Summary of Interdisciplinary Bovine TB Research at MSU

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Purpose of the Presentation

- Present a summary of past and present interdisciplinary bovine TB research activities at MSU
Major Areas of Research

Biomedical Sciences

Wildlife Ecology

Social Sciences
Major Research Areas

- Pathogenesis
- Diagnosis
- Wildlife Ecology
- Economics
- Human Ecology
- Beliefs and Attitudes
- Epidemiology, Risk Assessment
Major Areas of Research

- Biomedical Sciences
- Epidemiology
- Epidemiology and Risk Assessment
- Surveillance
- Public Health

Graduate students:

J. Dunn (MS), A. Fine (PhD),
R. Miller (MS), B. Norby (PhD),
M. Wilkins (PhD), A. Adams (MS)
Major Areas of Research

- **Biomedical Sciences**
  - Disease Pathogenesis
  - Diagnostics
    - Ante-mortem
    - Post-mortem

*Graduate students:*

K. Butler-Diegel (PhD)
K. Clarke (PhD)
K. Mersterhazy (PhD)
L. Zwick (PhD)
H. Simmons (PhD)
Major Areas of Research

- Wildlife Ecology
  - Deer ecology and behavior

  *Graduate students:*
  
  J. Blanchong (PhD), M. Garner (PhD), B. Hughey (MS), D. Muzo (MS), A. Felix

- Social Sciences
  - Economics
  - Human Ecology
  - Beliefs and Attitudes
Summary of Major Areas of Research
Biomedical Research

- Epidemiology
  - Epidemiology and Risk Assessment
    - Domestic and captive animals
    - Wildlife
  - Surveillance
  - Public Health
Epidemiology and Risk Assessment

- Environmental and farm management factors associated with tuberculosis on cattle farms in northeastern Michigan

- Lead Investigator: J.B. Kaneene

- Results:
  - Risk↑ – TB prevalence & wildlife attractants
  - Risk↓ – Poor deer habitat & excluding deer from premises

Biosecurity will reduce herd risk for TB
Epidemiology and Risk Assessment

- Development of on-farm risk calculator to estimate herd risk of TB and cost-benefit of different risk reduction strategies
  - Lead Investigators: J.B. Kaneene, C. Wolf
  - Results:
    - Farm risk model based on previous studies
    - Model validated through simulation

Tool for on-farm use to develop TB prevention programs
Epidemiology and Risk Assessment

- Geographic distribution and spatial analysis of Mycobacterium bovis infection in white-tailed deer

  - Lead Investigators: J.B. Kaneene, S. Fitzgerald

  - Results:
    - Spatial clusters of TB in associated with habitat that promoted congregation of deer for extended periods of time

Identify locations where TB can be spread for wildlife TB control programs
Epidemiology and Risk Assessment

- Influence of supplemental feeding of white-tailed deer on the prevalence of bovine tuberculosis in Michigan wild deer
  - Lead Investigators: J.B. Kaneene, S. Fitzgerald
  - Results:
    - TB↑ – Quantity of feed and good deer habitat
    - TB↓ – Poor deer habitat

Eliminate/reduce supplemental feeding of deer
Epidemiology and Risk Assessment

- *Historical factors influencing the occurrence and distribution of bovine TB in Michigan wildlife*
  - Lead Investigator: J.B. Kaneene
  - Results:
    - Feeding deer increased numbers, degraded habitat
    - Winter starvation led increased contact with TB-infected domestic cattle

Importance of biosecurity, supplemental feeding, population control in historical & current context
Surveillance

- Sensitivity and specificity of bovine TB skin tests in Michigan when a perfect reference test is not available

  - Lead Investigators: P. Bartlett, R. Tempelman, J.B. Kaneene

  - Results:
    - Bayesian models
    - Test performance comparable to other studies

Understanding skin test performance for improving ante-mortem surveillance
Surveillance

- Simulation modeling to estimate herd-level sensitivity, specificity, and predictive values of TB diagnostic tests for cattle
  - Lead Investigators: P. Bartlett, D. Grooms, J.B. Kaneene
  - Results:
    - Current tests for detecting TB cattle herds work well
    - Herds with < 100 cattle should test more frequently

Improve effectiveness of surveillance protocols
Surveillance

- **Determining survival of M. bovis in environmental samples**
  - Lead Investigators: J.B. Kaneene, C. Bolin
  - Results:
    - *M. bovis* survived in farm substrates under Michigan weather conditions for 6-10 wks
    - Methods for culturing *M. bovis* from environmental samples

Information for premises decontamination
Surveillance

- Development and application of molecular techniques for detection of *M. bovis* in environmental samples

- Lead Investigators: J.B. Kaneene, S. Bolin, C. Bolin

- Results:
  - Nested PCR primers developed
  - Effective for detection of *M. bovis* in soil samples

Improved detection for surveillance
Surveillance

- **Develop risk-based surveillance system for bovine TB testing**
  - Lead Investigator: J.B. Kaneene
  - Results:
    - Sampling adjusted to herd management and geographic risk factors
    - Increase sampling in high risk areas, reduce in low risk areas

Development of more efficient and economical TB surveillance programs
Public Health

- *Human M. bovis Infection and Bovine Tuberculosis Outbreak*
  - Lead Investigator: P. Bartlett
  - Results:
    - 2 human cases of *M. bovis* in MI-born residents
    - Epidemiologic and molecular links to deer/cattle outbreak strain

**Demonstrated public health risk of bovine TB in Michigan from animal reservoir**
Public Health

- **Injuries associated with bovine TB testing livestock in Michigan**
  - Lead Investigator: P. Bartlett
  - Results:
    - Injuries resulting from livestock testing in veterinarians, farmers, farm workers
    - Frequency and severity of injury

Degree of health impacts for regulators, policymakers
Absence of M. bovis infection in dogs and cats residing on infected cattle farms in Michigan

Lead Investigators: P. Bartlett, S. Fitzgerald

Results:

No infection in 18 cats, 5 dogs from cattle farms

Pets not major risk for zoonotic M. bovis infection
Disease Pathogenesis

- *Experimental inoculation of wild birds*
  - Lead Investigators: S. Fitzgerald, J.B. Kaneene, J. Sikarskie, C. Bolin
  - Results:
    - Starlings, crows, pigeons, mallard ducks, turkeys
    - Pigeons moderately susceptible, shed organisms for at least 60 days

Pigeon control may be important for cattle farms
Disease Pathogenesis

- *Experimental inoculation of rodents*
  - Lead Investigators: S. Fitzgerald, J.B. Kaneene, C. Bolin
  - Results:
    - Norway rats, meadow voles, wild house mice
    - Voles and house mice highly susceptible to *M. bovis*

**Importance of rodent control**
Disease Pathogenesis

- **Experimental inoculation of other wildlife**
  - Lead Investigators: S. Fitzgerald, J. Sikarskie, J.B. Kaneene
  - Results:
    - Virginia opossum
    - Opossum highly susceptible but does not transmit readily

Opossums are spillover hosts and not reservoirs of TB
Disease Pathogenesis

- Efficacy of *M. bovis* vaccination using RB51 subunit vaccine and BCG
  - Lead Investigators: S. Fitzgerald, J.B. Kaneene, T. Mullaney
  - Results:
    - BALBc mice with BCG, RB51 subunit vaccine
    - BCG more effective than RB51

Vaccine development for livestock, wildlife reservoirs of TB
Diagnostics

- Ante-mortem testing
- Post-mortem testing
Ante-Mortem Diagnostics

Retrospective study of Johne’s Disease (M. paratuberculosis infection) and false positive TB tests in cattle

Investigator: S. Fitzgerald, S. Bolin, J.B. Kaneene

Results:

Less than 1.5% of false reactors had evidence of M. paratuberculosis infection, significantly less than in non-reactor cattle

No significant associations between M. paratuberculosis and false positive TB tests
Ante-Mortem Diagnostics

- Effect of *M. paratuberculosis* infection on caudal fold skin test and gamma interferon assay for TB in cattle
  - Investigators: J. Kaneene, D. Grooms, S. Bolin, C. Bolin
  - Results:
    - No cross-reactivity with gamma interferon assay
    - Non-significant increase in false positive CFT

No significant associations between *M. paratuberculosis* and false positive TB tests
Ante-Mortem Diagnostics

- **Identification of optimal gene targets of bovine TB using RT-PCR**
  - Investigators: S. Bolin, P. Coussins, D. Grooms, C. Bolin
  - Results:
    - Identified genes TNF-alpha and IL-1alpha as possible targets
    - Non-significant increase in false positive CFT

High potential for use in designing diagnostic tests
Post-mortem Diagnostics

- Comparison of post-mortem techniques for the detection of Mycobacterium bovis in white-tailed deer

  - Lead Investigators: S. Fitzgerald, J.B. Kaneene
  - Results:
    - Compared histopathology, acid-fast staining in culture, group-specific genetic probe
    - Gold standard: mycobacterial culture & identification

Group-specific gene probe may be used as new ‘gold standard’ for TB detection
Wildlife Ecology

- White-tailed deer ecology
- Behavior and Movement
- Genetic relatedness
Wildlife Ecology

- White-tailed Deer Behavior and Movement
  - Lead Investigators: S. Winterstein, H. Campa, R.B. Peyton
  - Results:
    - Described deer feeding behavior and potential for TB transmission at baiting and feeding sites
    - Tracked and quantified deer migration and dispersal
    - Effects of habitat on feeding and movement

Information for models to predict wildlife TB and MDNR feeding & baiting regulations
Wildlife Ecology

- Genetic relatedness and the spread of bovine TB
  - Lead Investigators: K. Scribner, S. Winterstein
  - Results:
    - Contacts btw related deer within social groups contribute to TB transmission
    - Supplemental feeding eradicated spatial genetic structure

Information on TB transmission within family groups, for feeding/baiting regulations
Social Sciences

- Economics
- Human Ecology
- Beliefs and Attitudes
Economics

- *Attitudes, Behavior, and Effort of Hunters in Bovine TB Areas of Michigan*
  - Lead Investigators: F. Lupi, B. Peyton
  - Results:
    - Quantified hunter contributions to economy
    - Hunting site location choices based on deer density, public hunting land, economic considerations

Understanding hunters’ motivation and economic contributions, for policymakers
Economics

- Economic Consequences of Bovine TB for Michigan Livestock Agriculture
  - Lead Investigators: C. Wolf, S. Nott, S. Harsh
  - Results:
    - Valued losses due to herd depopulation
    - Decision-making (costs, incentives) when TB present

Understanding full economic consequences of TB at farm level, for producers, regulators and legislators
Human Ecology

The impact of bovine TB on the farm family ecosystem, and sustainability of farming after TB diagnosis

- Lead Investigators: R. Griffore, L. Phenice

Results:
- Lower satisfaction with family life
- Lack of information, poor communication
- Policies, enforcement: insensitive & unexpected

Impact on families, and farmer attitudes that will affect compliance with TB control programs
Attitudes and Beliefs

Farmers’ attitudes and behaviors related to transmission of Bovine TB to cattle

- Lead Investigators: R. Griffore, L. Phenice
- Results:
  - Case-control study of farmers with/without TB
  - Groups differed on importance of wildlife biosecurity and use of wildlife control permits

Understanding whether farmers’ attitudes transfer to behaviors that reduce TB risks
Attitudes and Beliefs

**Attitudes, Behavior, and Effort of Hunters in Bovine TB Areas of Michigan**

- Lead Investigators: F. Lupi, B. Peyton
- Results:
  - Overall decline in hunting regardless of TB in area
  - Hunting location mainly based on deer density
  - Different priorities between hunters in TB areas versus other areas

**Understanding hunters’ motivation to improve hunting industry in TB area**
Summary
Summary

- Bovine TB research at Michigan State University has taken an interdisciplinary approach.

- MSU has worked with many individuals from state and federal agencies:

  **State of Michigan**
  - MDNR
  - MDA
  - MDCH

  **USDA-APHIS**
  - VS
  - WDA
Summary

Several graduate students, the next generation of researchers, have been trained

Research has been published in refereed scientific journals, technical reports, pamphlets/leaflets
The question:

Where do we go from here?
Thank You