Rollback Eradication of TB from Wildlife in NZ

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Bovine TB

- A global cattle disease that can infect humans
- Caused by *Mycobacterium bovis*
- Spreads by breath, saliva, raw meat and milk
- In NZ, often spreads to possums, feral pigs, ferrets, wild deer...
• Goals under National Pest Management Plan (v4)
PEST MANAGEMENT
Reduces pests which carry and spread TB

MOVEMENT RESTRICTIONS
Stops the spread of TB from infected or high risk animals

DISEASE CONTROL
Identifies and manages infected herds
Eradicating TB from Wildlife

Pest control to **break main TB cycle in wildlife**

- Mainly possums
- Ferrets in some areas (Central Otago)
Why Control Possums?

- Possums can maintain TB at high densities
Why Control Possums?

• Infected possums die
Why Control Possums?

• But not before they have infected others
Why Control Possums?

• TB is maintained
Why Control Possums?

- Herd can become re-infected from possums
- Curious cows lick dead possums covered with TB pus
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• Curious cows lick dead possums covered with TB pus
Why Control Possums?

• But if possum numbers are reduced...
Why Control Possums?

• But if possum numbers are reduced...

• TB cannot be sustained and dies out
Breaking the TB Cycle

Spatially-explicit Individual-Based Model of possum and TB disease dynamics
Breaking the TB Cycle

- Simulate control activities to determine effect on TB persistence

- Suppress possums to low levels for 10-15 years (<1/ha)

- TB cannot be sustained
Refining Control

- Type of control – trapping vs aerial 1080
- Number and frequency of controls
- Spacing of trap & bait lines
- Empirical testing of predictions
Surveillance to Prove Freedom

- Wildlife surveillance to prove absence

1. Detect, trap and test possums for TB

2. Inspect and test other animals
   - pigs, ferrets, deer
Surveillance to Prove Freedom

- Find TB?
  - do more control!

- Don’t find any TB?
  - **Truly gone?**
  - Or
  - **Didn’t look hard enough?**

Absence of Evidence ≠ Evidence of Absence
Probability of Freedom

Our conclusion depends on:

1. How confident we were that no TB remains in possums before looking.

2. How hard did we look?

3. How confident do we want to be in declaring wildlife is TB free

\[ PoF = \frac{Prior}{1 - (SSe(1 - Prior))} \]

**Prior**: Prior probability TB is absent

**SSe**: System-level sensitivity - chance of finding TB if present

**PoF**: Posterior probability of freedom
PoF Framework

1. Setting a Prior

- Disease history
- Control history
- Decision tree

Prior
Prob. TB eliminated
PoF Framework

2. Sensitivity from Surveillance

i. Test proportion of population for TB

ii. - Calculate chance of finding TB if present,
   - Proportion tested (n/N)
   - Accuracy of test (SeTest)
   - Design prevalence (m)

\[
SSe_{Pop} = 1 - \left(1 - SeTest \frac{n}{N}\right)^m
\]
PoF Framework

2. Sensitivity from surveillance

- Based on spatial arrangement of devices
- Need to know animal home range size and detectability

SSe

If TB possums were present, what is chance we would detect TB
Sentinels

• Pigs: Spill-over hosts
• Great at ‘finding’ TB
• Highly infectious, with large home range

• Ferrets: moderate home range, but less infectious

• Deer: large HR, low infection rate
PoF Framework

3. Combine Prior and SSe to get...

\[ P_{\text{Free}} = \frac{\text{Prior}}{1 - (SSe(1 - \text{Prior}))} \]

PFree
Probability area is free of TB given TB not detected
\[ \Pr(\text{TB-}|S-) \]
• Surveillance is difficult and very costly in some regions
Surveillance then Control

- Do survey to prove TB at low levels
- then control to eliminate all infected possums
Remote central c.6500 ha bush area not intensively surveyed since 2006
SSe = 0.10
n=426 possums
N = c.4200

>95% kill
• Aerial control
Too much surveillance? Know when to walk away

- Correct decision made
  - No TB, therefore **no consequences**
    - 95% of time (?)

- Incorrectly declare freedom
  - TB remains therefore will have to **re-control**
    - 5% of time (?)
Stopping Rule

Surveillance costs
• 100% chance of incurring

Re-control
• Cost * Chance of incurring
• Socio-political costs
Stopping Rule

Depends on habitat related factors

- If re-control is $\$, stop later
- If surveillance is $\$, stop earlier
Livestock as Sentinels

• Absence of TB in livestock provides info on TB absence in wildlife
• Especially useful for assurance phase
1. 1990s: TB in ferrets where possum abundance was high

**TB in ferrets was spill-over from possums**

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   **TB in ferrets was spill-over from possums**

2. But transmits between captive ferrets
   **Ferret to ferret infection?**

Ferrets as a Host?!

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   – 182 possum TB surveys in areas with 5+ yrs good control
   – 100,000 post mortems – no TB

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   **Possum TB rare absent from most farmland**

4. 2000s: TB not rare in ferrets
   – 417 ferret TB surveys
   – 35,000 ferrets, 406 TB+

   **Is TB cycling in ferrets after eradicated from possums?**
**Current research**

**Possums:**
- Low density (0.02/ha)
- No TB

**Ferrets:**
- Variable density
  - $<1/\text{km}^2$ in west
  - $4/\text{km}^2$ in central east
- TB prevalence 3.5%
  - All TB in east

$\Rightarrow$ Supports TB persistence in ferrets **without possum spillover**
The End is in Sight

Well on the way to TB eradication from NZ

From 1700 to 26 herds

From 10.4 million ha to <7.5m
Lessons learned

• Partnerships are key:
  – OSPRI funding sound science
  – Evidence based technical decisions

• Good team
  – Strong leadership
  – Diverse skills

• Continual improvement

• Coordinated & systematic approach
Beyond TB

• PoF framework applied to pest eradication

• Other wildlife disease opportunities