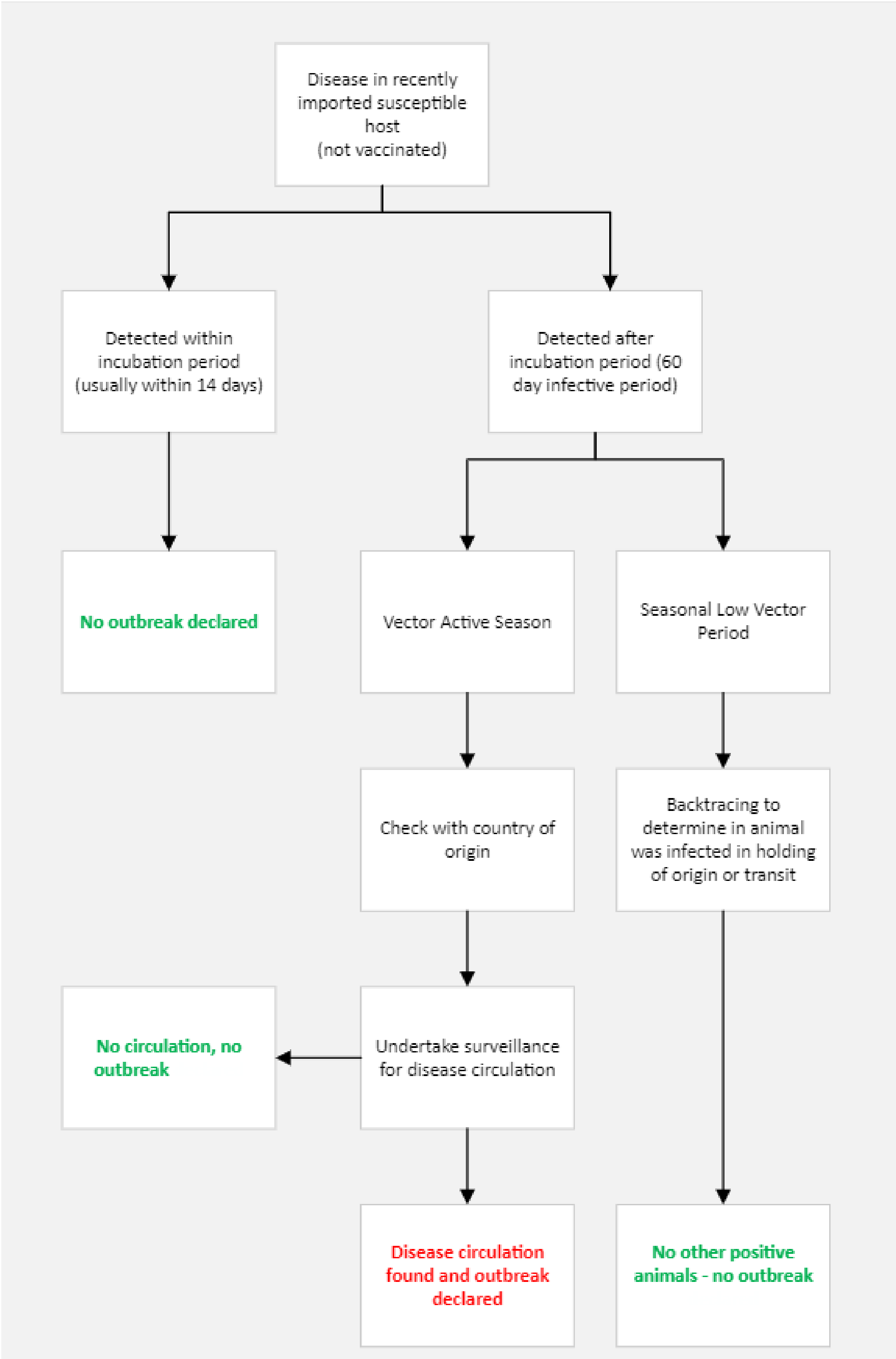

Figure 12: Risk pathways for importing infected live susceptible animals in a scenario where there has been undetected spread to a country with no known presences of BTV and the animal is not vaccinated. If detected during the incubation period, no outbreak would be declared. If detection occurs during the infectious period and Great Britain is in the seasonal vector low period (SVLP), back tracking is conducted to determine if the animal if infected at the origin or during transit. As circulation cannot occur during the SVLP, no outbreak occurs. If this same scenario occurs in the vector active season, surveillance must be conducted to determine if circulation has occurred, if this is found to be the case an outbreak would be declared.

The annual average number of BTV-8 infected livestock which would not be detected by serological testing or clinical checks before leaving isolation in Great Britain was estimated to be 0.04 (rounded to 1 significant figure) (72). This is a conservative estimate, based on the assumption that 100 animals per month are imported from an affected country (when there has been undetected spread). However, the actual number of live animals imported is likely lower, therefore, the annual likelihood of BTV entry into Great Britain, is likely to be lower. This likelihood is also based on a worst-case assumption that infected animals would remain infectious for up to 60 days.

Under the conditions of the health certificates, live ruminants may not pass within 10km of an BTV case reported within the past 30 days while being transported. However, Culicoides have the potential to disperse up to 150km over land by the wind (Nelson et al., 2022). Therefore, 10km is not necessarily far enough away from reported cases to prevent the animals from being exposed to BTV infected midges during transit, particularly if transport vehicles stop off along the way (Nelson et al., 2022).

While infection during transit cannot be ruled out, there are no known reports of live ruminants becoming infected with BTV in this way. It is also unlikely that an infected Culicoides midge would bite an animal in a rapidly moving vehicle (Marion England, Pirbright Institute, personal communication, 2023). The likelihood of BTV infection during transit would be further reduced by the requirement for vehicles used to import live animals to be treated with authorised insecticides or insect repellents. The uncertainty relates to the lack of data on the transport routes, including journey times, used to import live animals from Spain or Italy. There is additional uncertainty due to the lack of information on the exact nature and efficacy of the insecticides or repellents applied to the vehicles used to transport the animals.

Exposure assessment

Although the NAME modelling work described above only considers movement of infected vectors over water bodies, simulation models are also available which can simulate the spread of virus between farms, both through the movement of infected midge vectors and the movement of infected livestock animals. These include the Pirbright Institute's (TPI's) Bluetongue Virus Transmission Model, a model run by Scotland Government's Centre of Expertise on Animal Disease Outbreaks (EPIC), and a model run by Liverpool University. These 3 models were all used following the re-emergence of BTV in France in 2015 to explore potential BTV-8 spread within Great Britain if infected vectors entered the south of England, and the TPI model has since been used to identify potential reasonable worst-case scenarios for BTV-3 spread within Great Britain following the incursion of infected midges as well as due to the importation of infected livestock. These models explicitly include the impact of temperature on virus transmission (which can influence the biting rate, mortality rate, and rate of development of infectiousness in midges), and were fitted to data from the 2007 BTV-8 outbreak in Great Britain, which remains the only large-scale outbreak the country has experienced to date. This parameterisation is considered appropriate for both the post 2015 and 2024 outbreak scenarios (S. Gubbins, pers comm).

The TPI modelling work from 2015 onwards explored the impact of different vector incursion locations and timings, different movement restrictions, different temperature profiles, as well as the impact of pre-existing immunity and vaccination. Some scenarios of particular interest are:

- incursion via infected midges happening in spring (May), summer (July) or autumn (September), to account for seasonality in spread
- incursion via infected midges happening at 3 locations in southern England (Hampshire, Kent and Suffolk), to account for differences in livestock demographics and risk of airborne vector incursions from continental Europe
- different historical temperature profiles, to account for the impact of temperature on vector behaviour and virus spread
- different movement restrictions (including zones with complete movement cessation as well as zones in which movements to areas of lower risk were not permitted)

The TPI modelling work commissioned in early 2024 was used to estimate a Reasonable Worst-Case Scenario (RWCS) for BTV-3 spread, which was then used to inform resource planning. As for previous work, the impact of virus incursion timing and location was considered, along with a range of different livestock movement restrictions. As well as vector-borne incursions, a number of scenarios relating to virus incursion through the importation of infected animals (cattle or sheep). As the focus was on a RWCS, it was assumed that daily temperatures were as for 2006 (which has consistently given the greatest amount of BTV spread in Europe for all years assessed over the last 20 years).

A total of 42 different scenarios were considered, representing:

- 2 different incursion dates (May and July)
- 7 different incursion locations
- 3 different movement restrictions approaches

Of the incursion locations, 2 are associated with the windblown movement of infected vectors into 5 randomly selected farms (informed by historical predicted vector incursions):

- east coast (Norfolk, Suffolk, Essex, Kent, East Sussex), to represent potential vector incursions from the Netherlands or Belgium
- south coast (Cornwall, Devon, Somerset, Dorset, Hampshire, Isle of Wight, West Sussex, East Sussex), to represent potential vector incursions from France

There are also 5 incursion locations associated with the importation of infected cattle or sheep into high livestock density areas of Great Britain:

- south coast (Cornwall, Devon, Somerset, Dorset, Hampshire, Isle of Wight, West Sussex, East Sussex), to represent potential vector incursions from France
- sheep into North Powys or South Powys
- sheep into Cumbria
- cattle into Cheshire, Staffordshire or Derbyshire
- cattle into Devon or Somerset
- cattle into Dumfriesshire or Ayrshire.

The 3 movement restrictions approaches are:

- no movement restrictions
- 100km protection zones (PZs) and 150km surveillance zones (SZs) around detected premises
- PZs and SZs with 20km control zones (CZs) with complete movement restrictions maintained for the duration of the simulation

The following maps (Figure 13) are livestock demographic maps for sheep and cattle livestock density in both 2014 and 2022, which are used as inputs in the modelling work). These are still considered suitable representations of our livestock populations. The Pirbright model does not replay historical movements but generates similar movement patterns based on historical movement data (grouped by month and county). The post 2015 work used 2006 movement data and the 2024 work used 2019 data (selected to avoid any changes in movement patterns immediately following the COVID-19 pandemic).

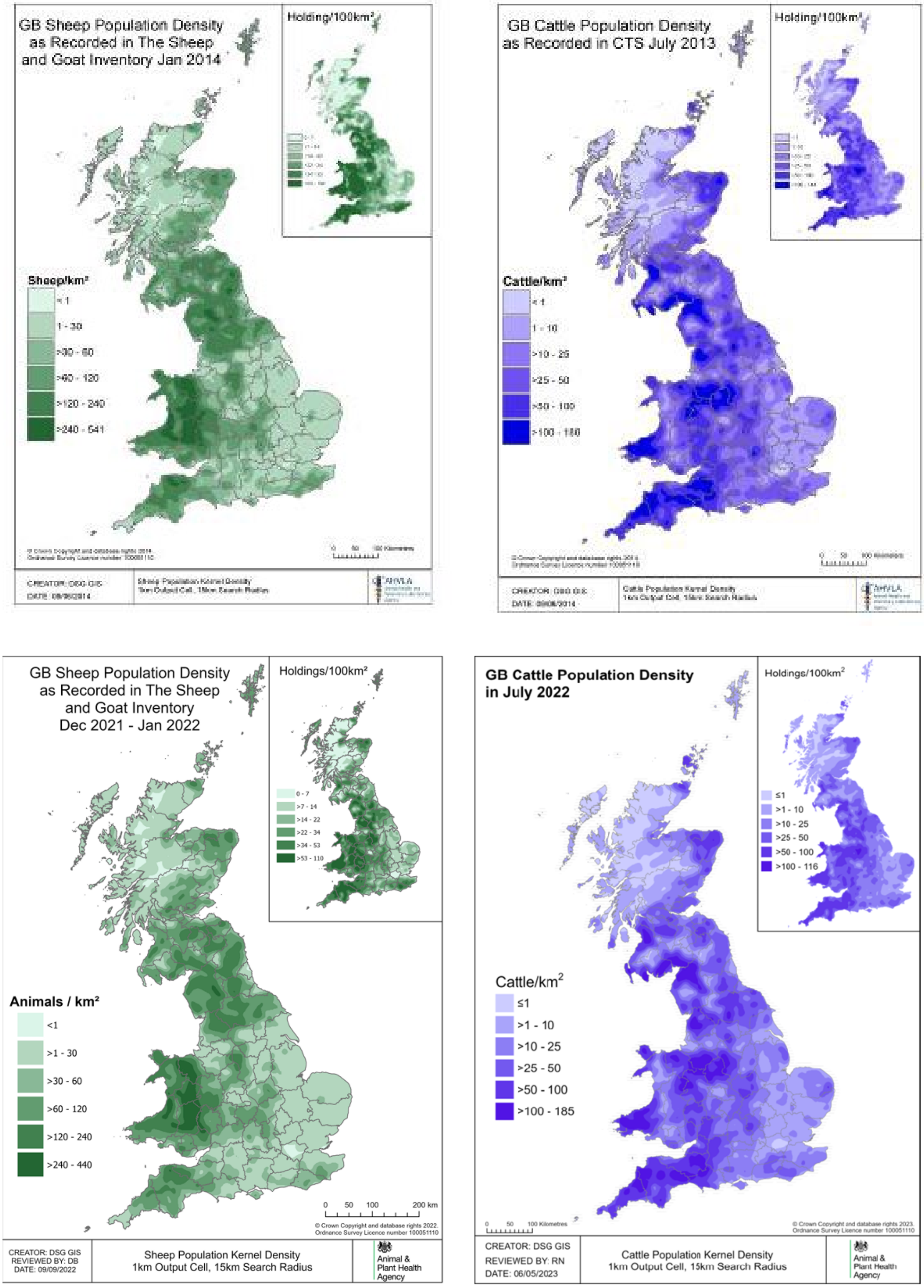

Figure 13: Data from the Sheep and Goat Inventory, January 2014 and January 2022 and the Cattle Tracing System, July 2013 and July 2022, highlighting the density of sheep and cattle in Great Britain. Wales, south-west and north England have the greatest populations of sheep and goat (Dark green) and cattle (dark blue).

Temperature

Temperature has a large impact on virus spread and is included in the TPI model as the daily temperature within a 5km gridded landscape across Great Britain (grid squares of 25km^2 in area) from a historical year. The impact of temperature was explored in the post-2015 work, which demonstrated that temperatures from 2007 (which had a relatively cool summer and autumn) resulted in lower amounts of spread than under temperatures from 2005, which themselves resulted in lower spread than temperatures from 2006 (which had the warmest summer and autumn (56). Temperature data from 2006 were therefore used for the RWCS modelling work in 2024.

As well as variation year on year, seasonal temperature fluctuations mean that virus spread varies over the course of a single year, with most spread occurring in the summer and autumn months. This can impact upon the probability of virus spread following initial entry. In the post 2015 modelling work, a baseline scenario with no controls showed that there was a high probability that an incursion of vectors in May, July or September would lead to an outbreak developing as a result, but that not all incursions will develop into cases and not all cases will lead to secondary spread. Similar results were obtained for the 2024 vector incursion scenarios work when the number of incursion locations was reduced from 5 to a single location. For the scenarios considering the import of (single) infected livestock, secondary virus spread only occurred in a minority of scenarios. Approximately 1 in 6 (single infected) imports in May and between 1 in 4 and 1 in 2 in July resulted in any onwards virus spread.

In cases where secondary spread occurs, the total number of farms which experience infection over the course of the year is greatest following incursions in May and lowest following incursions in September. This is of course related to the duration of the remaining vector period, the time needed for disease spread and the temperature under which BTV can replicate in the vector. The 2024 modelling (using 2006 temperature data) has also shown that even with May virus incursions, the vast majority (over 95%) of infections and detections occur between July and October (inclusive), with most in September or October. A peak of detection routinely occurs around late September.

The initial location of infection also impacts upon the number of farms which experience infection. In the post 2015 work, infected vector incursions into Hampshire led to more infected farms than those in Kent and in turn more than those in Suffolk. Similarly, in the 2024 work, incursions into the southern coastal counties generally resulted in larger numbers of infected farms than those in the eastern coastal counties. These patterns are related to livestock density. When considering virus entry through livestock import, the total outbreak size also varies depending on the initial infection location, with the largest outbreaks (amongst simulations in which secondary spread occurred) following from initial infection in Cheshire, Staffordshire, and Derbyshire, or in Devon and Somerset. The scale of these outbreaks was comparable to those following vector incursions.

Movement controls

Measures to prevent and control incursions of bluetongue are outlined in the Great Britain Bluetongue Virus Disease Control Strategy. The main controls once disease is confirmed to be circulating in the midge population rely on movement controls and vaccination. In the absence of an authorised vaccine for bluetongue serotype 3 (BTV-3) the main controls rely on slowing the spread of the virus through movement controls. Such controls would be given effect by establishing disease control zones that restrict movements of susceptible animals out of those zones, except under licences approved by APHA, to prevent transporting virus elsewhere. The size of such zones will depend on a number of factors, including the extent of geographical spread, and may change over time to reflect evolving circumstances.

Modelling work has shown that movement restrictions would be effective at reducing the total numbers of infected farms and the total spread of virus by the end of the season, but are not able to prevent spread. This is because they would not be expected to have any substantial impact on vector dispersal (which is considered to be responsible for the majority of virus movement). However, as livestock movements are able to move the virus over much longer distances than vectors are capable of, removing or reducing the range of these moves through restrictions is able to reduce the risk of distant seeding of new foci of infection. The 2024 modelling work showed that the relative impact of these measures are greater for May than July virus incursions. For May entries of infected vectors into either the east or the south of the country:

- PZs and SZs reduce the number of infected farms by about half (eastern entries) or one-quarter (southern entries)
- PZs, SZs and CZs reduce the number of infected farms by about five-sixths (eastern entries) or two-thirds (southern entries) for May incursions; with less of an effect for later incursions

Despite these findings, it is worthy of note that there are considerable challenges when attempting to model vector movement. The current TPI model assumes that vector movements occur as a random, diffusive, process, with the vast majority of between-farm moves occurring within a distance of around 25km (56) . However, modelling vector movement in different ways could impact upon vector spread and therefore the predicted efficacy of movement restrictions.

Pre-existing immunity

There would be very limited immunity in animals in Great Britain for BTV-3 from the recovered animals in 2023 (7 sheep and 119 cattle were affected out of 46,000 PCR tested animals, and no routine serological testing was done).

There would be very little immunity in animals in Great Britain for BTV-8, there may be some imported animals which would have received the BTV-8 vaccine as a requirement of the health certificate if they originated from a country affected with BTV-8.

Animals which are naturally infected are immune for life and will test positive for antibodies. Although vaccination is recommended to protect an animal for a single year, there are still likely to be residual antibodies as demonstrated by several authors and as confirmed by the OIE (now WOAH) and EU Reference Laboratory at the time (The Pirbright Institute) who demonstrated antibodies could be detected up to 4 years after vaccination (57, 58).

Our own testing of animals destined for third country exports has also highlighted those vaccinated animals still express antibodies several years later.

Summary of key uncertainties

There are several key uncertainties in this assessment that impact on the estimate of the likelihood of disease entry and exposure.

These uncertainties include:

- the extent of spread of different BTV serotypes, including the 'new strain' of BTV-8 in France and BTV-3 in Northern Europe on the Continent over the coming months
- the level of vaccination used on the Continent against BTV-8, or any future vaccination against BTV-3 (amongst sheep and cattle) and the efficacy of these vaccines
- the suitability of climatic conditions (especially temperature) on the Continent for virus spread during 2024, higher temperatures (particularly over the summer and autumn months would be expected to result in greater virus spread and wind patterns could potentially result in longer vector movement distances than are currently included in the model
- the frequency, timing, and locations of any potential windborne incursions of vectors into Great Britain from Northern Europe. Previous work conducted by the Met Office has demonstrated that this is highly variable year on year
- the probability of BTV-3 overwintering (through long-lived infected vectors and/or vertical transmission in cattle)

- the suitability of climatic conditions in Great Britain for virus establishment and spread during 2024
- the impact of seasonality in livestock numbers and demographics (around lambing) on the risk of virus infection and spread
- the impact of livestock movement restrictions on livestock movement patterns within Great Britain, the introduction of movement restrictions may result in changes to movement patterns rather than a complete cessation of non-permitted moves (as is assumed in the model).in south-east England

Summary of key assumptions

This report assumes that:

- BTV-3 has similar transmission rates and overwintering mechanisms to BTV-8 with a lack of published data
- BTV-8 is circulating in northern France
- a large number of cases of BTV will occur in Belgium, Netherlands, Germany and northern France in 2024 if BTV-3 overwinters in Europe
- 2024 will have similar meteorological conditions in Europe to 2023
- over the course of the year, plumes of infectious vectors are likely to reach Great Britain
- BTV requires a mean temperature of 15°C, but replication has also been recorded at 12°C at a much slower rate
- infected animals would remain infectious for up to 60 days
- there is very little herd immunity to BTV-3 or BTV-8 in Great Britain

Conclusions

The risk question is "What is the risk of BTV overwintering or being introduced into Great Britain (Great Britain) from northern Europe and infecting livestock at least once in 2024?"

The results of the risk assessment are summarised in Table 12. These represent the probability that at least one livestock animal in infected in Great Britain in 2024.

Table 1212: Summary of risks of entry of bluetongue virus in Great Britain such that at least one livestock animal is infected in 2024.

Hazard	Route	Probability that at least one livestock animal is infected in Great Britain in 2024	Uncertainty
BTV-3	Overwintering in Great Britain	Low to medium	High
BTV-3	Entering Great Britain from northern Europe through windborne incursion	Very high	High
BTV-8	Entering Great Britain from northern France through windborne incursion	Medium	High
BTV-3 and BTV-8	Imported live animals	Very low	Low
BTV-3 and BTV-8	Transplacental	Very low	Low

Hazard	Route	Probability that at least one livestock animal is infected in Great Britain in 2024	Uncertainty
BTV-3	Overwintering in livestock (bloodmeal and testes)	Very low	Low

Given the current data, the number of cases of the 'new strain' of BTV-8 in France is unknown and was last reported to have spread across most of the south of France. The whole of France is being treated as a restriction zone, and so it is not known how far the disease has spread. Although BTV-8 itself does not prevent importation of susceptible livestock into Great Britain (these animals can be imported from countries affected by BTV-8 given that the animal is vaccinated and conforms with the Great Britain health certificate requirements), susceptible livestock cannot be imported from France due to the presence of EHDV-8, for which there is currently no vaccine. Similarly, the lack of a vaccine for BTV-3 means that it is not possible to import susceptible livestock from any countries affected with BTV-3 into Great Britain. For this reason, there risk of import of BTV in live animals is considered as very low. At present the risk of BTV-8 being introduced into Great Britain through windborne midges is medium. The lack of consolidated data in France and the uncertainty around the monthly surveillance being carried out in France in sentinel herds contribute to the high uncertainty.

There was a brief cold snap in northern Europe in winter of 2023 to 2024 with temperatures in January 2024 in Maastricht in south-east Netherlands and in England on average lower by 3.5°C and 2.2°C respectively than that in January 2007 in Maastricht (Table 5) when BTV-8 overwintered in northern Europe. However, overall the winter of 2023 to 2024 has been very mild with the warmest February on record in England (63) and the winter monthly temperatures in England 2024 (Table 1) and in Maastrich 2023 to 2024 (Table 5) have generally been higher than those in Maastricht in 2006 to 2007. Although the cold January of 2024 could have provided some protective effect against overwintering both in south-east England and northern Europe, it is considered here that infectious midges small proportions have survived through the winter. Also, cattle are often housed in northern Europe and the heat from the cattle would prevent low temperatures which may be beneficial to any Culicoides which are present in the housing. However, only a fraction of the midges will survive the winter, and hence the probability of each individual midge surviving the winter is assumed to be low both in south-east England and northern Europe. The key point however is that this is not very low or negligible. Based on the numbers of infected livestock in 2023 with much higher numbers in northern Europe compared to south-east England, the probability an autumn midge is infected is assumed to be very low in south-east England but low in northern Europe. Taking into account the huge number of midges in northern Europe, the aggregated probability that BTV3 reemerges in cattle or sheep is estimated to be very high in northern Europe in 2024 but only low to medium in south-east England. Thus, even if BTV-3 does not re-emerge in south-east England this year, there is the higher probability that it will in northern Europe simply because of the higher number of infected midges as judged from the number of outbreaks last season. There is high uncertainty in these risk estimates because of lack of information of herd immunity in the livestock herds.

Predicting the likely incursion and spread is therefore difficult particularly given the uncertainty around over whether BTV-3 will overwinter in northern Europe and spread further, and regarding the new strain of BTV-8 in France. This new season will need to be monitored closely. Certain future events will trigger close monitoring such as the first clinical cases reported in northern Europe as confirmation of overwintering, and onward circulation in previously affected countries or new territories like Denmark, or BTV-3 in France. Any suspicion of disease in Great Britain must be reported promptly, and any changes will be carefully considered with regards to risk management.

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