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A Density Analysis of the Distribution of Standard Reactors and Visible Lesions in Irish Herds: a Focused Approach to Visualising the Location of Bovine Tuberculosis Infections

R.F. Hammond

Introduction
The Veterinary Epidemiology and Tuberculosis Investigation Unit's annual publication of selected papers has continued to improve the visualisation of data from the national data base for tuberculosis in cattle. The techniques for visualisation are centred around Geographical Information technology. Enhancements in data output are possible with new software and more refined data. This paper continues the refinement of data visualisation presenting a methodology that allows a more focused approach to the national distribution of bovine tuberculosis. The presentation format has the potential for use as a management tool to assist with the implementation of the national eradication programme for bovine tuberculosis.

As in previous papers the data are processed using Environmental Systems Research Institutes' Arcview® and Spatial Analyst® software. District Veterinary Offices determine the point locations for all herd restrictions that occur within counties for each calendar year; there are between 8,000 and 10,000 restrictions in any one year. Allied to this the national data base for tuberculosis in cattle is collated in the Veterinary Epidemiology and Tuberculosis Investigation Unit and has been used for episode analysis (O'Keeffe et al., 1999) and the development of the ER76 investigation protocol (O'Keeffe and O'Driscoll, 1997). Hammond et al. (1999) illustrated the possible refinement of reactor animals per one thousand tests (APT) data previously presented on a District Electoral Division basis to show the distribution of restricted herds on a point location basis. A further evolution of this process is described and illustrated here.

Methodology
The methodology for this study is as previously described (Hammond et al., 1999). The variables used for this application were the numbers of standard reactors and number of animals with visible tuberculous lesions associated with the restricted herds. Using the Environmental Systems Research Institute, Spatial Analyst® the data were subjected to a density kernel analysis to determine the density per square kilometre of standard reactors and of animals with visible lesions in restricted herds nationally. Kernel estimation is a technique that uses point locations to produce a smooth estimate of density, from an observed sample of observations. This technique produces a smooth raster image of point density that is visually easy to interpret. The software allows the data to be further manipulated to create a surface contour. Surface is an abstract class used to represent continuous spatial phenomena and returns a collection of isolines for a surface that are based on interval and base values for numbers of standard reactors.
Results
The data are derived from returns for the years 1993, 1995, 1997 and 1999 and queried on the basis of $\geq 2$ standard reactors and the detection of a visible lesion in an animal from a restricted herd for that year. There are 2,832, 2,732, 2,075 and 2,763 restricted herds respectively that conform to the definition query. Figures 1 - 4 illustrate the data for the combination of standard reactors by contour and visible lesions by pixel for each year.

Discussion
The combination of contour and pixel visualisations (Figures 1 - 4) illustrate the areas in the country where active tuberculosis infection of the herd has been confirmed. The sequence of figures also shows that over the four years there are certain areas of the country which have had a persistent infection present. These observations show that this approach to data analysis can assist in the management of tuberculosis in the national herd by identifying and delineating those areas of the country in which *Mycobacterium bovis* has been and continues to be a constant hazard. By addressing tuberculosis in cattle in a focused manner by targeting resources to eliminate *M. bovis* from the areas of high persistence, acceleration of the eradication programme can be achieved.

References


Map showing Density (sq. km) of Standard Reactors by contour and Visible Lesions by pixel

LEGEND

Density of Std. Reactors per sq. km.
Density of Visible Lesions per sq. km.

< 0.1  
0.1 - 0.18  
0.18 - 0.27  
0.27 - 0.36  
> 0.4  

Non-agricultural land

Veterinary Epidemiology and Tuberculosis Investigation Unit - 2000
Map showing Density (sq. km) of Standard Reactors by contour and Visible Lesions by pixel

1995

LEGEND

\[
\begin{align*}
&\text{Density of Std. Reactors per sq. km.} \\
&\text{Density of Visible Lesions per sq. km.}
\end{align*}
\]

- $< 0.1$
- $0.1 - 0.18$
- $0.18 - 0.27$
- $0.27 - 0.36$
- $> 0.4$

- Non-agricultural land

Veterinary Epidemiology and Tuberculosis Investigation Unit - 2000
Map showing Density (sq. km) of Reactors Animals by contour and Visible Lesions by pixel

1997

LEGEND

Density of Std. Reactors per sq. km.
Density of Visible Lesions per sq. km.

\[ < 0.1 \]
\[ 0.1 - 0.18 \]
\[ 0.18 - 0.27 \]
\[ 0.27 - 0.36 \]
\[ > 0.4 \]

Non-agricultural land

Veterinary Epidemiology and Tuberculosis Investigation Unit - 2000
Map showing Density (sq. km) of Reactors Animals by contour and Visible Lesions by pixel

1999

LEGEND

Density of Std. Reactors per sq. km.
Density of Visible Lesions per sq. km.

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