Bovine TB in Northern Ireland

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www.afbini.gov.uk

Importance of the agricultural sector to NI

- NI covers 14,130km^2
  - 46.4% rural (6,560 km^2)
- Agriculture core component of NI economy and society: £351m to NI GVA
- "*agri-food is our most successful industry*" AFSB 2013
- Directly employing 26,000 (3.2% total NI employment)
- The densest poultry population and one of the most dense cattle populations in the UK
- Cattle farming is the main agricultural activity in NI
- Characterised by farm fragmentation and rented seasonal grazing (conacre)

Importance of the agricultural sector to NI

- 25,000 farms: modal size 20-30 hectares. Predominance of 'very small' farm businesses in NI
- 88% provide dairy, sheep and/or beef products
- 1,609,000 cattle (2015): average herd size 79
- Beef 15,090 farms (260,325 cattle) and dairy 3,537 farms (311,520 cattle): beef and dairy average 17.3 and 88.1, respectively
- 2015 output £393.8m for beef sector and £479.9m for dairy sector
- Competent Authority DAERA = Department of Agriculture and Rural Affairs
  - Department of Agriculture and Rural Development
 - Department of the Environment
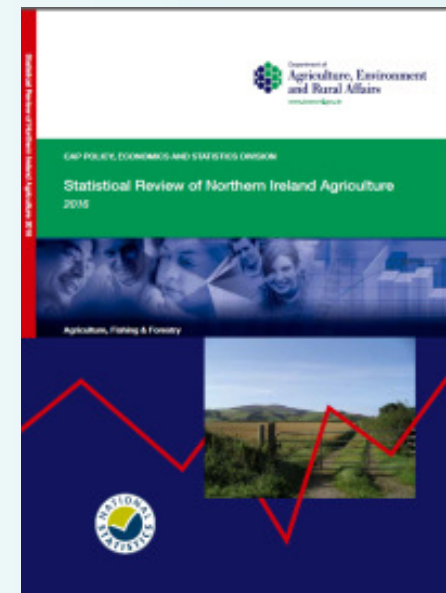
The TB Problem

- The programme is not resulting in a reduction in disease levels
- FVO 2015 – "…*but the herd incidence rate has stagnated at levels above 6%, which is not what would be expected with an effective eradication programme in place.*"
- Current herd incidence – 8.23%. Highest since 2005.
- Reactor numbers in 2016 highest since 2004
- Many factors influencing spread of infection
- Much is still not understood…

afbi Agri-Food and Biosciences Institute °

TB Herd and Animal incidence:
(12 month moving average: January 2002 to March 2017)
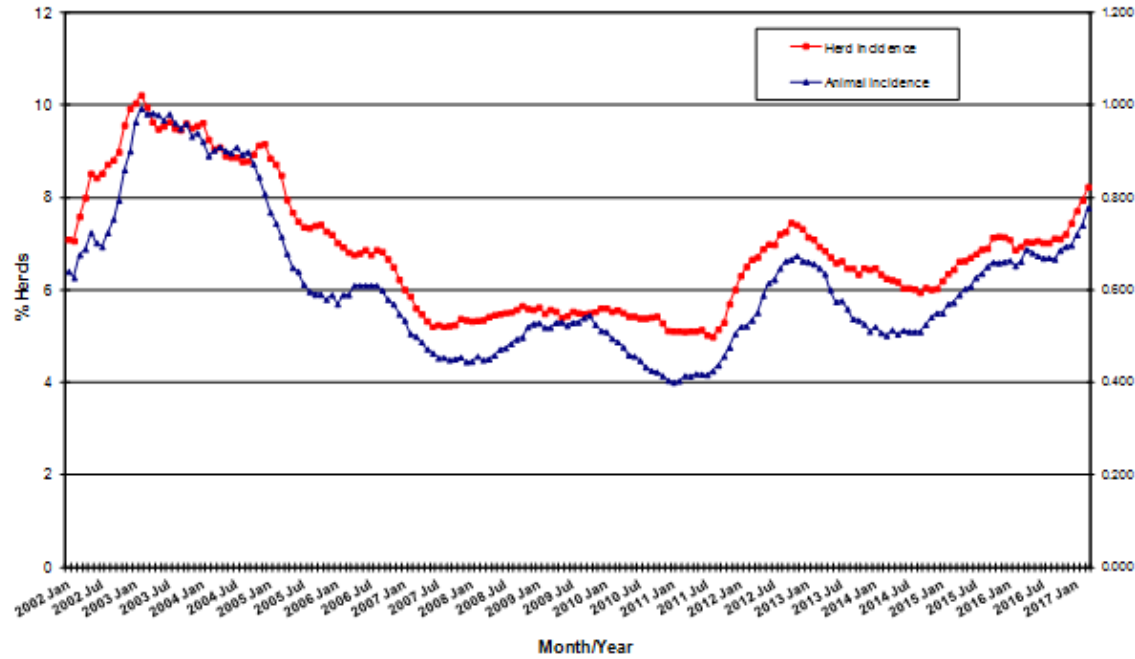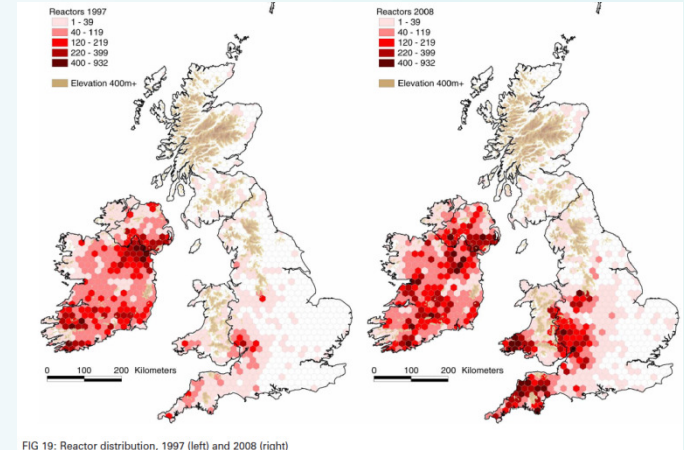
DAERA Veterinary Epidemiology Unit disease statistics

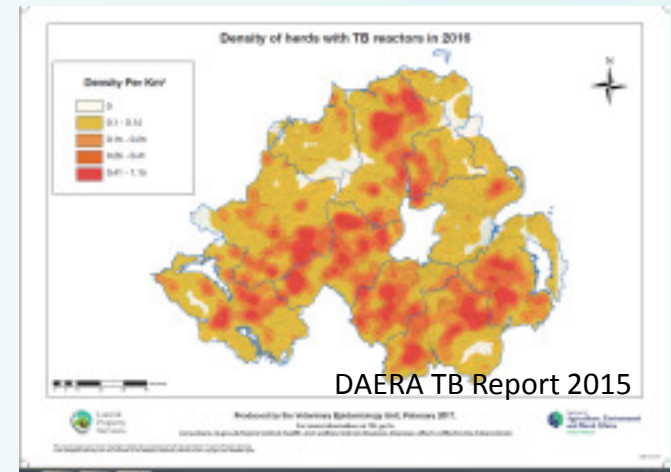FIG 19: Reactor distribution, 1997 (left) and 2008 (right)

Abernethy and others 2013
https://www.ncbi.nlm.nih.gov/pubmed/23292950

Density of herds with TB reactors in 2015

DAERA TB Report 2015

The TB Programme

- Detection of infection by live animal or *post mortem* surveillance
  - Annual comparative tuberculin testing and targeted IFN blood testing
  - PME every animal slaughtered for human consumption
- Removal of infected and/or exposed animals
- Controls applied to breakdown herd
- Tracing and risk assessments lead to further testing in other herds
- Approved by EU for co-funding
- Programme costs in excess of £30 million annually
- New Practitioner Contract with enhanced QC
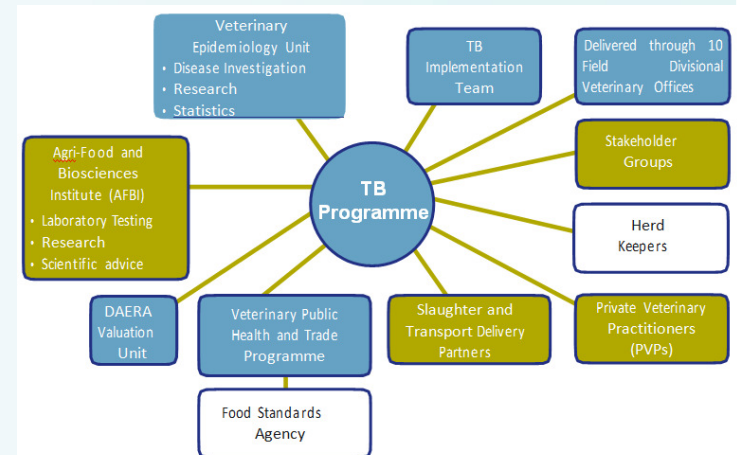
AFBI contribution

The AFBI contribution to the TB programme is continuous

- Histopathology
- Bacteriology
- Molecular Strain typing
- IFNG blood testing
- DNA comparisons
- Post mortem examination
- Forensic Pathology
- Badger Road Traffic Accident Survey
- Specific advice
- Project/Governance Groups
- Collaborations with other scientists

AFBI Contribution

Specific recent projects:

- Literature Reviews – slurry spreading; cattle to cattle transmission; badger to cattle transmission; bTB tests; bTB tests in badgers; International application of the Gamma Interferon test

- TB Biosecurity Study

- Badger Cattle Proximity Study

- Gamma interferon Project

- Badger Sett Survey

- Test, Vaccinate, Remove (TVR) wildlife intervention research

- TB Strategic Partnership Group

AFBI Contribution

Ongoing research:

- Evaluation of multiple reactor and chronic breakdown herds
- TB transmission dynamics using genome epidemiology
- Role of endemic diseases and other factors
- Resuscitation promotion factors enhanced culture
- Optimisation and enhancement of the test format for gamma interferon
- Improve reliability of genomic prediction
- TB molecular epidemiology – analysis of cattle movements and optimisation of epidemiological investigations

An Integrated Eradication Programme

Bovine Tuberculosis Eradication Strategy for Northern Ireland

The TB Strategic Partnership Group

2016

Thematic Recommendation Chapters

Section B

Given the complexity of the disease and the multitude of factors which impact on it, we focused on the key factors in disease spread and the steps necessary to effect the change we want to achieve. We have focused our recommendations into 7 key themes which need to be addressed in order to make a difference. These themes are however all interrelated and do not stand alone.

Chapter 1
Governance: To establish effective governance arrangements to oversee the reduction and eradication of bTB so enabling the farming industry, Government, PVPs, nature conservationists and other key stakeholders to work in partnership, with the principle of shared commitment.

Chapter 2
Culture and Communications: To encourage a change in culture and attitude so that all stakeholders understand and accept the part they have to play in achieving bTB eradication and recognise that their contribution will make a difference. To improve communication so that all stakeholders receive relevant, timely and appropriate information.

Chapter 3
Tools and Processes: To minimise the potential for bTB transmission to herds, within herds and from herds, through the maximisation and enhancement of the existing tools and processes, and the utilisation of emerging technologies.

Chapter 4
Wildlife: To address the bTB reservoir in badgers to help eradicate bTB in cattle herds and contribute to the health of the badger population.

Chapter 5
Herd Health Management: To promote improved herd health management across all types of cattle holdings, slaughterhouses and at cattle markets, in order to reduce the risks associated with the spread of disease, and introduce actions and practices that will improve herd health.

Chapter 6
Finance: To re-balance the cost of the disease between the public and private sectors, so encouraging a change of culture and attitude, and a shared commitment to the control and eradication of bTB. To identify new sustainable arrangements which would allow Government to maximise and better deploy resources.

Chapter 7
Research: To ensure that research into bTB is given a priority within the DAERA research agenda. To ensure that the Tuberculosis Eradication Partnership (TBEP) has the ability to influence the bTB research agenda, is aware of emerging recommendations from research to inform future reviews of the Strategy and has a role in disseminating relevant research findings to stakeholders.

Badgers: DAERA-led RTA survey and Test, Vaccinate and Remove (TVR) badger study

Population 2012 34,100 (95% CI 26,000-42,000)
in 7,600 social groups

- RTA 1998-present
- TB prevalence 15.3% (95% CI 13.1-17.5)

- TVR 100km^2 with 2km buffer 2014-2019
- Sett side DPP serology test
- BCG vaccinate DPP-, remove DPP+
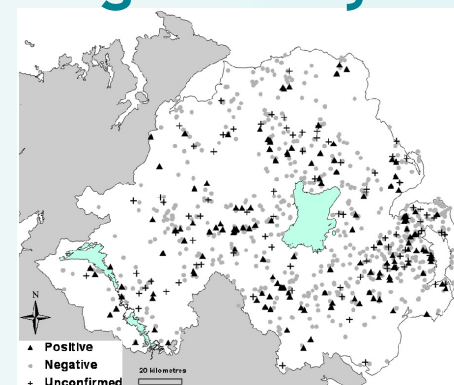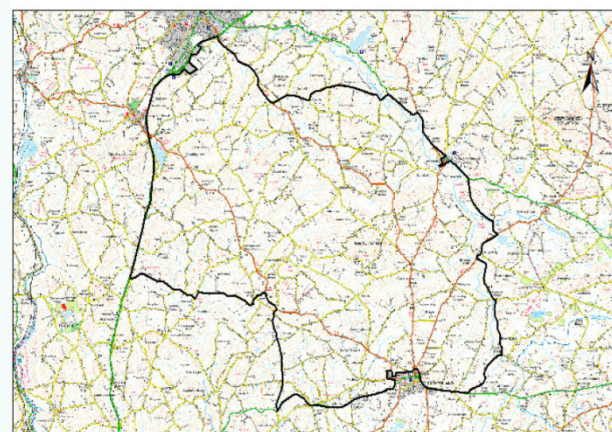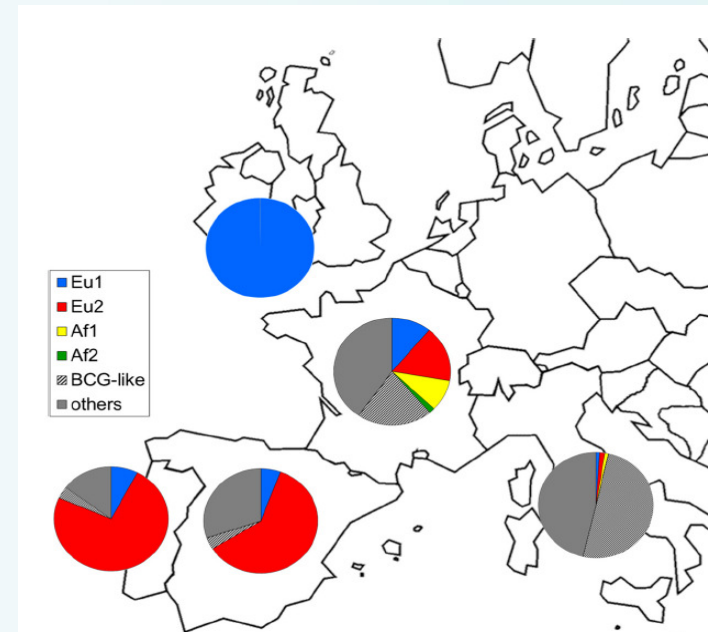- TV 2014, TVR 2015-
- Research studies associated with TVR

Figure 1: Map of TVR area in County Down (Banbridge area)

THE TEST AND VACCINATE OR REMOVE (TVR) WILDLIFE INTERVENTION RESEARCH PROJECT
YEAR 1 REPORT - 2014

Molecular typing – bovine TB

- AFBI genome-enabled tools to investigate TB evolution, epidemiology and outbreaks

- What does this tell us about TB? …and how does this help control?

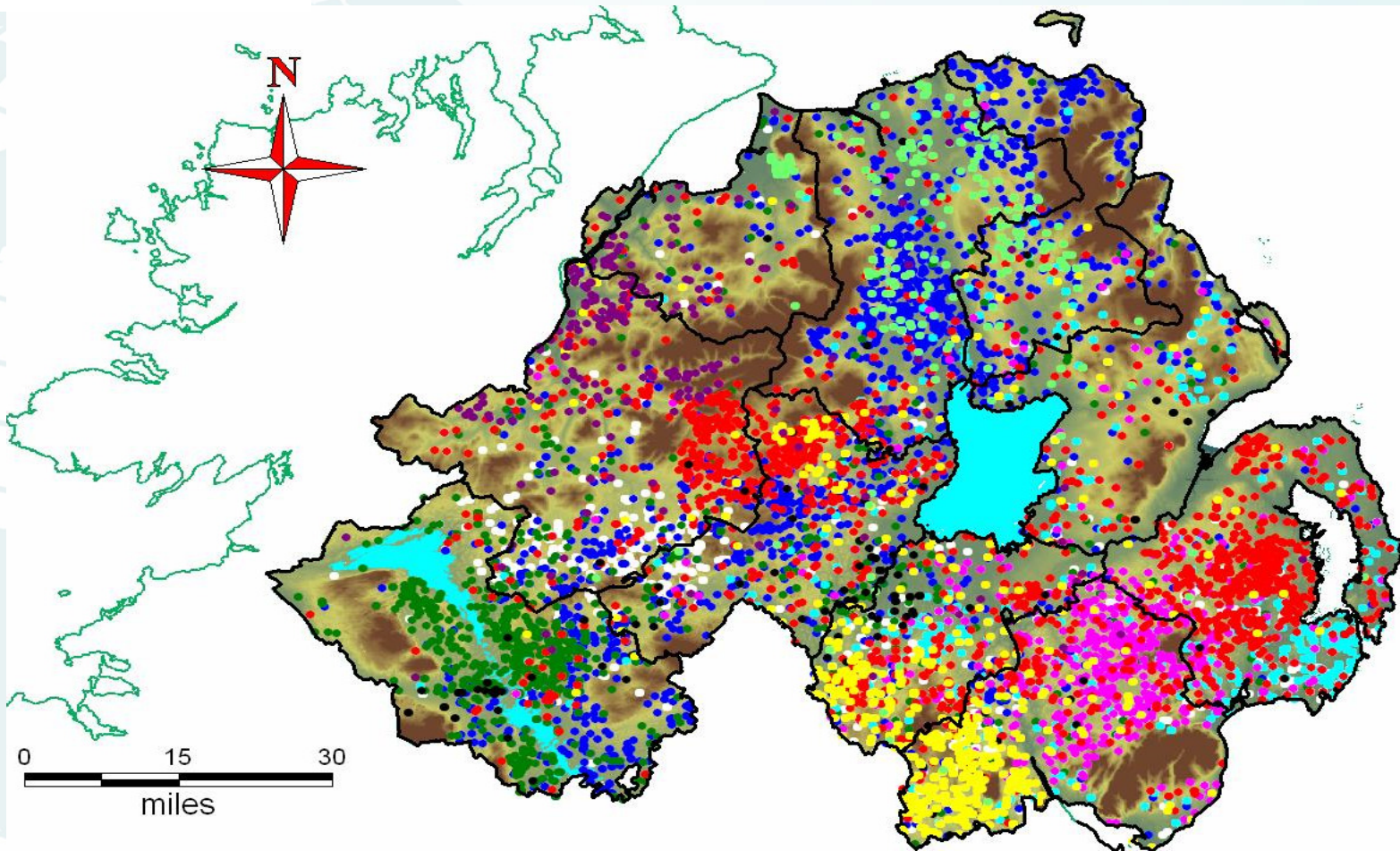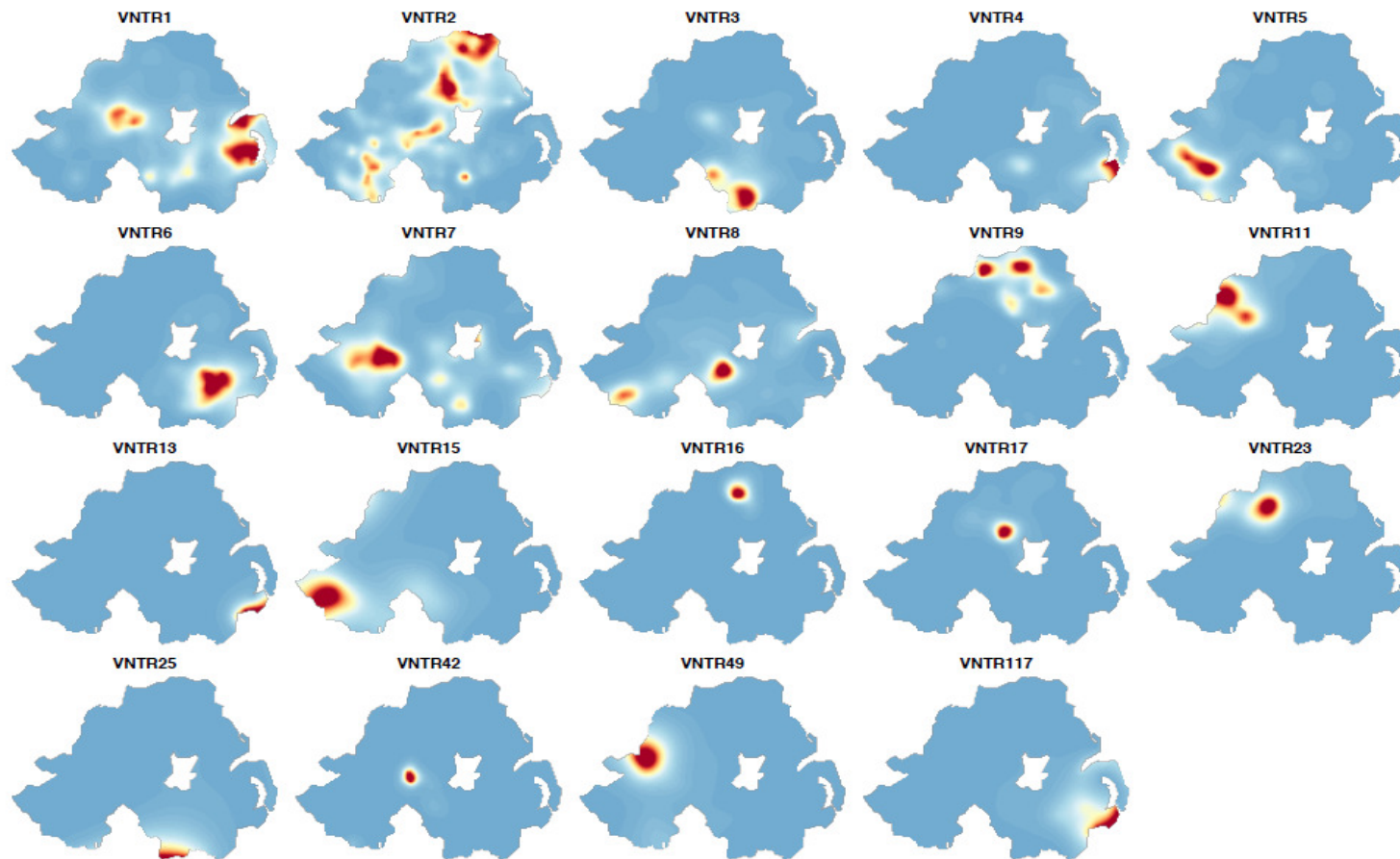- Deep ancestry shows UK and Ireland dominated by their own TB strain family (EU1)

Legend:
- Eu1
- Eu2
- Af1
- Af2
- BCG-like
- others

Rodriguez-Campos S, Smith NH, Boniotti MB, Aranaz A. Res Vet Sci. 2014 Feb 25.

- TB strains - striking local geographical clustering
  - **Locally-driven epidemic: a series of local micro-epidemics**
  - Valuable for tracing locally, nationally and internationally

Dr Hannah Trewby @Glasgow

Cattle ○

RTA badger ☆
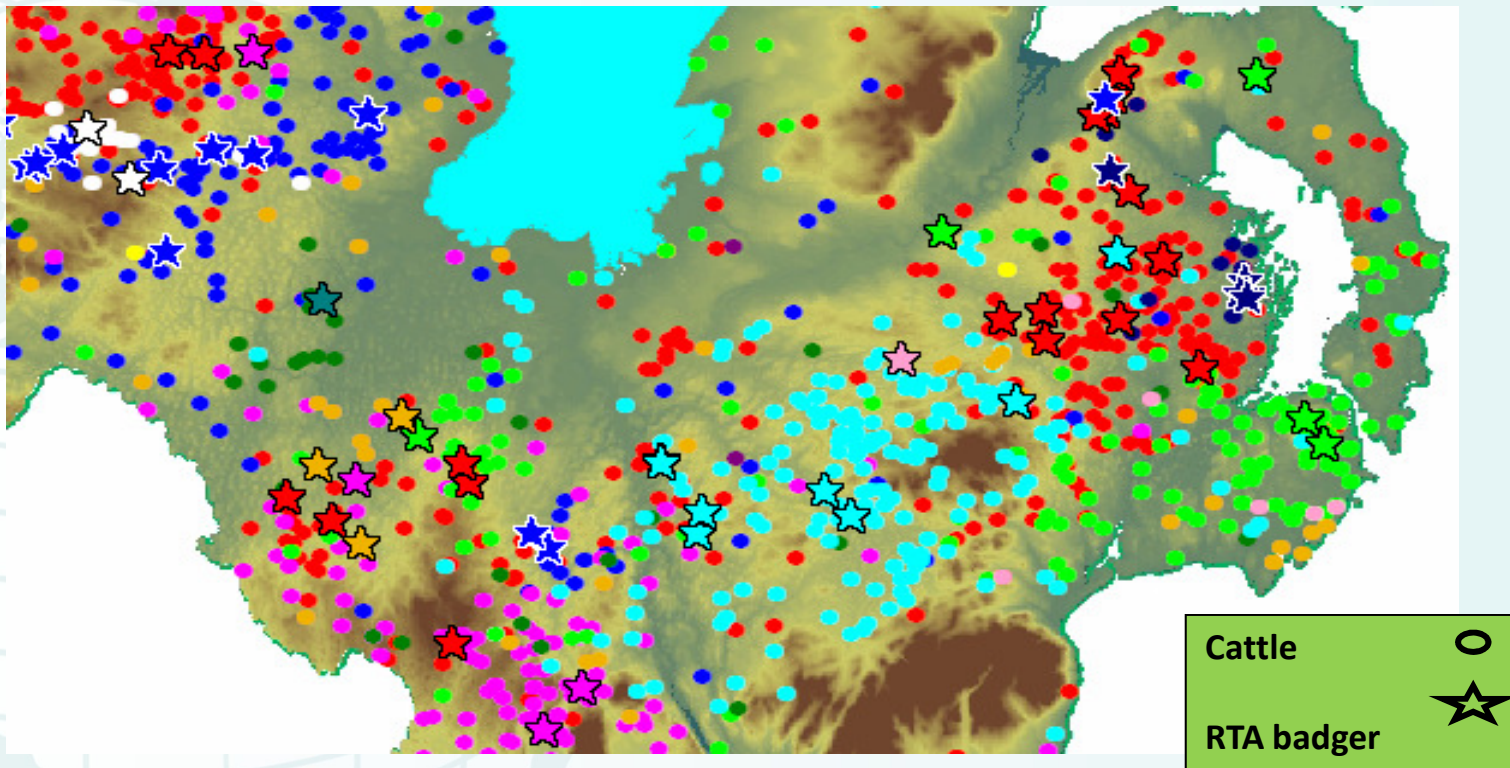
- Cattle and badger TB strains associated at <u>regional</u> level
- Lacking direct genetic evidence of transmission chains linking cattle and badgers at <u>farm</u> scale

Pathogen WGS – bovine TB

- **Genomic epidemiology** – target one strain
  - Molecular typing, **bacterial WGS** and mathematical modelling (Glasgow)
  - *"First direct evidence of <u>ongoing</u> TB transmission between cattle and badgers at the individual farm level"*
  - **Also signals of cattle-cattle spread (amplification) within some study herds**

- Providing insights into disease transmission dynamics which were previously unattainable
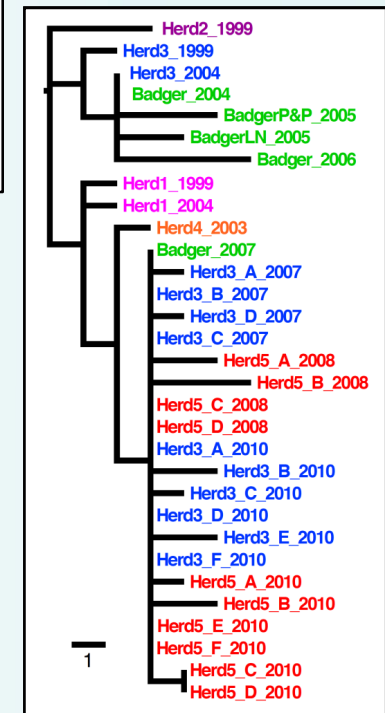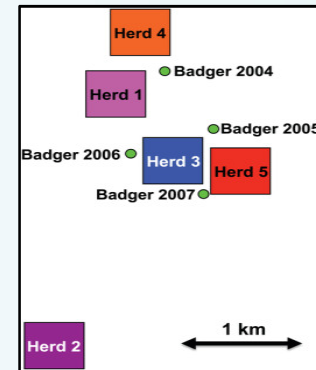
Genomics – cattle resistance to bovine TB

- Parallel genetics studies identified heritable genetic variation in risk of TB – exploitable via **selective breeding**

- Industry-led national genetic and genomic evaluations (EBVs) for TB resistance in dairy cows (SRUC and *AHDBDAIRY*)

- _**TB Advantage**_: new genetic selection trait launched January 2016 – a world first

- NI data being included in EBV estimates

- AFBI key role

PROCEEDINGS OF **THE ROYAL SOCIETY** B | **BIOLOGICAL SCIENCES**

Bovine tuberculosis: the genetic basis of host susceptibility

A. R. Allen, G. Minozzi, E. J. Glass, R. A. Skuce, S. W. J. McDowell, J. A. Woolliams and S. C. Bishop

Proc. R. Soc. B 2010 **277**, 2737-2745 first published online 2 June 2010
doi: 10.1098/rspb.2010.0830

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NEW GENETIC INDEX LAUNCHED TO HELP BREED AGAINST BOVINE TUBERCULOSIS

NEWS 08 JAN 2016 SHARE

Genomics – cattle resistance to bovine TB

Controls - VLs (GEMMA - covariates fitted)

- NI case-control genetic association study estimated heritability of **0.23**

- Mapped genetic variants associated with TB disease trait

- Demonstrated that **genomic prediction/selection** was feasible for the TB resistance trait

OPEN ACCESS Freely available online
PLOS | ONE

Genomic Prediction for Tuberculosis Resistance in Dairy Cattle

Smaragda Tsairidou[1]*, John A. Woolliams[1], Adrian R. Allen[2], Robin A. Skuce[2], Stewart H. McBride[2], David M. Wright[3], Mairead L. Bermingham[1], Ricardo Pong-Wong[1], Oswald Matika[1], Stanley W. J. McDowell[2], Elizabeth J. Glass[1], Stephen C. Bishop[1]

1 The Roslin Institute and R(D)VS, University of Edinburgh, Midlothian, United Kingdom, 2 Agri-Food and Biosciences Institute, Belfast, United Kingdom, 3 School of Biological Sciences, Queen's University of Belfast, Belfast, United Kingdom

- Disease genetics in the future?
  - Only some diseases amenable
  - Exciting new opportunities to exploit genetic variation in new traits

Heredity
The official journal of the Genetics Society

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