Use of New Technologies in Pest Control






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Use of New Technologies in Pest Control

So many new technologies being developed
Lots of challenges:

- wild animals often with cryptic behaviour
- complex environments need knowledge of interactions
- unique to New Zealand problems
- often involves lethal control
- challenging environments
- requires specialist expertise
- no perfect tools available
- enormous pressure to find fast fixes
- balance effectiveness against costs and benefits










Pest Control in New Zealand

No perfect tools - means not easy decisions
Decisions are made depending:

- pest species
- effective tools available
- what drives the need for control
- suitability for that environment
- other species present
- location
- welfare impacts and social license
- balance effectiveness against costs and benefits

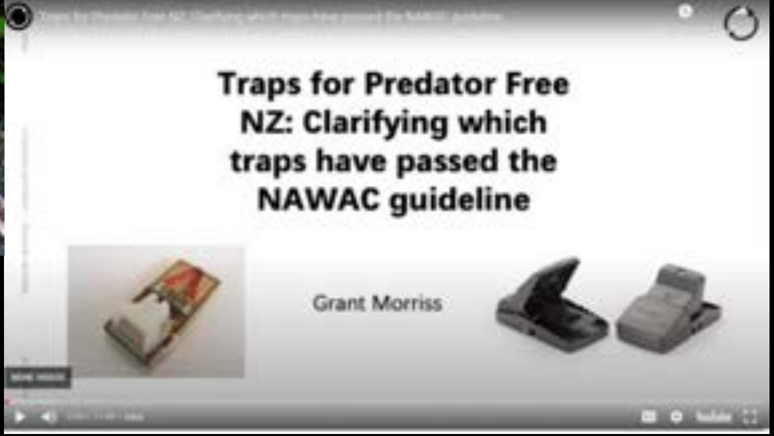









Traps



New traps and target species
Self re-setting traps
New techniques for monitoring traps
Self reporting trapping networks

Camera traps

Use of AI for target/non-target recognition
Survey – presence/absence
Thermal cameras

Guidance and tools for best use

Using trail cameras to detect pests and understand how pests interact with traps and baits:

Drones and Helicopters

- Detection
- Bait delivery

Infrared and thermal technology

- Detection
- Precision shooting

Audio monitoring

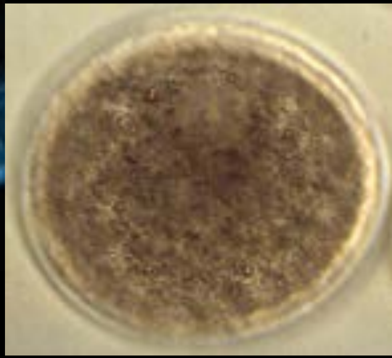
- Detection

Molecular tools

- Detection eDNA, scat analysis
- Genotyping identifying animal source and movements
- New generation control technologies eg fertility control such as Trojan females, sterile males, contraceptive vaccines

Non-lethal control tools

- Aversion training
- Prey detection – chemical camoflage



Toxins

Currently the most effective tools

Commonly used vertebrate pesticides:

- 1080
- cyanide
- brodifacoum
- PAPP (para-aminopropiophenone)
- cholecalciferol
- pindone, diphacinone, and coumatetralyl

Ongoing work improve efficacy, animal welfare impacts, specificity, strategic use and to identify alternative toxins

Precision Pest Control

The Approach:

- Develop and validate technologies/platforms which have the potential of identifying toxins with improved:
    - Species or taxa specificity - minimal non-target effects
    - Humaneness – certainly better than anticoagulants
    - Environmental impact – decreased persistence

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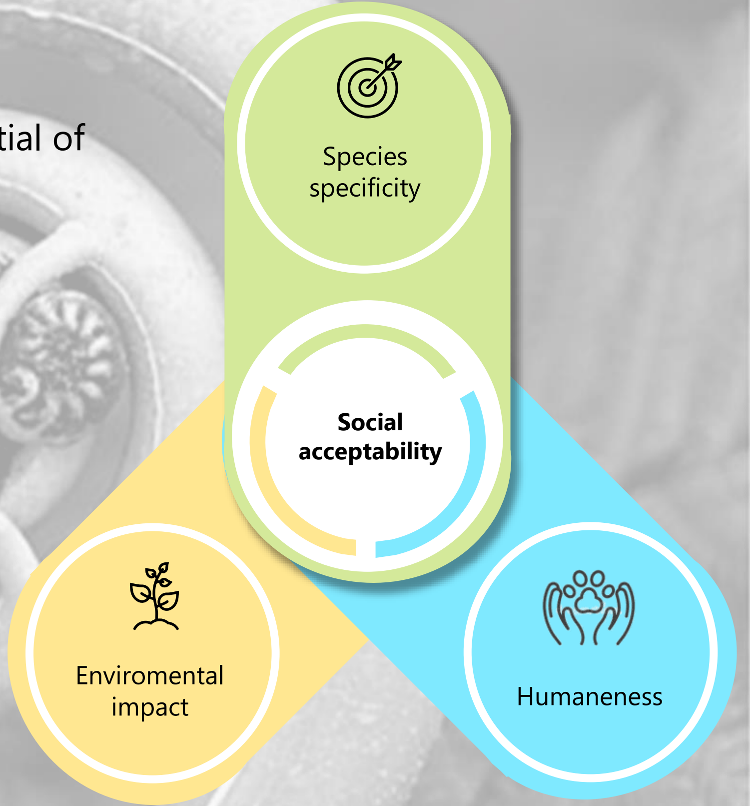
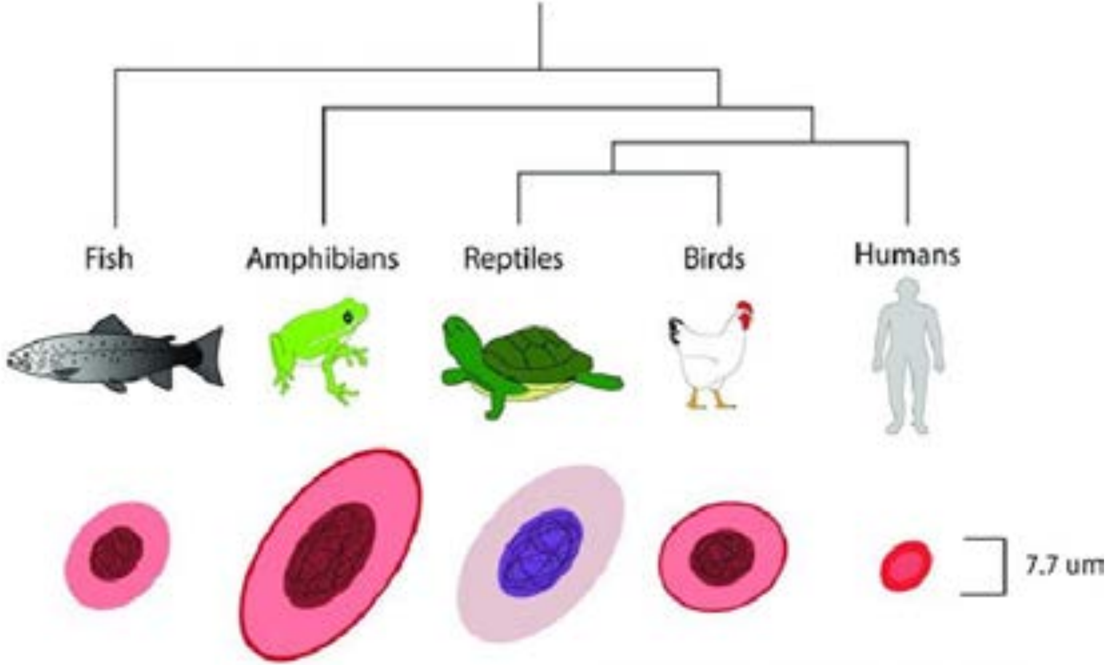
Socially acceptable toxins

- Stoats, mice, and possums as model test species:
  stoats and possums are key targets for PF2050; and mice are the most economically important rodent pest globally



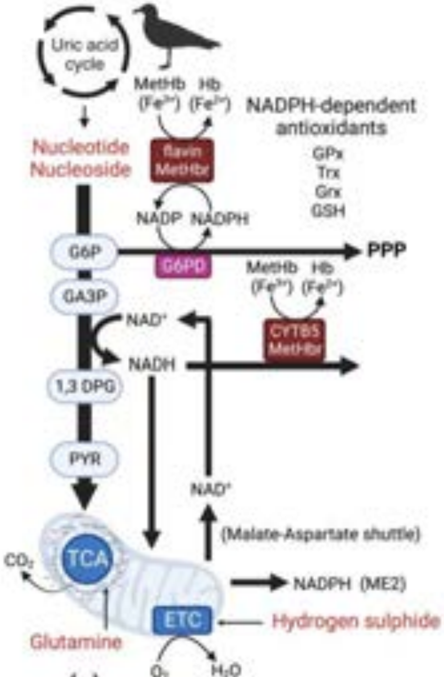
Dr. Clive Marks - Nocturnal Wildlife Research
Brian Hopkins – MWLR
Dr. Erica Hendrikse– MWLR
Dr. Tony Hickey – Auckland Uni

Mammalian erythrocytes - no nucleus or mitochondria



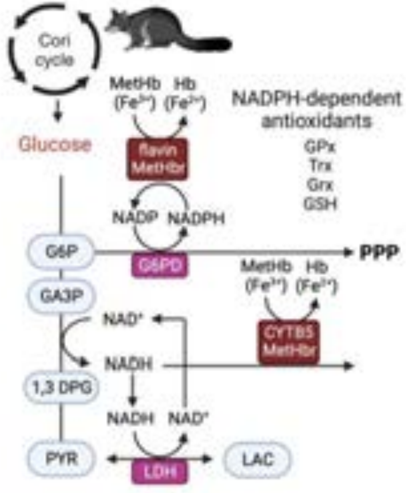
Differences in erythrocyte metabolic strategy seek to exploit

BIRD - aerobic



(a)

MAMMAL - anaerobic



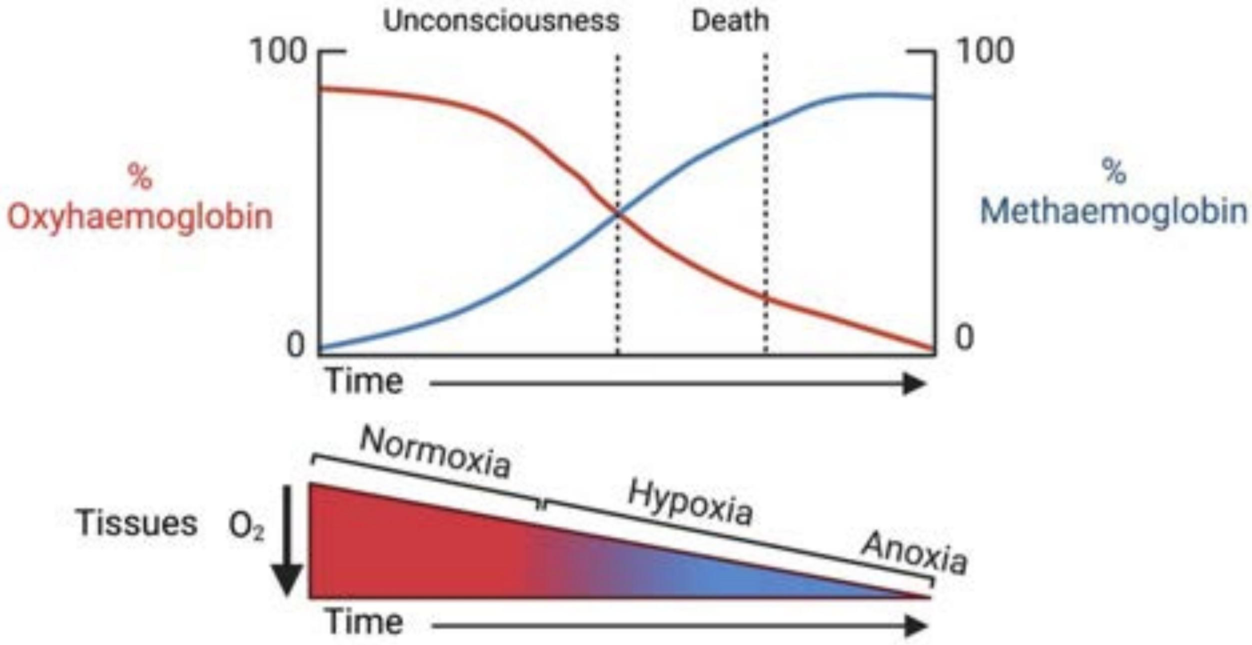
(b)

Aim to enhance the toxicity of methaemoglobin-forming agents

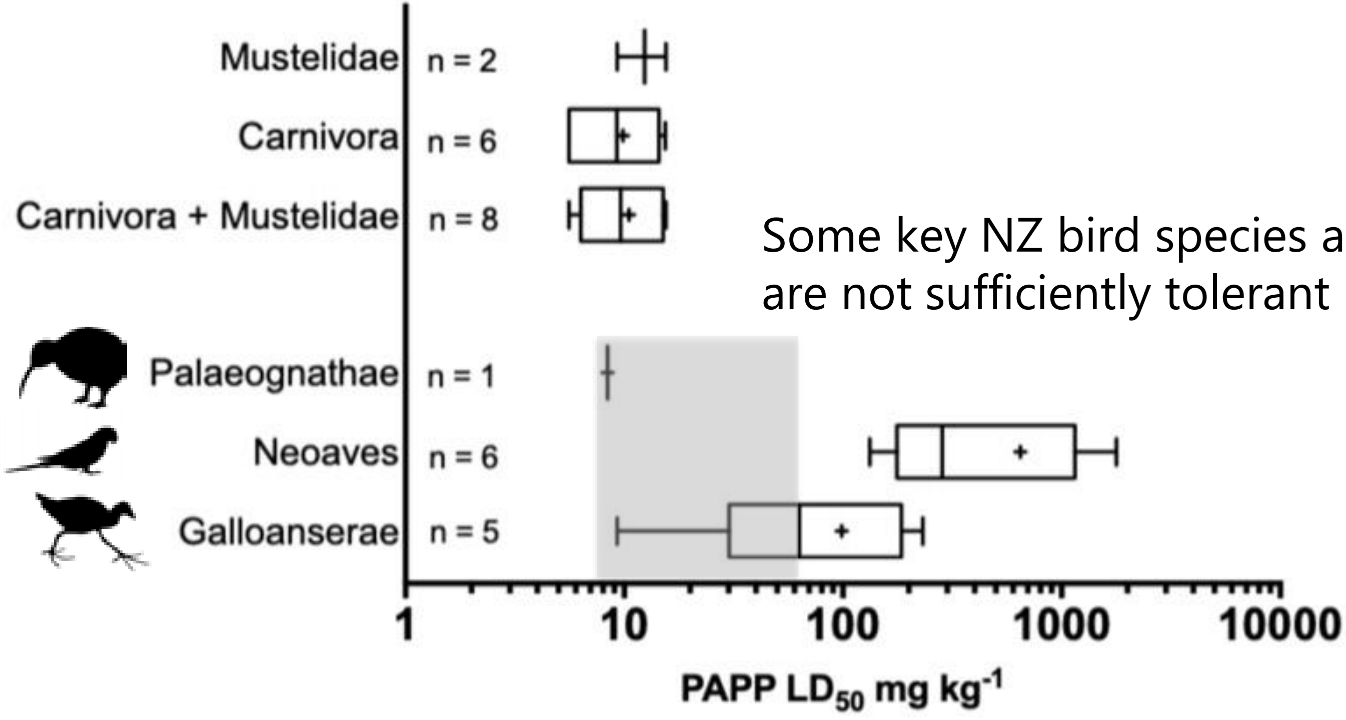
Methaemoglobin:

- Oxidises haemoglobin from $HbFe^{2+}$ to $HbFe^{3+}$
- Prevents haemoglobin from carrying oxygen
- Rapid unconsciousness
- Humane death
- E.g. PAPP already largely "mammal-specific"

Unconsciousness well prior to death



PAPP is already mammal-selective, but…



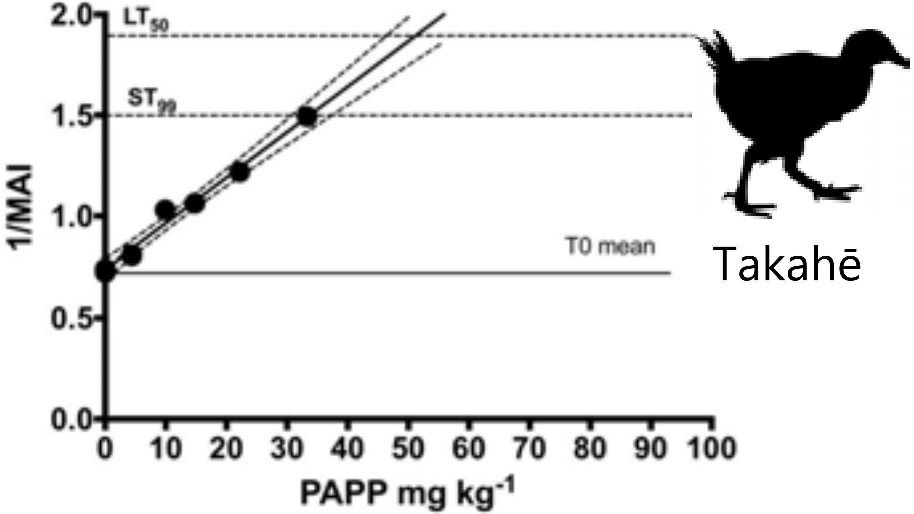
Some key NZ bird species and clades are not sufficiently tolerant

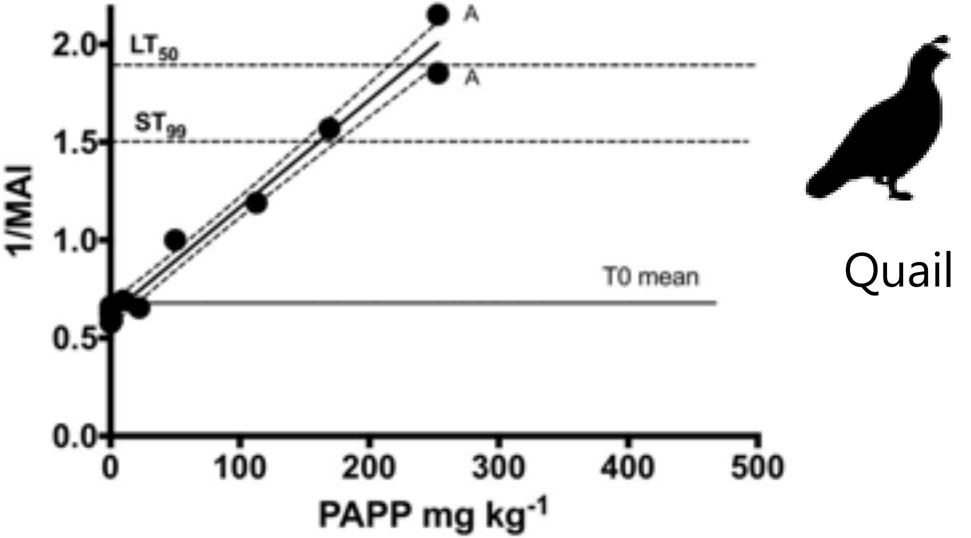
1. Replaced lethal-dose assays

As a means to:

- Determine comparative species sensitivity *in vivo*
- Predict lethal dose (LT_{50}) and survival threshold (ST_{99}) estimates
- Produce regulatory data for high value species
- Screen for synergist and protectant agents in an *in vitro* high-throughput assay

Sub-lethal dose-response data used to model the ST_{99} and LD_{50} dose from sequential doses of PAPP





Used a sub-lethal dose response assay that:

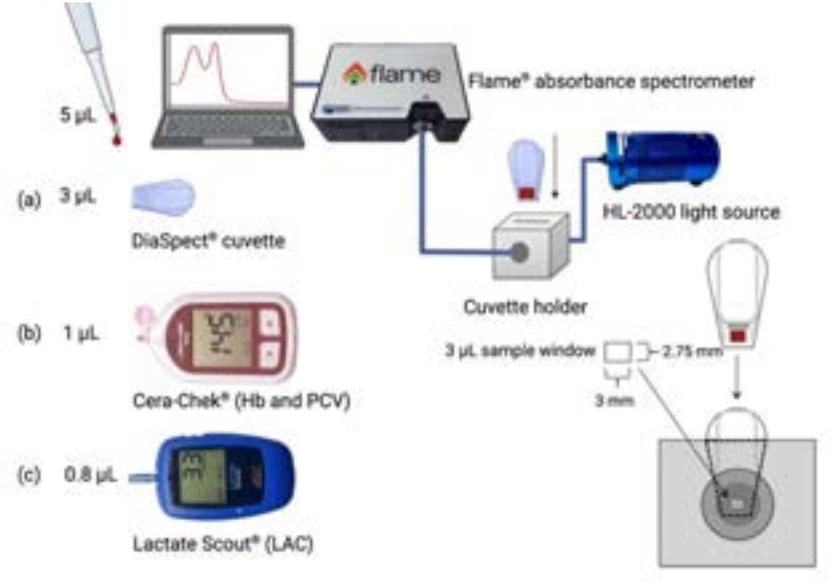
- Replaced the LD_{50} bioassay
- Predicts ST_{99} and LT_{50} without death as an endpoint
- Can determine NOEL and LOAEL doses
- Monitored adverse affects over a 72h period
- Assessed impact on health and welfare

2. Methaemoglobin Absorbance Index (MAI)

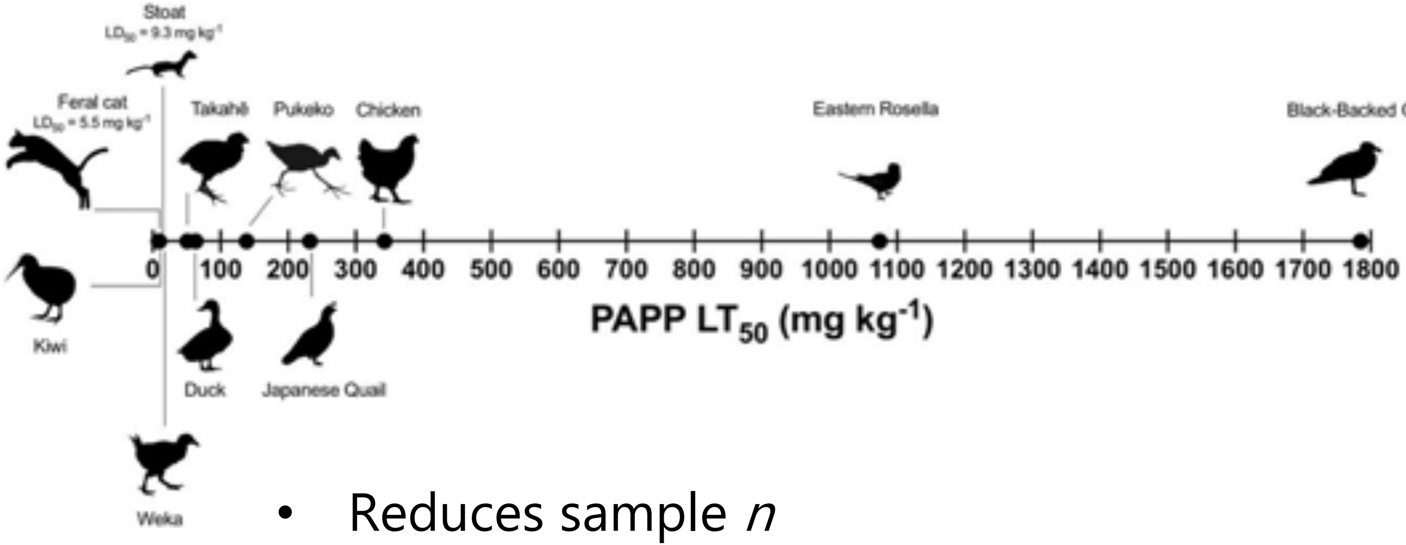
- Measured spectroscopically from very small blood samples
- Indicates extent of methaemoglobinaemia
- Easily determined from 3 μL blood samples
- Samples some 50-fold smaller that used in commercial oximeters
- MAI is directly linked to survival probability

Customized instrumentation - reduction and refinement

- Reduce total blood volumes to 5 µL
- Refines blood sampling technique
- Reduces trauma from repeat samples
- Can be used in 10 g birds



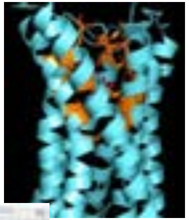
Defines ST_{99} and LD_{50} in birds without the need for lethal outcomes

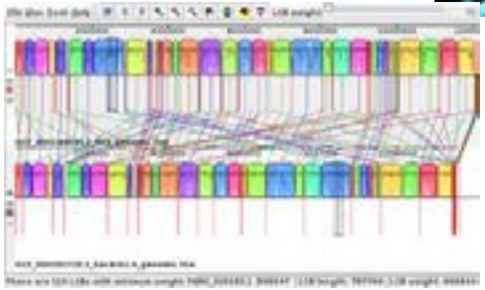


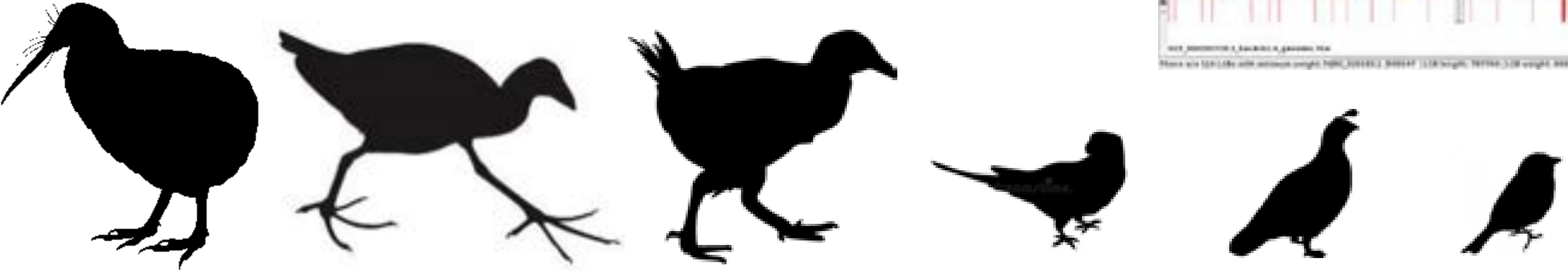
- Reduces sample *n*
- Eliminates death as endpoint
- Can be used in high conservation value species

3. High-throughput *in vitro* assay

- Replacement of *in vivo* assays in high-throughput screening
- Coincidental screening against target (mammal) and non-target (bird) blood
- Potential for screening 1000s of agents per year
- Able to short-list agents for sub-lethal dose-response assays

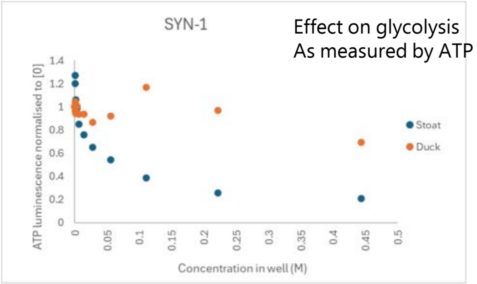


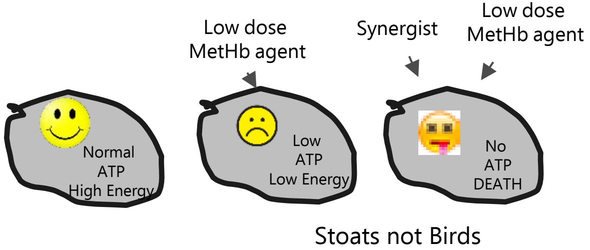


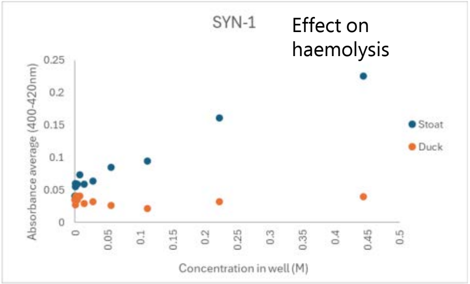


Used for assessment of PAPP synergists

- Predictive in vitro compound screening assay that measures several relevant biological parameters related to MetHb toxin affects.
- Screening has identified several compounds that have differential effects on cell metabolism (ATP production) between stoats and birds that potentially can be used to synergise PAPP/Na Nitrite effect in stoats without effecting birds







- Screen cells with low dose MetHb agent with range of synergists
- Investigating potential combinations of these compounds with PAPP and Na Nitrite
- Submitted a provisional patent application (application number 2024901039) to IP Australia on the potential for the in vitro assay to be used to identify and assess the comparative efficacy of such compounds.

This illustrates:

- Potential to advance the 3Rs in pest control
- Accelerate R&D whilst minimizing animal welfare impact
- Many other non-lethal *in vivo* and *in vitro* research methods could be developed
- Takes time and resources
- Need for dedicated program that accelerates 3R R&D and develops new generation of approaches
- Better animal welfare outcomes will be technology-led

Pest Control is a Challenge

New Technologies for control:

- are being developed and show promise
- no silver bullets on horizon – need to be realistic
- requires a complex combination of tools and strategy for success
- supported by solid understanding of biology/ecology/modelling

Solutions:

- needed for unique to New Zealand issues
- for real problems that need real immediate solutions
- should aim for continuous improvement

Requires a balance of effectiveness against costs and benefits with the aim of continually improved animal welfare and maintaining social licence to operate









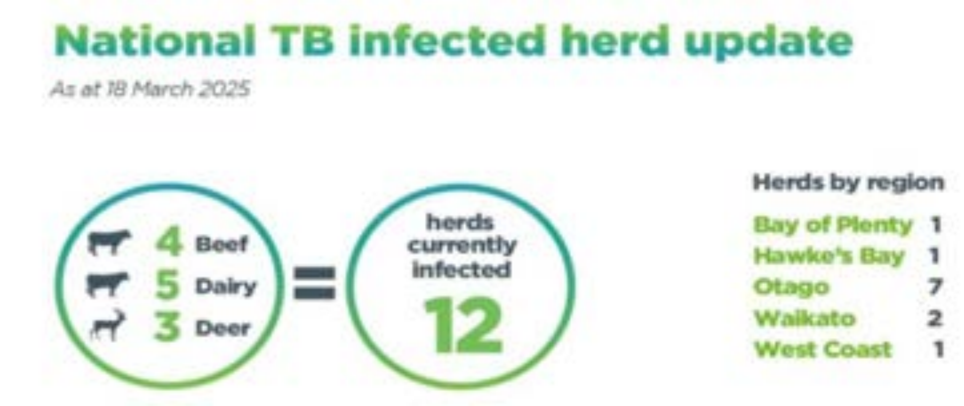

The TB plan — making eradication a reality

Infected herd numbers peak

This peaked in 1994, with over 1700 cattle and deer herds infected with TB. This represented a herd infection prevalence of more than 2%, far higher than in most

Between 2011 and 2016, we:

- achieved eradication of TB from 1.6 million hectares
- got proof that eradication is feasible in challenging areas, like the Hokonui Hills
- maintained an annual infected herd rate well below the 0.4% target (at 0.09%) with 43 infected herds in 2016.



Technological Advances in :

- Modelling of TB spread and control
- Possum detection and movements
- Improved baits
- Aerial use of 1080
- Reduction in sowing rates
- GPS and helicoptors
- Residual trap catch index
- Better TB detection in cattle and wildlife
- Genotyping of TB strains
- Encapsulated cyanide
- Novel methods for detecting TB
- Eradication strategy of TB in wildlife

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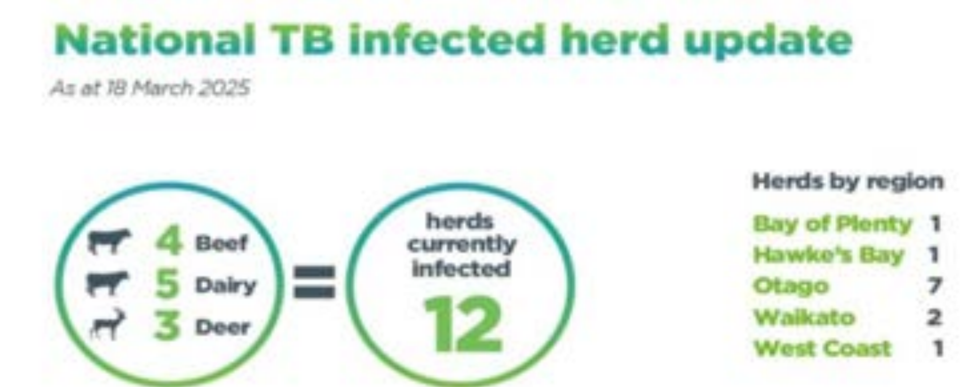

Outcome was :

- Fewer livestock infected with TB
- Less livestock testing and culling
- Less wildlife infected with TB
- Reduced non-target species impacts
- Reduced sub-lethal poisoning
- Better targeting of control efforts – timeliness and location
- Conservation benefits for native wildlife
- Conservation benefits for flora and ecosystems

- Major economic benefits to major primary industries and communities