

Modelling Bluetongue (BTV-3) spread and control for Scotland

Sibylle Mohr¹, David Ewing², Ian McKendrick², Louise Matthews¹, Harriet Auty¹, Giles Innocent², Luiza Toma³



¹University of Glasgow, ²BioSS, ³SRUC



Introduction

- Bluetongue virus BTV-3 is a non-contagious, viral disease that affects cattle, sheep, goats, deer, and camelids and is primarily transmitted by midges. Bluetongue does not present a risk to human health, but it is a notifiable disease in the UK and can have a devastating impacts on livestock.
- Increased incidence of midges carrying the BTV-3 virus from continental Europe have led to incursions into the East and South of England and disease risk is likely to increase with warmer temperatures due to climate change. There is now evidence of some local transmission of BTV-3 circulating in counties on the East Coast of England (Norfolk, Suffolk).
- The Scottish Government's Centre of Expertise in Animal Disease Outbreaks (EPIC) conducts simulation modelling, movement analysis and economic modelling to evaluate impacts and control options for BTV-3, to support Scottish Government decision-making to assess and minimise impacts on Scotland.

Methods

(1) Snap-out zones (movement analysis):

What are Snap-out zones?

- Movements within the zones are permitted.
- Movements from inside to outside zones are banned.
- On incursion of BTV to England, consideration given to snapping out control zones to the whole of England.

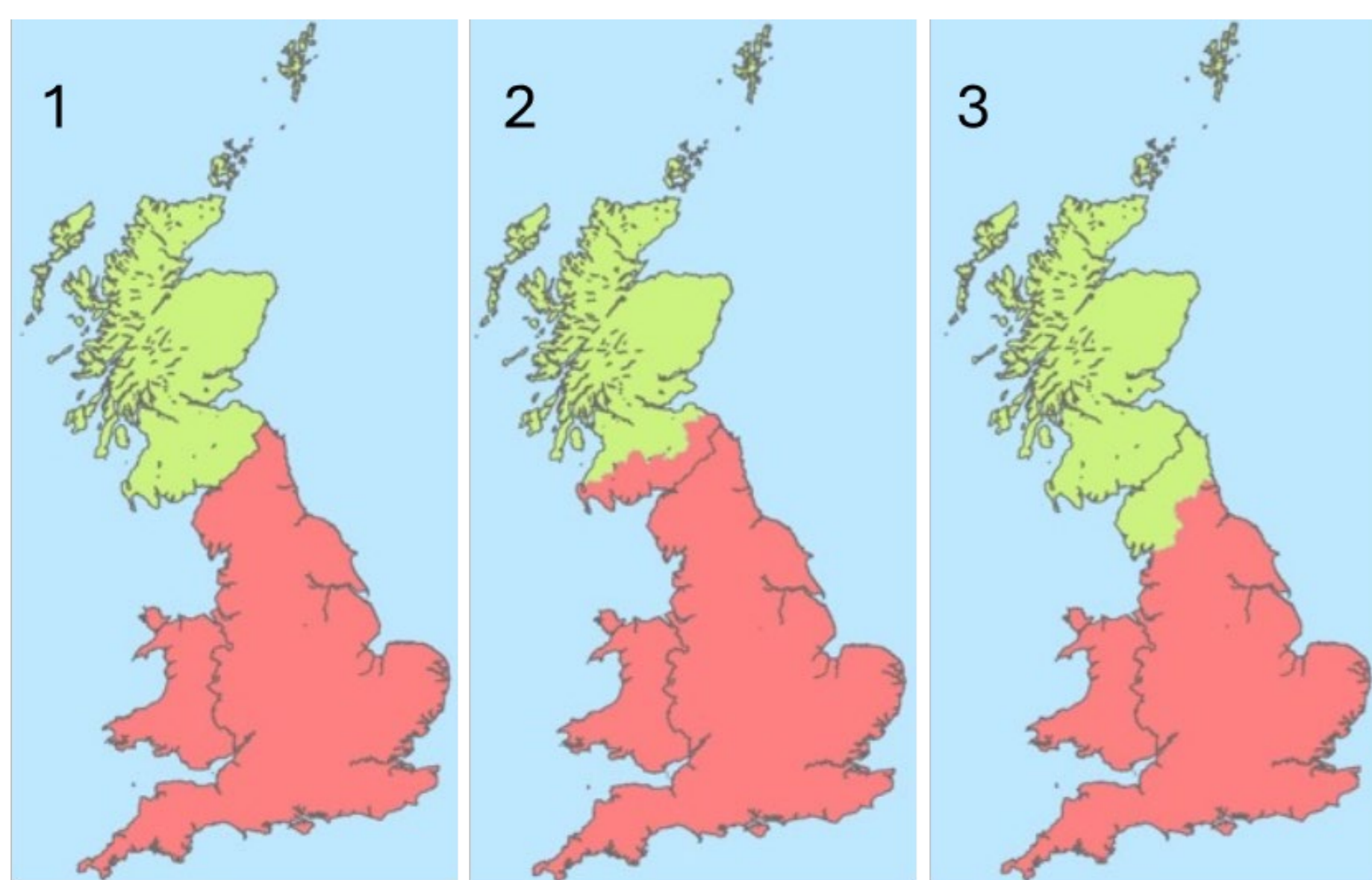
Question: What is the predicted impact on movements and trade for Scottish livestock under the following snap-out zone scenarios?

- (1) Baseline scenario – boundary is at the English/Scottish border: Scotland is outside any snap-out zones, and the whole of England and Wales are in the zones.
- (2) South of Scotland is part of the snap-out control zones.
- (3) North of England (along with Scotland) is outside the snap-out zones.

Data: Cattle and sheep movements in GB (2018 – 2023)



Fig. 1. The 3 snap-out zone scenarios. Animals can move from the green to the red areas, but not from red to green.



(2) Simulation Modelling:

Stochastic model:

Modelling the spread and control of bluetongue virus in Scotland (based on Bessell et al. 2016).

- Simulates between farm spread of BTV; parameterized to BTV-8.
- Generates dynamics of numbers of infected hosts and vectors.
- Between farm transmission based on choice of spatial kernels.
- Extrinsic virus incubation period dependent on mean monthly farm temperatures.

Modelling Scenarios:

- Btv-3 introduction into East Coast of England / Southern Counties of Scotland / Northern Counties of England using HadUK historical 5km-gridded temperature data.
- Evaluate changes if mean temperatures increase by 1°C.
- Ongoing work on vaccination scenarios.

Results

Snap-out zones analyses:

- Including the Southern Scotland (Scenario 2) is most detrimental to Scottish livestock movements: cattle more affected (~9% drop in cattle movements compared to Scenario 1).
- For sheep, the impacts of Scenario 2 are less detrimental, -> ~95% of Scottish sheep can be moved.
- Excluding the Northern counties of England (Scenario 3) allows most Scottish livestock to be moved (99% of sheep, 98% of cattle) but improvements on Scenario 1 are small (~2% increase of movements).

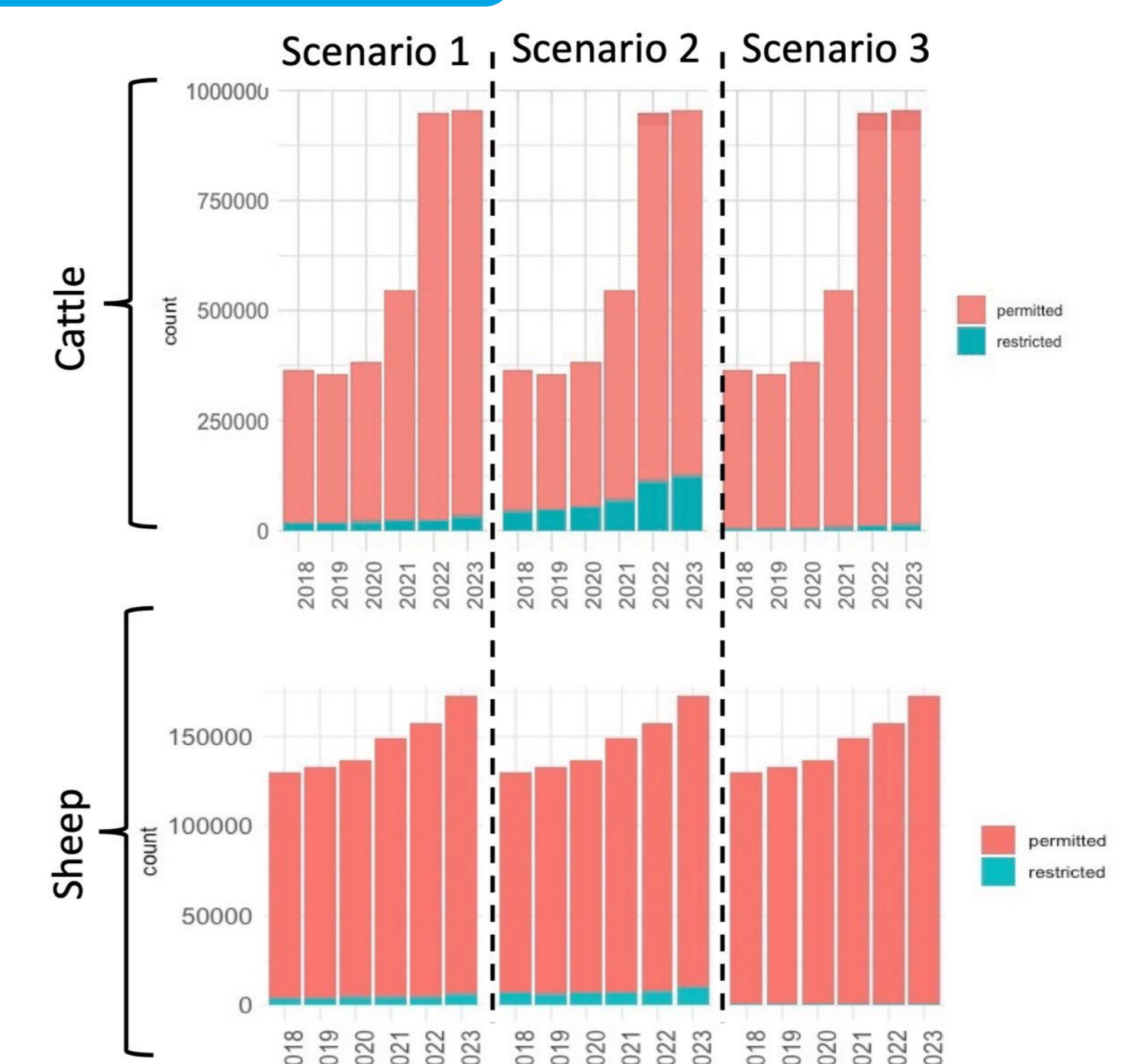


Fig. 2: No. restricted (green) vs. permitted (red) moved livestock for each snap-out zone scenario for cattle (top) and sheep (bottom), as applied to 2018-2023 movement patterns. Scenario 1: England/Wales only snap-out zone; Scenario 2: Southern Scotland in snap-out zone; Scenario 3: Northern England excluded from snap-out zone.

Simulation analyses:

- Incursions seeded into the East Coast of England are predicted to have minimal impact on Scotland.
- There is predicted to be some risk of onwards transmission when seeding in Southern Scotland or Northern England but only minor outbreaks are predicted for Scotland.
- Increased temperatures are predicted to cause larger outbreaks.

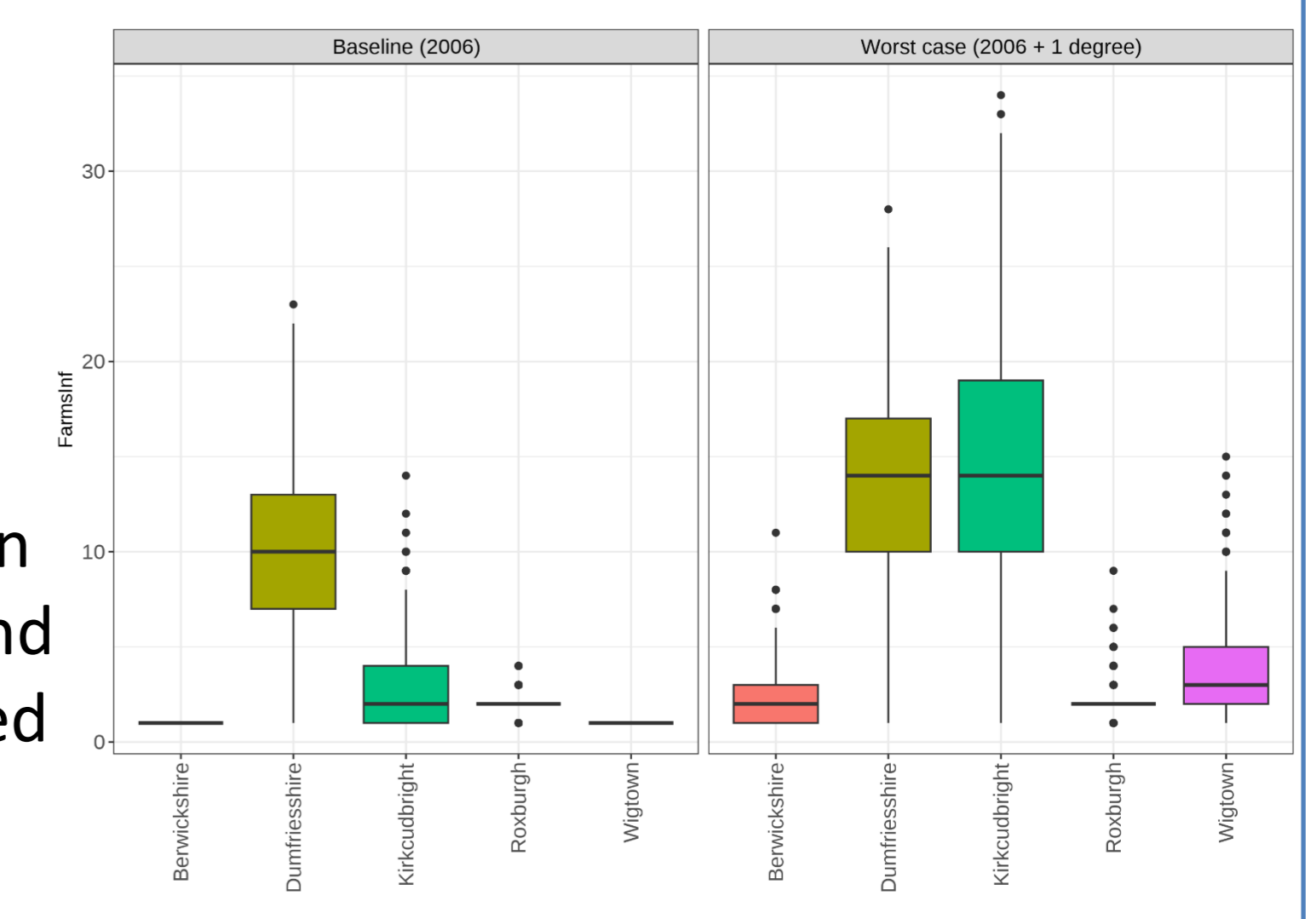


Figure 3: No. of farms in each county of southern Scotland predicted to be infected when BTV is seeded in Southern Scotland under recent climate scenario (left) and under 1°C climate warming (right).

Discussion

- Simulations predict that any incursion in Scotland would cause only minor BTV-3 outbreaks.
- Higher temperatures lead to larger outbreaks but impacts on Scotland are small; highest risk estimated to be when introduction occurs in June/July.
- Simulation model has been adapted to use daily temperatures (both historical and climate projections); Economic modelling of scenarios under way.

References:

Bessell et al. (2016). Assessing the potential for Bluetongue virus 8 to spread and vaccination strategies in Scotland. *Sci Rep.* 2016 Dec 13;6:38940. doi: 10.1038/srep38940. PMID: 27958339; PMCID: PMC5154200.

