Rollback Eradication of TB from Wildlife in NZ

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Manaaki Whenua
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@EcolModAG

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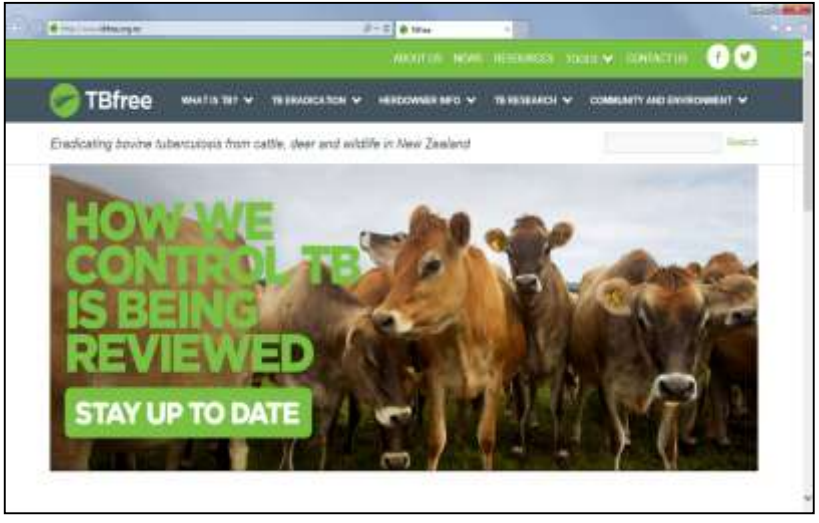
Our Land, Our Future

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…

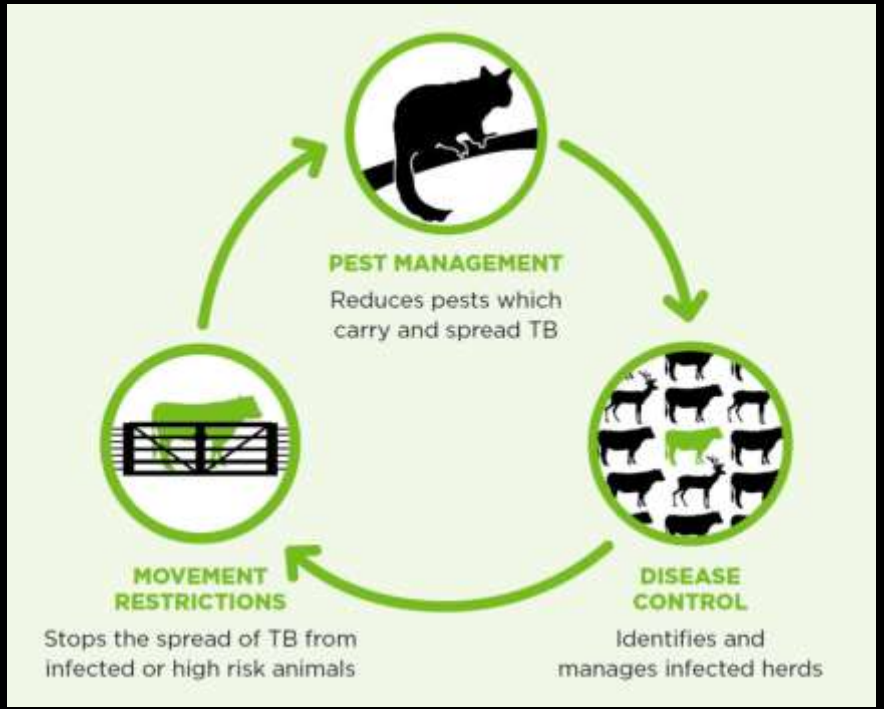
- Goals under National Pest Management Plan (v4)




KEEP FINGERS CLEAR

TBfree


NAIT
34
TOP TIP TUESDAY
TAG AND REGISTER


PEST MANAGEMENT
Reduces pests which carry and spread TB
DISEASE CONTROL
Identifies and manages infected herds
MOVEMENT RESTRICTIONS
Stops the spread of TB from infected or high risk animals

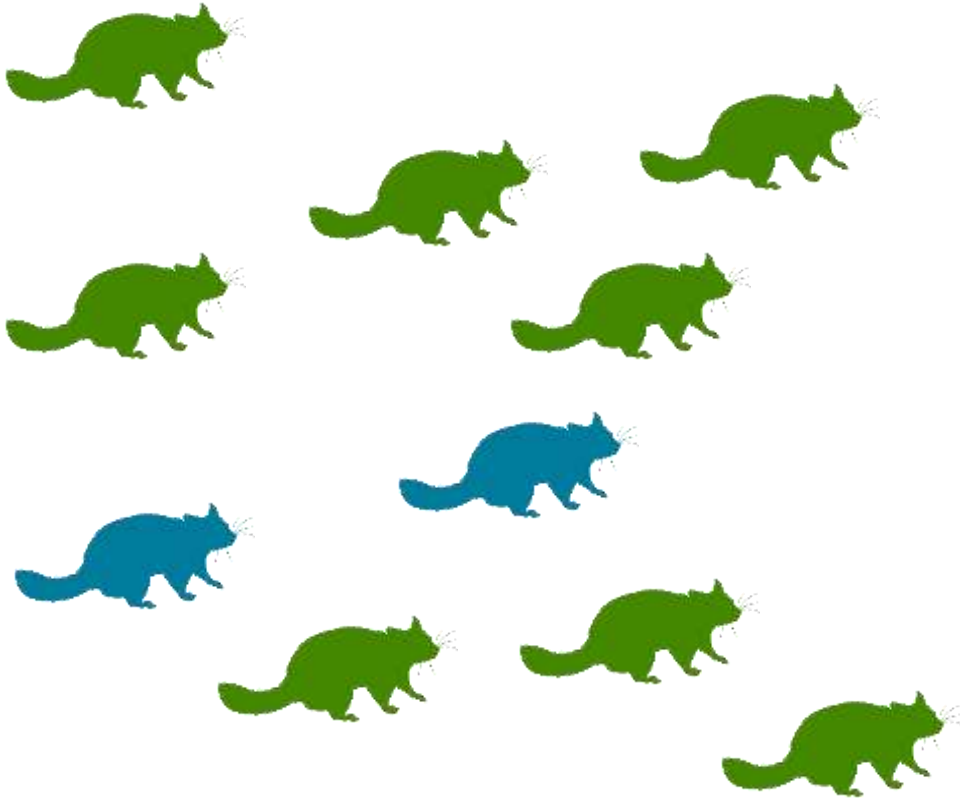
Eradicating TB from Wildlife

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

- Mainly possums
- Ferrets in some areas (Central Otago)

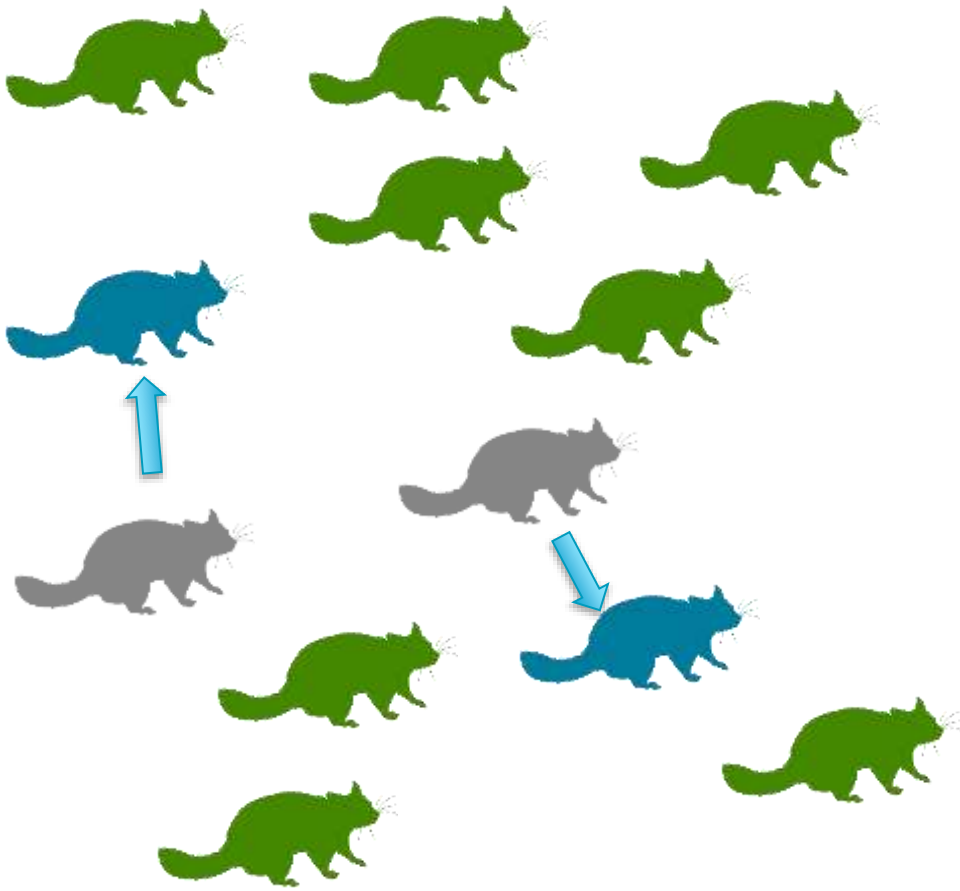
Why Control Possums?

- Possums can maintain TB at high densities



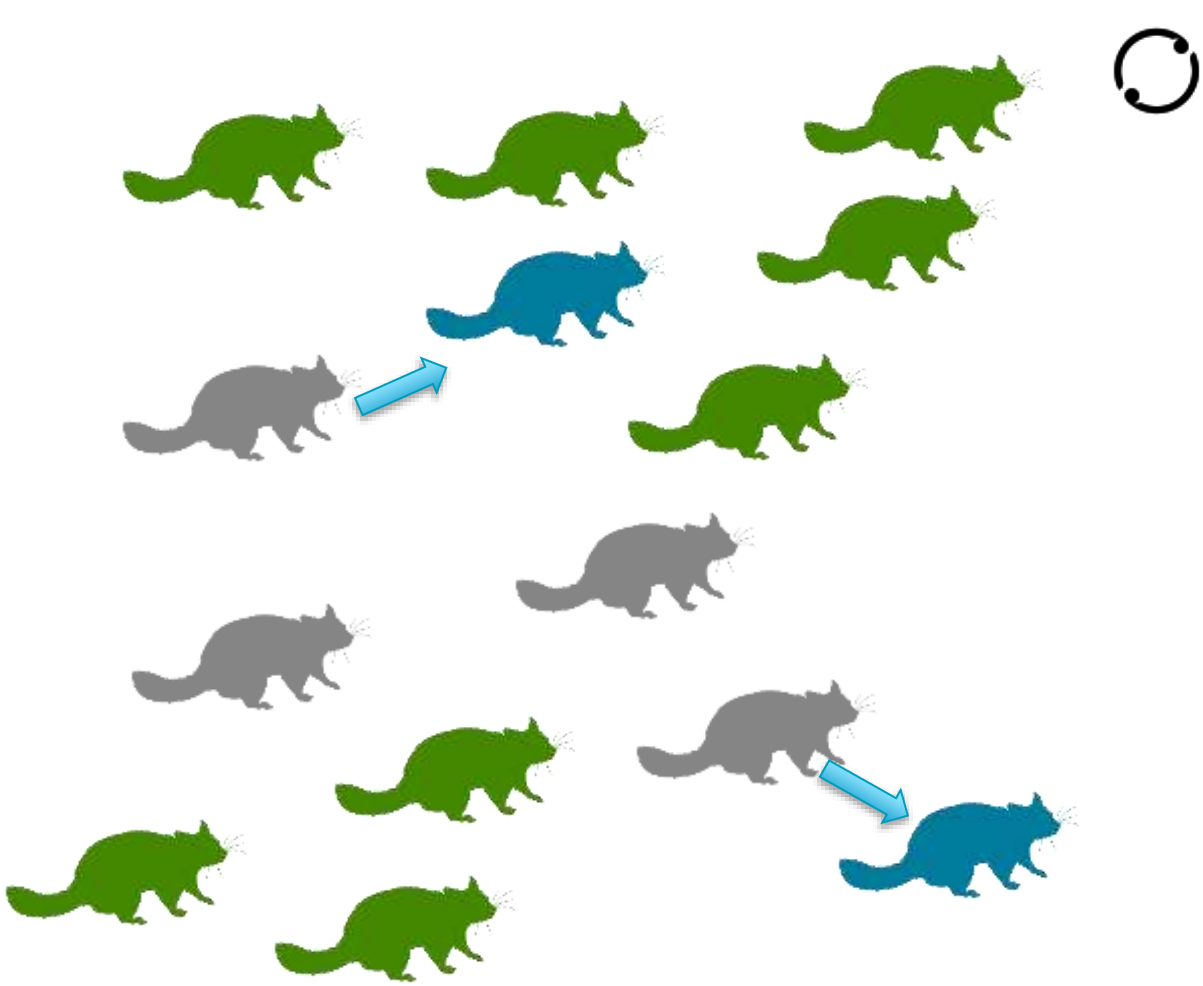
Why Control Possums?

- Infected possums die



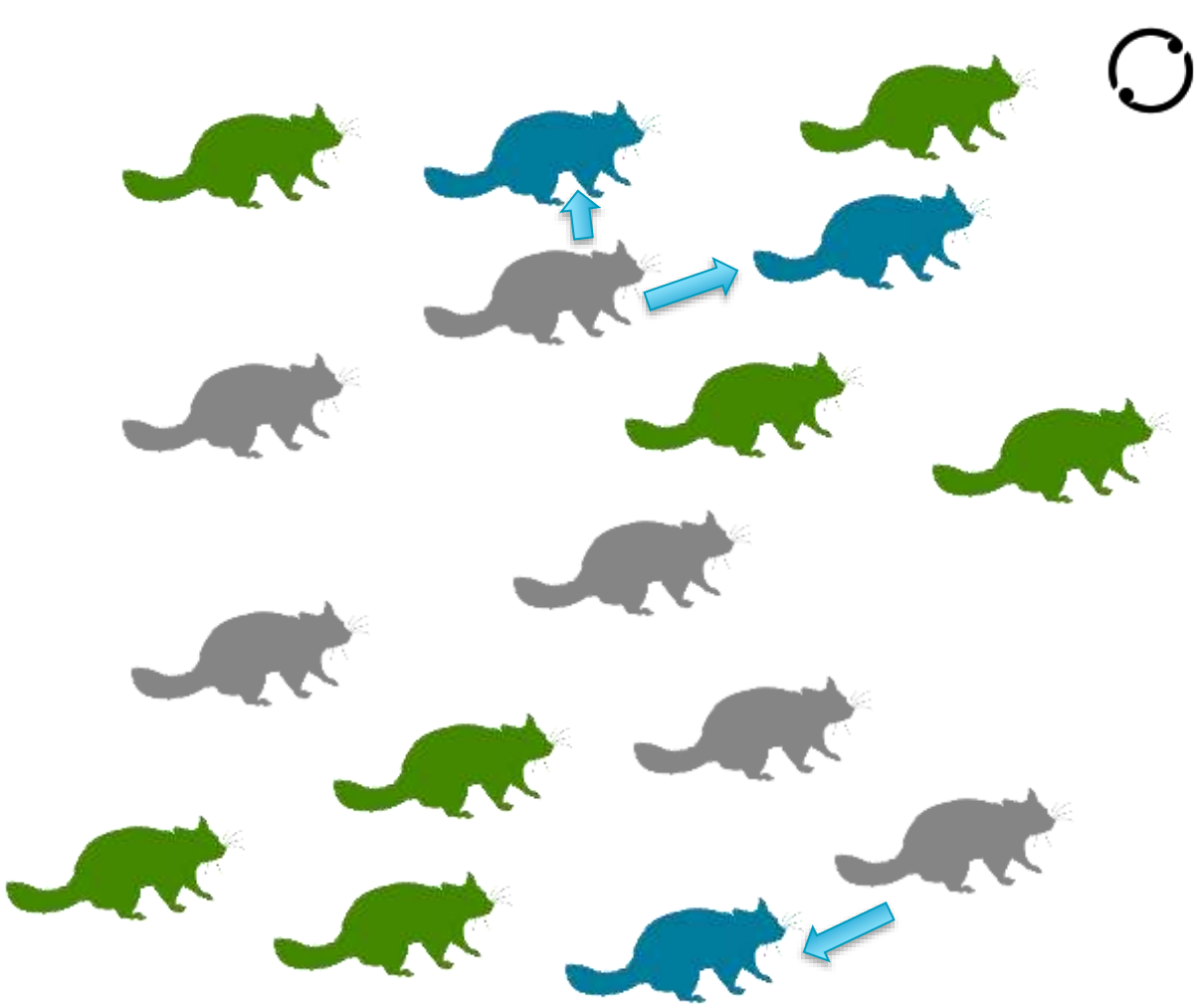
Why Control Possums?

- But not before they have infected others



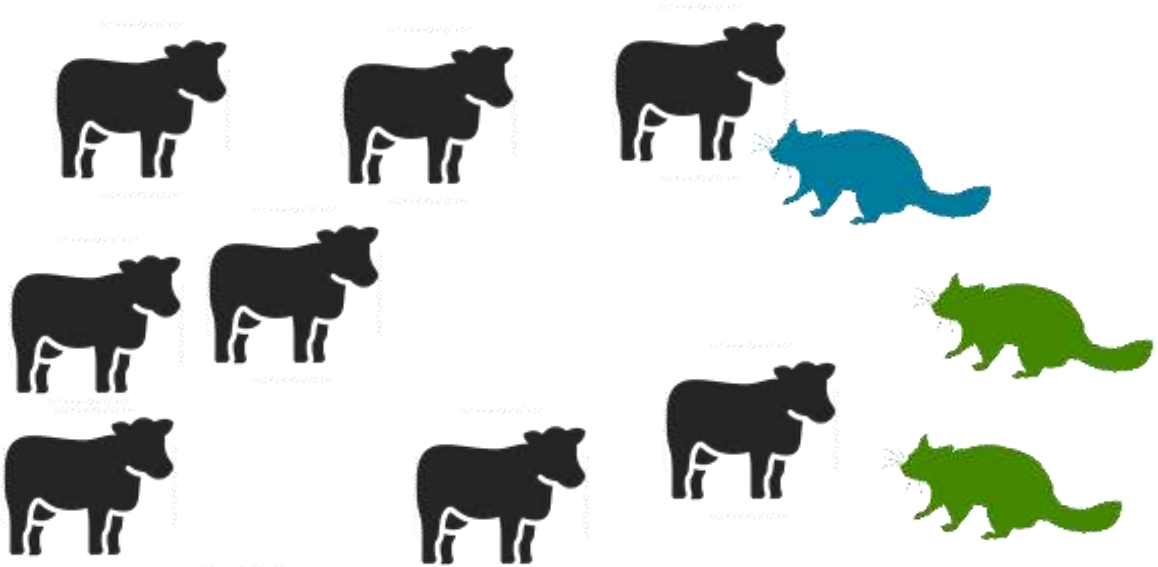
Why Control Possums?

- 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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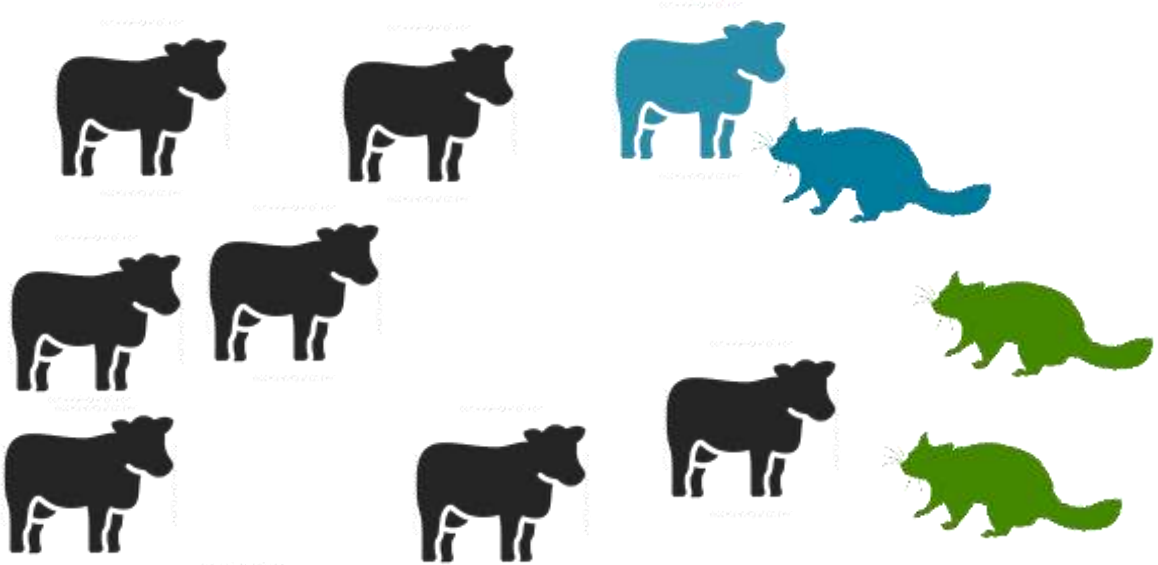


Why Control Possums?

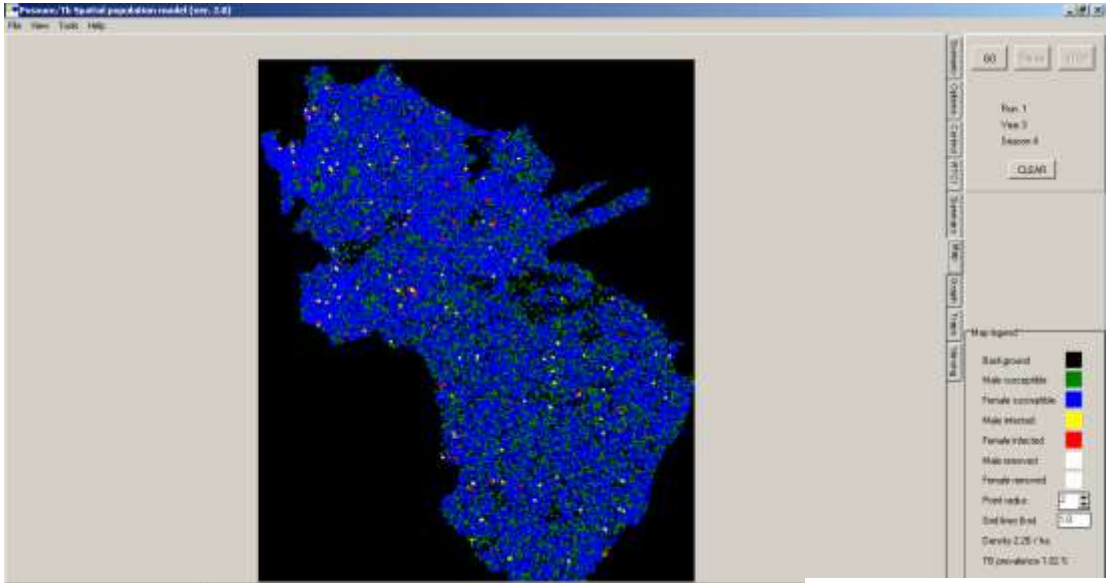
- But if possum numbers are reduced…

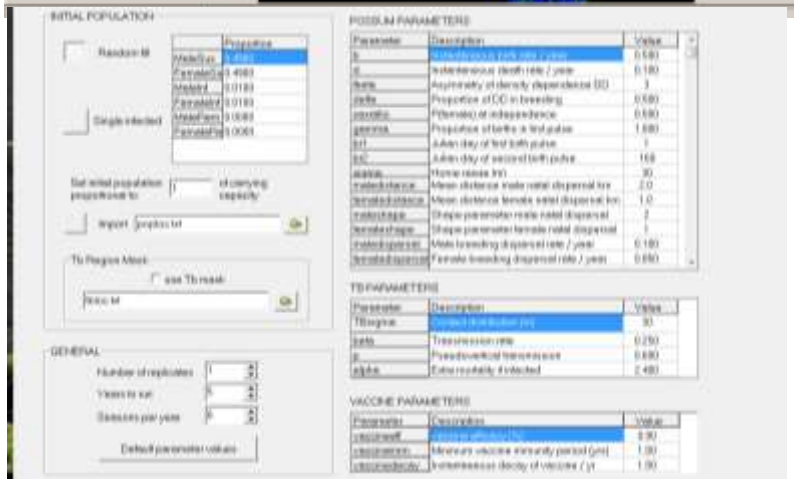
Why Control Possums?

- 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





Journal of Applied Ecology

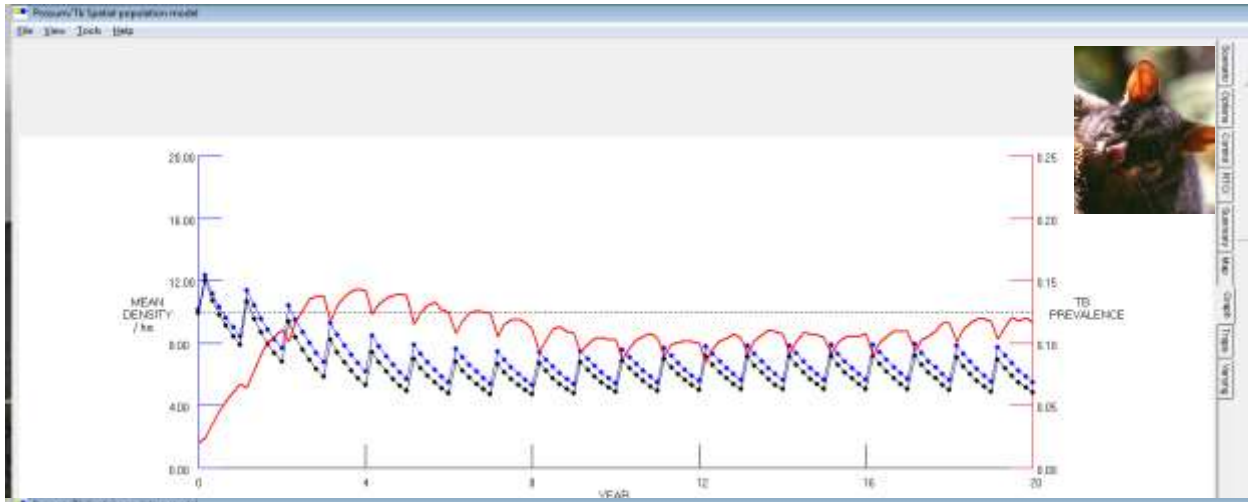
Management of bovine tuberculosis in brushtail possums in New Zealand: predictions from a spatially explicit, individual-based model

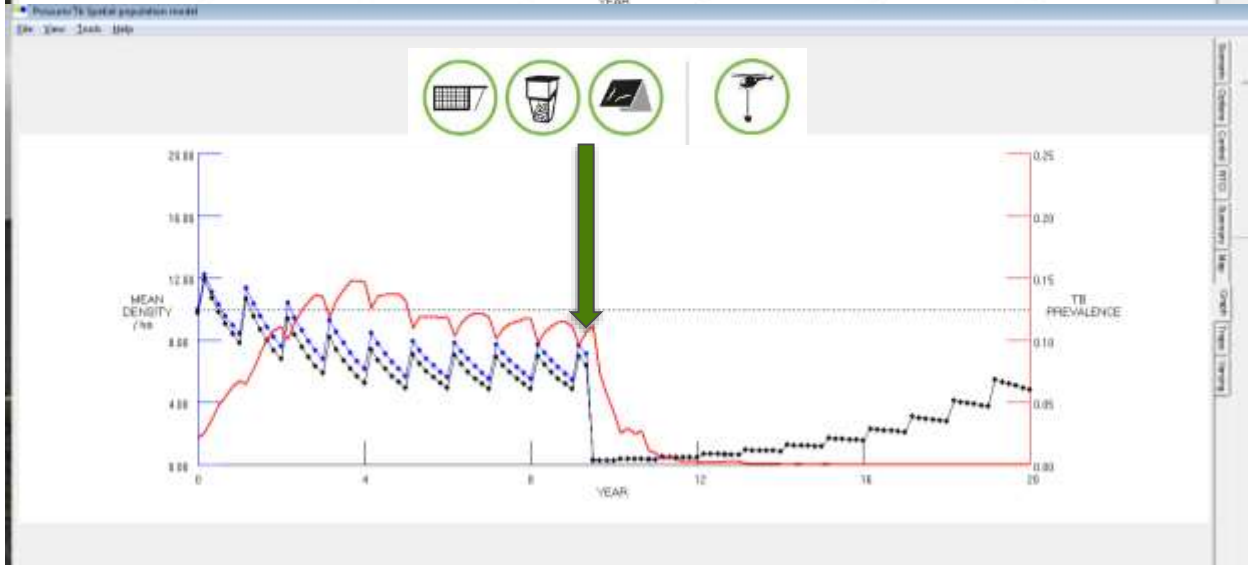
David S. L. Ramsey[1]* and Murray G. Efford[2]†

[1]Landcare Research, Private Bag 11052, Palmerston North, New Zealand; and [2]Landcare Research, Private Bag 1930, Dunedin, New Zealand

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

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

Thomas Bayes
1701-1761

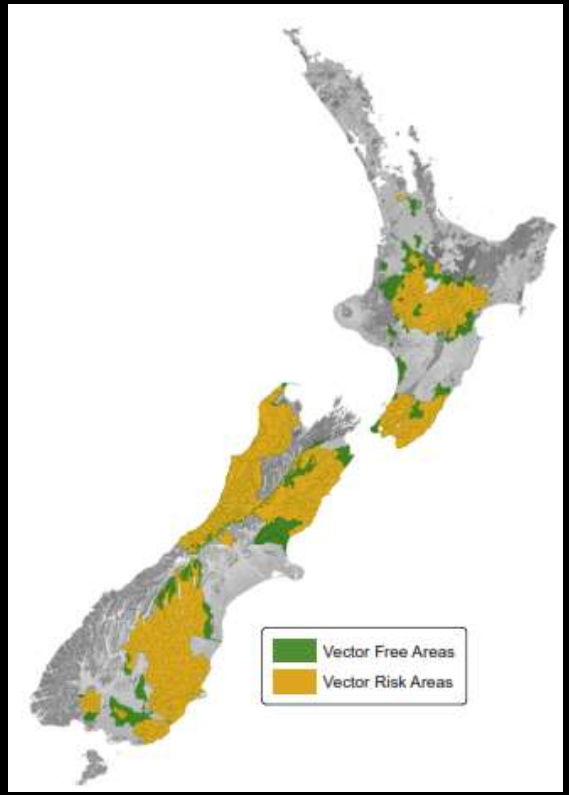
Prior: Prior probability TB is absent

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

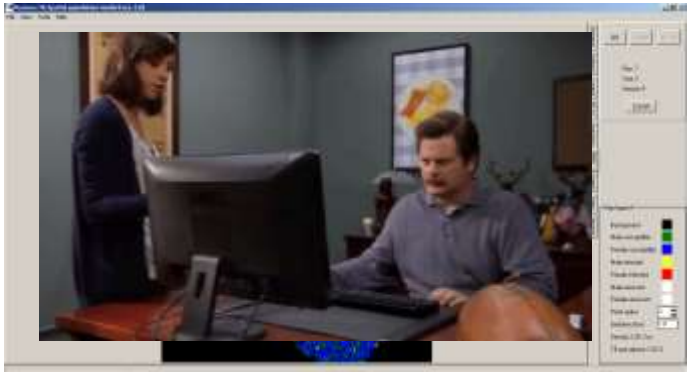
PoF: Posterior probability of freedom

PoF Framework

- 1. Setting a Prior



OSPRI TBfree



- Disease history
- Control history
- Decision tree

Prior

Prob. TB eliminated

PoF Framework

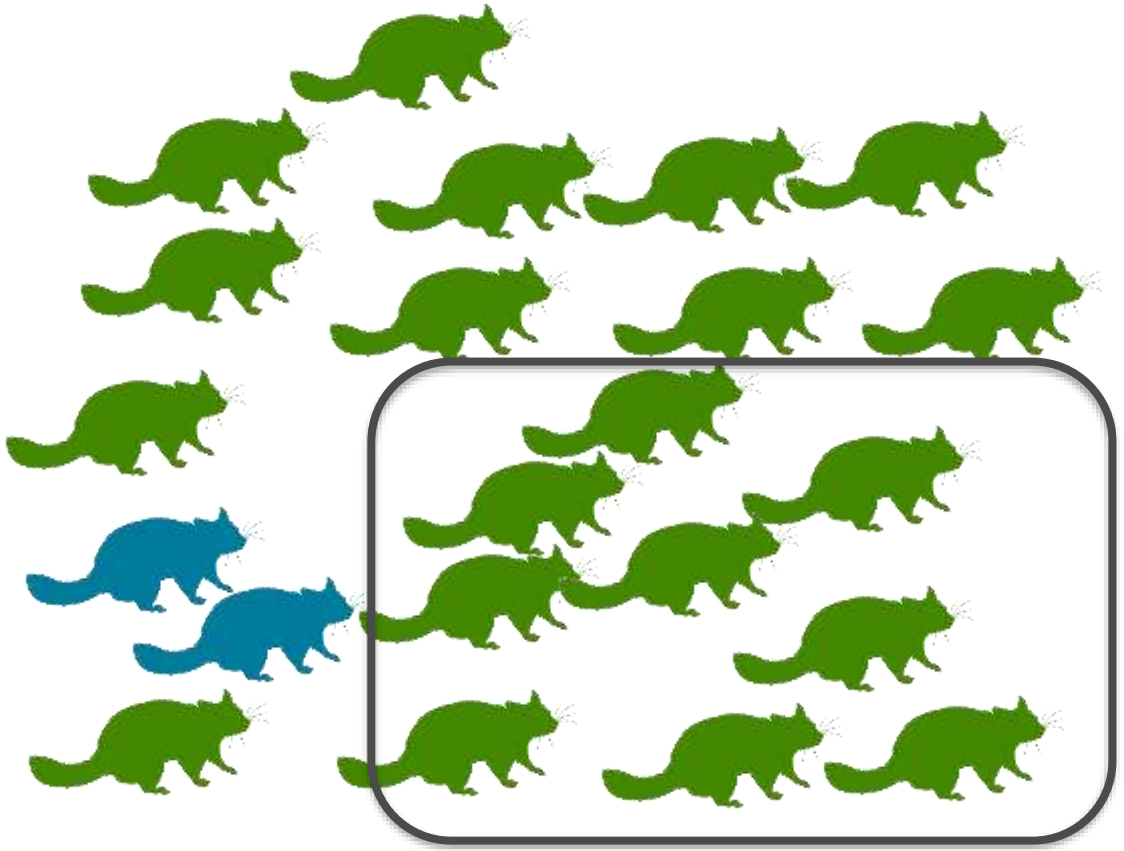
2. Sensitivity from Surveillance

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

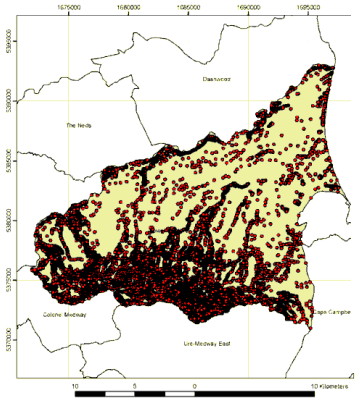
-Based on spatial arrangement of devices

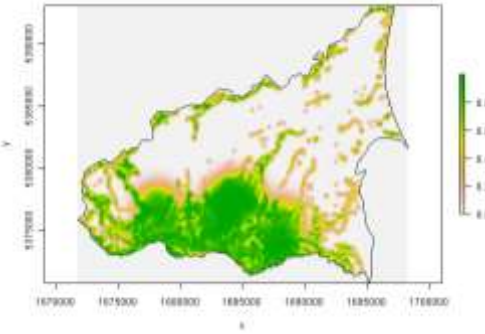
- Need to know animal home range size and detectability

SSe

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

A novel approach to assess the probability of disease eradication from a wild-animal reservoir host



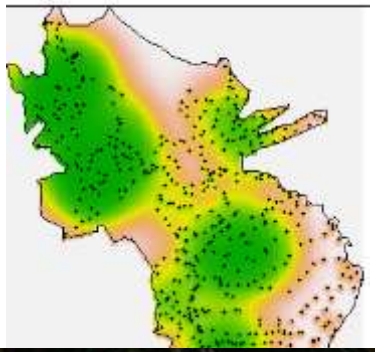


Sentinels

- 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



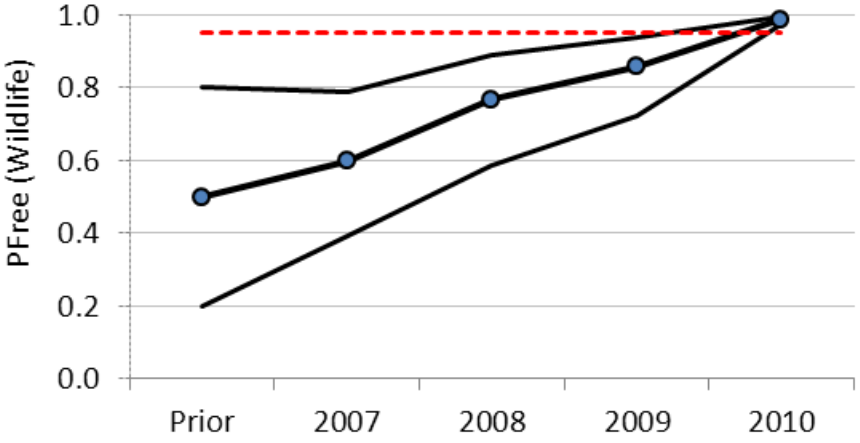
PoF Framework

3. Combine Prior and SSe to get…

$$PFree = \frac{Prior}{1 - (SSe(1 - Prior))}$$

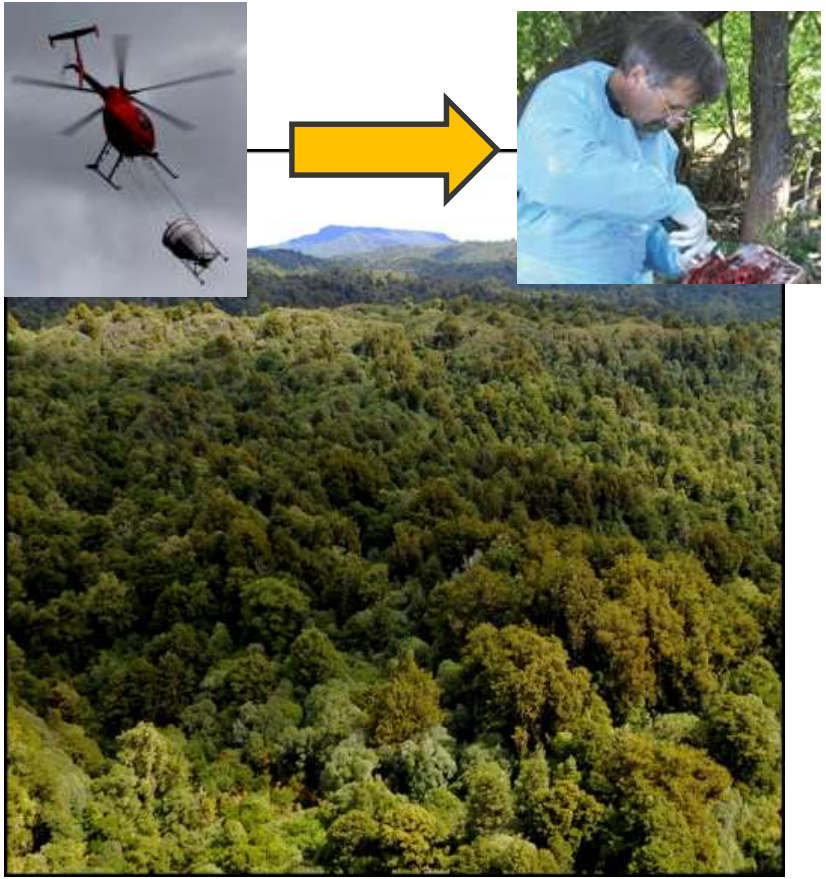
PFree

Probability area is free of TB given TB not detected
Pr(TB-|S-)



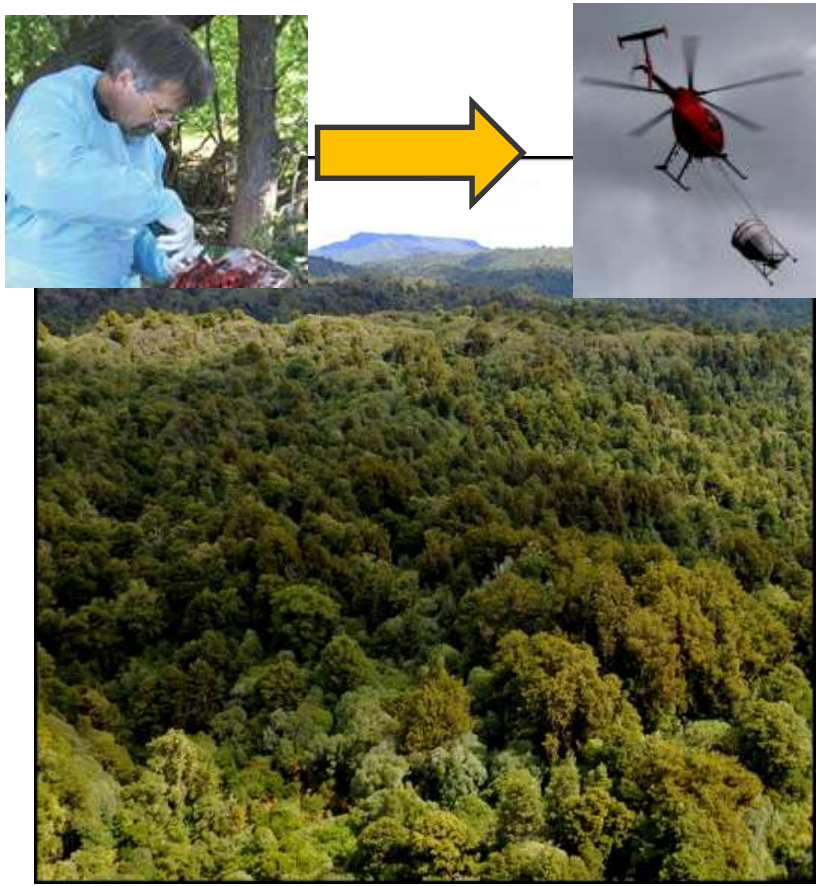
Control then Surveillance

- Surveillance is difficult and very costly in some regions



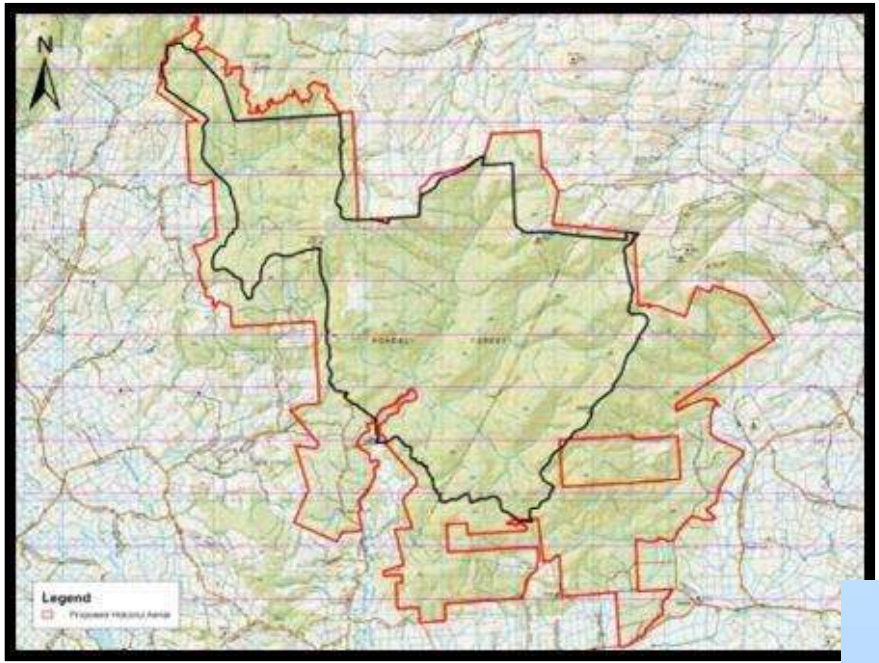
Surveillance then Control

- Do survey to prove TB at low levels **then** control to eliminate all infected possums



Surveillance then Control: Hokonui Hills

Remote central c.6500 ha bush area not intensively surveyed since 2006

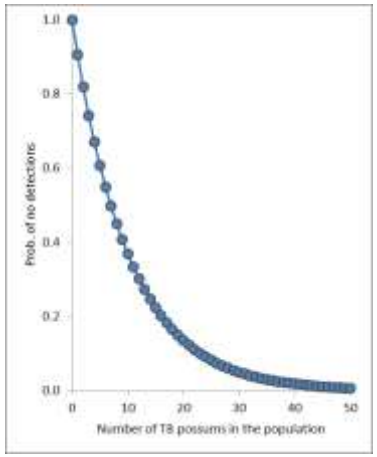


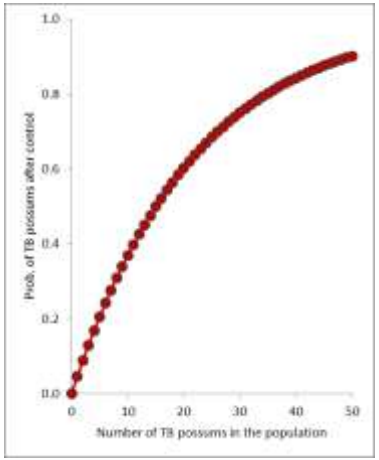
Surveillance then Control: Hokonui Hills

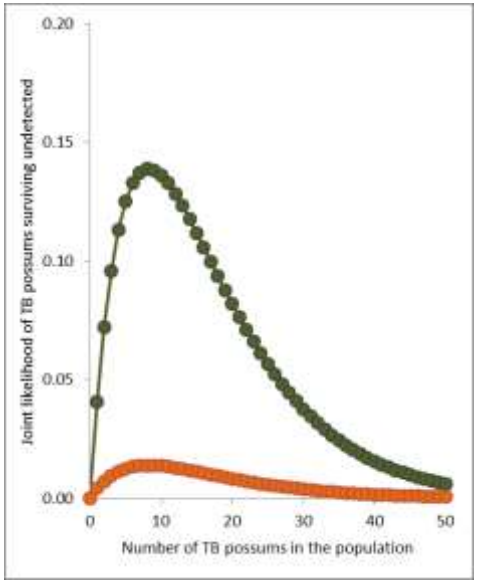
SSe = 0.10
n=426 possums
N = c.4200

>95% kill

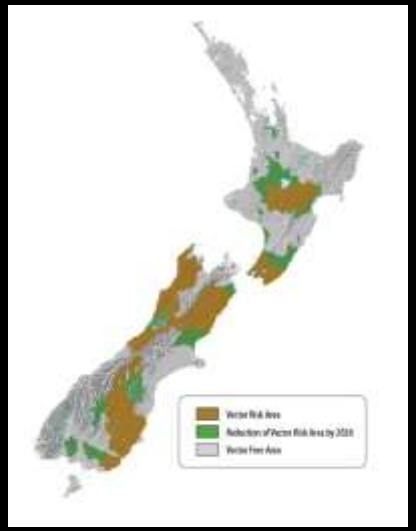
- Aerial control

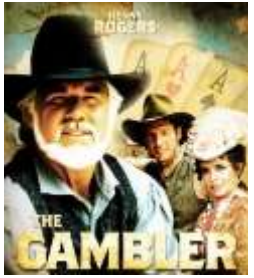






Too much surveillance? Know when to walk away





- 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

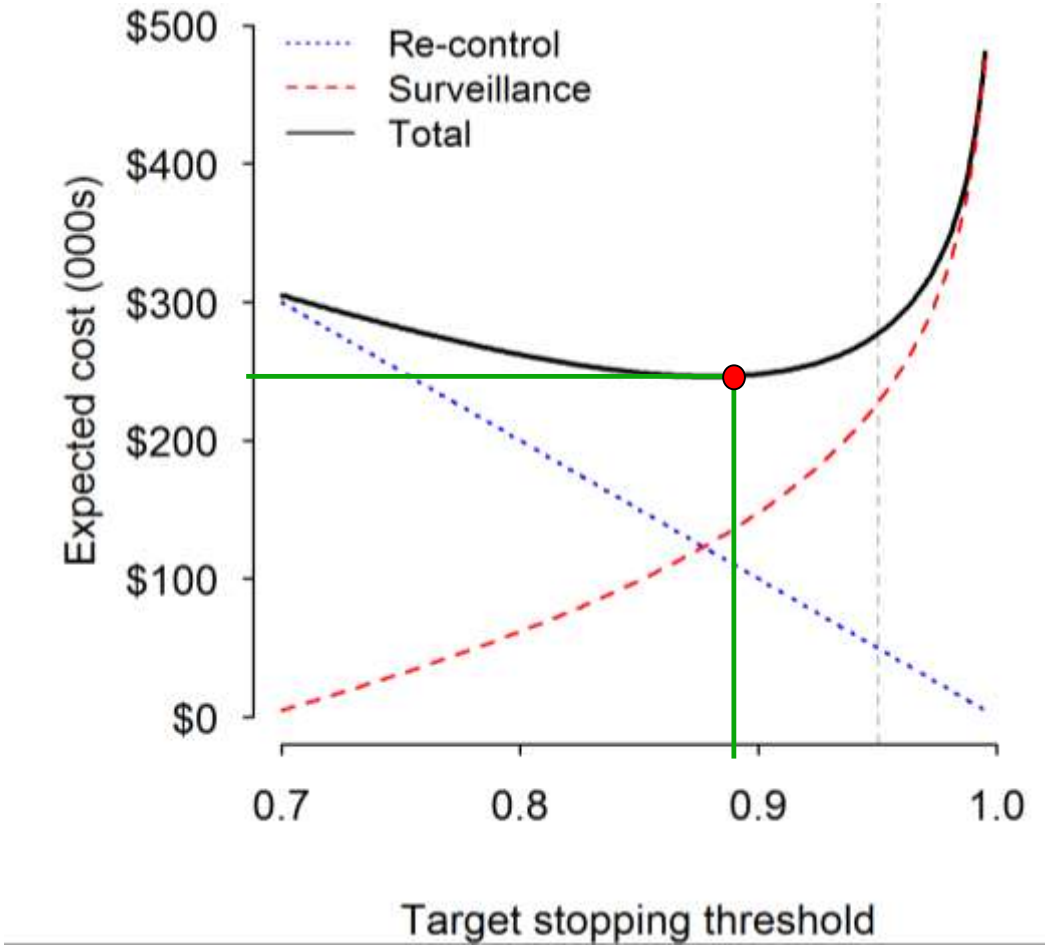
Surveillance costs

- 100% chance of incurring

Re-control

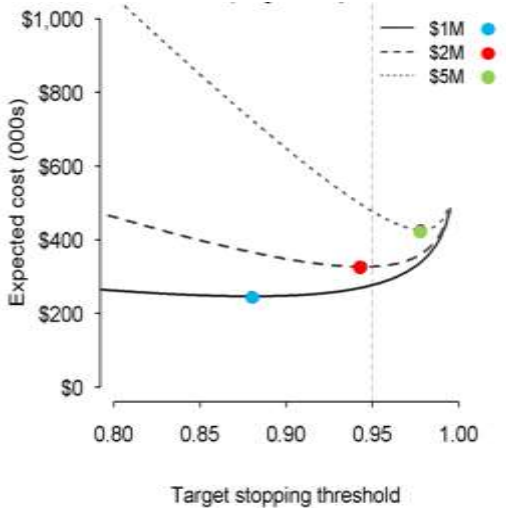
- Cost * Chance of incurring

- Socio-political costs



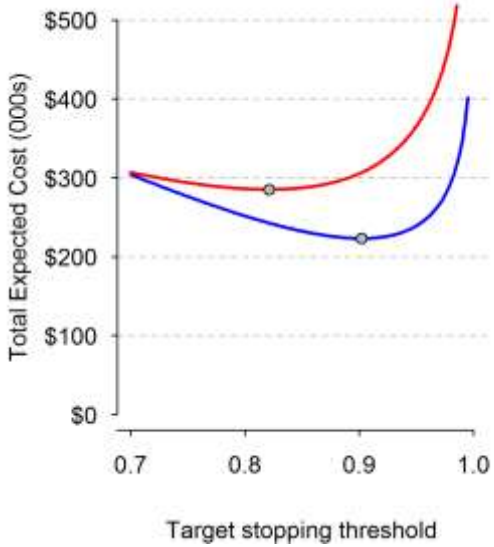
Stopping Rule

Depends on habitat related factors



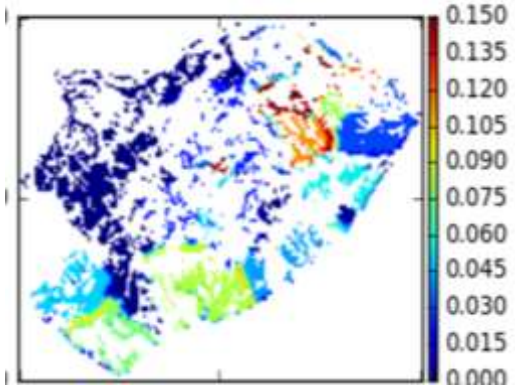
If re-control is $$, stop later

If surveillance is $$, stop earlier



Livestock as Sentinels

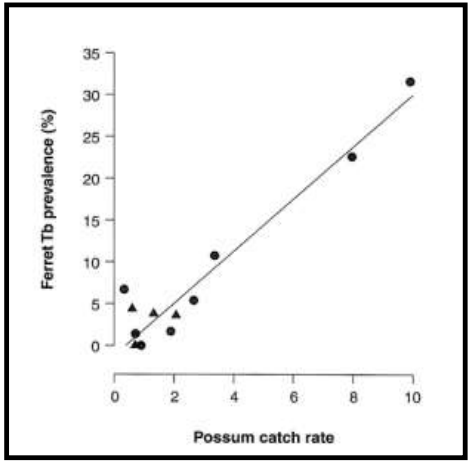
- Absence of TB in livestock provides info on TB absence in **wildlife**
- Especially useful for assurance phase



Ferrets as a Host?!

1. 1990s: TB in ferrets where possum abundance was high

TB in ferrets was spill-over from possums



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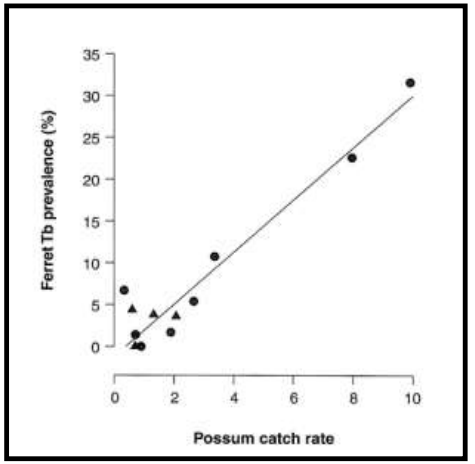

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2. But transmits between captive ferrets

   Ferret to ferret infection?

A wild-caught female ferret scavenging a male ferret carcass.

Ferrets as a Host?!

3. 2000s: TB rare in possums
   - 182 possum TB surveys in areas with 5+ yrs good control
   - 100,000 post mortems – no TB

Possum TB rare absent from most farmland

Ferrets as a Host?!

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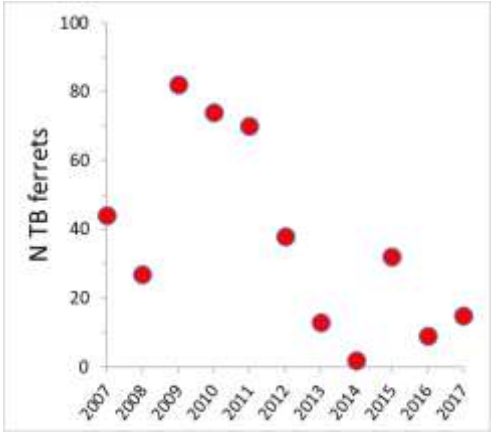
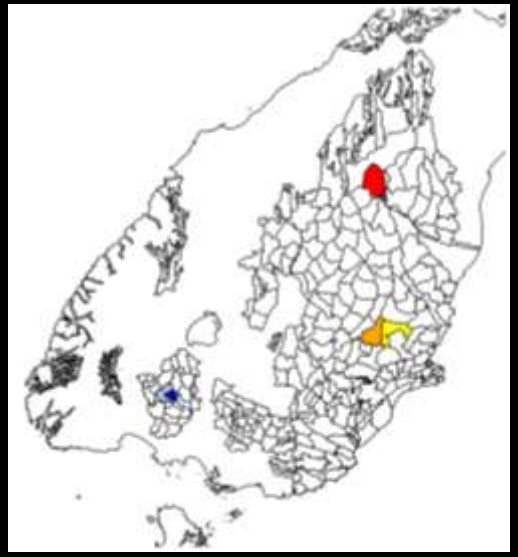
4. 2000s: TB not rare in ferrets
   - 417 ferret TB surveys
   - 35,000 ferrets, 406 TB+

Is TB cycling in ferrets after eradicated from possums?



Current research



Possums:

- Low density (0.02/ha)
- No TB

Ferrets:

- Variable density
  - <1/km^2 in west
  - **4/km^2 in central east**
- TB prevalence 3.5%
  - All TB in east

⇒Supports TB persistence in ferrets without possum spillover

Benmore VCZ

The End is in Sight

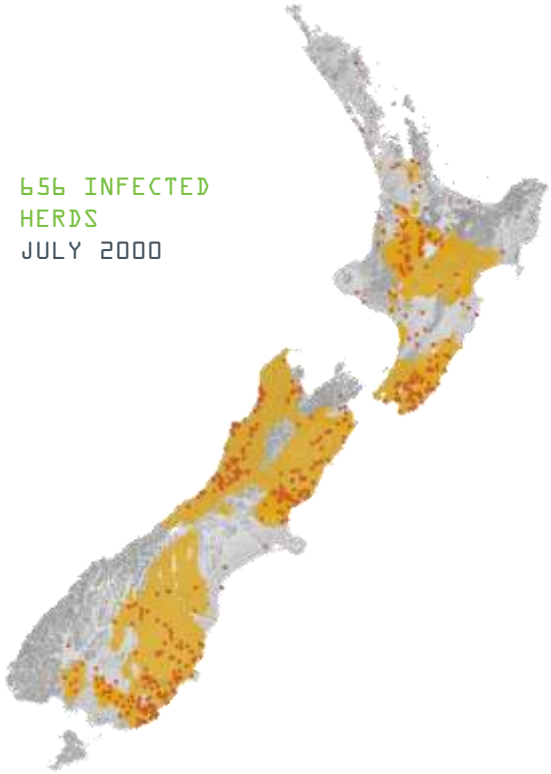
Well on the way to TB eradication from NZ

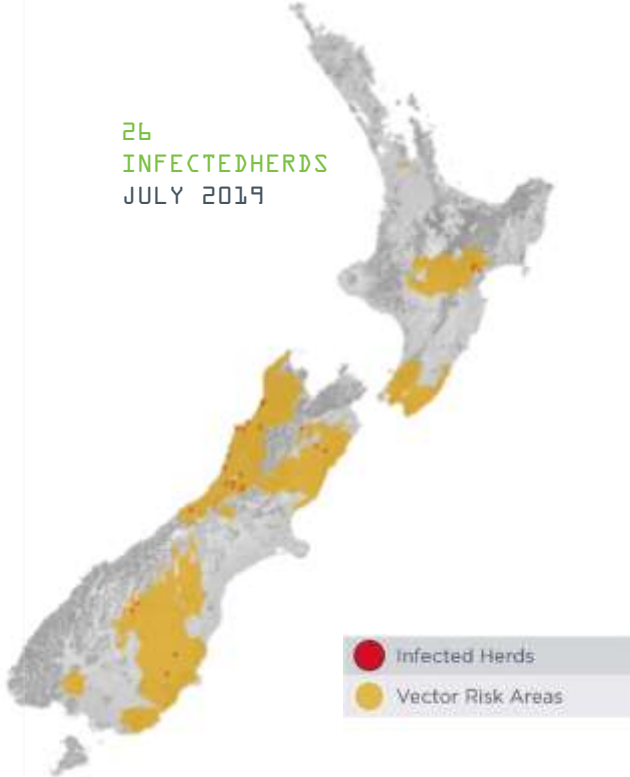
From 1700 to 26 herds

From 10.4 million ha to <7.5m

OSPRI

TBfree





Lessons learned

- Partnerships are key:
  - OSPRI funding sound science
  - Evidence based technical decisions
- Good team
  - Strong leadership
  - Diverse skills
- Continual improvement
- Coordinated & systematic approach

OSPRI

Manaaki Whenua
Landcare Research

Dr. Paul Livingstone
Research Manager (Retired)

Dr. Graham Nugent
Research Area Leader

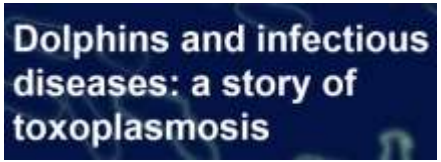
Dean Anderson, Mandy Barron, Grant Morriss, Ivor Yockney, Bruce Warburton, Graham Nugent, Dave Morgan, Peter Sweetapple (absent)

Beyond TB

- PoF framework applied to pest eradication

PREDATOR FREE
2050
kia uru ora, return to life

- Other wildlife disease opportunities



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