Risk assessment for Bluetongue Virus (BTV) entry into the United Kingdom

Qualitative risk assessment

June 2015
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Summary

This qualitative risk assessment uses available evidence to provide an estimate of the likelihood of bluetongue virus serotype 4 (BTV-4) entry to the UK, as a result of the current BTV-4 circulation in continental Europe. It should be noted however, that the assessment does not consider the impact of any potential interventions (such as vaccination) in any of the currently infected areas. The assessment considers four possible scenarios for the spread of BTV-4 during 2015: 1) the disease did not overwinter at all, 2) the disease overwintered in vector populations only, 3) the disease spread to central Europe over the winter, 4) the disease spread rapidly in spring 2015 and reached northern Europe by late summer 2015.

The results of the assessment suggest that the risk of BTV-4 entry to the UK in 2015 under scenario 1 was negligible, under scenario 2 was very low, under scenario 3 was medium and under scenario 4 was high. This highlighted that the likelihood of BTV-4 entry to the UK increases depending on the time point at which the virus spreads to northern Europe. However, there was high uncertainty surrounding when, or even if, this would occur; Scenario 1 was considered the least likely to occur and assessed as having a negligible probability, scenario 2 was assessed as having a medium probability, scenario 3 was assessed to have a low – medium probability and scenario 4 was assessed to have a very low probability of occurrence. So, while it is likely that BTV-4 will overwinter and therefore spread further north, whether it is able to reach the UK this year is uncertain. A key point for consideration is the time at which an incursion would occur, since an outbreak earlier in the vector activity period would likely enable further spread domestically.
Taking into account both the risk of entry from the scenarios and the likelihood of the scenarios occurring, this assessment suggests that for the scenario considered the highest risk of BTV-4 entry to the UK this year is low - medium. It is important to note however, that the estimation of risk uses a number of worst-case assumptions. Consequently, the estimation of risk in a number of circumstances adopts a cautious approach. However, should BTV-4 spread faster than expected or re-emerge closer to the UK, then the risk of BTV-4 entry would increase and should be re-assessed.

Introduction

Bluetongue (BT) is a non-contagious disease of ruminants (notably cattle and sheep) and is on the World Organisation for Animal Health list of notifiable diseases [1]. The disease is caused by bluetongue virus (BTV), which is an orbivirus of the Reoviridae family, currently has 26 known serotypes [2-4] and is usually transmitted via the bites of infected Culicoides midges.

The virus is known to be present in Southern Europe, BTV serotypes 1, 2, 4 and 16 have all been identified in the Mediterranean basin [5], but only BTV serotypes 1, 8 and 25 and three vaccine strains of BTV-6, BTV-11 and BTV-14 have previously been identified in Northern Europe circulating in Culicoides obsoletus [6, 7]. The virus has previously been able to reach the UK during the 2007 epidemic of BTV-8 [8-10], and, if not controlled, has the potential to have a considerable economic impact [3, 6]. Currently, BTV-4 is circulating around Southern and South Eastern Europe, in areas where the vector C. obsoletus is predominant [11] and, given the previous spread of BTV-8, there is concern as to whether it could spread to Northern Europe and subsequently to the United Kingdom (UK). Consequently, a risk assessment was commissioned to investigate the risk of entry of BTV-4 to the UK.

Risk question

Within this qualitative assessment, we specifically assess the risk of BTV-4 entry to the UK during 2015, via infected midges and live animal importation. As such, the specific risk question is:

*What is the risk of a BTV-4 infected animal being present in the UK during 2015?*

Given the differing nature of spread (via vector or importation), the interpretation of BTV-4 entry must be clarified. The presence of a BTV-4 infected animal via the vector route is assumed to be the result of an infectious vector reaching the UK and thus infecting an animal. Conversely, entry via animal importation is assumed to be
the result of one infected animal entering the UK, i.e. the risk is estimated per animal. Such an approach is taken because once BTV has been detected in EU MSs importation will be restricted and therefore estimating the risk of entry of 1 or more animal per year becomes a challenge, i.e. estimating the actual number of animals imported is unclear.

Due to the uncertainty surrounding the location(s) of BTV-4 in the spring of 2015, we consider four scenarios and assess the likelihood of each scenario occurring. This should provide evidence to make an informed policy decision, under the various scenarios. The agreed scenarios were:

i. Disease does not overwinter within the animal and vector populations in Italy, Greece, Bulgaria, Romania and Hungary;

ii. Disease does not overwinter within the animal population, however low levels of infectious vectors remain present, and new cases occur next year in regions where disease is already present (i.e. in Italy, Greece, Bulgaria, Romania and Hungary) at the same rate as before;

iii. Disease overwinters within both the animal and vector populations and has spread silently during the winter into Austria, Southern Germany, Czech Republic, Switzerland, Slovenia;

iv. Disease has overwintered within both the animal and vector populations and spread rapidly during the early spring and first cases are detected in North Germany, Netherlands and Belgium in late summer.

The point at which the virus emerges in Northern European countries is thought to play a crucial role in the likelihood of BTV-4 entry to the UK, though it is acknowledged that the time at which the virus is likely to emerge will depend on climate and is therefore likely to vary between location [12, 13]. As shown in Figure 1, emergence of BTV-4 cases at various times during the vector movement period could change the risk of entry to the UK. The development of the above scenarios should therefore capture any change in risk.
Figure 1: Timeline for BTV-4 spread

Hazard identification

The hazard is identified as BTV-4, which is currently circulating in Southern and South Eastern Europe, specifically Italy, the Balkans (notably within the EU in Greece, Bulgaria and Romania) and Hungary. Although a modified version of BTV-4 and BTV-1 have been identified as circulating in Spain [11], incursion to the UK from Spain is thought to pose a lesser risk, given transmission is via a different vector species (*C. imicola*) compared to that found in the UK (*C. obsoletus*). Disease entry for this strain of BTV from Spain is therefore not assessed here.

Risk assessment

This risk assessment was conducted following the OIE framework [14]. However, it was agreed that only the entry of BTV-4 into the UK would be assessed. Consequently, we only completed the entry assessment. Further information regarding the potential exposure and consequence of BTV in the UK has been discussed elsewhere [8-10]. As well as estimating the risk of BTV-4 entry under each scenario, we can also estimate the current risk of entry to the UK, based on the risk estimate of the scenario deemed to be the most likely to occur. In this risk assessment, we defined the categories of risk based on previous, well accepted, definitions [15]:

**Negligible** – Event is so rare that it does not merit to be considered.

**Very low** – Event is rare but cannot be excluded.

**Low** – Event is rare but does occur.

**Medium** – Event occurs regularly.
**High** – Event occurs very often.

**Risk pathway**

The risk pathway for the entry of BTV-4 into the UK is shown in Figure 2. The pathway highlights the two key routes of entry; namely, the importation of infected animals and the windborne spread of infected midges. It is also important to note that we define disease entry as “the presence of a BTV positive animal in the UK,” as opposed to the presence of an infectious vector. This is based on the assumption that an infectious vector reaching the UK is likely to infect a ruminant (discussed later) and gives the 2 routes the same end points.

![Risk pathway diagram]

**Figure 2: Risk pathway for entry of BTV-4 into the UK**

**Overwintering of bluetongue virus**

The cycle of bluetongue transmission has been well documented, with transmission occurring during peak vector activity periods, ceasing during the winter before re-emerging at the start of the next vector period [16]. This is known as “overwintering.” In order for any further transmission and thus potential risk to the UK, this must occur.

Under cool temperatures, both midge activity and virus replication cease [16], though the longevity of midges may increase [17]. A mild winter however, could increase the duration of suitable conditions for vector activity and virus replication. The exact time at which the disease may reappear can vary, however, and was estimated to be between April and May during the 2007/2008 outbreak [18]. Given that northern Europe has seen the largest increase in temperature during the winter over a number of years, the temperature conditions are unlikely to inhibit overwintering [19].
At temperatures below 12-15 °C virus replication ceases, but the virus may persist in both the host and vector populations, should temperature increase [18, 20]. It has been suggested that adverse weather conditions of 100+ days, could minimise BTV survival [3]. However, given Italy and Croatia have reported new BTV-4 outbreaks during February 2015 [21], it is likely that conditions have been suitable for BTV to overwinter.

A number of theories on how BTV overwinters exist, whereby BTV persistence could be due to the vector population or the host (cattle and sheep) population. Both horizontal and vertical transmission within the animal population have been suggested as mechanisms for BTV persistence [16]; however the exact mechanisms of overwintering remain largely unknown.

Should overwintering not occur, then it is highly plausible that the disease could retract in terms of geographical distribution, resulting in a decrease in BTV-4 prevalence on the continent. However, given the past history of the virus, there is little to suggest that the disease will fail to overwinter. Instead, the main concern is whether the disease will spread during the winter or remain geographically restricted, which could depend on whether the virus persists in the animal and/or the vector populations.

Assessing the risk that BTV-4 enters the UK via infected midges

The main route of BTV transmission is believed to be via infected midges [2], notably C. obsoletus for the UK [5]. In order for infected midges to reach the UK, a number of events in the vector life cycle must occur, such as successful overwintering and initial travel over land to Northern Europe, culminating in travel over the channel; such long distances are usually done on the wind [22].

Assessing the probability an infectious vector reaches the UK (P₁)

In order for an infectious vector to reach the UK, we need to consider i) the speed of spread, ii) the initial location of the vector and iii) the time period of risk.

Speed of vector movement

The speed of vector movement determines the distance the disease is able to spread (ignoring the movement of viraemic livestock or wildlife). Given that the disease has spread northward approximately 800km since its incursion into Europe [23], further disease spread seems likely. Movement of the vector is dependent on a number of factors including temperature and air movement [24, 25]. Previous modelling of the transmission of various virus', including BTV, found suitable temperature and air conditions for vector movement between late July and early
October [26, 27]. Assuming a similar pattern for the forthcoming year, then we could expect a similar pattern of vector movements.

Movements of midges on the wind follow a different pattern over land compared to over water, whereby distances over water of 700km in a single movement could occur, but not over land [25]. Vector movement over land has been shown to intermittently stop and cause local disease spread at distances between 35 and 85 km, rather than long distance spread, which are unlikely to occur, despite suitable wind conditions [25]. Given that the UK is approximately 1,400 km from the current most northerly point of BTV-4 circulation, it seems unlikely that the disease would reach the UK in one movement. As such, movement could be thought to be in two separate stages; movement north on the continent and movement to the UK across the channel. Meteorological data during 2006-2008 suggested we could expect between 2.7 - 12 wind events per month suitable for Culicoides movement to the UK from northern France [28]. Clearly the point on the continent that acts as the source for UK incursion affects the likely location for entry into the UK. Previous studies, looking at various sources, showed the south and south east coast of the UK to be more exposed to wind patterns that would be sufficient for vector movement [29]. However, suitable conditions do not necessarily equate to further spread [25].

Using data from the current outbreak in southern Europe reported into the EU Animal Disease Notification System database, locations for the spread of BTV-4 cases can be plotted (Green points, Figure 3). The suspected date of a BTV-4 outbreak in each location was then used in order to calculate the approximate speed of vector movement, assuming the outbreaks are a result of a vector originating from Greece (assumed original location of BTV-4). The initial movement from Greece to Bulgaria was found to be particularly fast, especially when compared to the speed of movement to other locations. Assuming the average speed of movement between Bulgaria and Hungary is more reflective of the expected travel, we could expect an average speed of approximately 8.07 km day\(^{-1}\). While it is noted that this value is particularly high (given movements tend to be over distances of <5 km [25, 30]), this strain of BTV-4 has appeared to have spread far more rapidly than previous outbreaks. While this assumes that transmission has occurred via infected midges, animal movements between the currently infected countries were minimal during 2014 (trade of cattle and sheep between Greece and Hungary/Bulgaria and Greece and Bulgaria, respectively, according to the Comtrade database). It is noted however, that given the movement of sheep pox in the region, there are unlicensed movements of animals and movements of wild ruminants both within and between the countries in the region.

Given the overwintering of the disease, the initial spread is likely to begin in the northern Balkan region. Depending on the exact foci, BTV-4 spread to Germany and the UK (red points, Figure 3) could be between 104-140 and 182-218 days
respectively. This however assumes that travel is constant and therefore may not account for the life cycle of both midges and BTV transmission, which would increase this duration considerably; the duration for the biological processes and chain of events to occur (extrinsic incubation period (EIP)) was estimated to be up to 4 weeks [25]. This is not an unrealistic figure given the incubation period in Culicoides midges varies between 2 days and several weeks, depending on temperature [18]. As such, these calculations are based on worst-case scenarios.

Figure 3: Map of the 2014/2015 BTV-4 outbreak in Europe. Green dots: location of an outbreak during 2014/2015, Red dots: locations for vector movements.

Initial location of an infectious vector

It is important to note, that while BTV-8 was able to reach the UK during the 2007/2008 outbreak, the foci of the outbreak was in the Netherlands [31], which is considerably closer than the current BTV-4 outbreak (foci in Greece). Given the current location of the virus, visible signs of disease spread to northern Europe (e.g. to Germany, the Netherlands) should act as a warning of increasing likelihood for disease entry to the UK. However, this assumes that, with successful overwintering, virus spread will be initiated from the Balkan region. It is theoretically possible that the virus could emerge further afield at the start of the vector movement period.
Should the virus appear further north, then, like the previous outbreak, incursion into the UK during the year is more likely.

Overwintering in the vector population combined with mild winter temperatures could result in low levels of vector movement during a usual “quiet” period. While overwintering seems to have occurred, given the recently emerging outbreaks in Italy and Croatia [21], whether this has resulted in any “silent spread” of infected midges remains unknown. Importation of infected animals could also lead to new foci. Although Belgium, France and Germany did import live animals from some of the currently BTV-4 infected countries during 2013, trade during 2014 has not occurred (Comtrade database), presumably due to movement restrictions, and so the likelihood of the virus emerging elsewhere in the spring due to animal movements is low. However, it should be noted that the emergence of new foci as a result of vector movements via transport (such as trucks) has not been considered.

**Time period of risk**

The time at which the virus spreads north is likely to play a crucial role in the likelihood of BTV-4 entry to the UK. Cases can usually be expected to re-emerge around April, with the active vector season during the summer and autumn [18, 27]. During this time, the vector can move various distances, depending on a number of factors such as air movement and temperature. The assessment of vector movements above suggests that the earliest time at which an infected midge could reach central Germany is between 3.5 – 4.5 months (depending on starting location of the vector); this would increase to approximately 5.0 – 6.4 months to reach the Netherlands. Assuming BTV-4 overwinters and cases re-emerge in April (in a similar manner to 2007), the earliest possible point BTV-4 could be expected to emerge in the Netherlands is early September. This would clearly be towards the end of the vector movement period, thus entry to the UK this year would be unlikely.

This however makes a lot of assumptions and is therefore extremely uncertain. While it seems unlikely that BTV-4 would be able to enter the UK this year (2015), warning signs would be visible given monitoring of the situation on the continent. For example, if BTV-4 is present in Northern Germany or the Netherlands in June, there is still a sufficient period for the vector to be able to reach the UK. Consequently, the likelihood for BTV-4 entry to the UK is considerably increased.

**Assessing the probability an infectious vector contacts a susceptible host in the UK (P₂)**

Should the vector reach the UK, then there must be a pool of susceptible animals present in order for the disease to enter the country. As mentioned previously, cattle and sheep are the main hosts for BTV. Given that the disease is most likely to come
from the continent, then the most likely locations for disease entry are Norfolk, Suffolk and Kent; as shown from the previous BTV-8 outbreak [9, 27, 29].

Norfolk and Kent have high cattle densities [32, 33], with Kent also having a high density of sheep [20]. Cattle and sheep alive during the last BTV outbreak are unlikely to be present on farm and therefore there are unlikely to be any vaccinated animals within the population. Furthermore the protection afforded by vaccination is serotype-specific [3]. As such, any previous vaccine would only protect against BTV-8 and not against the potential threat of BTV-4.

Given a population of naïve animals are present in the location where vector incursion is most likely to occur, we assume, for simplicity, the presence of infected midges in the UK will result in an infected animal. Again, this adopts a cautious, worst-case scenario approach. The time between the introduction of the virus and clinical detection will be dependent on passive surveillance. Given the likely nature of the spread, surveillance for BTV is likely to be heightened depending on the proximity to the UK.

**Likelihood of BTV-4 entry via infected midges given each scenario**

Assuming the presence of an infectious vector in the UK results in BTV-4 entry, entry to the UK depends only upon the ability of the virus to spread. As discussed above, this is likely to happen in two stages; firstly across the continent and then to the UK. The probability that BTV-4 spreads north and then enters the UK is summarised in Table 1.
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Probability an infectious vector reaches the UK ($P_1$)</th>
<th>Probability an infectious vector contacts a susceptible ruminant in the UK ($P_2$)</th>
<th>Overall risk of BTV-4 entry to the UK via infectious midges</th>
<th>Uncertainties/Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Disease does not overwinter within the animal and vector populations</td>
<td><em>Negligible:</em> Failure of BTV-4 to overwinter will result in outbreaks remaining within the current location, with a decreasing prevalence within certain areas. Therefore unlikely to spread towards Northern Europe.</td>
<td></td>
<td></td>
<td><em>Negligible</em></td>
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<tr>
<td>in Italy, Greece, Bulgaria, Romania and Hungary</td>
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<tr>
<td>2) Disease does not overwinter within the animal population, however</td>
<td><em>Very low:</em> Using available evidence, as a worst case, predicted to take 5-6.4 months for the virus to reach northern mainland Europe. This however may not take into account the temperature dependent EIP. Therefore the virus is unlikely to reach northern mainland Europe during the current vector movement period.</td>
<td></td>
<td></td>
<td><em>Very low</em></td>
</tr>
<tr>
<td>low levels of infectious vectors remain present, and new cases occur</td>
<td></td>
<td></td>
<td></td>
<td>- The speed with which the virus is able to spread. (All calculations focus on a worst-case scenario and therefore the actual rate of spread is likely to be lower than stated here.)</td>
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<tr>
<td>next year in regions where disease is already present (i.e. in Italy,</td>
<td></td>
<td></td>
<td></td>
<td>- The likelihood of an infectious vector contacting a susceptible animal is assumed to be high. While the presence of an infectious vector in the UK will not necessarily result in an infection, it is assumed, for simplicity that it would.</td>
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<td>Greece, Bulgaria, Romania and Hungary) at the same rate as before</td>
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<td>3) Disease overwinters within both the animal and vector populations</td>
<td><em>Medium:</em> Using available evidence, as a worst-case, predicted to take 3 months for the virus to spread from Switzerland to northern mainland Europe. This however does not take into account the temperature dependent EIP. This would give sufficient time for the virus to become established within the region and with suitable climatic conditions could result in infectious vectors reaching the UK (predicted to be 2.7 - 12 suitable wind events per month).</td>
<td></td>
<td></td>
<td><em>Medium</em></td>
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<td>and spread silently during the winter into Austria, Southern Germany,</td>
<td></td>
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<td></td>
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<td>Czech Republic, Switzerland, Slovenia</td>
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<tr>
<td>4) Disease has overwintered within both the animal and vector</td>
<td><em>High:</em> Using available evidence, the presence of BTV in northern Europe can result in infectious vectors reaching the UK. Given that cases are already detected during the peak vector movement period this suggests that level of infectivity within the midge population could be high. Therefore the potential for vector movement to the UK is high.</td>
<td></td>
<td></td>
<td><em>High</em></td>
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<td>populations and spread rapidly during the early spring and first cases</td>
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<td></td>
<td></td>
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<tr>
<td>are detected in North Germany, Netherlands and Belgium in late summer</td>
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</table>
Assessing the probability that BTV-4 enters the UK via live animal imports

While the main route of transmission of BTV-4 is thought to be via infected midges [2], animal movements, and therefore importation of live animals, may also result in disease spread [6]. There are however regulations in place whereby movement restrictions and pre-export/post-import surveillance is carried out from high risk countries [34].

Assessing the probability an infected animal is exported to the UK ($P_3$)

In order for an infected ruminant to enter the UK, we need to consider i) the prevalence in the country the animal is being imported from, ii) the speed with which an animal can be detected as infected.

BTV-4 prevalence in the exporting country

Given that BTV-4 is currently circulating in the Balkans and Italy, these are the key countries of interest for the current situation. Using data from the TRACES database on animal importations, cattle imports from countries that would pose the greatest risk to the UK (based on either a high number of animal imports or currently circulating BTV-4) are shown in Figure 4. During 2014, the UK imported 5 and 8 sheep from Switzerland and France respectively.
Figure 4: Cattle imports to the UK by country. Figures show the number of imported cattle during 2014 from each country.

Should the disease spread on the continent (to Germany or the Netherlands for example) then the likelihood of importing from an infected country could increase (Figure 4). The health status of the animal (i.e. infected or not) is dependent on the prevalence of BTV-4 in the exporting country. However, the importation of animals from a BTV-4 positive country is unlikely once disease has been confirmed, given the restrictions that would be implemented (Bluetongue Regulations 2008 2000/75/EEC). What is of more concern is the time between disease incursion and detection, which is dependent on the methods of surveillance and test sensitivity.

Detecting an infected animal

Given that the disease is known to be circulating in Europe, an increased vigilance of bluetongue spread via surveillance is likely. However, there will nevertheless be a time between infection and confirmation of disease, during which importation of potentially infected animals can occur. An increase in awareness and surveillance could potentially minimise this time, however the risk cannot be fully eradicated.

Typically, cattle do not exhibit any clinical signs to BTV-infection, though some clinical signs were present with BTV-8 infection [3]. Instead, ruminants with BTV infection can be detected serologically for 35-60 days post infection (PI), though viral RNA can be detected up to 160 days PI [3]. As such, there are potentially a number of days during which infected animals could be imported to the UK prior to the confirmation of infection.

The sensitivity of the tests (calculated depending on the tests ability to identify BTV at various time points) used to detect BTV serotypes in EU reference laboratories has been shown to be variable, at least for those strains found in Europe (including BTV-4) [35]. Although the majority of tests are able to detect BTV-4 antibodies, the sensitivity varied between test type; the sensitivity of real-time assays were found to be higher than conventional RT-PCR assays [35]. The OIE nested RT-PCR and the real-time RT-PCR were shown to detect BTV 2 days post infection, though other tests could take longer to detect BTV. As such, animals that are potentially infectious could enter the UK for a minimum of 2 days before BTV confirmation.

Assessing the probability an infected animal is not detected by the post-import test ($P_4$)

Animals imported from restriction zones are moved under Annex 1 of the BTV legislation. All animals are required to have a veterinary check and travel with a corresponding health certificate. Pre-export and/or post-import tests are carried out on a risk basis in accordance with Directive 90/425/EEC [34]. Post-import tests
(using any test according to the OIE testing manual, with sensitivities described above) are carried out on a proportion of consignments (again on a risk basis) within 10 days of arrival to the UK. Tested animals must remain on the initial premises until the confirmation of a negative result; procedures such as animal tracing, insect collection and epidemiological assessments may be put in place should a positive result occur [34]. Furthermore, under EC 1266/2007, animals must be protected against exposure to midges and/or have been vaccinated against any serotype present in the area of origin for at least 60 days prior to transportation [36].

EU rules apply only to restricted areas, this means the majority of animals consigned for trade will not be under any restriction for movement and therefore are not tested prior to movement, such animals should therefore pose a lesser risk. However the concern arises that animals will have moved before a restriction zone is put in place and there will be no such requirement for pre-movement tests or other guarantees, beyond the regular veterinary inspection 48 hours prior to movement.

It is possible that a number of in-calf heifers are imported to the UK, which poses a different risk given transplacental transmission has been shown to occur within some strains [18]. Consequently, the timing of animal movements during 2015 may also be important, but was outside the scope of this assessment.

**Likelihood of BTV-4 entry via live animal importation given each scenario**

The probability that a BTV-4 infected animal enters the UK is summarised in Table 2.

**Scenario assessment**

The likelihood of each scenario occurring is assessed in order to identify the most likely risk of BTV-4 entry to the UK.

**Likelihood of scenario 1**

The key assumption under this scenario is that BTV does not overwinter. Given that BTV-4 outbreaks occurred in February 2015 in Croatia and Italy, this suggests that the virus has been able to overwinter, at least in some areas. Consequently, the likelihood of scenario 1 occurring is **negligible**.

**Likelihood of scenario 2**

The key assumptions under this scenario is that overwintering only occurs within the vector population and that new cases only occur within currently infected areas. While it is likely that BTV-4 has overwintered, the mechanisms by which this occurs remains unknown. However, should the virus continue circulating in currently infected areas, then it is possible for BTV-4 to spread, should climate conditions be
suitable. While there is some uncertainty, nothing suggests that vector movement is unlikely. As such, the likelihood of scenario 2 occurring is medium.

**Likelihood of scenario 3**

The key assumptions under this scenario are that overwintering occurs in both vector and host populations and that silent spread to neighbouring countries occurs during the winter. Overwintering in both populations is likely to result in BTV-4 spread; however the ability for the disease to spread silently is unknown. As such, the likelihood of this scenario occurring is low – medium.

**Likelihood of scenario 4**

The key assumptions under this scenario are that overwintering occurs in both vector and host populations and that rapid spread occurs during the spring. Although the disease has been shown to spread long distances, the likelihood of BTV-4 being able to reach northern Europe so quickly is unlikely (Section 5.3). As such, the likelihood of this scenario occurring is very low.
<table>
<thead>
<tr>
<th>Scenario</th>
<th>Probability an infected animal is exported ($P_3$)</th>
<th>Probability the post-import test does not detect an infected animal ($P_4$)</th>
<th>Overall risk of a BTV-4 infected animal entering the UK during 2015 due to live animal movements.</th>
<th>Uncertainties/Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Disease does not overwinter within the animal and vector populations in Italy, Greece, Bulgaria, Romania and Hungary</td>
<td>Negligible: Failure of BTV-4 to overwinter will result in outbreaks remaining within the current location, with a decreasing prevalence. Animal movement restrictions will already be in place and thus minimal imports from infected regions should occur.</td>
<td>Very Low: Should imports from such regions occur, all animals would be required to have a post-import test. Tests to detect are highly sensitive and should therefore detect an infected animal.</td>
<td>Negligible - The duration between infection and confirmation of disease is unknown. Given that clinical signs are uncommon, this duration can be highly variable.</td>
<td></td>
</tr>
<tr>
<td>2) Disease does not overwinter within the animal population, however low levels of infectious vectors remain present, and new cases occur next year in regions where disease is already present (i.e. in Italy, Greece, Bulgaria, Romania and Hungary) at the same rate as before</td>
<td>Negligible - Very Low: Within these infected countries, animal movement restrictions would already be implemented.</td>
<td>Very Low: Should imports from such regions occur, all animals would be required to have a post-import test. Tests to detect are highly sensitive and should therefore detect an infected animal.</td>
<td>Negligible - The duration between infection and confirmation of disease is unknown. Given that clinical signs are uncommon, this duration can be highly variable.</td>
<td></td>
</tr>
<tr>
<td>3) Disease overwinters within both the animal and vector populations and has spread silently during the winter into Austria, Southern Germany, Czech Republic, Switzerland, Slovenia</td>
<td>Low: Due to the silent nature of the infection, post-import testing will not be carried out given that movement restrictions would not yet be in place. Silent spread could result in a low prevalence of infected animals to be exported to the UK. The time of detection in any area will be dependent on surveillance. However, given clinical symptoms are uncommon (though were present in animals infected with BTV-8), there is potentially a prolonged period prior to confirmation of disease. However, upon confirmation of disease, movement restrictions would be implemented.</td>
<td>Very Low - Low: Given silent spread, imports from such areas will not have any restrictions in place and thus importation of animals would not require a post-import test. However, upon the confirmation of disease, all animals would be required to have a post-import test. Tests to detect are highly sensitive and should therefore detect an infected animal.</td>
<td></td>
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</tbody>
</table>
Disease has overwintered within both the animal and vector populations and spread rapidly during the early spring and first cases are detected in North Germany, Netherlands and Belgium in late summer.

*Very low*: Although the prevalence in each country could be high given such rapid spread, the detection of infected animals means movement restrictions would be implemented.

*Very Low*: Should imports from such regions occur, all animals would be required to have a post-import test. Tests to detect are highly sensitive and should therefore detect an infected animal.
Overall risk

A summary table showing the results of the risk assessment for each scenario is given in Table 3. In order to estimate the maximum probability of BTV-4 entry to the UK, the overall probability of BTV-4 and the likelihood for each scenario can be multiplied, in a manner similar to Gale et al [37]. Using this methodology, this assessment suggests that scenario 3 is considered to have the highest risk of BTV-4 entry to the UK this year, with a low – medium risk. However, it cannot be stated that this is the maximum risk to the UK as not all potential scenarios have been considered.

Table 3: Summary for the overall risk of BTV-4 entry to the UK given each scenario

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Assessment: BTV-4 enters the UK via infectious midges</th>
<th>Assessment: BTV-4 enters UK via live animal importation</th>
<th>Overall probability of BTV-4 entry</th>
<th>Likelihood of scenario occurring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Disease does not overwinter within the animal and vector populations in Italy, Greece, Bulgaria, Romania and Hungary</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
<td>Negligible</td>
</tr>
<tr>
<td>2) Disease does not overwinter within the animal population, however low levels of infectious vectors remain present, and new cases occur next year in regions where disease is already present (i.e. in Italy, Greece, Bulgaria, Romania and Hungary) at the same rate as before</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
<td>Medium</td>
</tr>
<tr>
<td>3) Disease overwinters within both the animal and vector populations and has spread silently during the winter into Austria, Southern Germany, Czech Republic, Switzerland, Slovenia</td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
<td>Low-Medium</td>
</tr>
</tbody>
</table>
4) Disease has overwintered within both the animal and vector populations and spread rapidly during the early spring and first cases are detected in North Germany, Netherlands and Belgium in late summer

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Very low</th>
<th>High</th>
<th>Very low</th>
</tr>
</thead>
</table>

Summary of key uncertainties

There are several key uncertainties in this assessment that impacts on the estimate of the likelihood of disease entry. These uncertainties include:

- The mechanisms of overwintering. There are potential differences in impact depending on whether BTV-4 overwinters in the animal or vector population or both. For example, the risk could increase should overwintering in the vector population result in the virus appearing in previously unaffected regions during the spring.

- The rate at which BTV-4 is able to spread is highly uncertain. Should the virus spread at a faster than expected rate, there is an increased risk that BTV-4 could reach Northern Europe (and potentially the UK) sooner than expected.

- The suitability of the climate conditions in Europe during 2015. The risk of BTV-4 spread could increase should climate conditions favour virus replication in the host etc. Less favourable conditions however could mitigate the risk.

Summary of key assumptions

It is important to note that the disease is assumed to originate from the current region of circulating disease (i.e. southern and south Eastern Europe). This has potential implications for vector movements, since if new foci arose closer to the UK at the start of the vector activity period, then the risk of disease entry is likely to increase. However, given that French and German animal imports predominantly come from currently uninfected countries, there is little evidence to suggest this would happen via this route. However, the emergence of new foci as a result of vector movements via transport or other means is a possibility, but was out of the scope of this assessment.
Furthermore, the estimation of risk uses a number of worst-case assumptions, mainly surrounding vector movements. It was also assumed that if an infectious vector reached the UK, then the virus would be considered to have entered the UK (i.e. assuming the vector contacts a susceptible ruminant). Consequently, the estimation of risk in a number of circumstances adopts a cautious approach.

**Conclusions**

While it is likely that BTV-4 will overwinter and therefore spread further north, whether it is able to reach the UK this year is uncertain. A key point for consideration is the time at which an incursion would occur, since an outbreak earlier in the vector activity period would enable further spread domestically [28]. This assessment suggests that scenario 3 poses the highest risk of BTV-4 entry to the UK this year, with a low – medium risk. It should be noted however, that the risk of BTV-4 entry, is heavily dependent on the speed with which the virus is able to spread. Consequently, should the virus spread faster than expected or re-emerge closer to the UK, then the risk of BTV-4 entry would increase.

Vaccines have been shown to be highly effective in BTV control by reducing the probability of an outbreak when given as a preventative measure [18, 28]. However, reactive vaccination (i.e. administering the vaccine when the virus is present) was found to have little effect on the likelihood of an outbreak, given the likelihood of an infectious vector contacting a susceptible animal is high, compared to the use of pre-emptive vaccination. As such, should the virus reach northern Europe during the vector activity period, the use of vaccines in the UK as a preventative measure may reduce the risk of entry into the UK, simply by reducing the susceptible pool.

**References**


34. DEFRA, GB Bluetongue Virus Disease Control Strategy: August 2014. 2014.

