Animal &
Plant Health
Agency

Research on badgers and TB at Woodchester Park

Dez Delahay
National Wildlife Management Centre

Principal areas of work

- Badger ecology and TB epidemiology in badger populations
  - Woodchester Park study
  - Population level disease dynamics
  - Movement and contact behaviour
  - Individual life histories

- Developing techniques
  - Surveying and capture
  - Abundance estimation
  - TB diagnostics
  - Oral vaccine bait

- Management of transmission between badgers and cattle
  - Consequences of interventions
  - Vaccination
  - Understanding and managing interactions - biosecurity

Long term study of badgers & TB at Woodchester Park

- Study began in1976
- 11 km^2 (7 km^2 core area)
- TB hotspot for cattle
- High badger density
- Short term ecological study?

Woodchester Park: Humble beginnings…….

MAFF

Central Science Laboratory

fera
The Food and Environment Research Agency

AHVLA
Animal Health and Veterinary Laboratories Agency

Some things have changed……

The Woodchester Park badger study

Capture-mark-recapture study

- Routine capture and testing for TB
- Individuals are marked and released
- Unique database
  - >15000 capture events
  - >3000 individuals
  - Life histories

Cheeseman, C. L., Jones, G. W., Gallagher, J. & Mallinson, P. J. (1981). *J. Appl. Ecol.*
Delahay, R. J., Walker, N., Smith, G. S., *et al.* (2013). *Epidemiol. Infect.*

Infection status

- Culture (since 1976)
- Brock ELISA (since 1982)
- Categories = negative, exposed, excretor, super-excretor

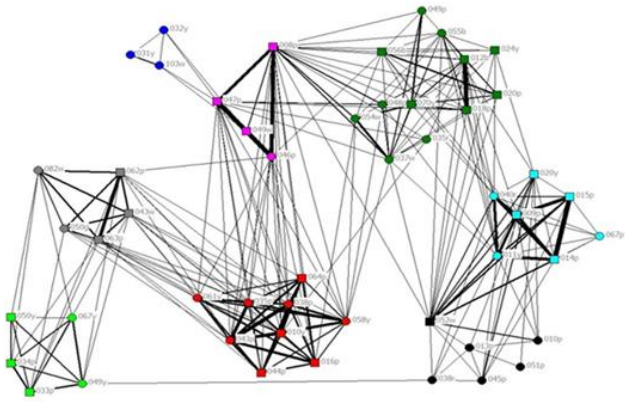
Since 2006

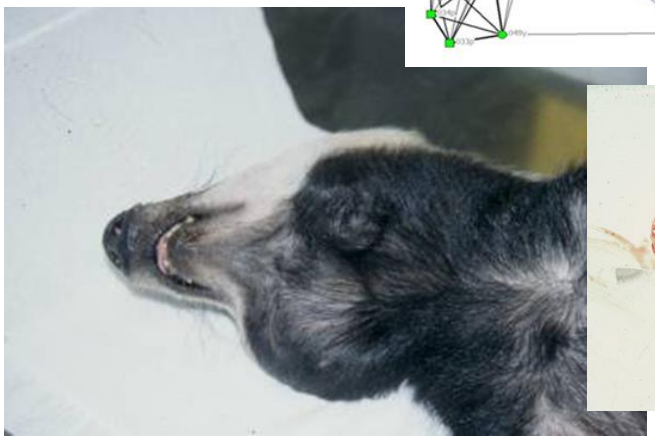
- StatPak (antibodies)
- Gamma Interferon

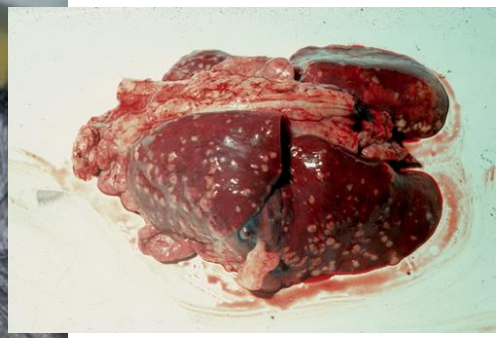
(Cellular – T cells)

TB in badgers

- Transmission routes:
  - Aerosol
  - Bite wounding
- Infected badgers can live for many years and reproduce successfully.
- Excretion in sputum, urine and faeces.
- Females more resilient
- Behavioural correlates
  - Sett use
  - Network position
  - Home range size and use
  - Bite wounding
  - Capture probability?

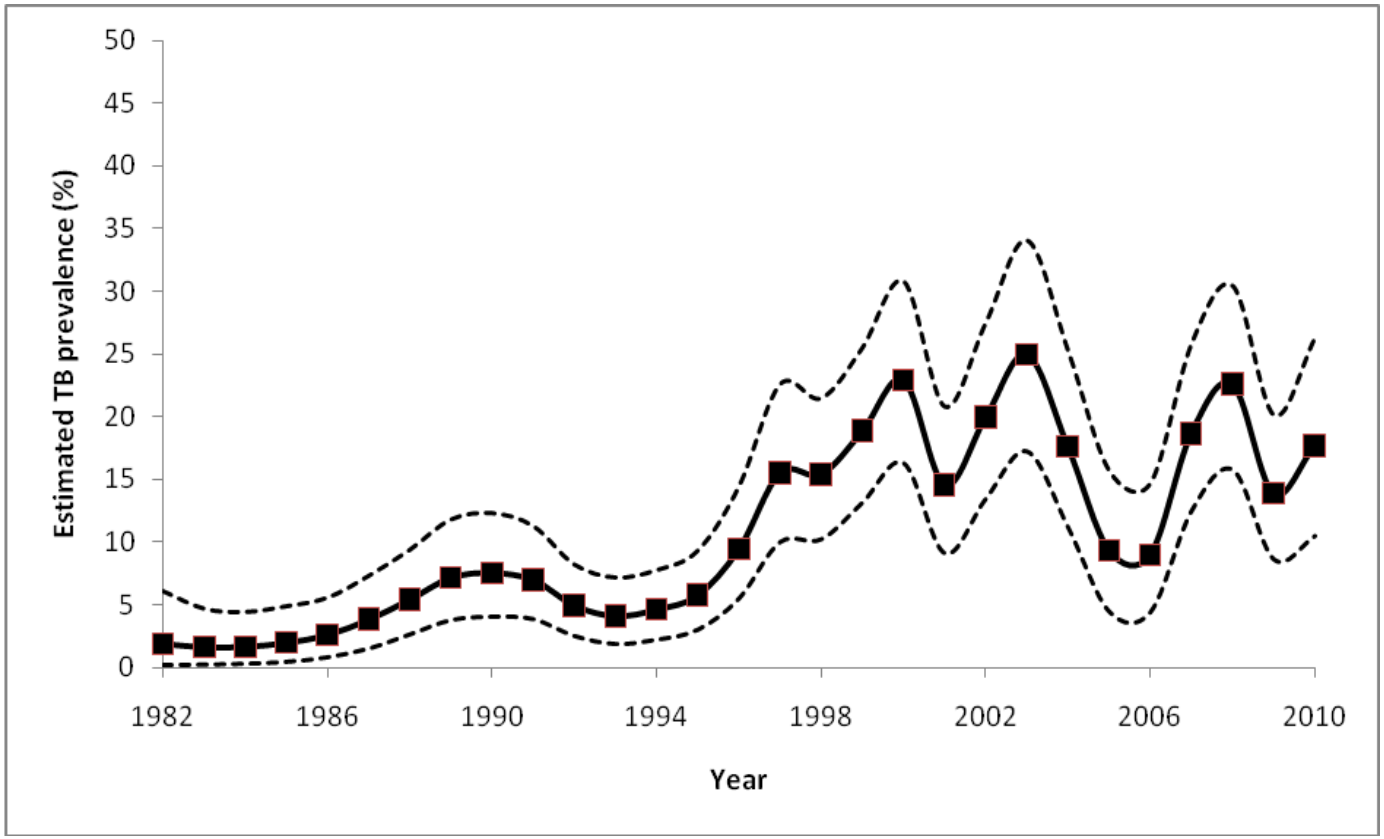






Jenkins, H. E., Cox, D. R. & Delahay, R. J. (2012) *PLoS ONE* ; Weber, N., Bearhop, S., Dall, S., Delahay, R. J. *et al*. (2012) *Behav. Ecol. Sociobiol*. ; Graham, J., Smith, G., Delahay, R. J., Bailey, T. *et al*. (2013) *Epidemiol. Infect*. ; Weber N., Carter, S., Dall, S., Delahay, R. J. *et al*. (2013). *Current Biology*.

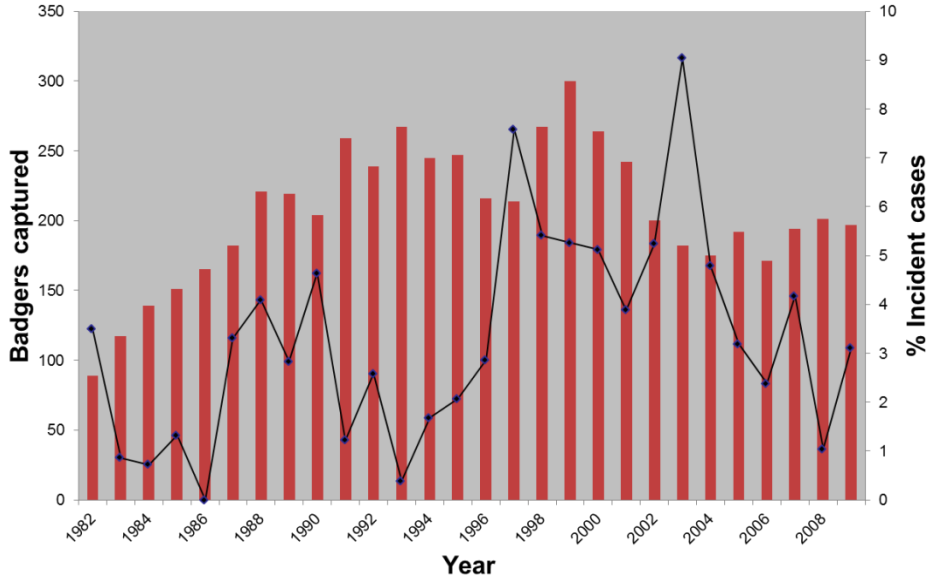
Temporal patterns of infection

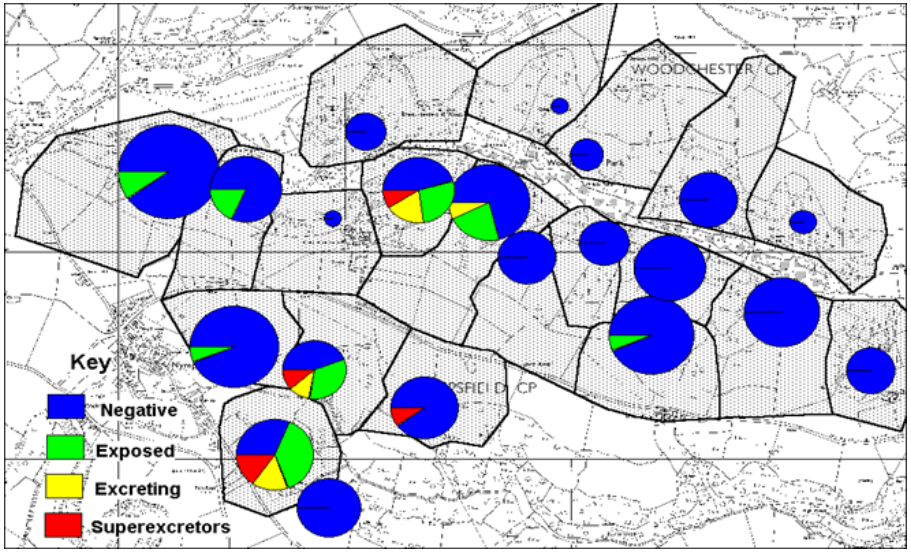


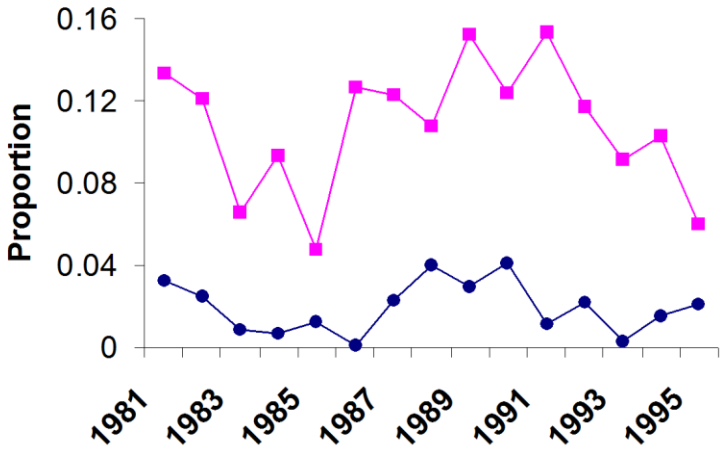
Using all available information (unified Bayesian approach)

(adjusted Brock ELISA + culture + Stat-Pak + gamma-interferon)

Drivers of disease spread?





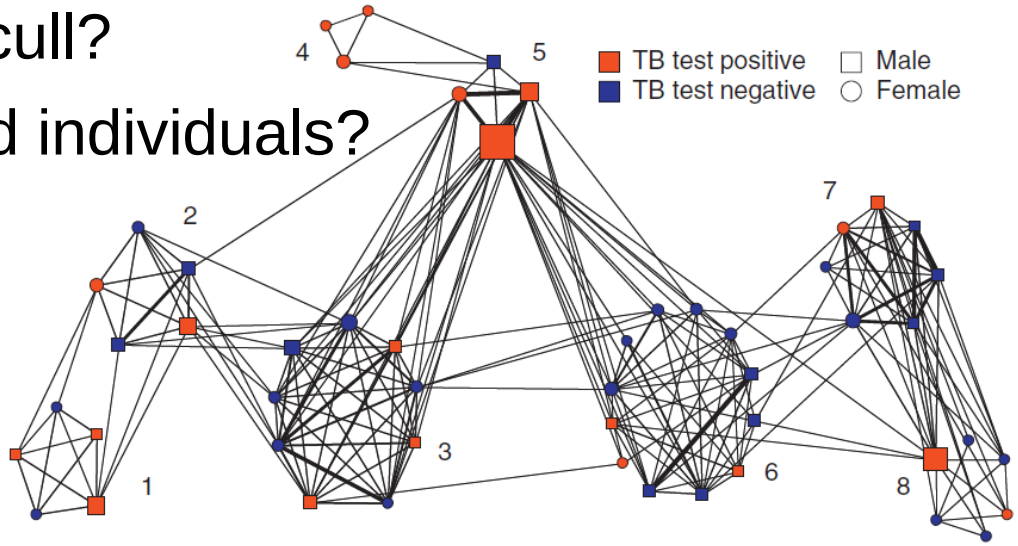


- Population density not a simple driver
- Population structure mitigates spread
- Individual and group risks increase with movement
- Consequences for management interventions (perturbation)

Delahay, R. J., Langton, S., Smith, G. C. *et al*. (2000) *J. Anim. Ecol*.
Rogers, L. M., Delahay, R. J., Cheeseman, C. L. *et al*. (1998) *Proc. Roy. Soc. B*
Vicente, J. Delahay, R. J., Walker, N. *et al*. (2007). *J. Anim Ecol*.

Investigating social behaviour & TB status

- Radio-tracking and proximity logger technology
- Test positive badgers are different,
  - Spend more time away from the main sett
  - Occupy different position in the social network
    - More isolated from group members
    - Nodes of ‘flow’
- Some individuals more important for disease spread
- What happens when we cull?
- How do we target infected individuals?



Weber, N., *et al.* (2012). *Behav. Ecol. & Sociobiol*.
Weber, N., *et al*. (2013). *Curr. Biol.*

Developing techniques

Remove only infected or infectious individuals or groups

- Diagnostic test
  - Adequate sensitivity & specificity
  - Even a test with poor performance may be useful
  - Combine tests?
- Challenges of live testing in the field
  - Restraint trap
  - Blood sample conscious animals
- Combine with vaccination

Development of an oral vaccine

- **Formulation**
  - ‘Happy home’ for live BCG
  - Bait that is attractive to badgers
  - Labelled
- **Bait Preference**
  - Measure bait disappearance and use cameras to determine behaviour and preference
  - Selected leading bait (peanut based)

- **Bait Uptake**
  - Assess different deployment strategies
  - Biomarkers in bait to measure uptake
  - Cameras used to assess non-target interference
  - *Season, dispersal pattern & age differences*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Reducing contact between badgers and cattle

- Direct contact rare at pasture, indirect contact more frequent.
- Direct contact observed at troughs and in buildings.
- Contamination of feed in troughs and buildings.
- Visits to buildings vary in space and time

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Garnett, B. T., Delahay, R. J. & Roper, T. J. (2002). *Proc. Roy. Soc. B.*
Garnett, B. T., Roper, T. J. & Delahay, R. J. (2003). *Appl. Anim. Behav. Sci.*
Drewe, J. A., O'Connor, H. M., Weber, N., McDonald, R. A. & Delahay, R. J. (2013). *Epidemiol. Infect.*


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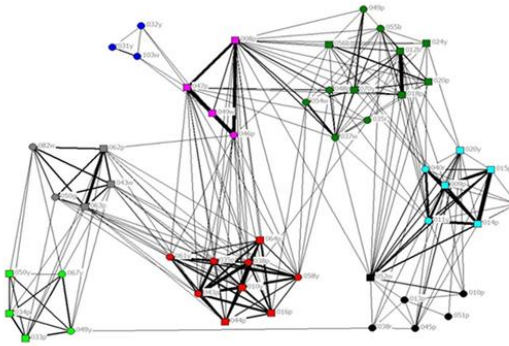
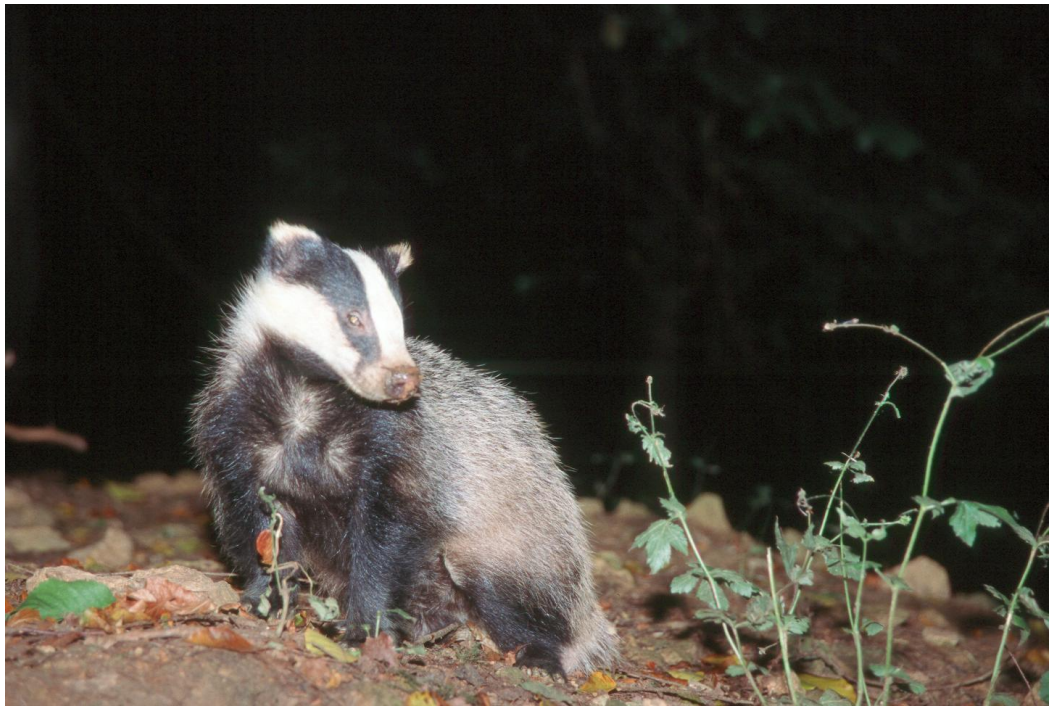
Current Research

- Perturbation and disease dynamics in badger social networks (NERC, Exeter)
- Heritability of susceptibility to TB in badgers (NERC, Exeter)
- Senescence and TB progression in badgers (NERC, Exeter)
- A Bayesian model of TB dynamics in badgers (NERC, Exeter)
- *M. bovis* genome sequencing in badgers and cattle (BBSRC, Glasgow)



- Tick-borne pathogens in badgers (Salford)
- Microbiome variation in badgers (Exeter/ZSL)
- Energy expenditure and TB status (Queens Belfast)

Thank you



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