Public Health England

Protecting and improving the nation's health

Spatial distribution of Shiga-toxin producing *E.coli* O157 in relation to agricultural land use in England.

Richard Elson. March 2016.

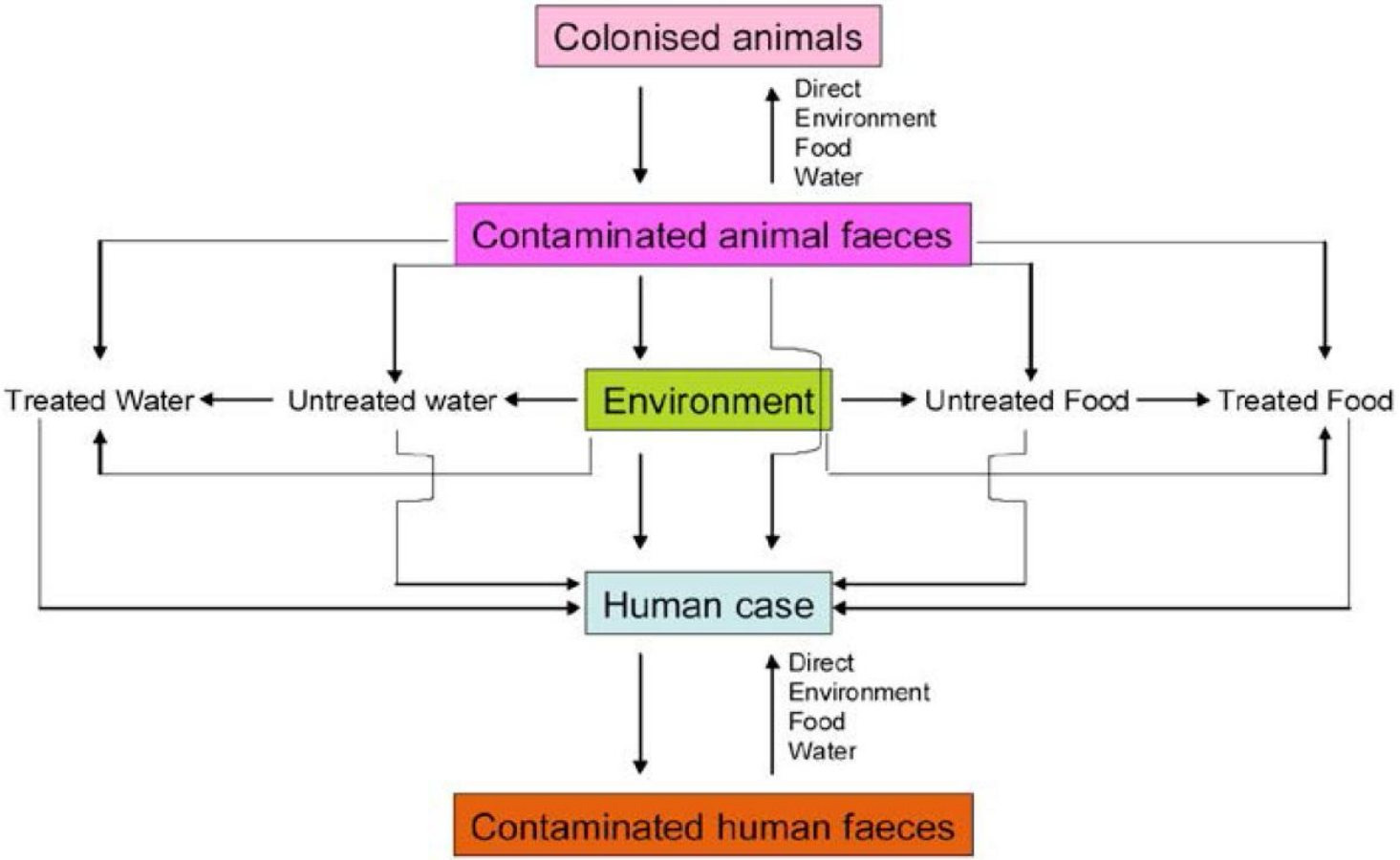
Overview

- Background
- Modes of transmission
- Risk profile of cases in England
- Spatial analysis VTEC O157 cases and cattle

The pathogen

- First identified as a pathogen in 1982
- Causes a range of symptoms – asymptomatic → life threatening
- Diarrhoea precedes HUS in around 10% of cases
- Low infectious dose
- Survives well in the environment
- Ruminants considered to be the main reservoir.

Modes of transmission



Risk profile - England

Exposure	Odds Ratio	P value	Cases exposed
Food from market stalls	2.93	0.02	7%
Watercress	2.61	0.01	9%
Farm contact	2.45	0.0004	24%
Travel away from home	2.23	0.0002	27%
Paddling	2.13	0.01	11%

Oct 1996 - Dec 1997; N=369

O'Brien *et al*. *EID. 2001*

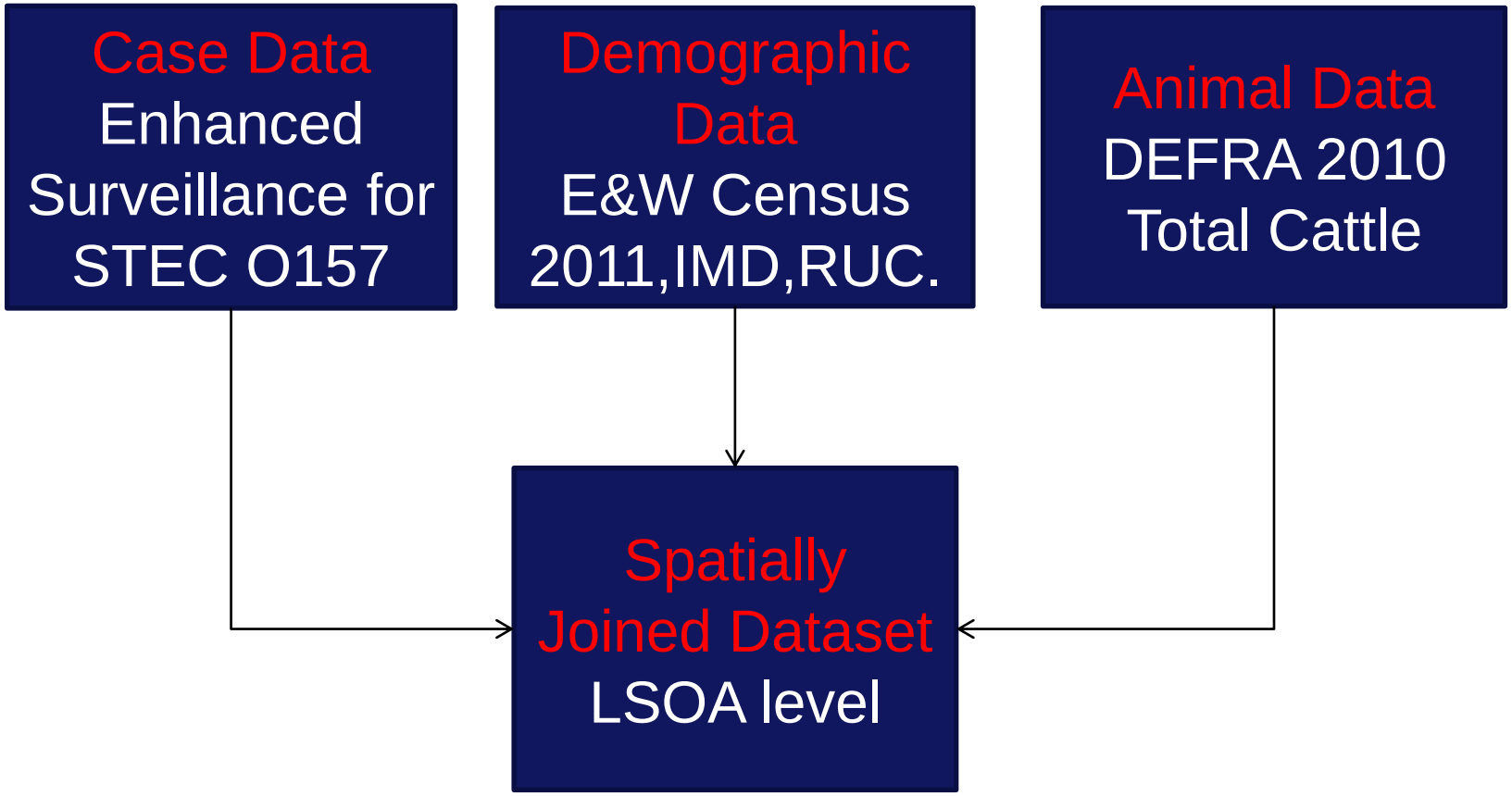
Risk profile - England

- Rates of infection higher in children and women.
- Incidence over 4 times higher among people living in rural areas compared to urban areas.
- Exposure to private water supplies, open fresh water, livestock and or their faeces was reported twice as often by people living in rural areas.
- Urban cases more likely to report visiting a farm, rural cases more likely to report living on or working at a farm or having access via family members.
- (Byrne et al. The Epidemiology, Microbiology and clinical impact of Shiga toxin-producing *Escherichia coli* in England, 2009-2012. In print.)

- VTEC incidence associated with higher cattle density, higher ratio of cattle to people and higher minimum temperature.

  (Grace, K. Investigation into the spatial and temporal patterns of sporadic cases of VTEC O157 in England 2009-2011. Unpublished MSc thesis 2013)

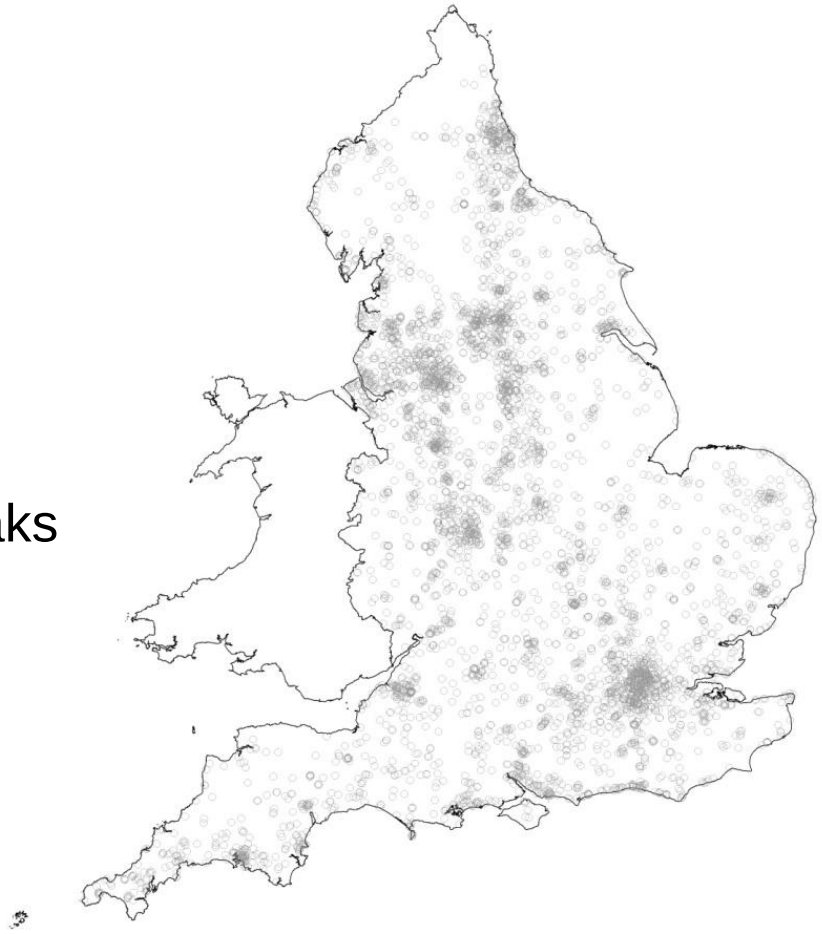
Data sources



Study population

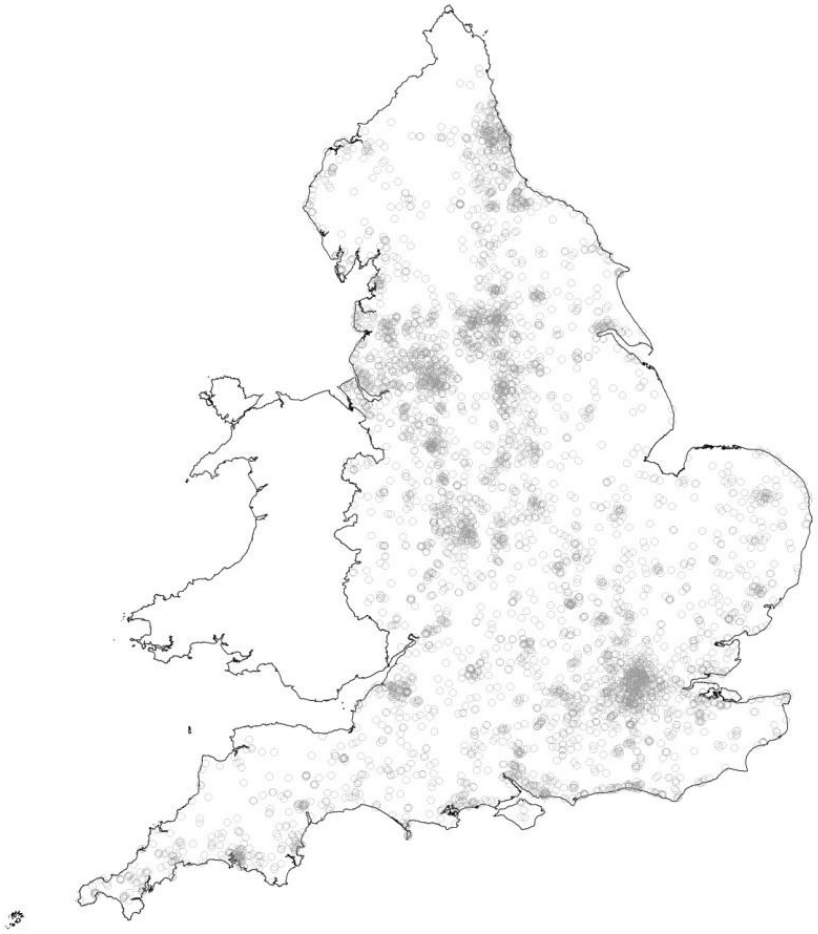
- Total of 4, 147 cases reported between 2009 and 2014.

- 24% linked to general outbreaks
- 22 % linked to household outbreaks
- 54% considered sporadic



Sporadic cases

- 70% live in areas considered to be urban
- Rates highest in rural areas (Rural CI 6.8/100K; Urban 12.7/100K)
- Rates highest in pre-school age band in both settings.
- Highest rates in males in pre-school and school age bands.
- Travel in UK reported by 20% of cases more cases in urban areas. (Urban 70%; Rural 30%)



Spatial distribution

Nearest neighbour analysis

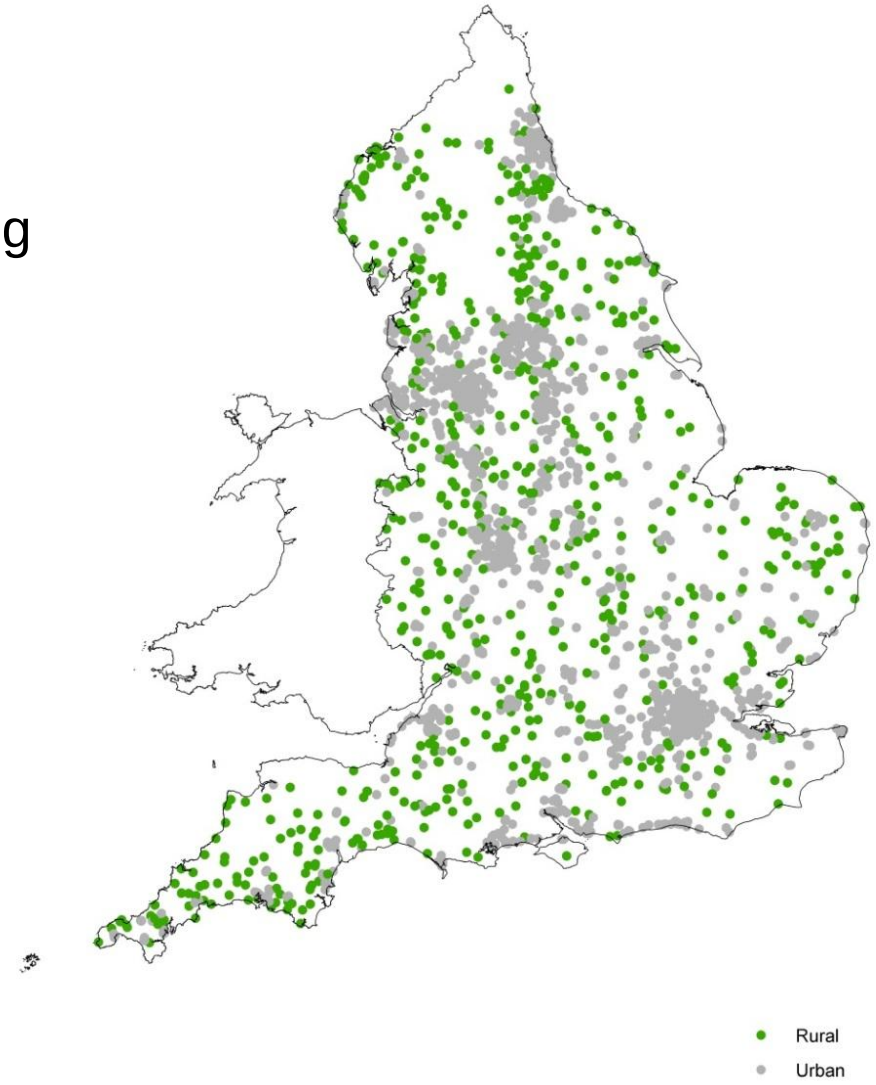
- Cases are not randomly dispersed
- Spatial relationships differ by setting
- NNR<1 indicates clustering

Rural

- Observed mean distance 5.9kms
- NNR =0.6 p<0.05

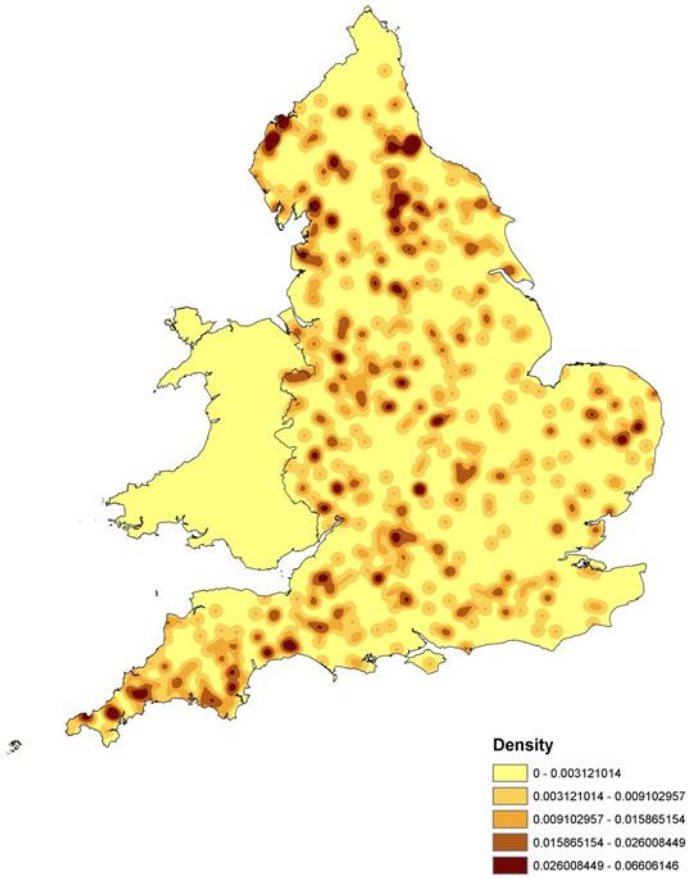
Urban

- Observed mean distance 2.1kms
- NNR=0.3 p<0.05

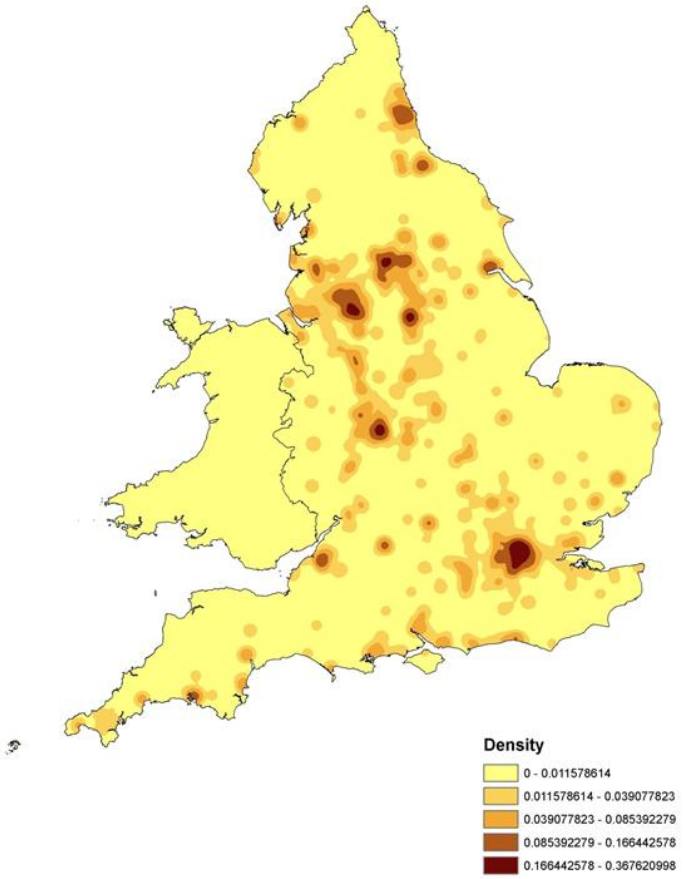


Rural and urban density

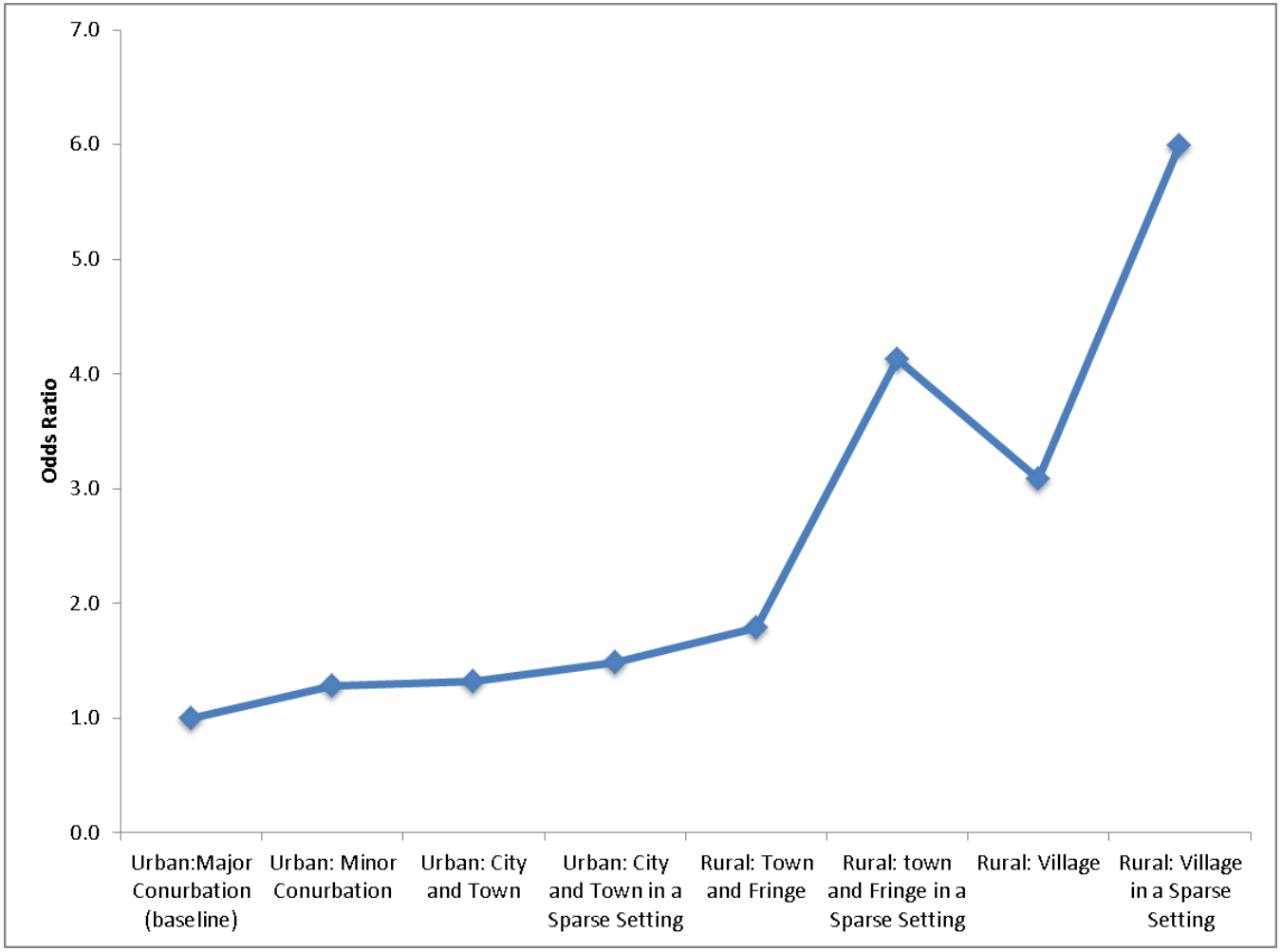
Rural



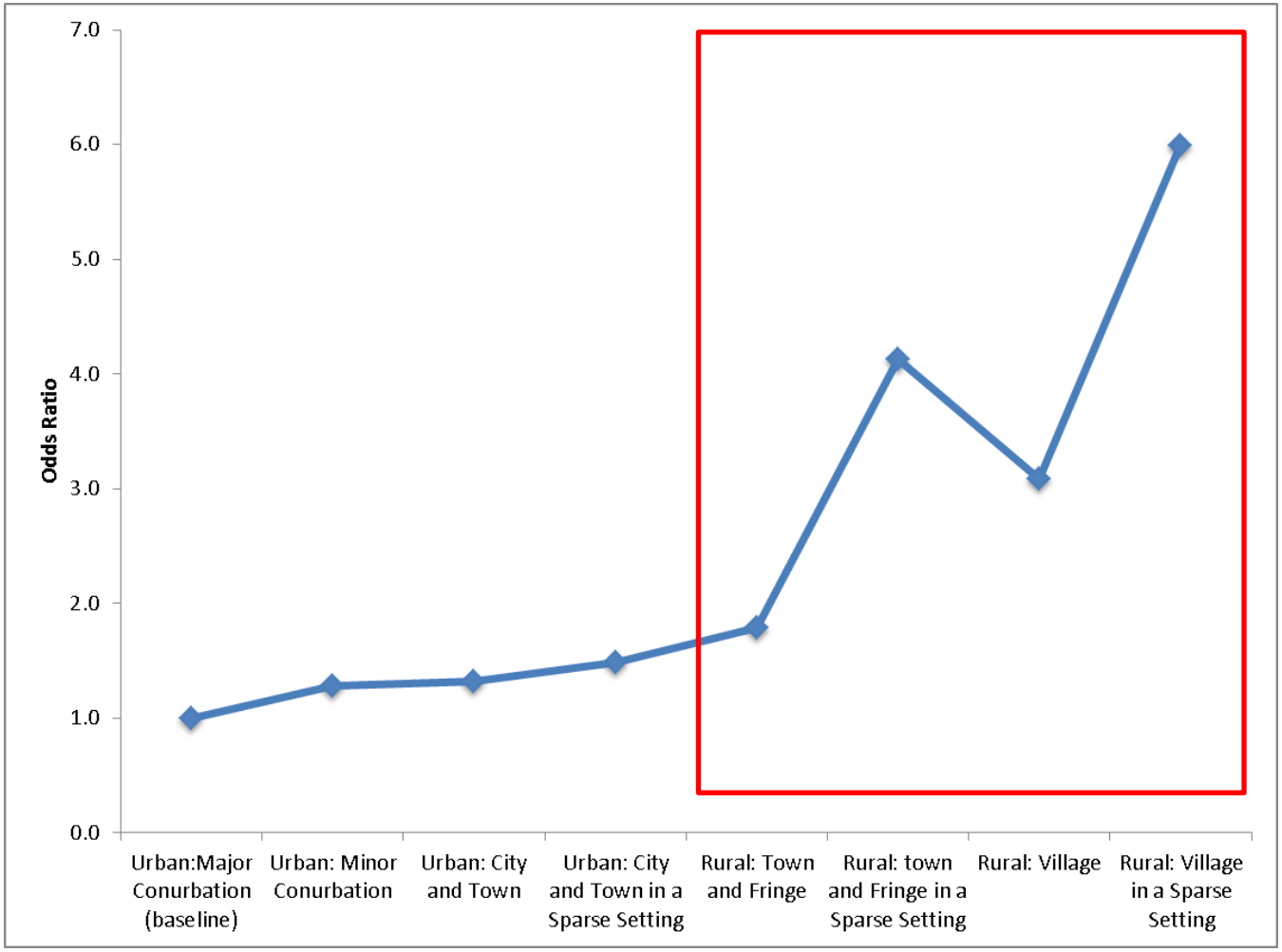
Urban



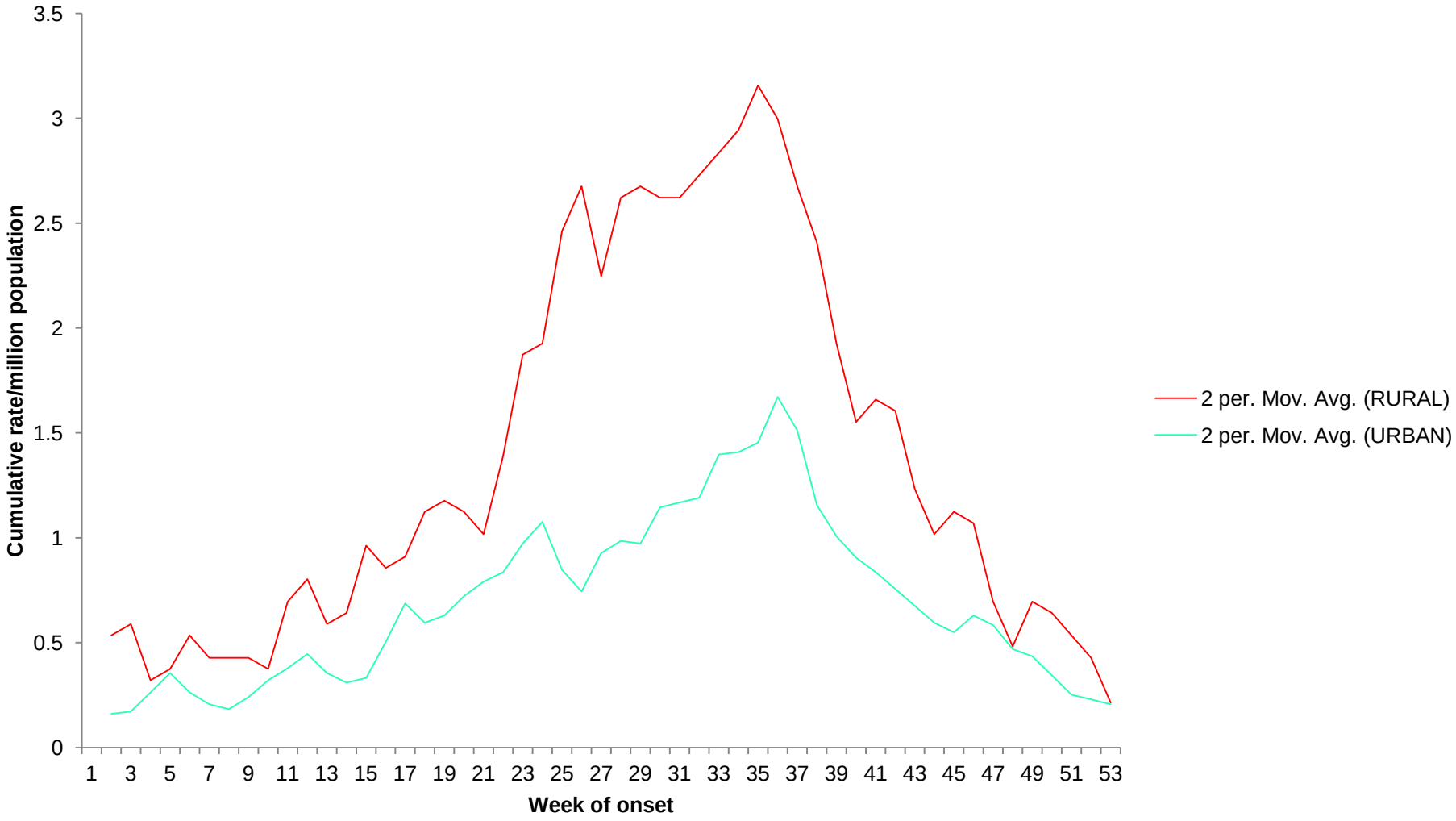
Place of residence



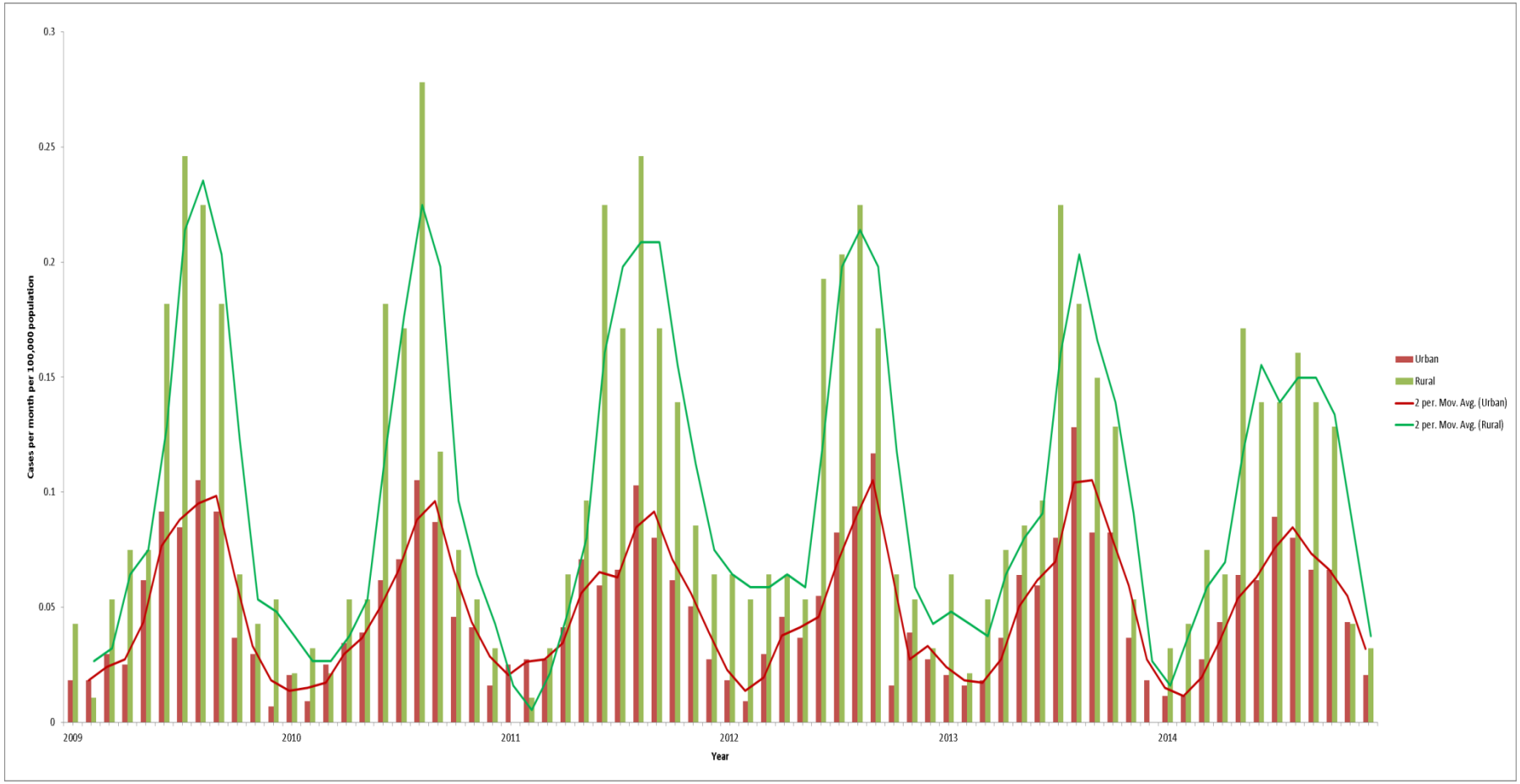
Place of residence



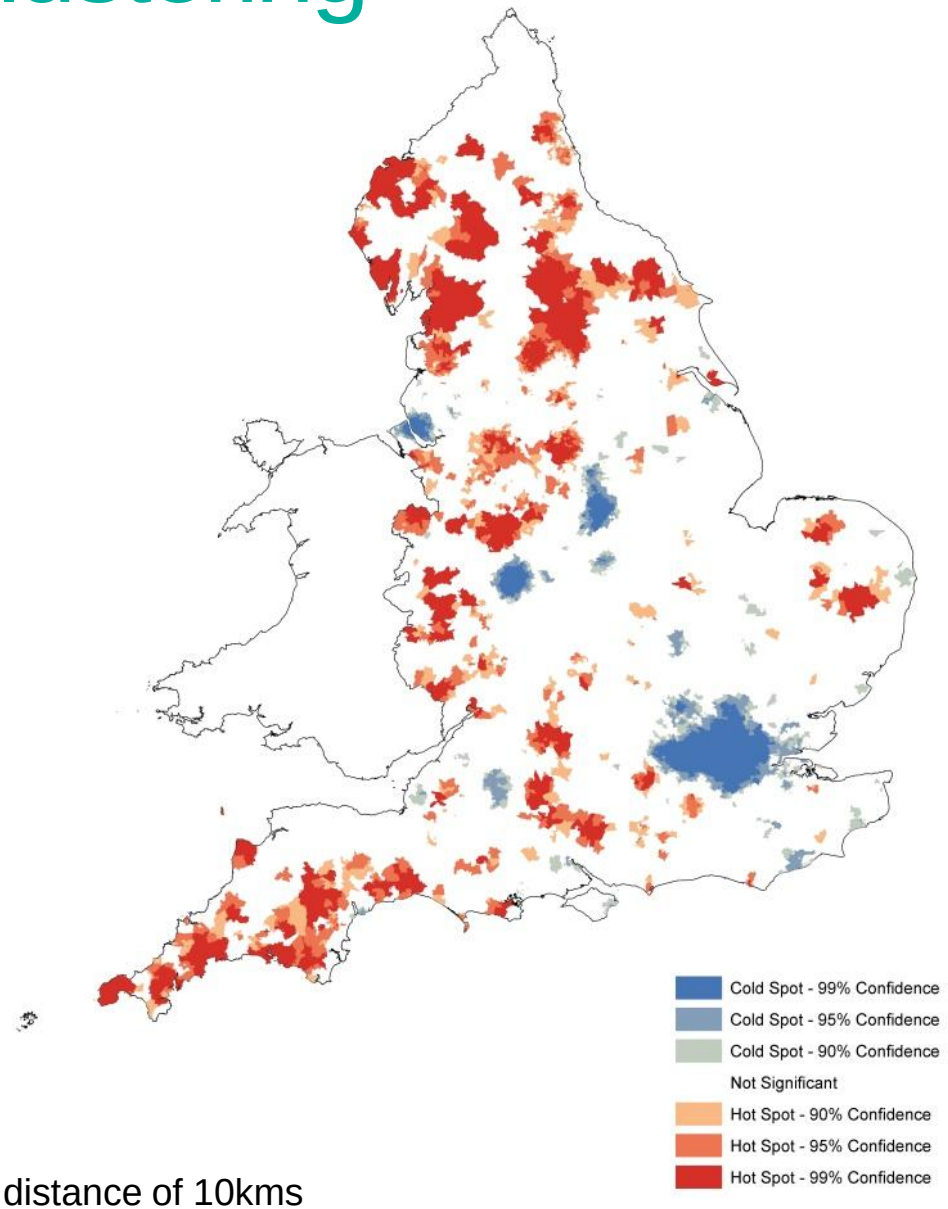
Seasonality of infection



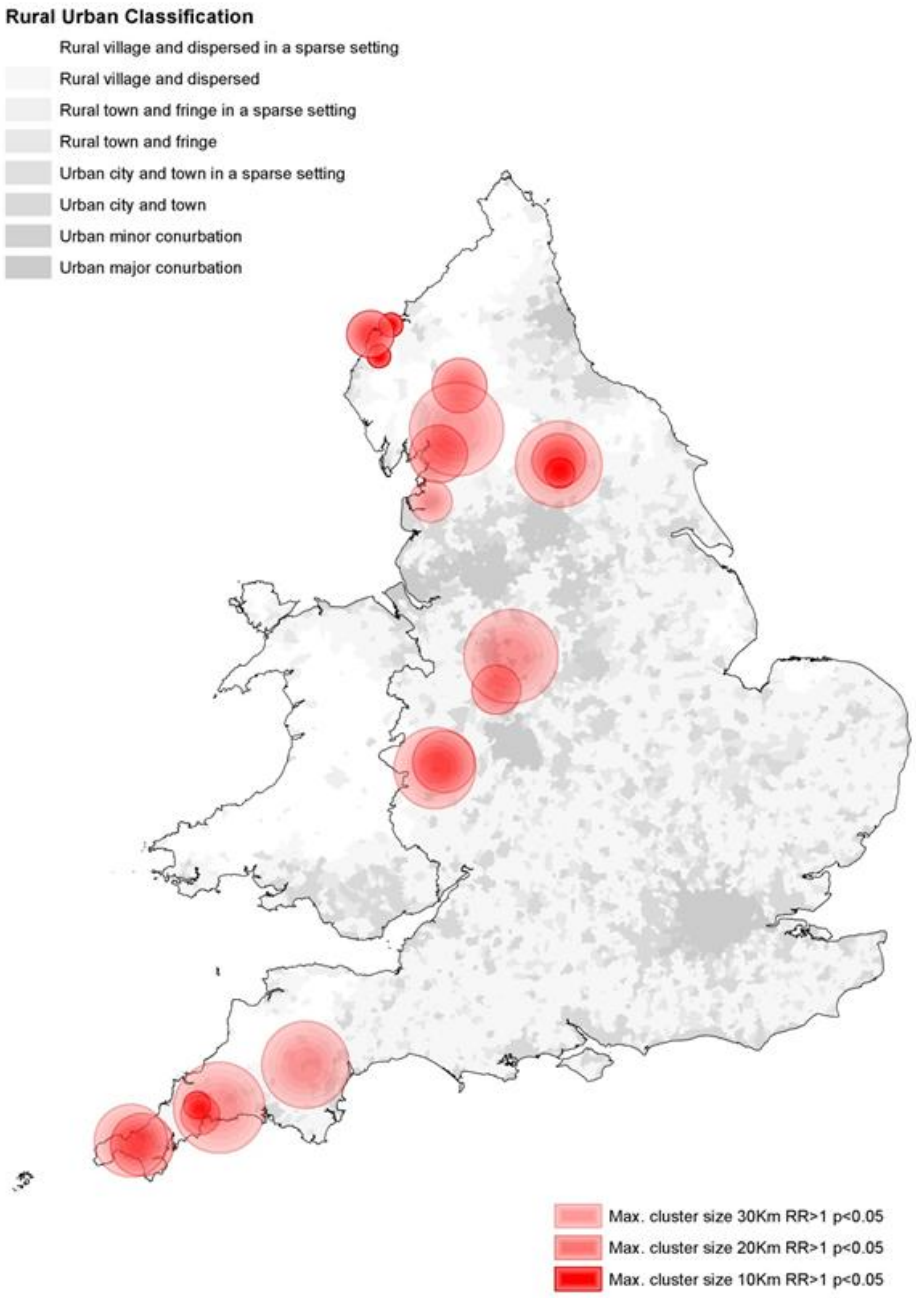
Seasonality



Spatial clustering

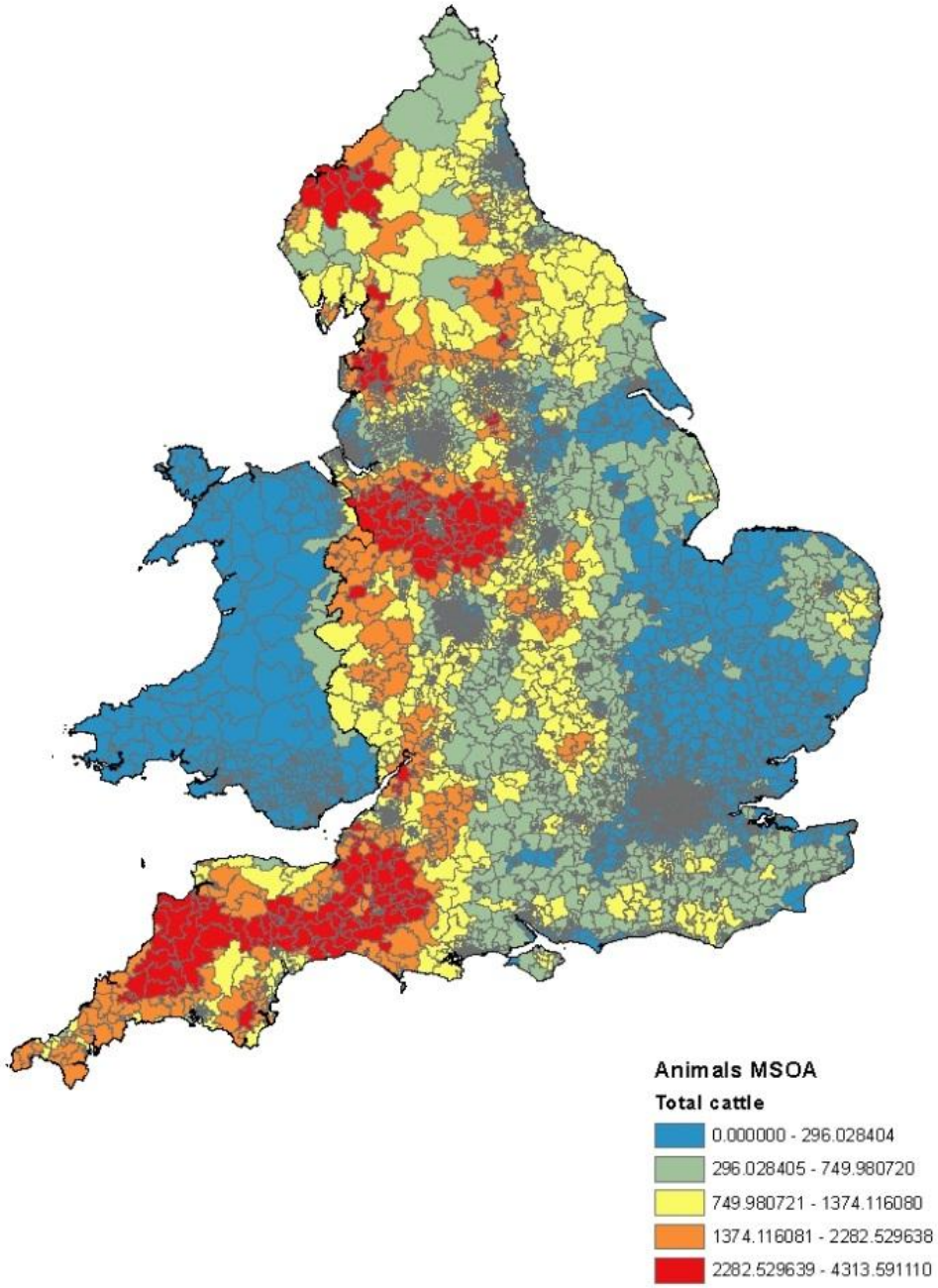


Getis Ord Gi* statistic. Fixed distance of 10kms

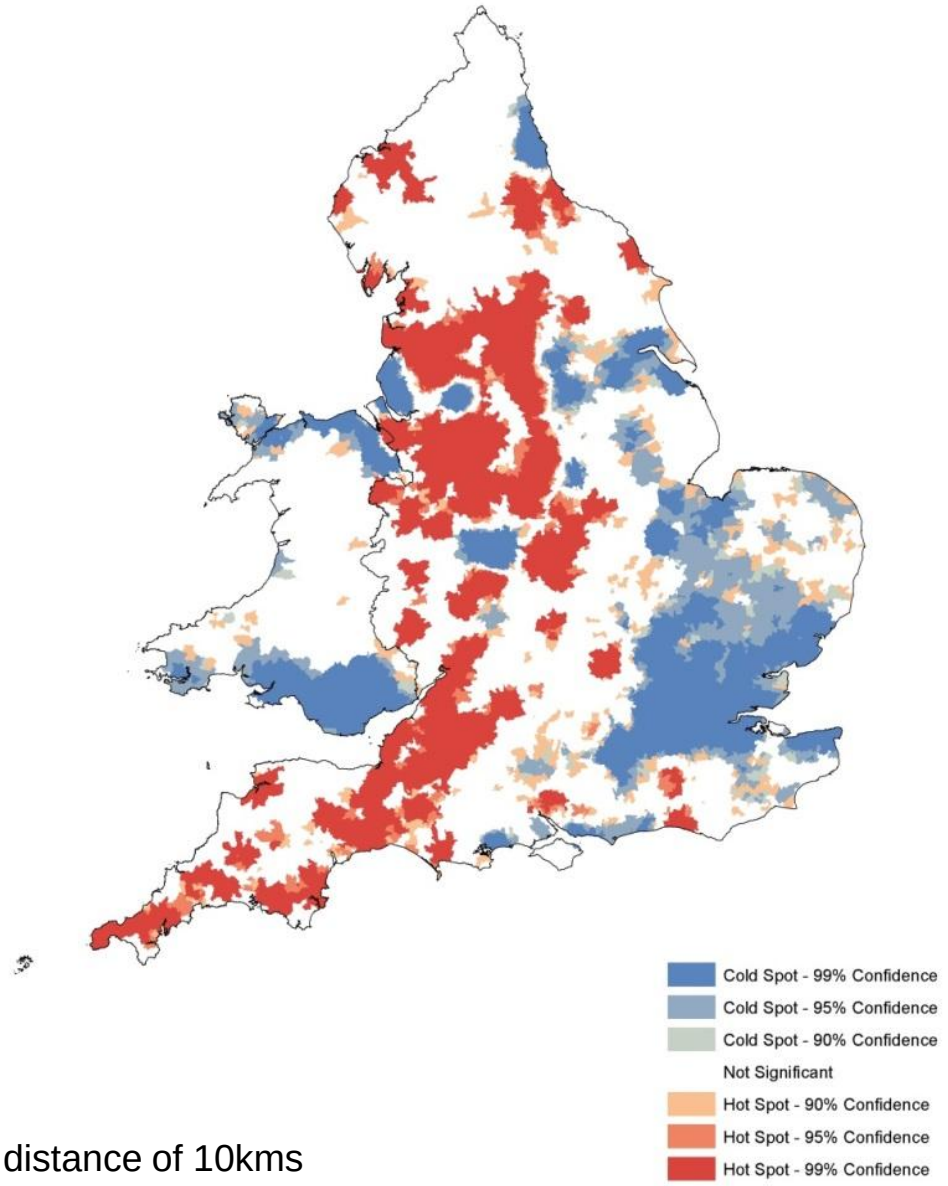


SaTScan, discrete Poisson model. 50% of population at risk. Max. cluster size 10-30kms.

Cattle


Animals MSOA
Total cattle
0.000000 - 296.028404
296.028405 - 749.980720
749.980721 - 1374.116080
1374.116081 - 2282.529638
2282.529639 - 4313.591110

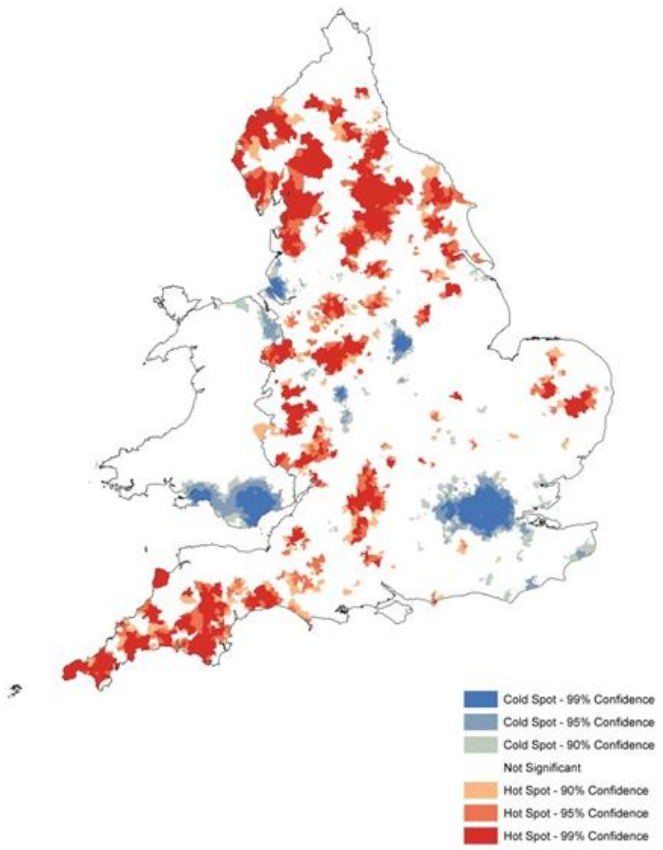
Spatial clustering – cattle.



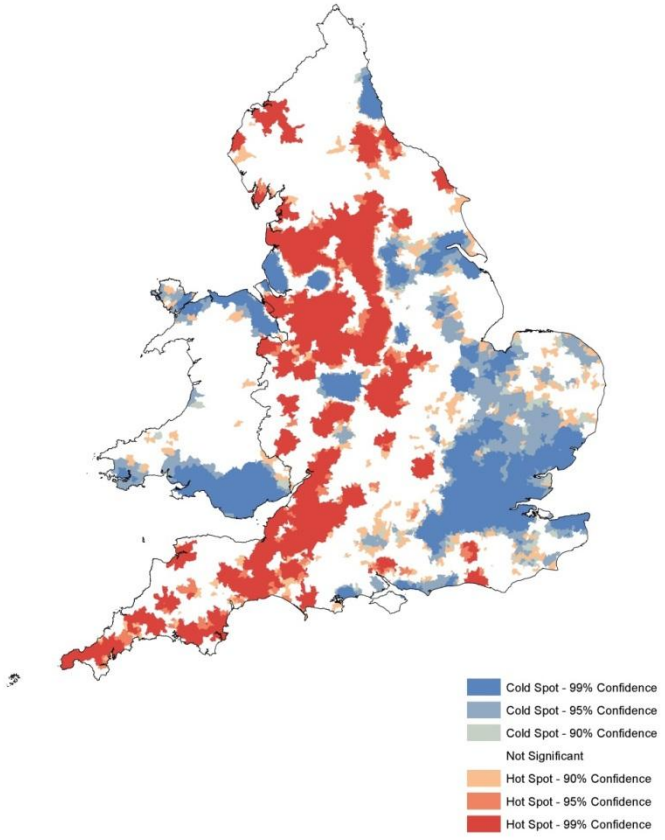
Getis Ord Gi* statistic. Fixed distance of 10kms

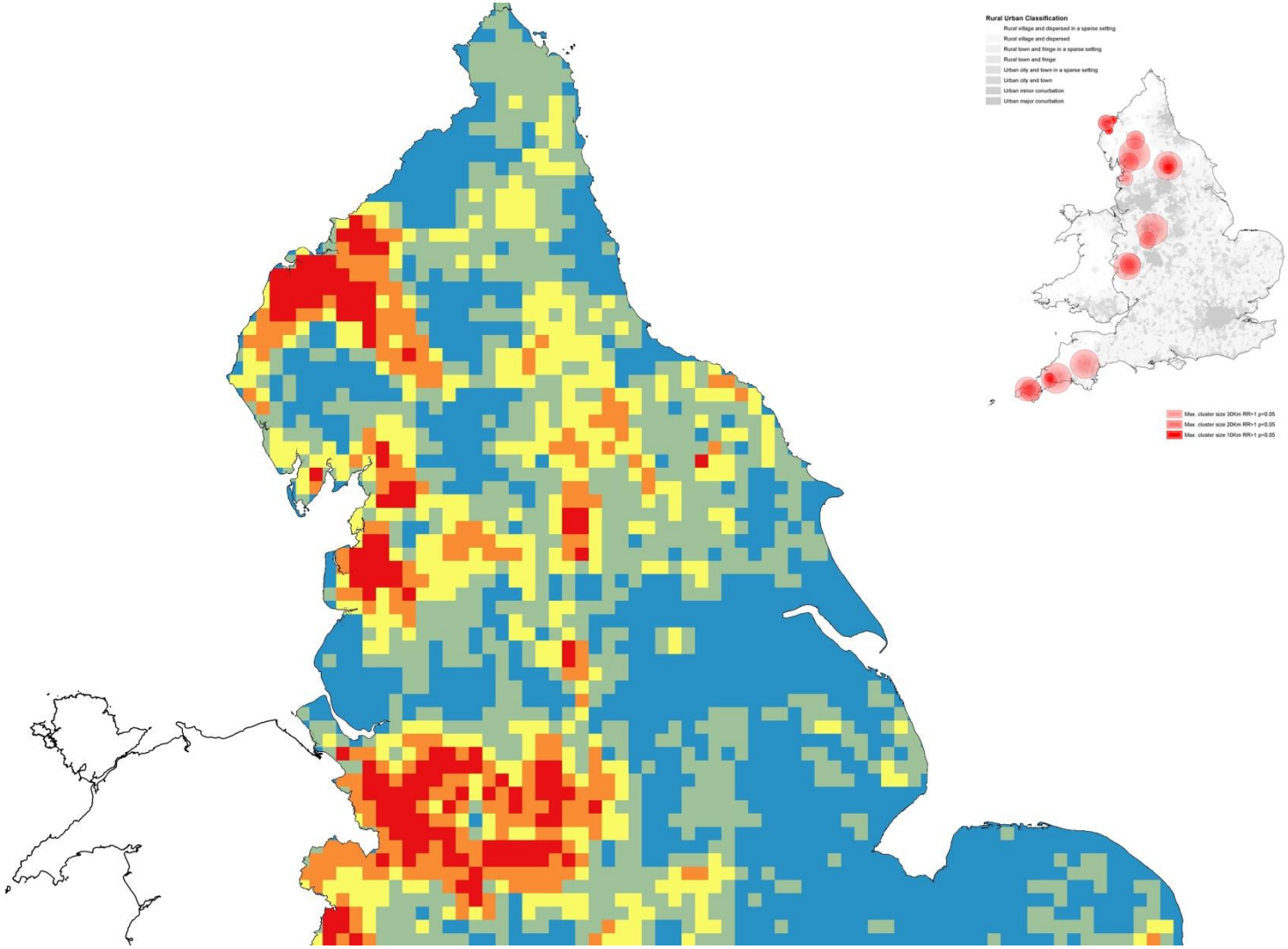
Spatial clustering

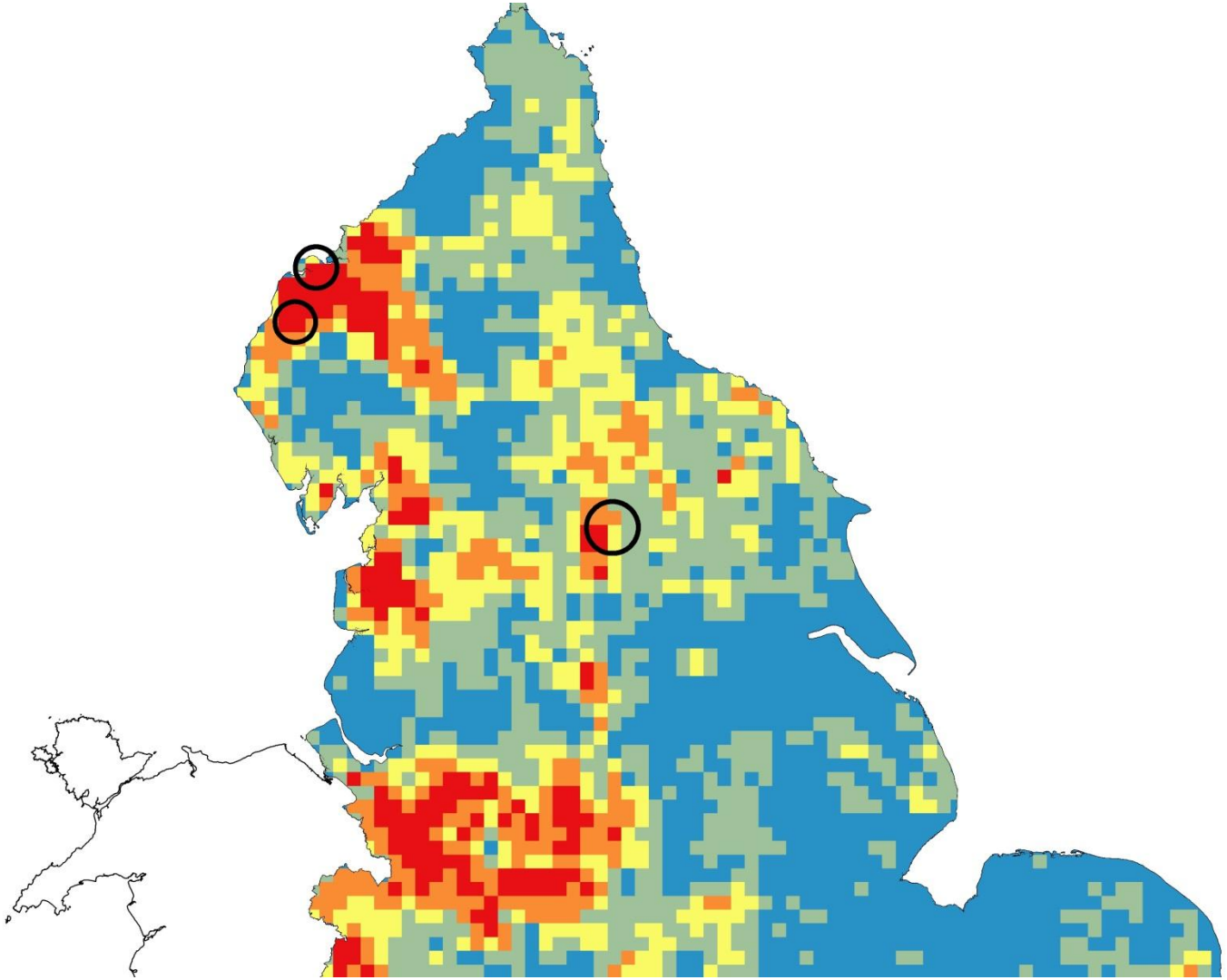
Clusters of sporadic cases of STEC O157 2009-2014
using the Getis-Ord* statistic.

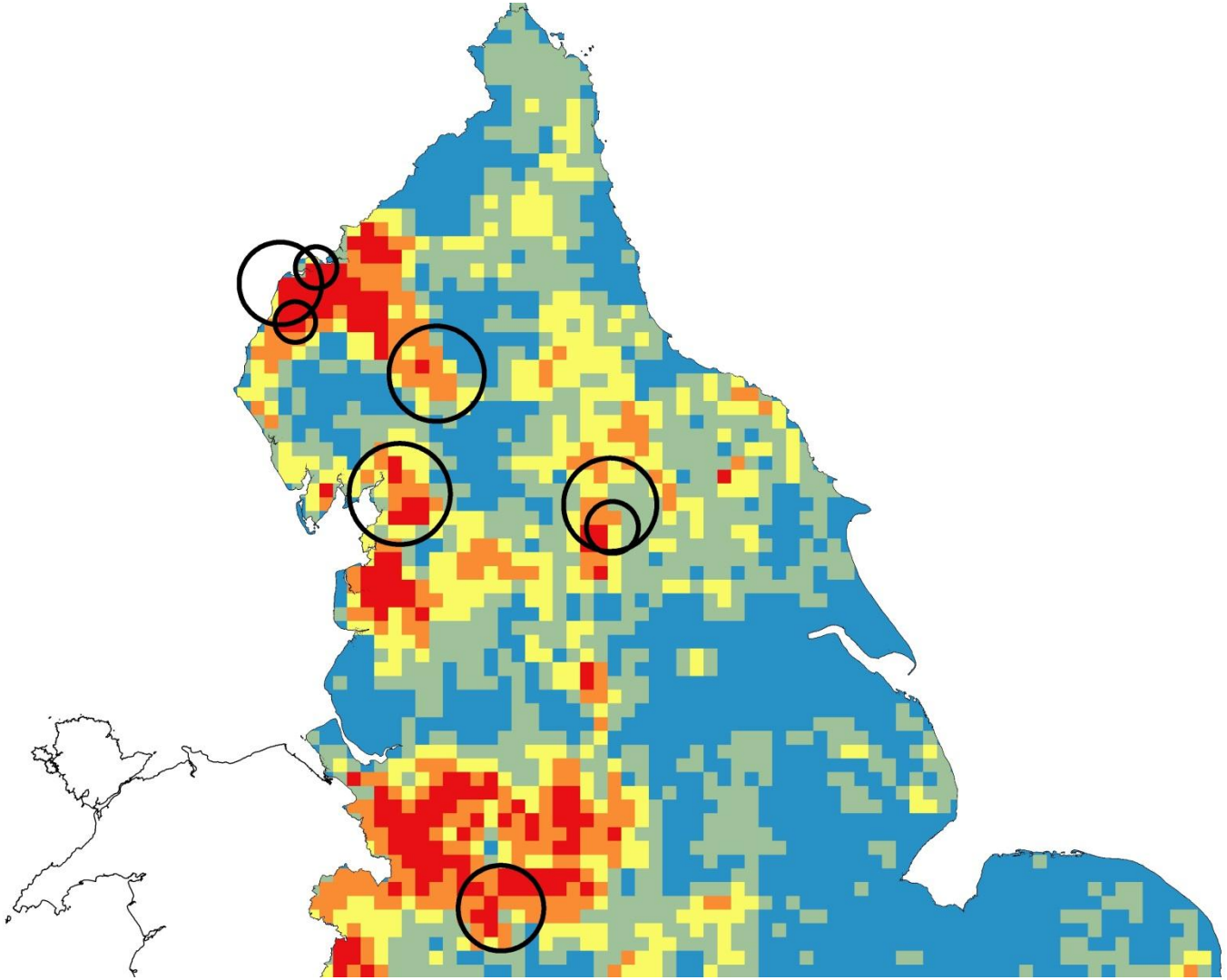


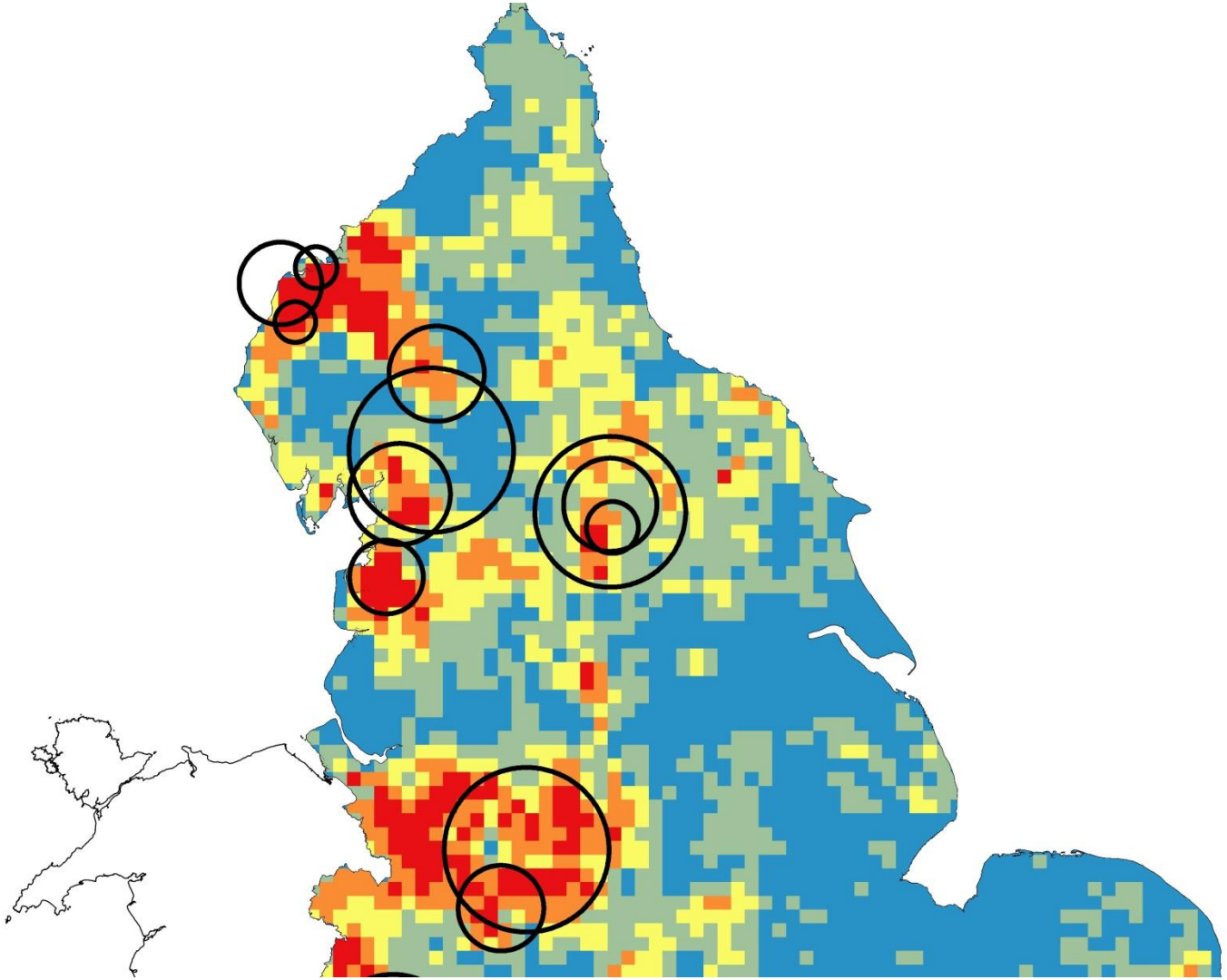
Clustering of cattle density using the Getis_Ord* statistic.
DEFRA Agricultural census data 2010.



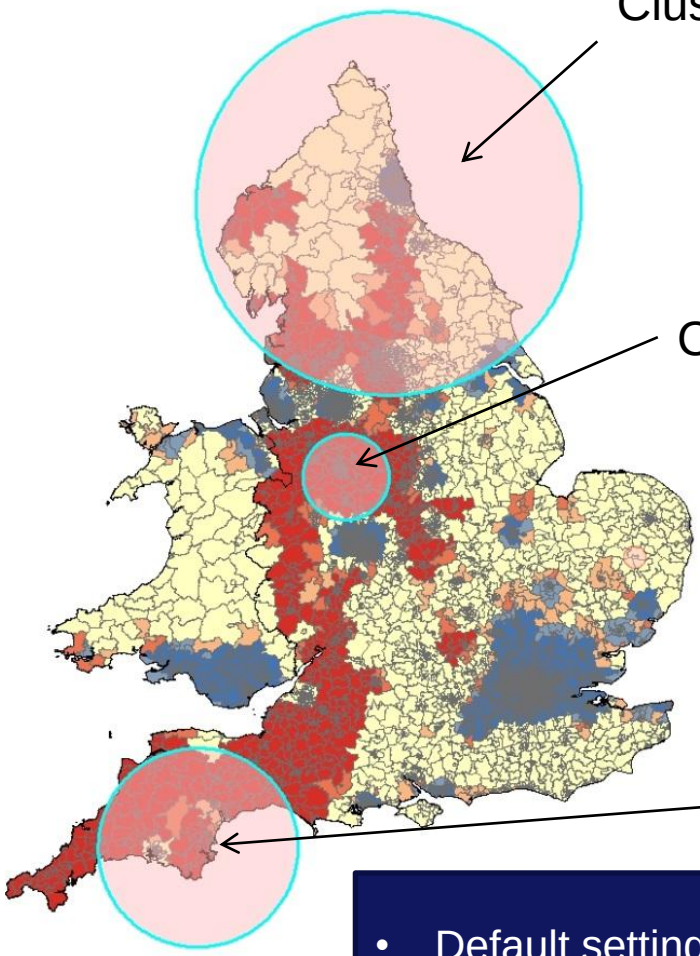

Rural Urban Classification
Rural village and dispersed in a sparse setting
Rural village and dispersed
Rural town and fringe in a sparse setting
Rural town and fringe
Urban city and town in a sparse setting
Urban city and town
Urban minor conurbation
Urban major conurbation
Max. cluster size 30Km RR>1 p<0.05
Max. cluster size 20Km RR>1 p<0.05
Max. cluster size 10Km RR>1 p<0.05







PT21/28 and cattle



Cluster 1. Obs. 185 Exp. 78 RR 3.1 p<0.05

Cluster 3. Obs. 31 Exp. 10 RR 3.2 p 0.004

Cluster 2. Obs. 37 Exp. 12 RR 3.1 p 0.0004

- Default setting – max. cluster size = 50% of population at risk.
- Purely spatial

Discussion

- Rates of infection are highest in rural areas
- Risk appears to increase with increasingly sparse rural settings.
- Sporadic human cases of VTEC O157 cluster spatially in areas of the country that have the greatest numbers of cattle.
- Some challenges in linking datasets

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- Dr. Jolyon Medlock, PHE

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