Epidemiological consequences of bluetongue serotype 1 incursions to Great Britain

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1. Introduction

The spread of bluetongue serotype 1 (BTV-1) into northern France in 2008-9 raised the risk of an introduction of the serotype to Great Britain (GB). Vaccination has been shown to be an effective method for protecting livestock against BTV and for reducing incidence of disease. However, while an inactivated vaccine against BTV-1 is available, its use in a pre-emptive manner in GB would require the declaration of a restricted or blue zone for the serotype with the associated costs for the livestock industry. Using mathematical models we assessed the risk to GB livestock in the event of an introduction of BTV-1 and evaluated strategies for the deployment of vaccine.

2. Modelling Approach

- A stochastic, spatially-explicit model was used to describe the spread of BTV-1 within and between farms in GB [1,2].
- The within-farm model included two host species (cattle and sheep) and one vector population (*Culicoides*).
- Between-farm transmission was described by a Gaussian transmission kernel.
- Vaccination was assumed to reduce the vector-host and host-vector transmission probabilities with 100% efficacy [2].

3. Incursion Scenarios

- The average frequency of incursions to each southern county of England over the period May-Oct, 2006-2008 were assessed using a modified version of the Met Office's dispersion model, NAME [3].
- Coastal areas of north-west France were assumed to be source areas of windborne BTV-1 infected *Culicoides* biting midges.
- All counties on the south coast of England were at risk, with the western-most counties (Kent and Sussex) at greatest risk and Cornwall at the lowest risk.
- Simulations were then carried out for three incursion dates (1st May, 1st July, 1st Sept).
- For each date the relative incursion frequencies are used to select the county in which the introduction occurred.

4. Vaccination Scenarios

- Thirteen vaccination scenarios were considered
- Baseline scenario: no vaccination
- Six reactive scenarios: uptake 80% or 95% within 20, 50 or 100 km radius of infected farms
- Six pre-emptive scenarios:

  uptake 50%, 80% or 95% in blue zone BZ 1 or BZ 2, plus reactive vaccination at 95% uptake in a 20km ring

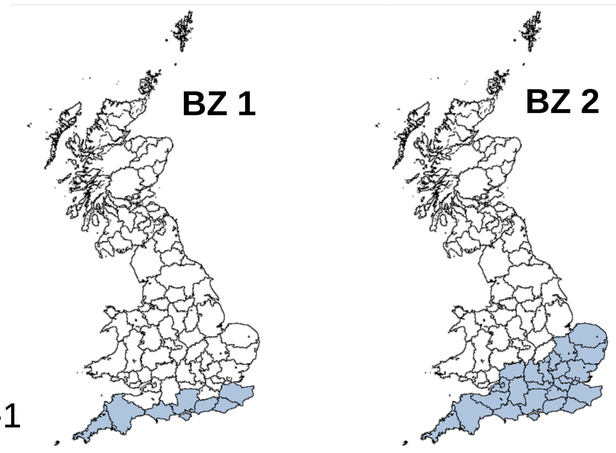

Figure 1. Blue zones (BZ) for BTV-1

5. Results

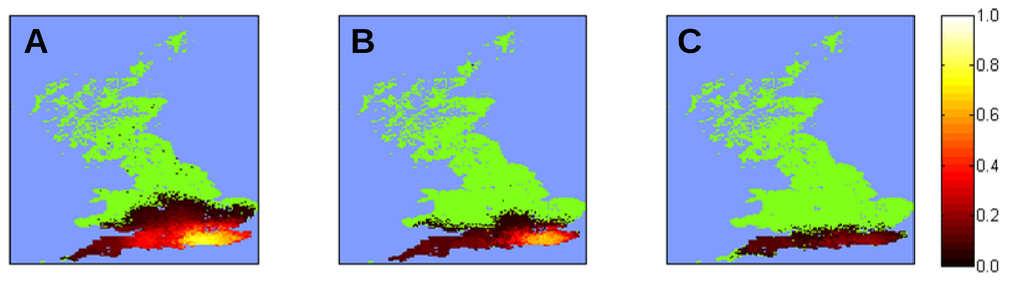

Figure 2. Cumulative risk of spread of BTV-1 in GB in the absence of vaccination for an incursion on A) 1st May, B) 1st July, C) 1st September

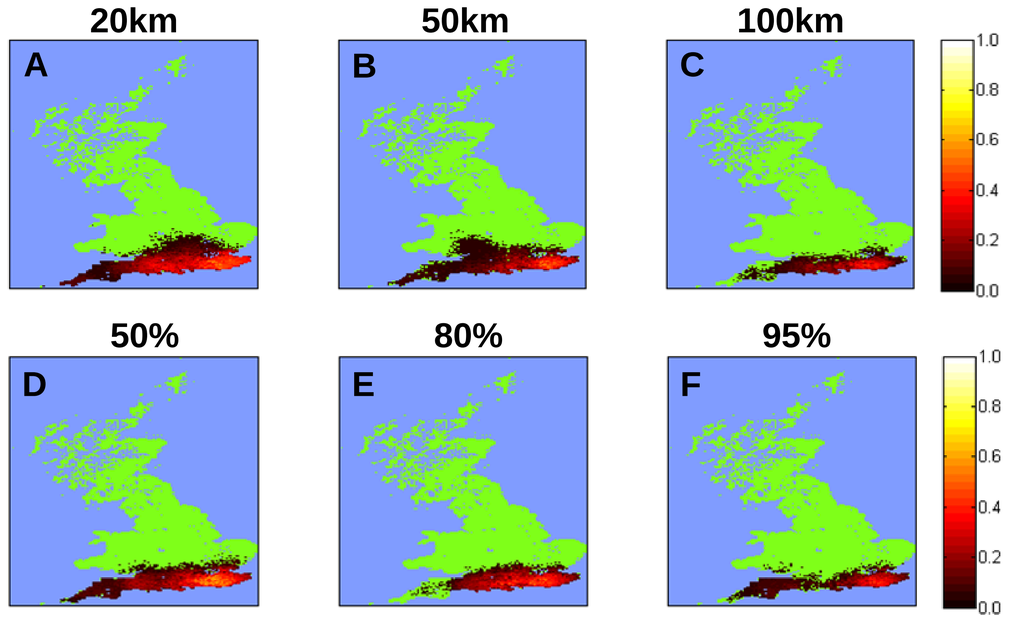

Figure 3. Cumulative risk of spread of BTV-1 in GB for (A-C) reactive scenarios with uptake of 95% (D-F) pre-emptive scenarios using BZ 2, when incursions occur on 1st May

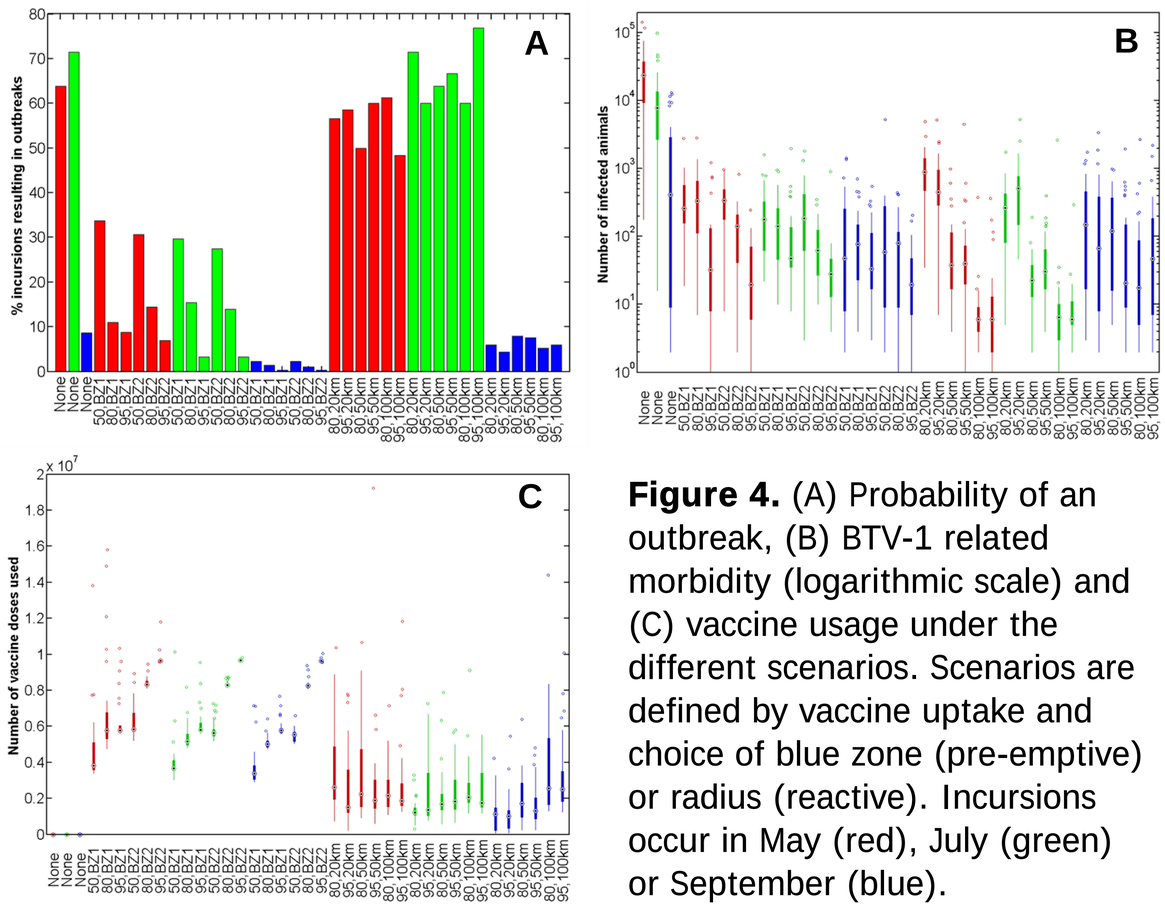

Figure 4. (A) Probability of an outbreak, (B) BTV-1 related morbidity (logarithmic scale) and (C) vaccine usage under the different scenarios. Scenarios are defined by vaccine uptake and choice of blue zone (pre-emptive) or radius (reactive). Incursions occur in May (red), July (green) or September (blue).

6. Conclusions

- In the absence of vaccination GB livestock are at risk from an incursion of BTV-1 to the south coast of England.
- The date of incursion significantly affects both the probability that an outbreak will take off and the size of an outbreak.
- The probability of an outbreak is significantly reduced by pre-emptive vaccination but, not by reactive vaccination.
- Both pre-emptive and reactive vaccination reduce outbreak size. The greatest reductions are seen for large-scale reactive vaccination.
- The size of the blue zone does not significantly affect the probability of an outbreak or the number of animals affected.
- The impact of reactive vaccination depends on the timing of the incursion and is greatly reduced for later incursions.

References [1] Szmaragd et al. (2009) *PLoS ONE*, **4**, e7741; [2] Szmaragd et al. (2010) *PLoS ONE* **5**, e9353; [3] Gloster et al. (2008) *Vet. Record* **162**, 298-302

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