RESEARCH BRIEF: Assessing the risk of CSF spread in Great Britain and its implication for Scotland.
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1. KEY MESSAGE

Using a simulation model of Classical swine fever (CSF), we found that large outbreaks would be rare and generated from a limited number of areas in GB. However, incursions in Scotland show significant potential to generate epidemics that spread across the entire British industry. The risk of spread from incursions in small producers (backyards and crofters) is low but these incursions could still generate widespread epidemics. These findings also have relevance for spread of African swine fever (ASF).

2. MAJOR FINDINGS

- The extent of CSF spread varies with the amount of time taken to detect disease after incursion (the high risk period, HRP). For example increasing the HRP from 2 to 8 weeks means a single introduction event would generate an epidemic (i.e. with at least 3 IPs) 7.8% rather than 2.8% of the time.
- Introduction events were restricted to the primary case 91.3% (for HRP of 2 weeks) to 81.3% (HRP of 8 weeks) of the time.
- Although unlikely, widespread epidemics (>50 IPs) of CSF could happen at any time of year in GB, regardless the duration of HRP.
- The location of introduction is important. Although the overall risk for CSF to spread and generate epidemics is low in both Scotland and the rest of GB, epidemics were more likely to occur if incursions were located in specific areas. In Scotland the highest risk areas to generate an epidemic is the North East (see Figure). Although most high risk areas have a high density of pigs, indicative of the location of industry hotspots, risk is also related to areas of high backyard farm density.
- The type of farms in which CSF is introduced is also important. Overall, an incursion occurring in a quality-assured pig holding would generate an epidemic 25% of the time if left undetected for 8 weeks. In contrast, an incursion in a small producer has a low risk of CSF spread in GB, but epidemics of >50 farms can still occur. This is because epidemics generated from incursions in high risk areas will generate large epidemics, regardless of the type of farms in which introduction occurs.
- The mechanisms of disease spread significantly differ between Scotland and the rest of GB. When incursions occurred in Scotland, spread was predominantly linked to animal movements, whereas spread from incursions in England and Wales was frequently due to local spread.

3. OBJECTIVES

The objectives of this modelling study were to (1) evaluate the potential for CSF to spread in Great Britain, and (2) explore how the risk of CSF spread varies with the time taken to detect an incursion as well as the geographical location and the producer type of the primary case.

4. POLICY IMPLICATIONS

- These findings help to determine the likely level of spread for an incursion, and inform where and when surveillance activities should be implemented to detect incursions of swine fever (CSF and ASF).
- Efforts should be made to ensure surveillance activities include small producers as well as to raise awareness of diseases and best practices in this sector of the industry.

5. IMPORTANT ASSUMPTIONS AND LIMITATIONS

The spread of CSF within the British swine industry was modelled using a spatially explicit, premises-based, discrete-time model in which within-farm prevalence is modelled explicitly. The model comprises modules which account for (1) the transmission of the disease between premises, (2) the influence of the within-farm prevalence on disease transmission between premises, and (3) mitigation and surveillance activities carried out to control epidemics.

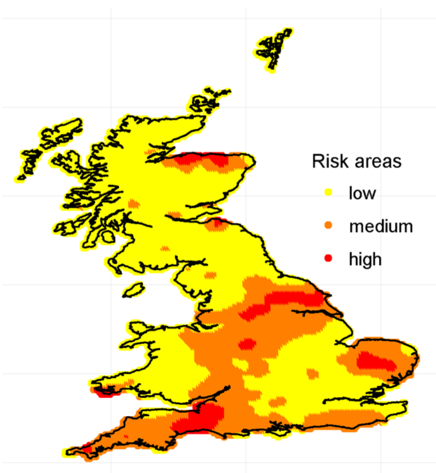
The spatial distribution of pigs and pig farms in Scotland, England and Wales were extracted from the Scottish Agricultural and Horticultural Census (2011 to 2013), English Survey of Agriculture, Horticulture, and Labour (2010) and the Survey of Agriculture and Horticulture (2011 to 2012), the Welsh Agricultural & Horticultural Survey (2010), and the Quality Meat Scotland (QMS) and Red Tractor registers for 2013. All non-slaughter movement data were extracted from ScotEID and AMLS.

The model incorporates the transmission of disease from premises to premises through the movement of pigs and through local spread following the introduction of CSF in a single randomly selected farm in GB.

The model is underpinned by a number of assumptions:

1. The model does not include the role of wild boar, sharing haulage vehicles or semen as transmission routes.
2. The local transmission and detection probabilities were based on the 2000 CSF outbreak in East Anglia and considered to be representative of all infected farms in UK, regardless of their production type, population size and within-farm prevalence.
3. In the model, all infected gathering places go back to the susceptible state after one day whereas infected farms would be culled within 24hours from the time of detection.

6. FIGURES



Spatial distribution of the risk areas for epidemic take-off in GB. Risk areas were identified based on the computed probability that a unique primary case generates epidemics which involves at least two other farms. All simulations in these figures considered an eight-week high risk period.

7. LINKS TO EXISTING PUBLICATIONS OR REPORTS

The work presented in this research brief was published in:

- Porphyre, T., Correia-Gomes, C., Chase-Topping, M.E., Gamado, K., Auty, H.K., Hutchinson, I., Reeves, A., Gunn, G.J., Woolhouse, M.E.J., 2017. Vulnerability of the British swine industry to classical swine fever. Scientific Reports 7, 42992. doi: 10.1038/srep42992.

The kernel transmission function and the detection function used in the model were published in:

- Gamado, K., Marion, G., Porphyre, T., 2017. Data-Driven Risk Assessment from Small Scale Epidemics: Estimation and Model Choic for Spatio-Temporal Data with Application to a Classical Swine Fever Outbreak. Frontiers in Veterinary Science 4, 16. doi:10.3389/fvets.2017.00016