Short-term Visit Report
Sadie Ryan and Michael Tildesley

Project Title: Using GIS to inform spatial epidemic models of disease transmission in US farms.

Sadie Ryan
National Center for Ecological Analysis and Synthesis (NCEAS)
University of California
735 State Street, Suite 300, Santa Barbara, CA 93101-5504
sjryan@nceas.ucsb.edu

Michael Tildesley
Centre for Immunity, Infection and Evolution,
University of Edinburgh,
Ashworth Labs, West Mains Road, Edinburgh EH9 3JT, UK.
michael.tildesley@ed.ac.uk

The UK 2001 foot-and-mouth disease (FMD) epidemic demonstrates what can be achieved when comprehensive spatial models and detailed host and case data are brought together. However, such data are rarely available for other diseases and farm demographies. In the USA, the only farm demography data in the public domain is available from the National Agricultural Statistics Service, which details the number of farms and livestock within each county and some information on farm size distribution. However, there is no indication of precise location or farm size. It is therefore vital to understand the precise role that knowledge of farm location has upon both potential epidemic sizes and preferred control strategies. Preliminary work shows that if our model is carefully parameterized to match epidemic behavior, aggregate UK county-scale data is sufficient to closely determine optimal control measures (specifically ring culling). This result also holds when extended to theoretical distributions of farms where the spatial clustering can be manipulated to extremes.

We have built on this analysis to investigate the geographical knowledge that will be needed to predict and manage future epidemics of FMD in the USA. Our recent work at NIMBioS suggests that location may be important where certain types of clustering occur (e.g. larger farms near each other), and that, when the model is not parameterized to match epidemic behaviour (as would be the case for predictive analyses), a lack of geographic accuracy will mislead management predictions, leading to a lack of disease control. To assess how addressing this geographical knowledge gap might work, using existing land use maps, we also developed “informed” location estimation maps (expert opinion) to test qualitative approaches to targeting control.

We plan to extend ongoing analyses to include 4 counties in the UK (Cumbria (England), Devon (England) Aberdeenshire (Scotland) and Clwyd (Wales)) and 5 counties in the US (Lancaster PA, Cuming NE, Franklin TX, Wright, IA, Humboldt IA) to explore a range of geographic scenarios. Additionally, we plan to move beyond modelling to address the issues of veterinary management options. The USA not only presents information privacy issues, but may also be more receptive to vaccination

programs than culling, so we are modelling the two control measures in tandem for this project, in discussion with veterinarians. We seek to create future model frameworks that can be adapted to other livestock diseases such as Bovine tuberculosis (BTb) and Brucellosis, and which will be appropriate to veterinary practice in the USA. In the absence of accurate spatial data, an approach such as this may provide efficient contingency plans to combat future outbreaks of disease.