Prioritising Insular Eradications Throughout New Zealand for Predator Free 2050

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Factors Determining Eradication Success

- ***Eradication***: the complete removal of all individuals of a particular population, or the reduction of their population density below sustainable levels.[1,2]

- Factors guaranteeing eradication success[2,3,4,5]:
    1. The rate of removal exceeds the rate of increase
    2. Immigration is zero
    3. All reproductive animals are at risk
    4. Suitable socio-political environment
    5. Benefit-cost analysis favours eradication over control

Factors Determining Eradication Success

1. The rate of removal exceeds rate of increase at all population densities
    - Populations subjected to control often show compensatory responses – e.g. increases in breeding and survival due to increased resource availability.
    - Many culled populations have high rates of increase (ecological release).
    - As densities decline, it takes progressively more resources to locate and remove individual animals.

2. Immigration is zero
    - Eradication will be unachievable if individuals can immigrate to the eradication area.
    - Remote offshore islands are the best candidates to meet this criterion because immigration can be prevented, or is unlikely to occur.

Factors Determining Eradication Success (cont'd)

3. All reproductive animals are at risk for control

- For eradication to be feasible, all reproductive (and potentially reproductive) members of the population must be susceptible to removal.
- With many pest control techniques, some animals will not be susceptible- e.g. inherited trap-shyness, neophobia, genetic resistance.

4. Suitable socio-political environment

- Conflicting community or administrative goals or administrative goals, or legal barriers, can thwart an eradication programme before it begins.
- Reliable information on the impacts of target species on production or environmental resources is often needed to create the necessary political will.
- Strong support from the wider community is also needed.

5. Benefit-cost analysis favours eradication over control

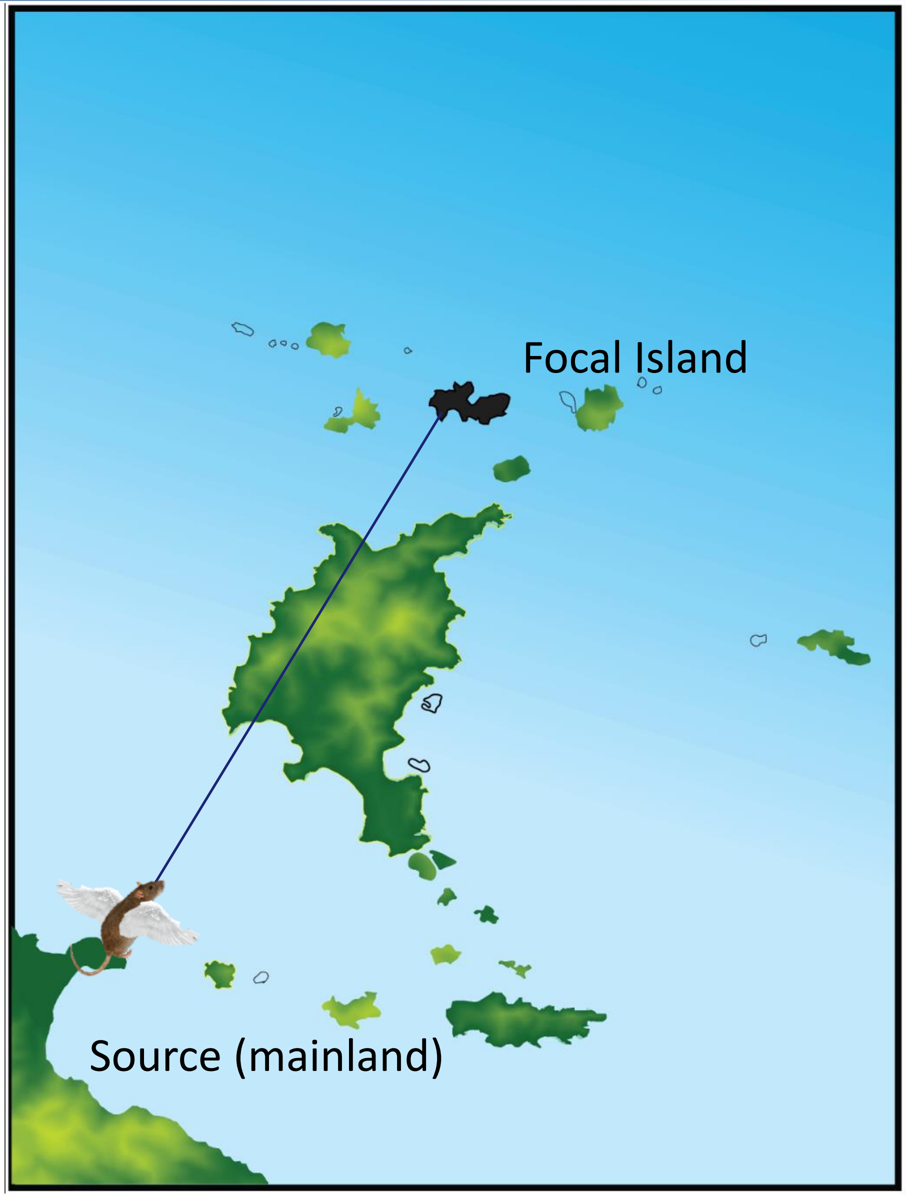
- Eradication requires a large initial outlay, but, if successful, there are not further costs, and benefits accumulate indefinitely.

What Factors Limit Eradication Success on NZ's Offshore Islands?

1. The rate of removal exceeds the rate of increase
2. Dispersal is zero
3. All reproductive animals are at risk
4. Suitable socio-political environment
5. Benefit-cost analysis favours eradication over control

Dispersal of Pest Organisms

Immigration Interpreted through the Lens of Insular Isolation



A multitude of isolation measures

- There have been a proliferation of metrics describing insular isolation. This has created a potential source of confusion for practitioners.
- It can be difficult to discern how many components of insular isolation are relevant and which variables should be used to represent those components.
- If we are to reliably characterise isolation, it is critical that these measures be described parsimoniously.

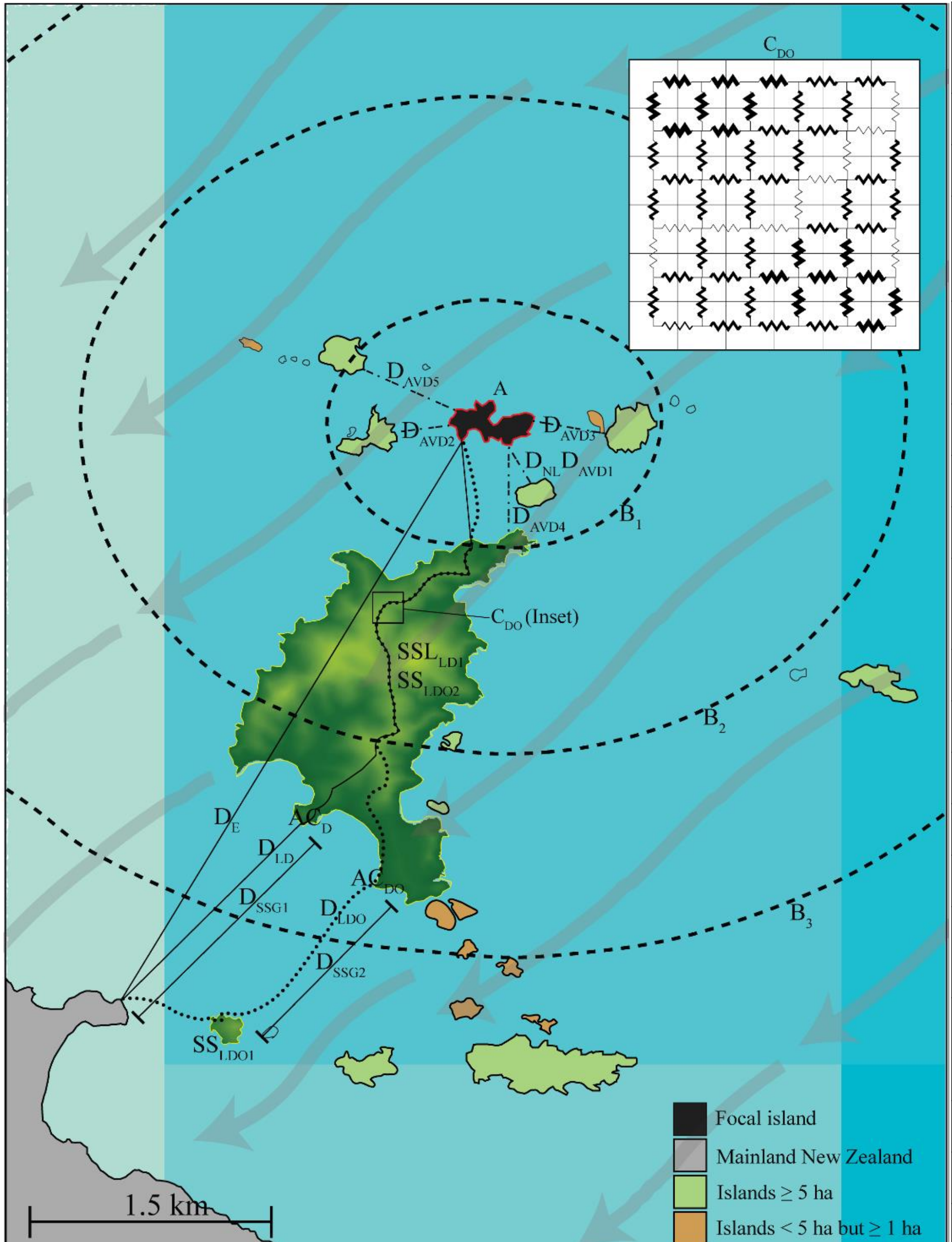
Species-specific isolation measures

- Multiple measures were context-specific, requiring behavioural details of a dispersing organism.
- We selected pests subject to New Zealand's Predator Free 2050 (PFNZ 2050) programme.
- Control measures have been successful but these pests are capable dispersers. Understanding insular isolation provides insight into the potential for reinvasion and for future eradications.

Rats (*Rattus spp.*)

Common Brushtail Possum (*Trichosurus vulpecula*)

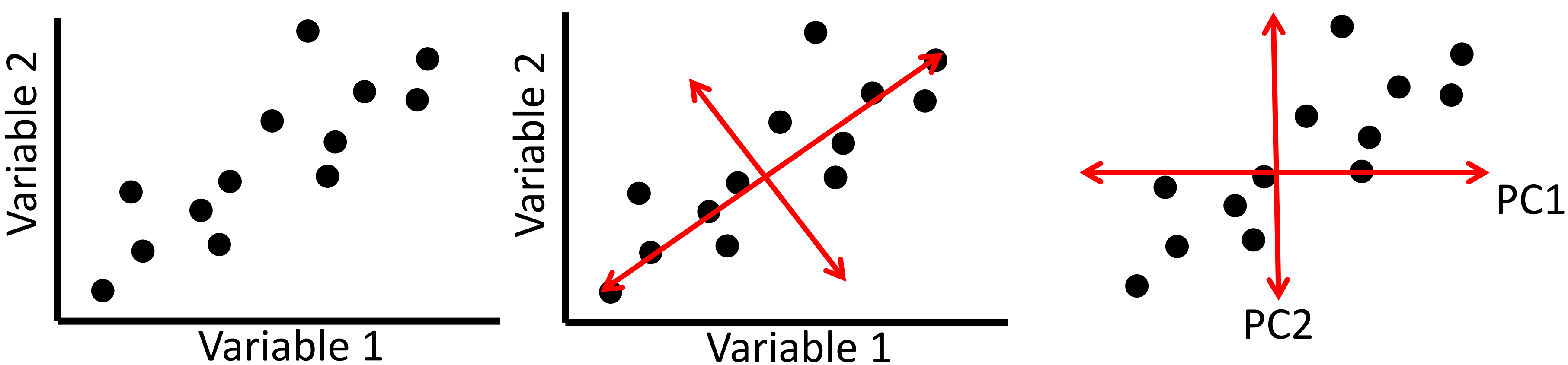
Mustelids (*Mustela spp.*)



Var	Isolation Metric	Symbol
	Distance Metrics	
1		
2		
3		
4		
5		
6		
7		
	Non-Distance Metrics	
8		
9		
10		
11		
12		
13		
14		
15		
16		

Statistical analysis

- We used principal components analysis (PCA) to reduce the dimensionality of our variables.
  - Based on variance of the data, PCA gives new latent variables characterising the primary components of isolation.
  - Principal components (PCs) were interpreted on the basis of their respective eigenvectors. PC factors were retained through use of a parallel analysis and reaffirmed via a screeplot and Kaiser’s criterion.



The composite measures of isolation

Variable	Metric Name	PC 1	PC 2	PC3
1 (D_E)	Euclidean Mainland Distance*	**0.97**	0.07	0.05
2 (D_{LD})	LCP DEM Distance*	**0.96**	0.12	0.03
3 (D_{LDO})	LCP DEM OCM Distance*	**0.96**	0.13	0.03
4 (D_{SSG1})	Longest DEM Stepping Stone Gap*	**0.94**	-0.04	0.04
5 (D_{SSG2})	Longest DEM OCM Stepping Stone Gap*	**0.95**	-0.03	0.05
6 (D_{NL})	Dist. to nearest life sup. landmass*	**0.60**	-0.54	0.12
7 (D_{AVD})	AVG Dist. to 5 nearest life sup. landmasses*	-0.19	-0.43	**0.74**
8 (A)	Island Area*	0.22	-0.37	**-0.75**
9 (B_1)	Landscape Isolation (1 km buffer)†	-0.67	**0.50**	0.13
10 (B_2)	Landscape Isolation (3 km buffer)†	**-0.78**	0.33	-0.06
11 (B_3)	Landscape Isolation (5 km buffer)†	**-0.74**	0.27	-0.13
12 (SS_{LD})	LCP DEM Stepping Stones Used	**0.54**	**0.66**	0.10
13 (SS_{LDO})	LCP DEM OCM Stepping Stones Used	**0.54**	**0.68**	0.05
14 (AC_D)	DEM Accumulated Cost*	**0.96**	0.04	-0.01
15 (AC_{DO})	DEM OCM Accumulated Cost*	**0.88**	0.04	-0.03
16 (C_{DO})	DEM OCM Commute Distance*	**0.95**	0.08	0.05
	Eigenvalues	9.79	1.98	1.17
	Percent of variance	61.22	12.38	7.33
	Total variance	**61.22**	**73.60**	**80.93**

Clustered Variables

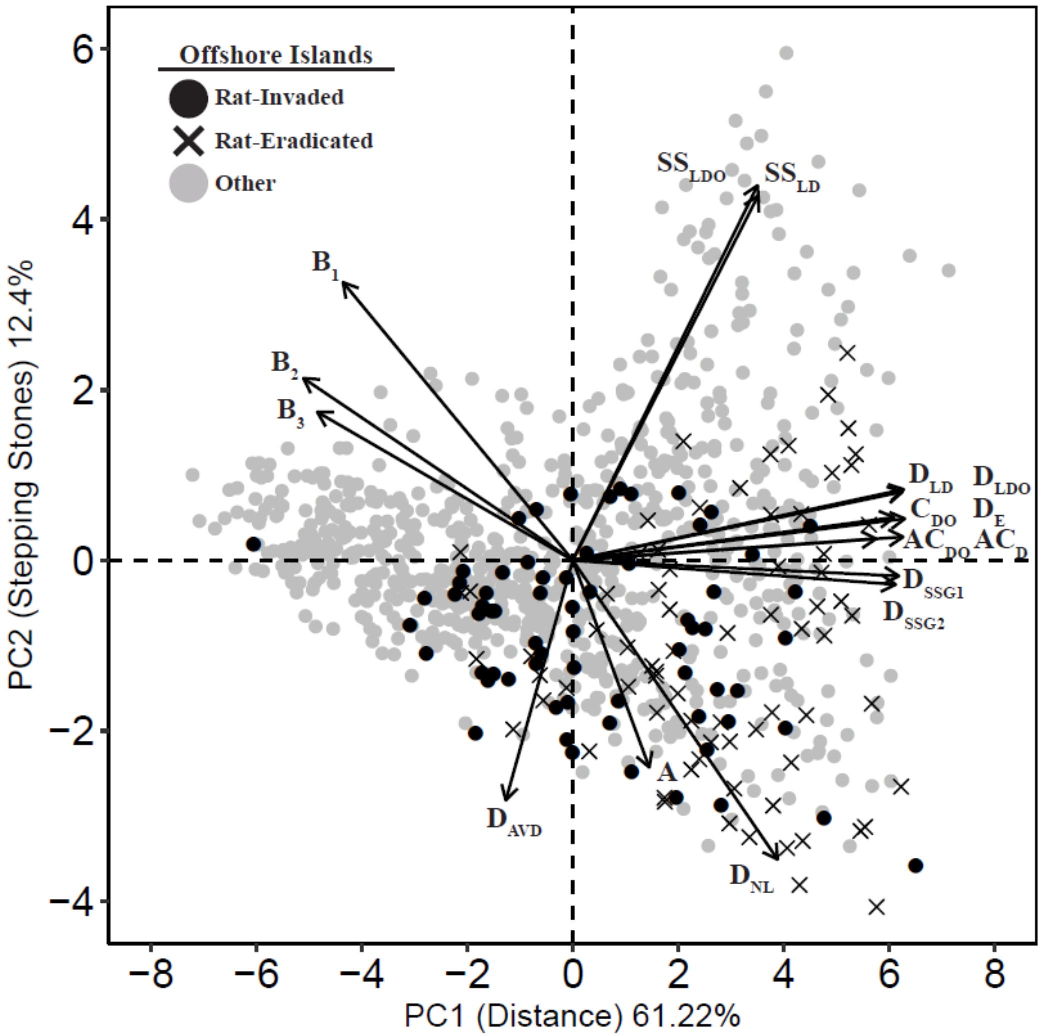
PC1: "Distance"

PC2: "Stepping Stones"

PC3: "Insular Network"

Discriminatory power of isolation measures

PCA bi-plot featuring PC1 & PC2 for each focal island (n = 890)



There was a significant main effect of isolation on groupings of rat-invaded and rat-eradicated islands (F = 22.73, p < 0.05).

These results agree with management practices transpiring throughout NZ's insular conservation history.

This outcome demonstrates the discriminatory power of our isolation characterisation in that these measures can successfully differentiate between actually occurring groups.

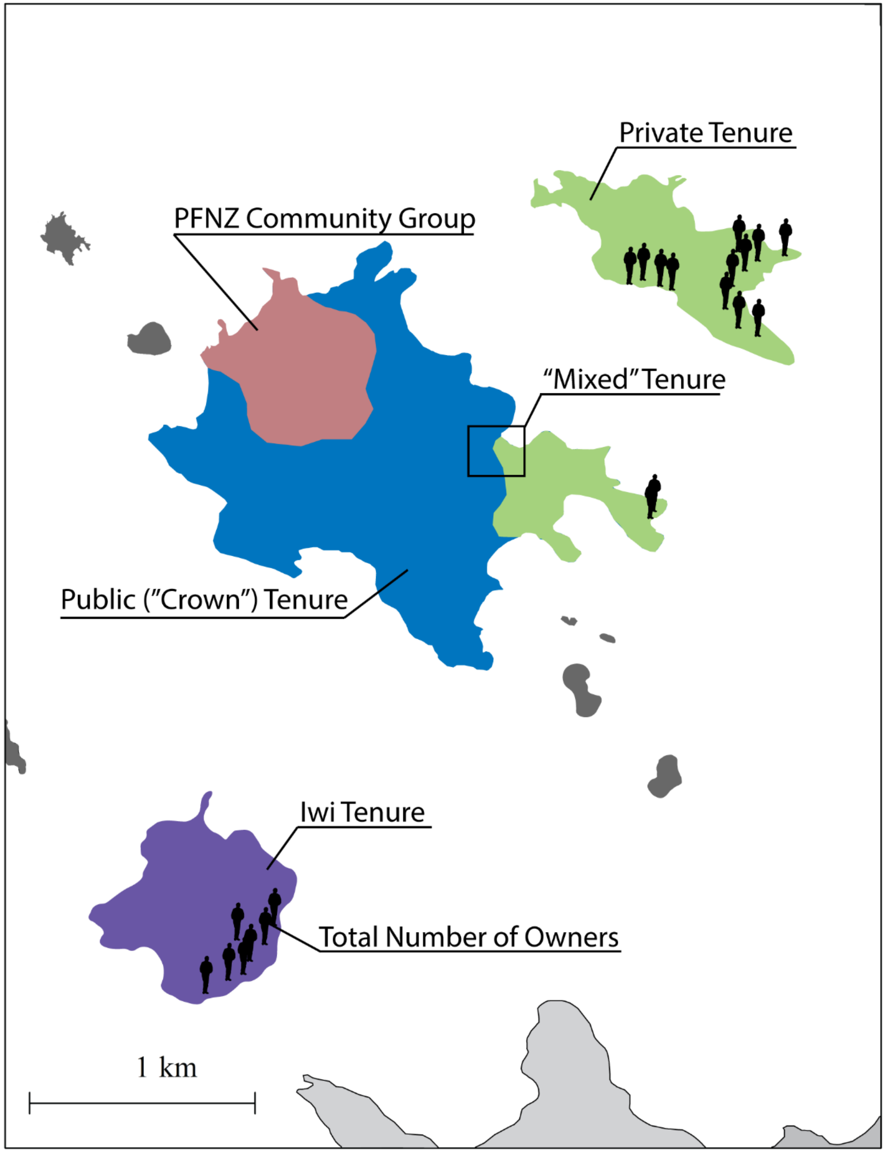
Socio-Political Environment

Socio-Political Environment

- Even when technical and economic criteria are met, social and political factors often play an overriding role in determining the prospects for successful eradication.

- The benefits of eradication (as opposed to continued control) must be convincing because community attitudes may not favour killing animals and because of the resources required.

- Proponents of eradication must consider the wider perspective of stakeholders because these programmes are often “all-or-nothing”.


Private Tenure
PFNZ Community Group
"Mixed" Tenure
Public ("Crown") Tenure
Iwi Tenure
Total Number of Owners
1 km

Prioritising NZ's Insular Eradications

Prioritising Insular Eradications Based on Limiting Factors

- We limited analysis to islands ≥ 5 ha and those ≤ 50 kilometres (km) from the New Zealand Mainland.

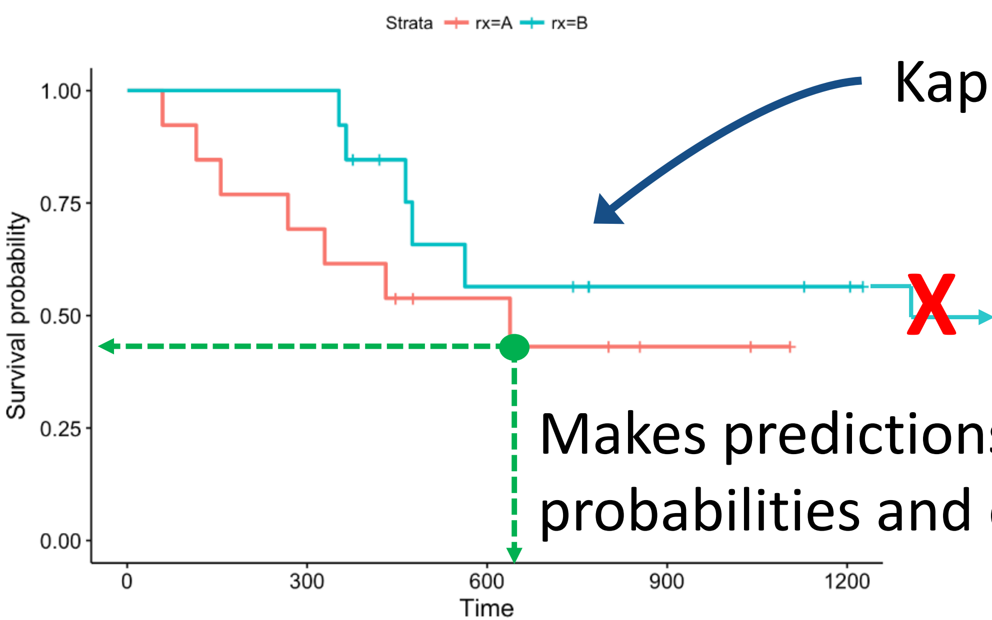
- Focused on *Rattus* species because of their extensive distribution, permanency (presence data is reliable), and their disproportionate impact on native biota.

- We are not inferring an island's ecological importance but, rather, the potential ease of eradication using currently-available tools.

- Islands that have a low probability of eradication will likely require "future tools" or different ways of thinking.

Prioritising Insular Eradications Based on Limiting Factors (Cont'd)

- Time-to-Event (or survival) analysis was used to quantify eradication times and probabilities.
  - A branch of statistics that investigates survival times and the factors that influence them.
  - Encompasses a suite of statistical tools that have broad application across many disciplines.



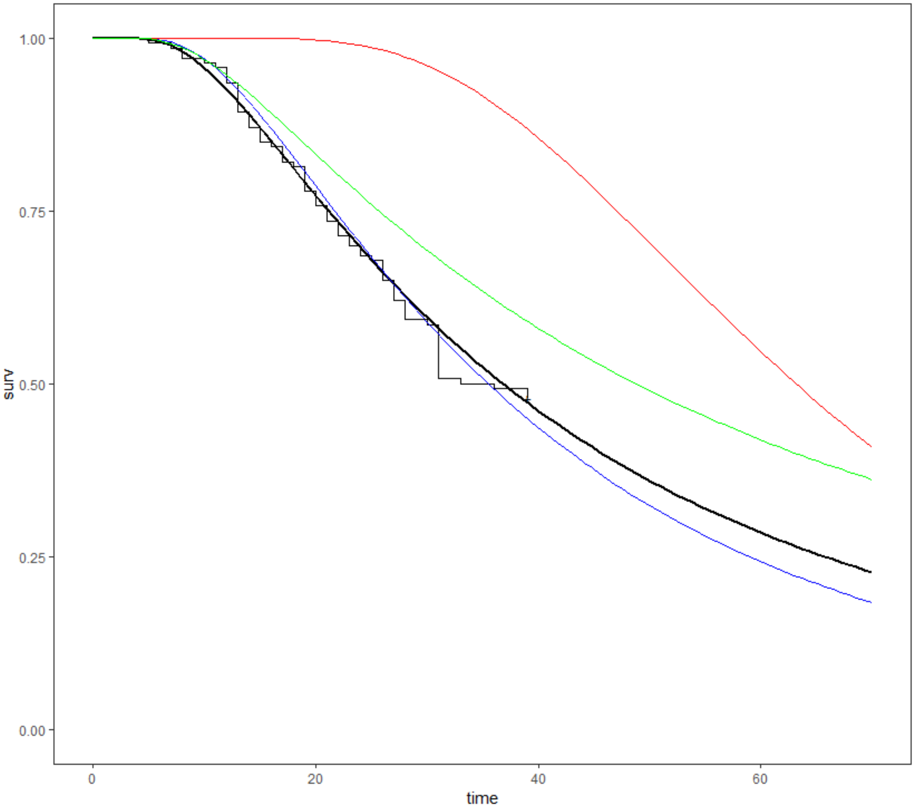
Kaplan-Meier survival curves

Cannot make inferences for the future

Makes predictions of event probabilities and event times

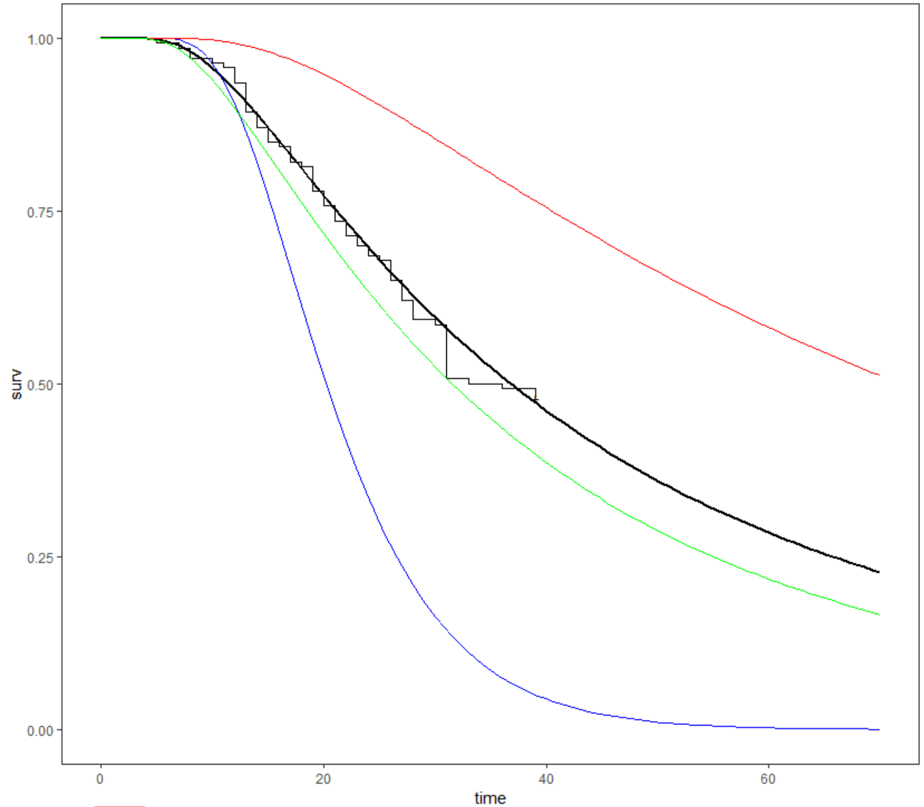
Parametric Survival Estimation

Effect of Isolation on Survival Estimation



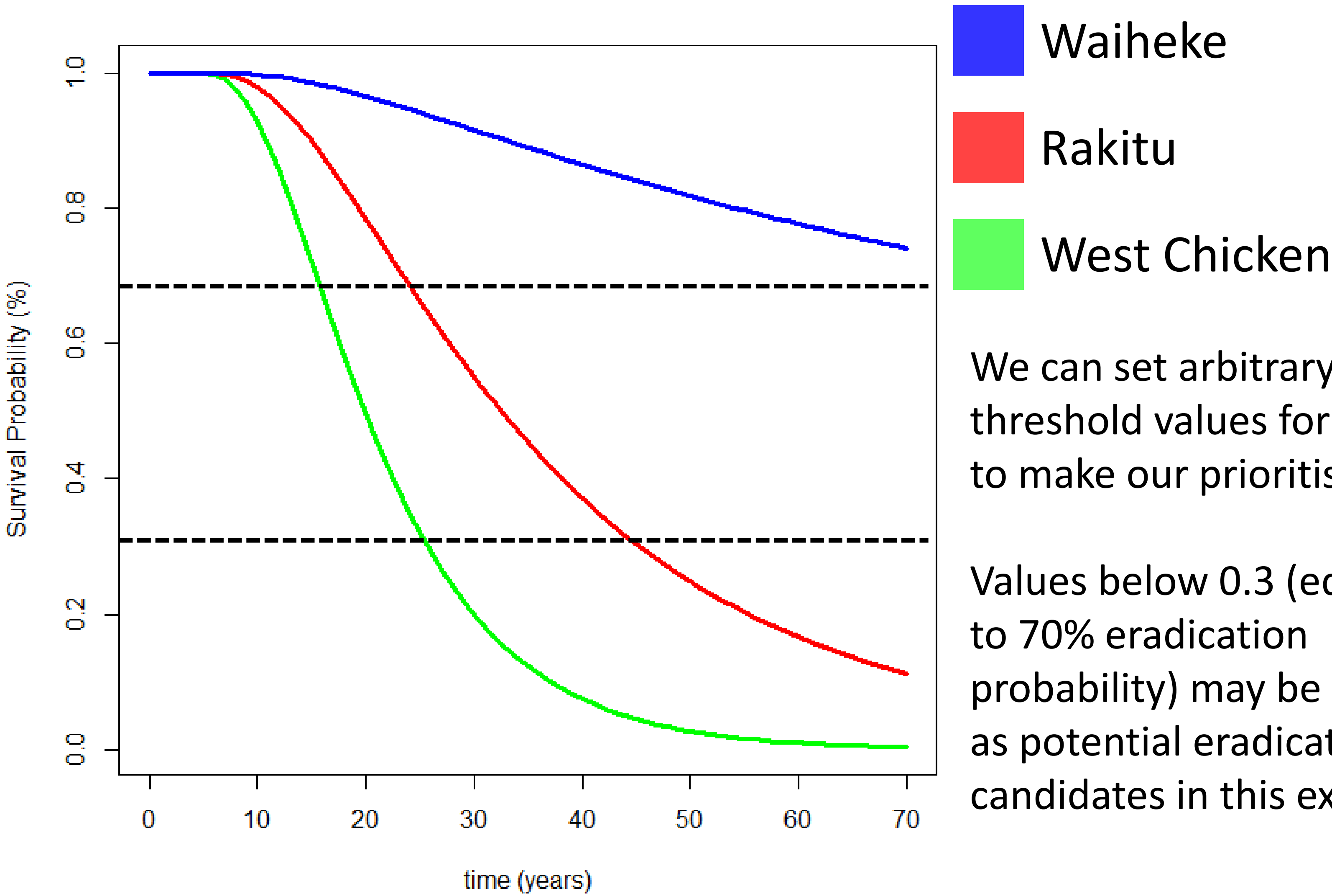
- Low Isolation (very accessible)
- Medium Isolation
- High Isolation (inaccessible)

Effect of Tenure on Survival Estimation



- Mixed Tenure
- Private and Iwi Tenure
- Public Tenure

Example Survival Curve Prioritisation



We can set arbitrary threshold values for which to make our prioritisation:

Values below 0.3 (equating to 70% eradication probability) may be viewed as potential eradication candidates in this example.

Thank you! *Mihi koe*

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