The influence of seedfall, rats and weather on populations of New Zealand forest birds, expressed as multi-factor density impact functions

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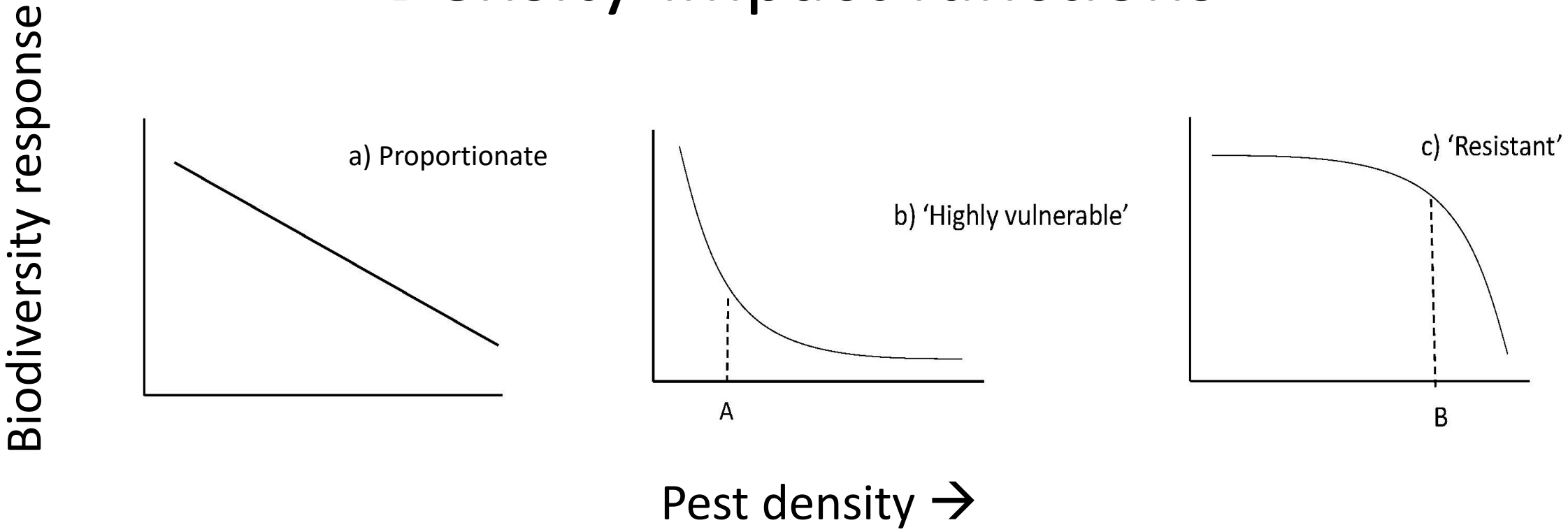
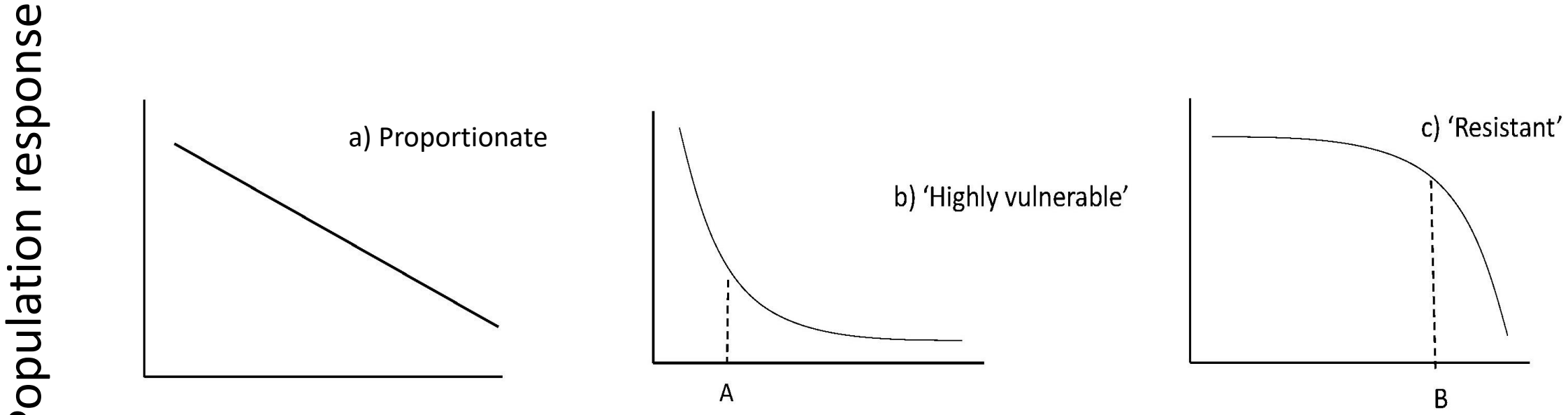
Density-impact functions



Norbury, Pech, Byrom & Innes (2015) Density-impact functions for terrestrial pests and indigenous biota: Guidelines for conservation managers. *Biological Conservation.* 191 409-420.

Population response functions

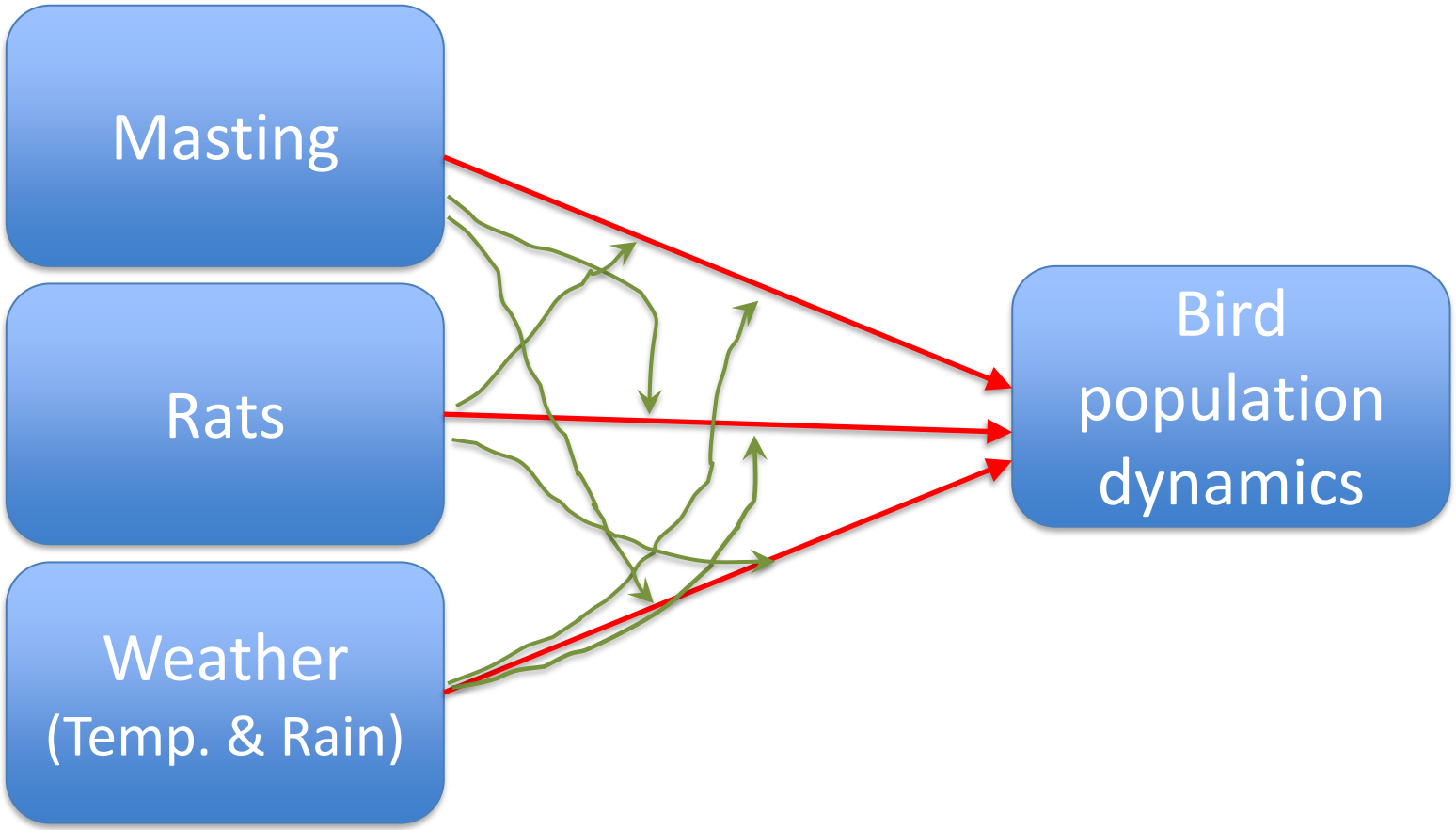


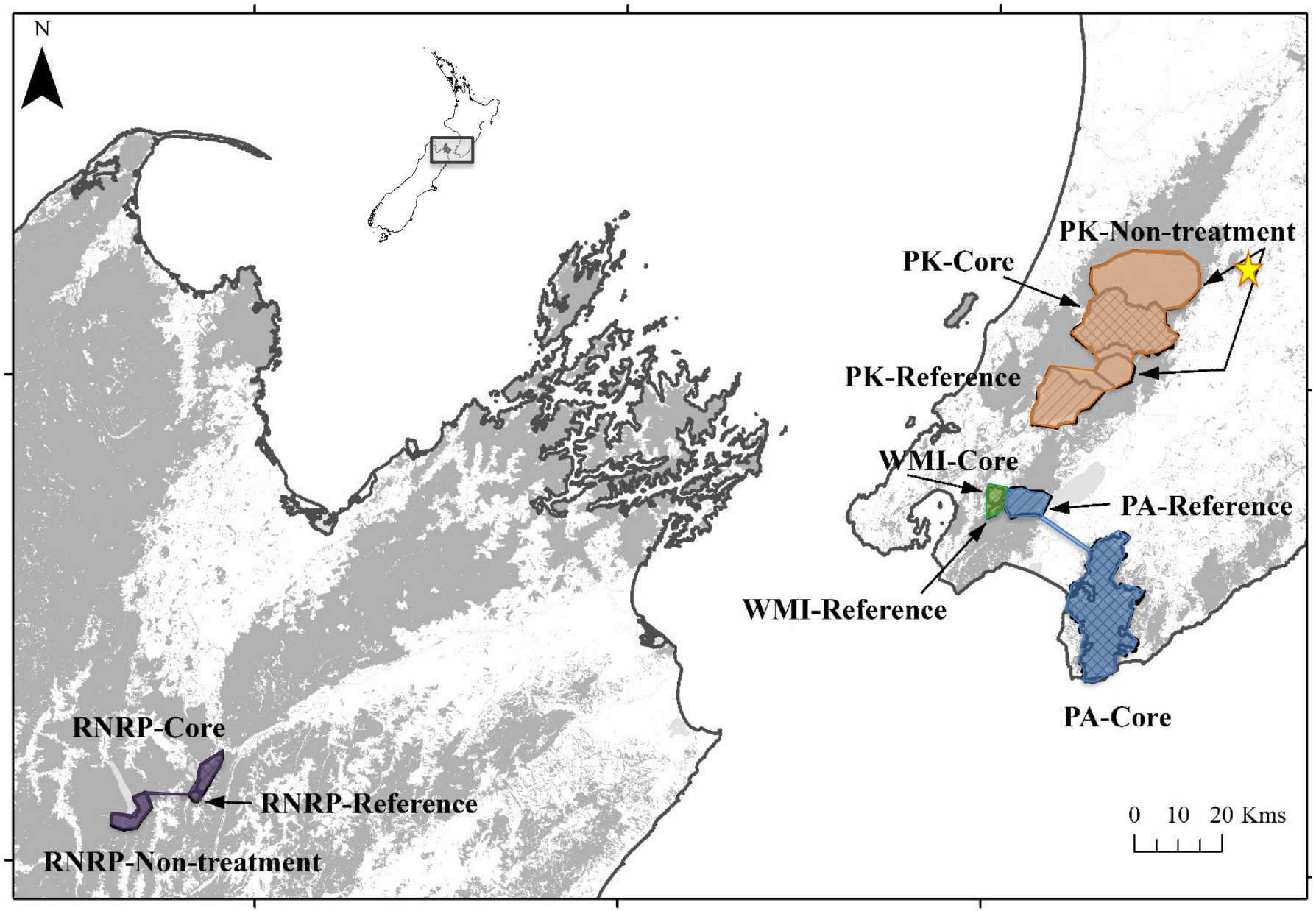
Influencing variable→

e.g. Pest density

Food scarcity

Weather


Masting
Rats
Weather
(Temp. & Rain)
Bird
population
dynamics



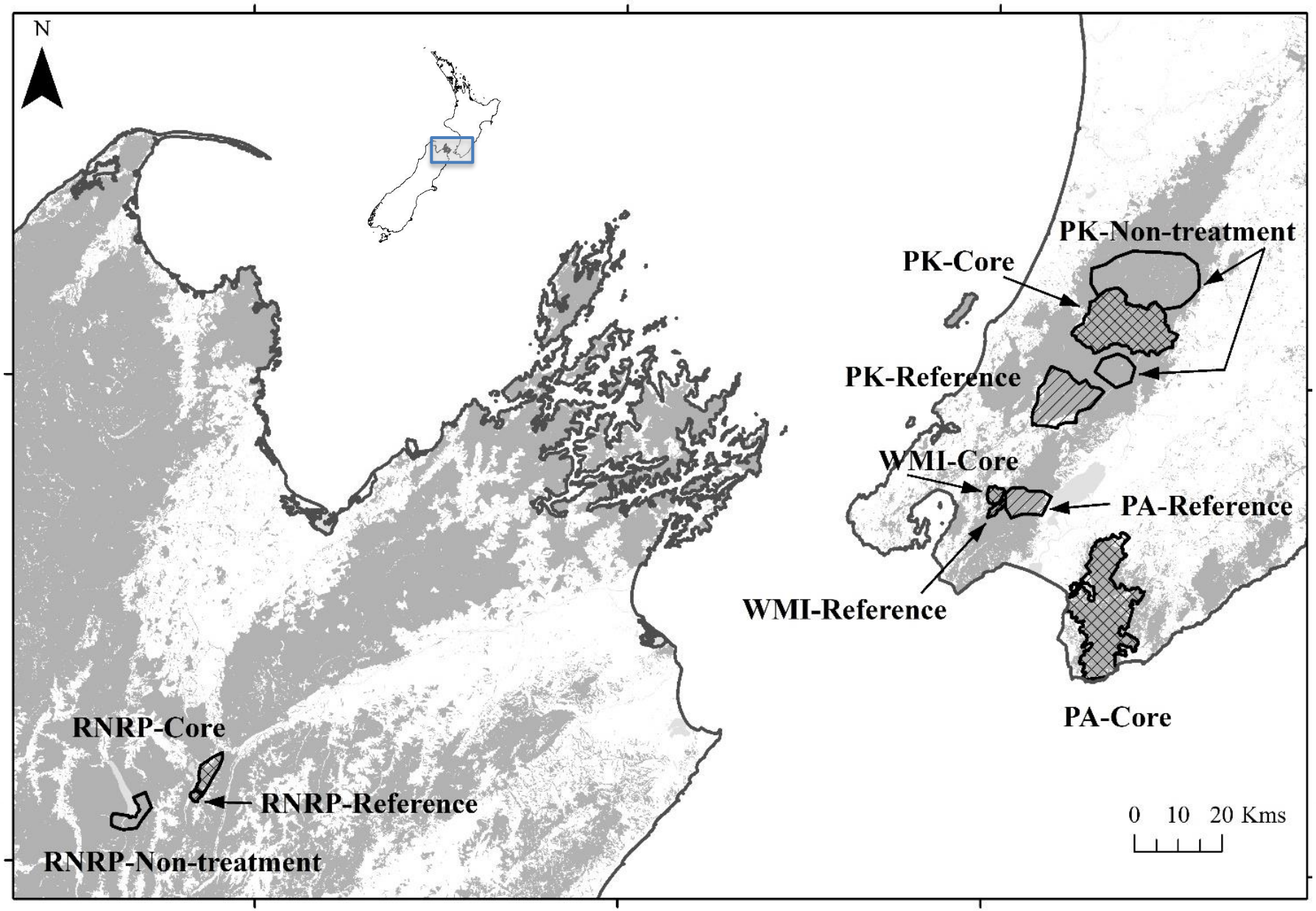
4 Projects

PK = Project Kaka
Tararua Ranges

WMI = Wainuiomata Mainland Island Project
Remutaka Ranges

PA = Project Aorangi
Aorangi & Remutaka Ranges

RNRP = Rotiti Nature Recovery Project
Nelson Lakes



Mammal control Treatments

Core

High intensity pest control

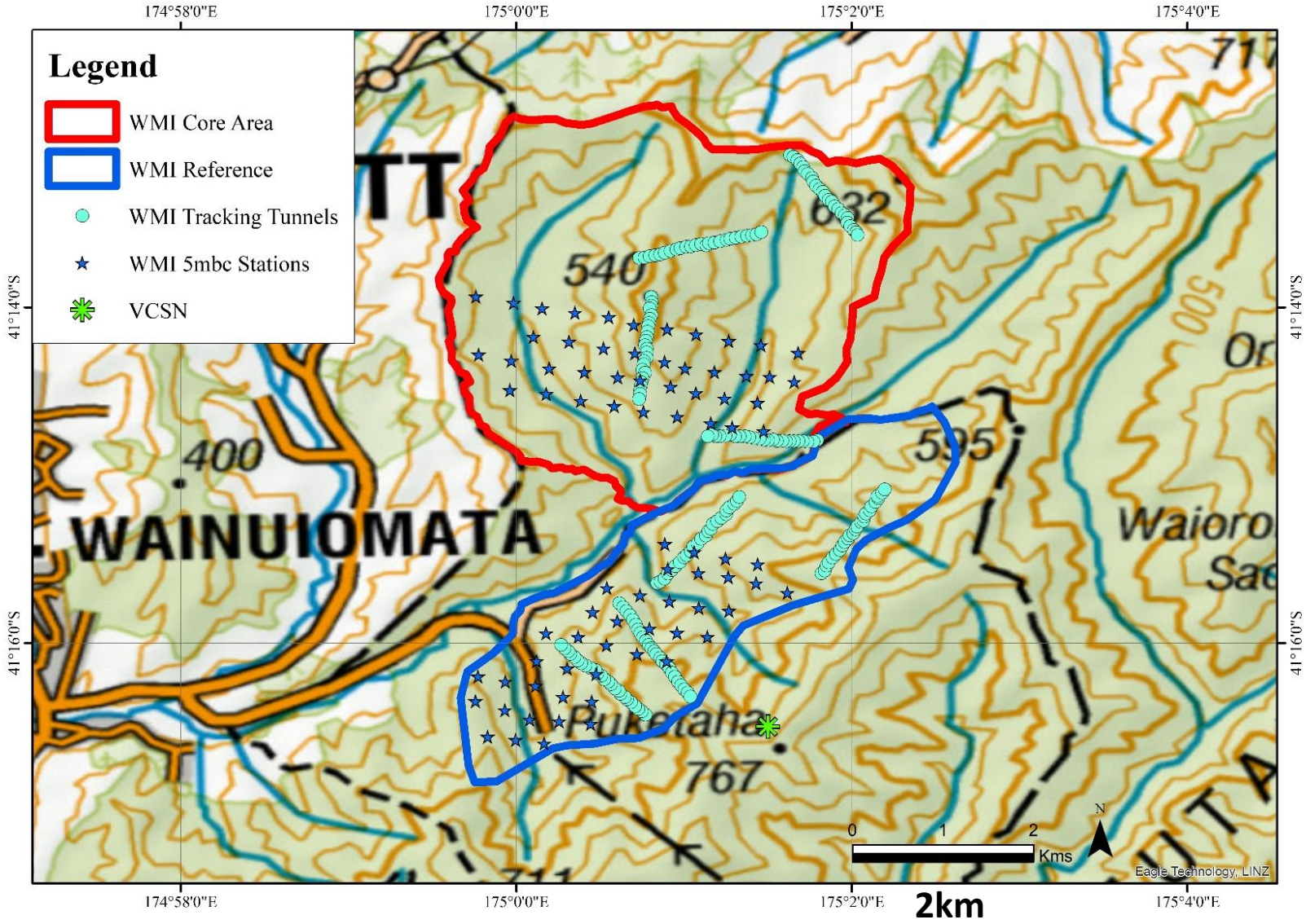
Reference

Lower intensity pest control

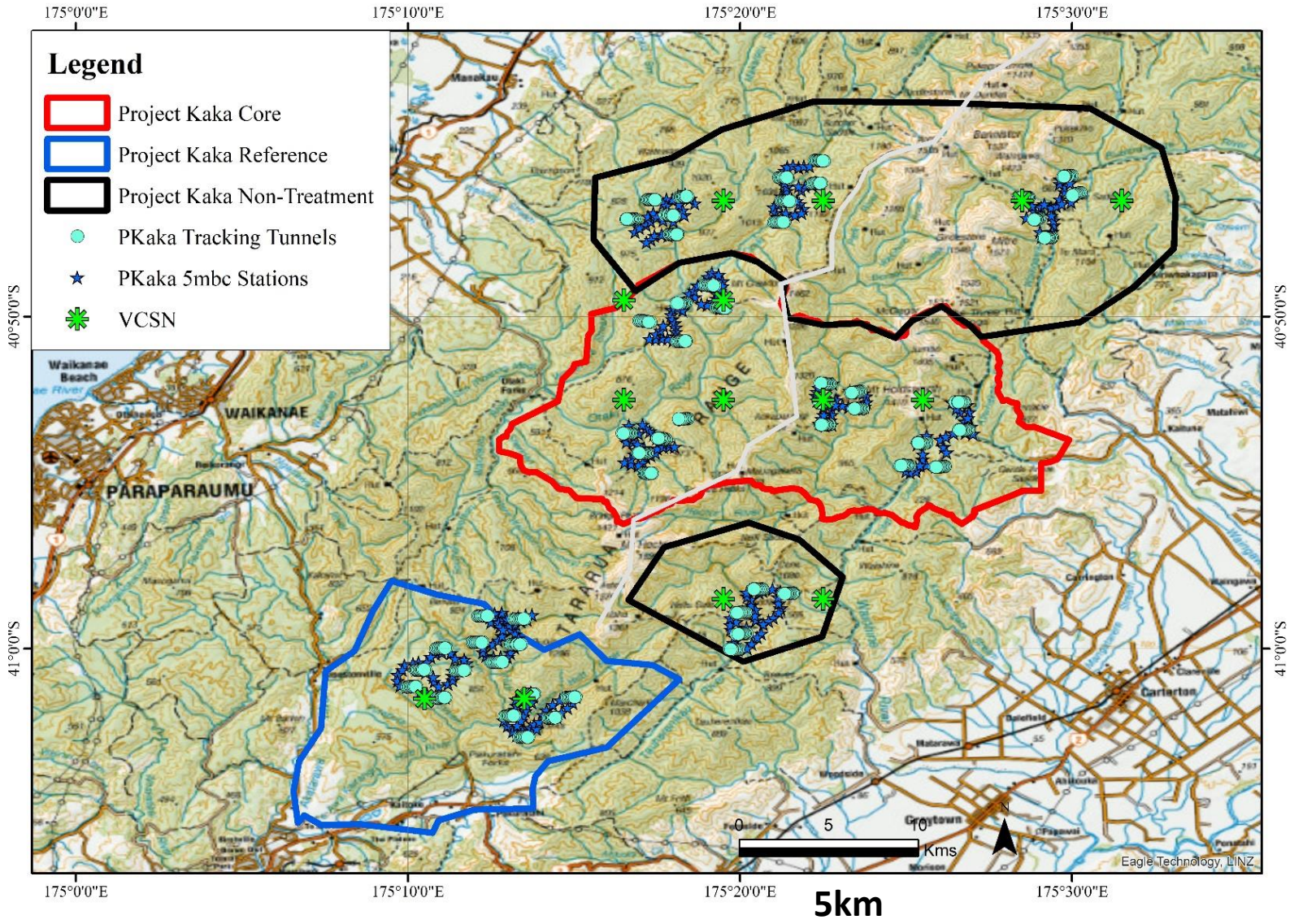
Non-treatment

Zero or minimal pest control

Wainuiomata Water Catchment Area (GWRC)



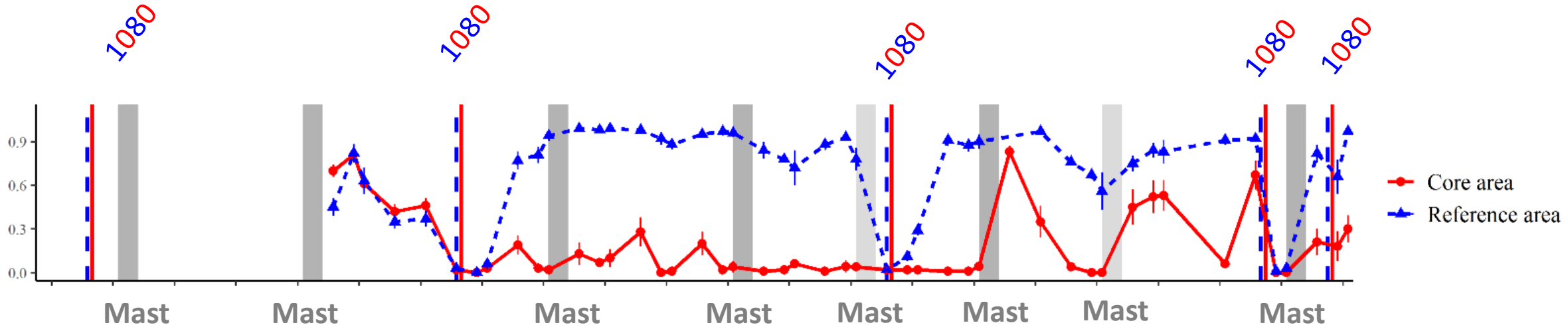
Project Kaka – Tararua Recovery Project (DOC)



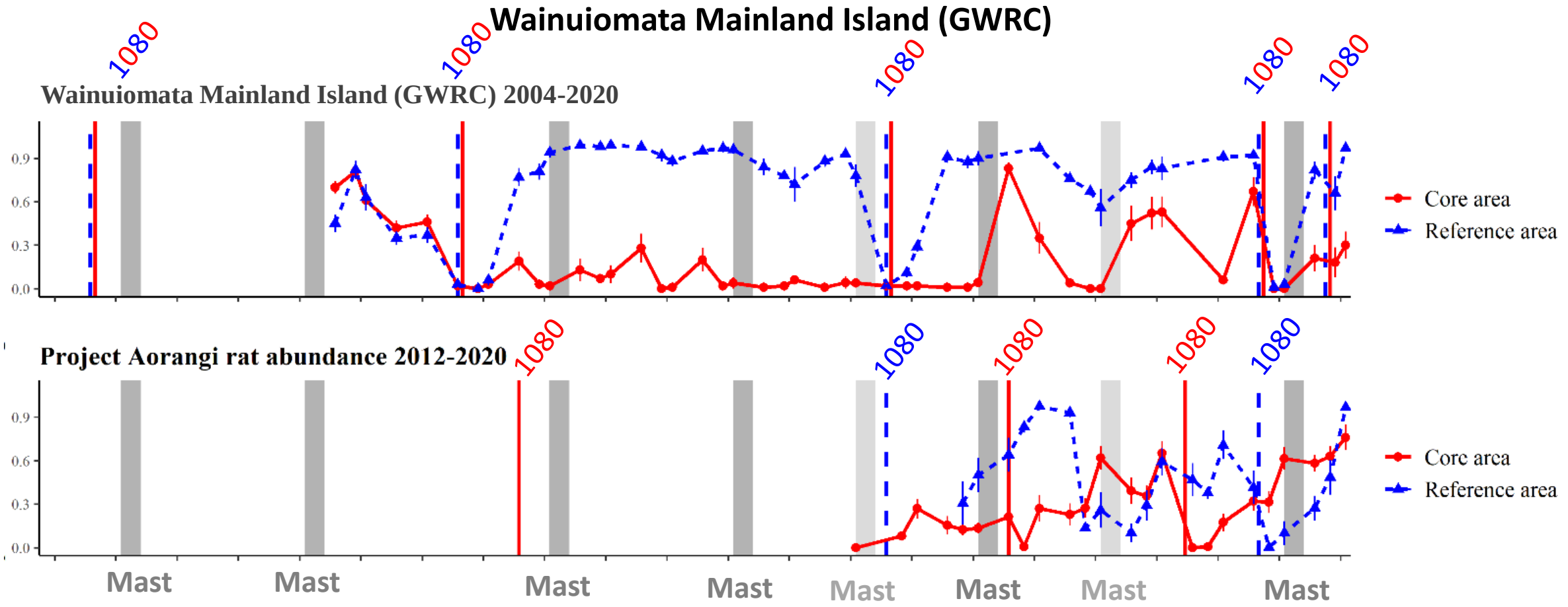
5km

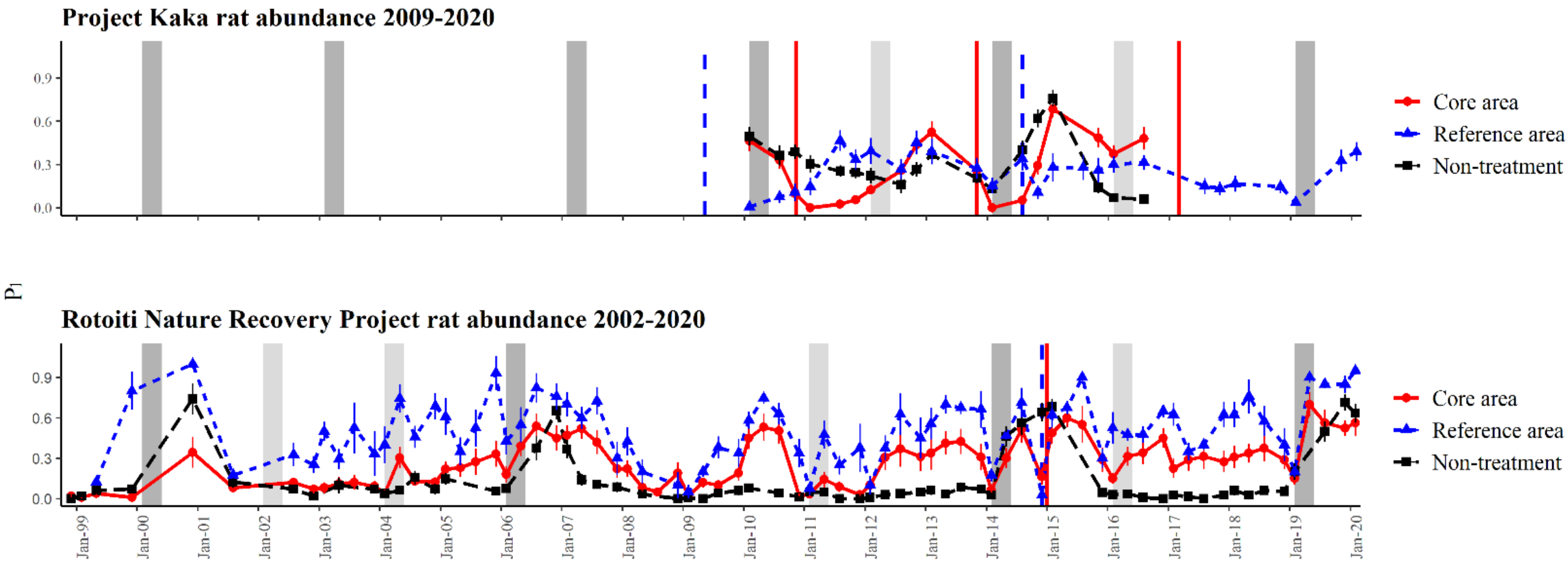
Rat dynamics

Wainuiomata Mainland Island (GWRC)



Rat dynamics

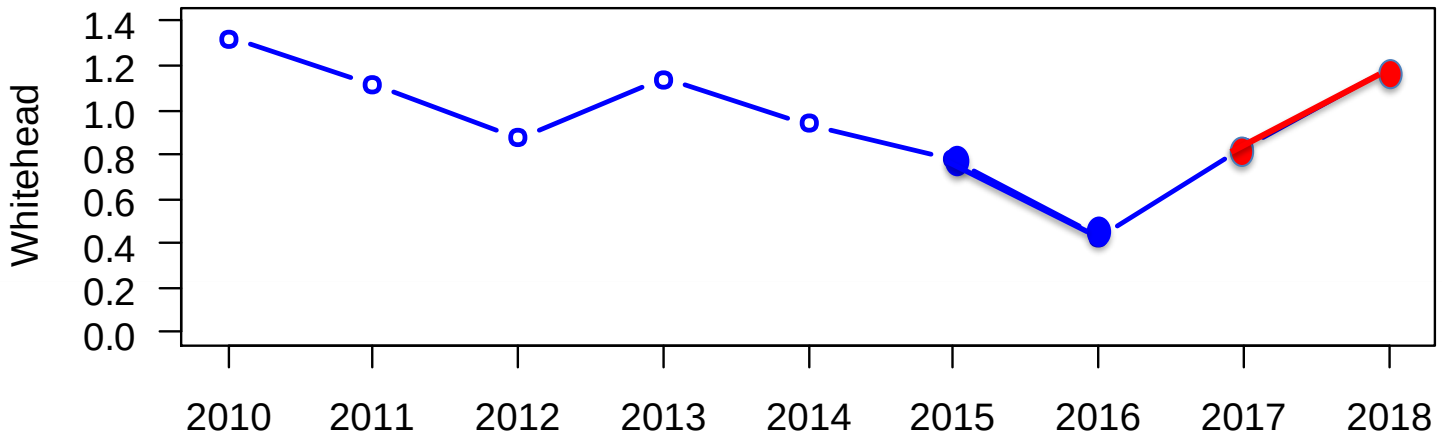



Project Kaka rat abundance 2009-2020
0.9
0.6
0.3
0.0
Core area
Reference area
Non-treatment
Rotoiti Nature Recovery Project rat abundance 2002-2020
0.9
0.6
0.3
0.0
Core area
Reference area
Non-treatment
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
Jan-19
Jan-20

The response variable (change in bird abundance)

$$\Delta_{bird\ popln} = Log\ Response\ Ratio = ln\left(\frac{\bar{x}_{y2}}{\bar{x}_{y1}}\right)$$

Change in popl^{n} index in one year ($y2$),
relative to the previous year ($y1$).



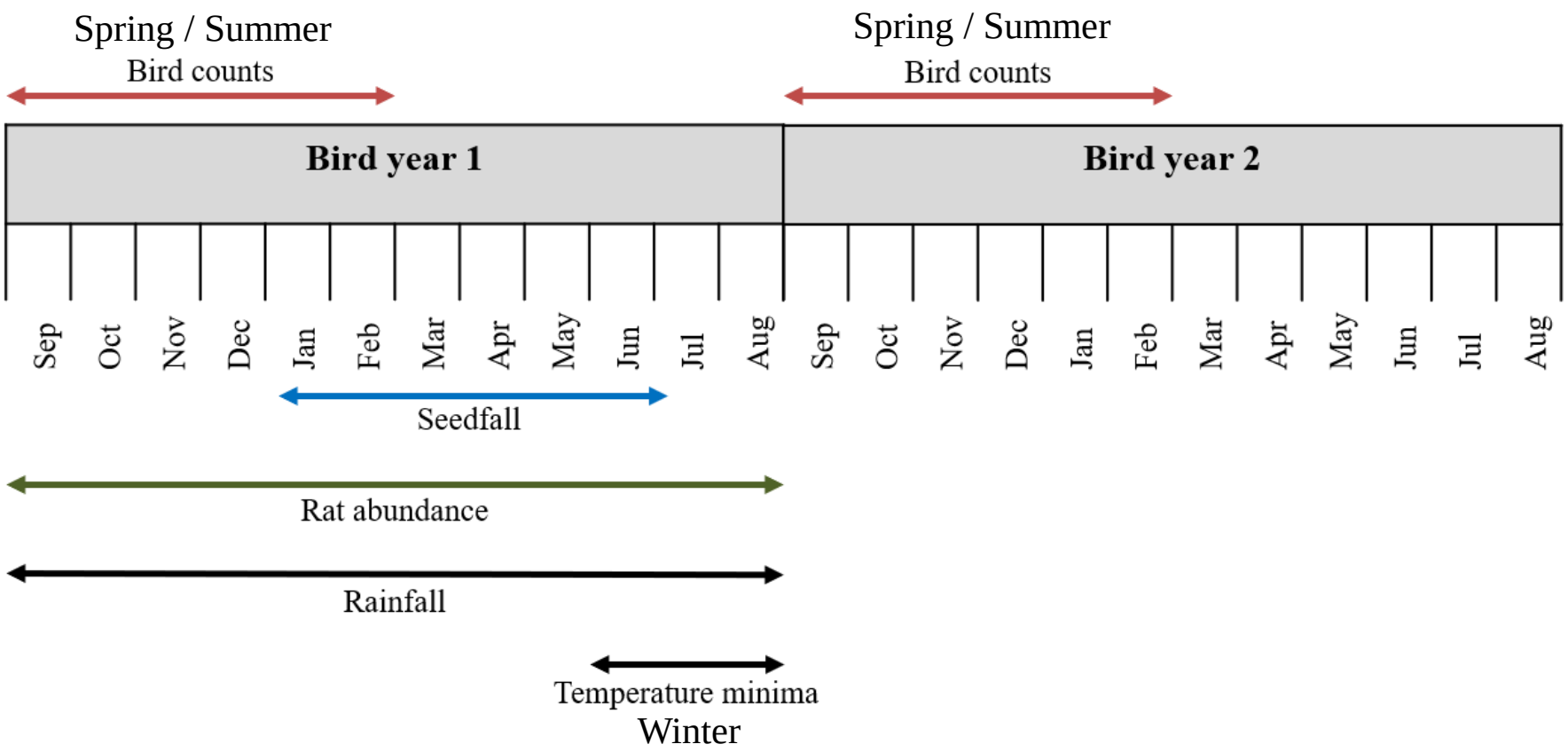
The response variable (LRR of bird abundance)

$$\Delta_{bird\ popln} = Log\ Response\ Ratio = \ ln\left(\frac{\bar{x}_{y2}}{\bar{x}_{y1}}\right)$$

Change in popl^{n} index in one year ($y2$),
relative to the previous year ($y1$).

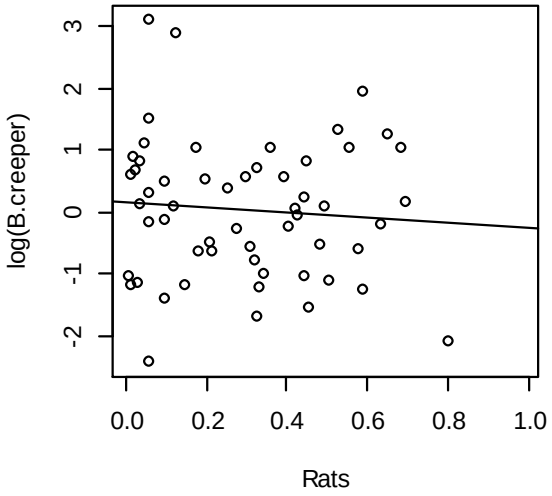
Then take logs to make the ratio symmetrical

E.g. Popl^{n} doubling from 2 to 4: log(4/2) → LRR = 0.693
Popl^{n} halving from 2 to 1 : log(1/2) → LRR = -0.693
No change → LRR = zero

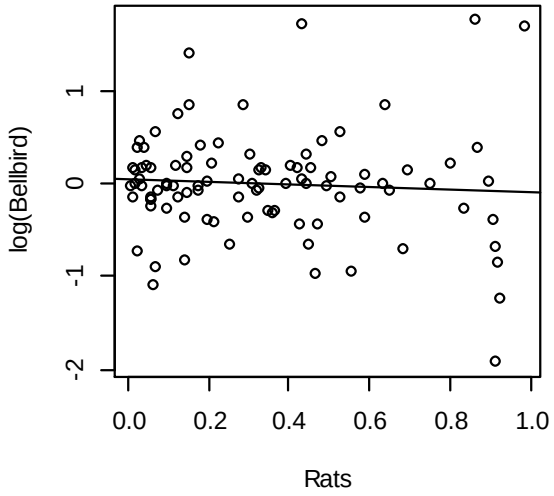

Spring / Summer
Bird counts
Spring / Summer
Bird counts
Bird year 1
Bird year 2
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Seedfall
Rat abundance
Rainfall
Temperature minima
Winter

Pest-Density Impact Functions

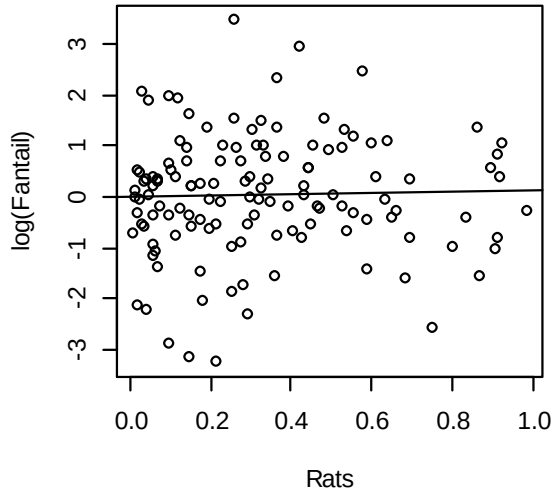
Brown creeper / Pīpipi



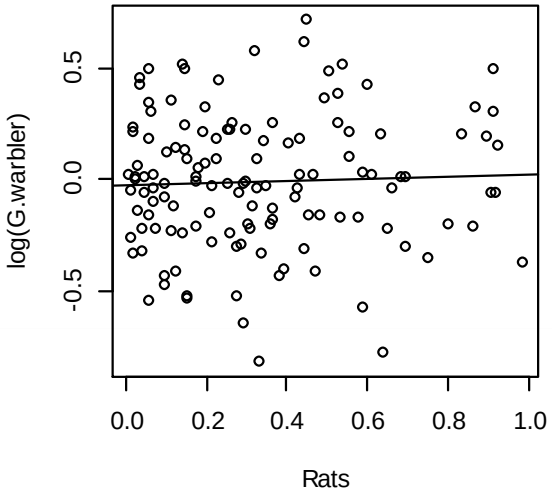
Bellbird / Korimako



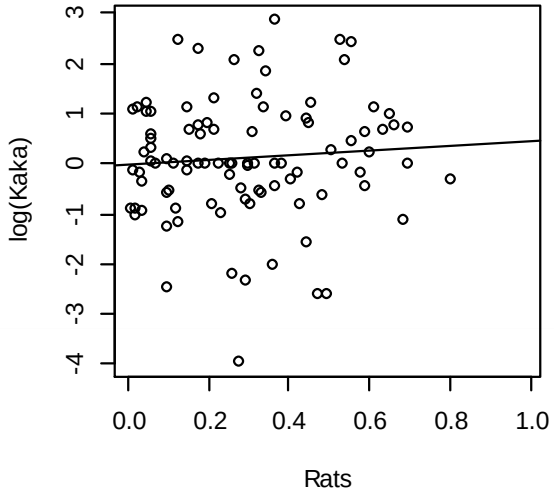
Fantail / Pīwakawaka



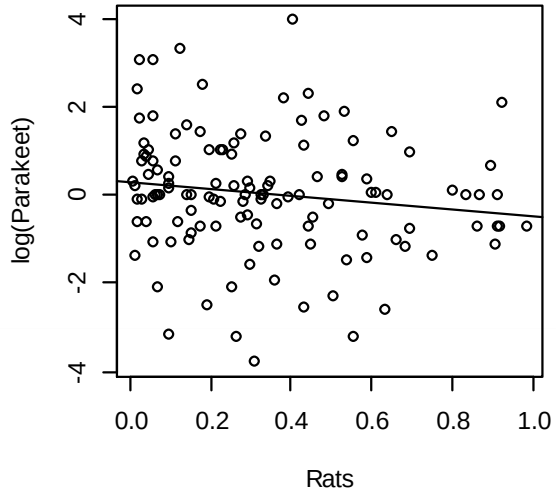
Grey warbler/ Riroriro



Kākā

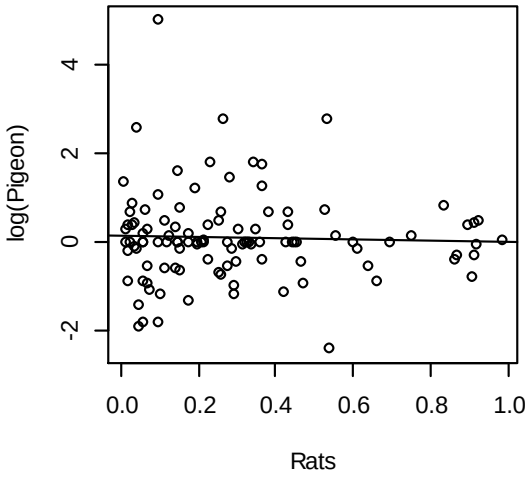


Parakeet / Kākāriki

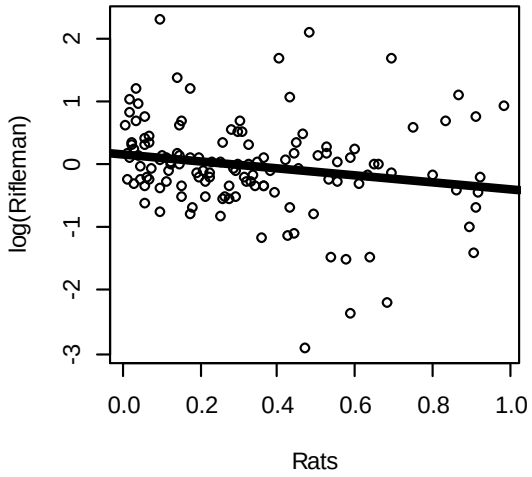


Pest-Density Impact Functions

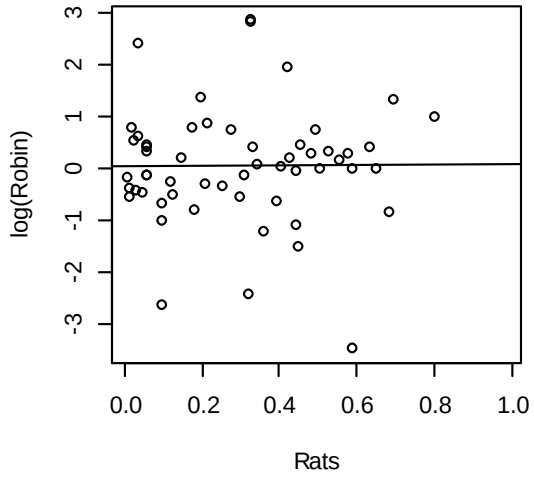
Kererū



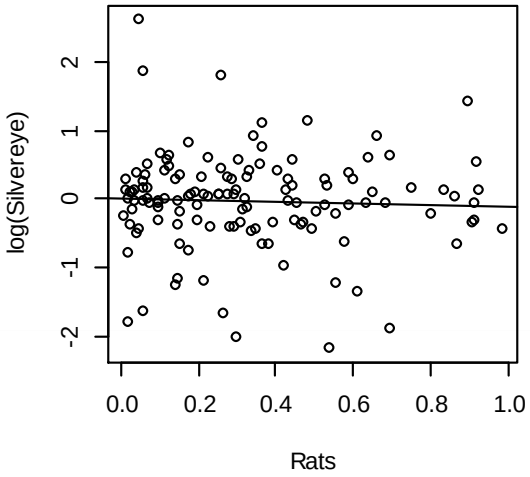
Rifleman / Tītipounamu



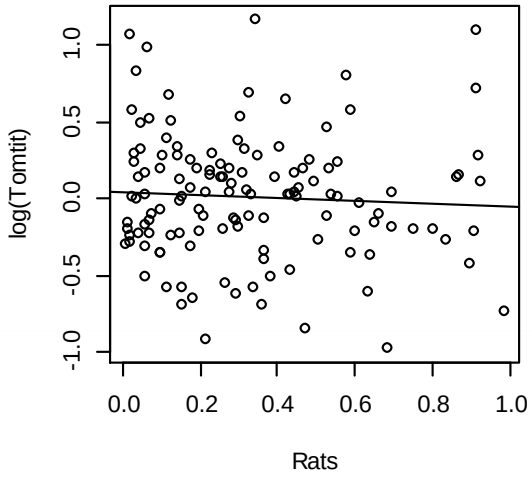
Robin / Toutouwai



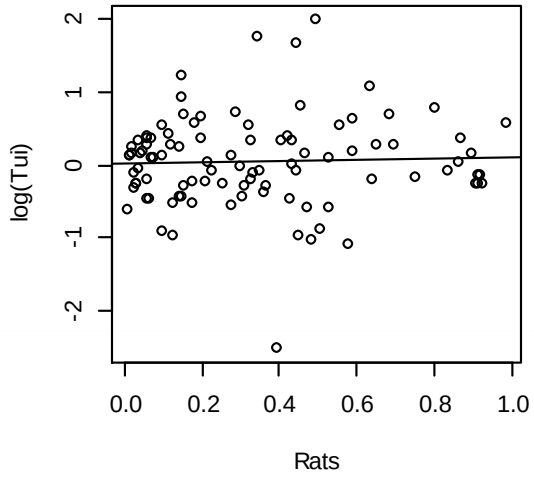
Silvereye/ Pīpipi



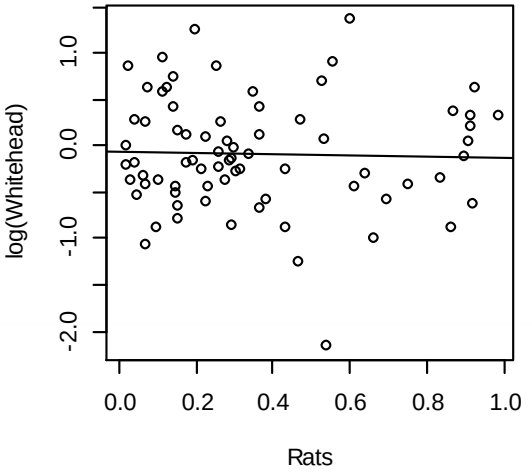
Tomtit / Korimako



Tūī



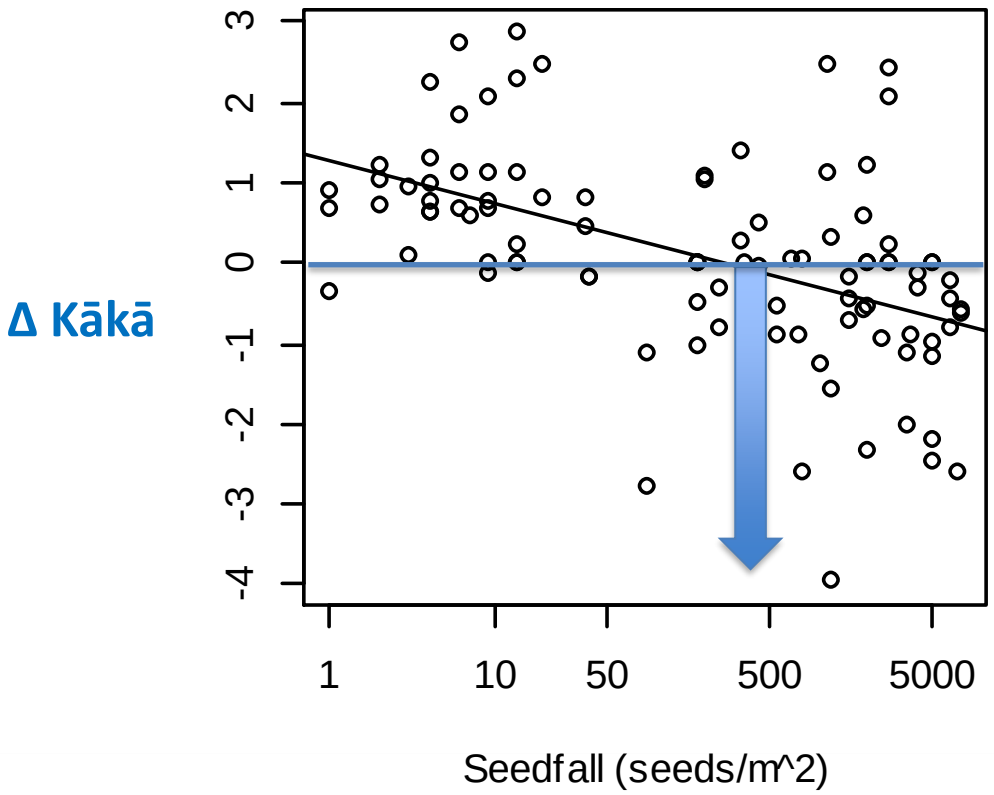
Whitehead / Pōpokotea



“Best” models

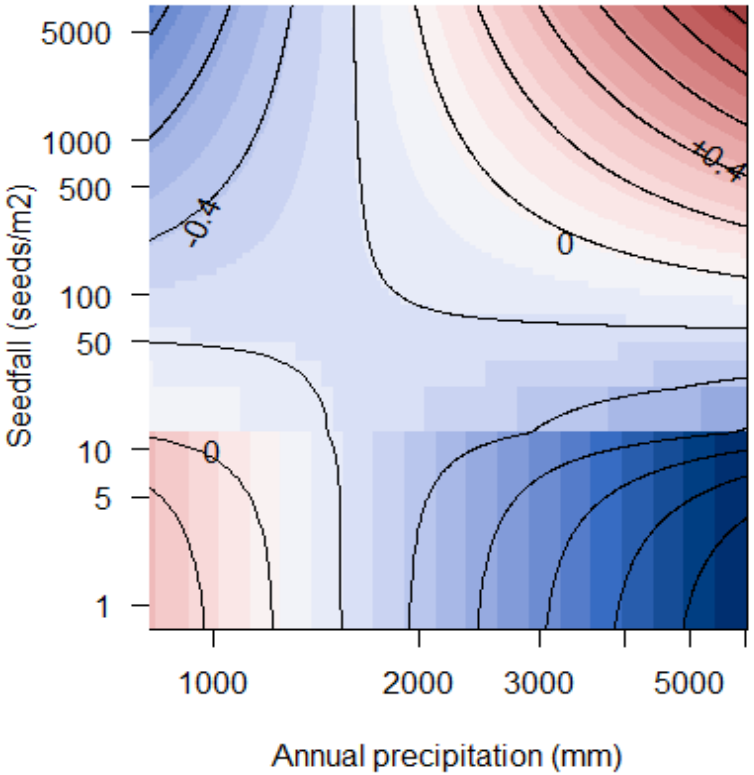
	Main effects	Number of significant drivers
Bellbird	rats + seed + temp + rain	0
Brown creeper	rats· + seed· + temp + rain	0
Fantail$^{\Omega}$	rats + seed· + temp + rain + (seed × rain)·	0
Grey warbler	rats + seed + temp + rain	0
Kākā$^{\Omega}$	rats + **seed*** + temp + rain	1
Parakeet	rats + seed + temp + rain	0
Kererū	rats + seed + temp + rain + **(seed × rain)***	2
Rifleman	**rats**** + **seed*** + temp + rain + **(rats × seed)***	2
Robin$^{\Omega}$	rats + seed + temp + rain	0
Silvereye	rats + seed + temp + rain + (**seed × rain)****	2
Tomtit	rats + seed + temp + rain	0
Tūī$^{\Omega}$	rats· + seed· + temp + rain	0
Whitehead$^{\Omega}$	rats + seed + temp + rain	0

Seed Density Impact Function

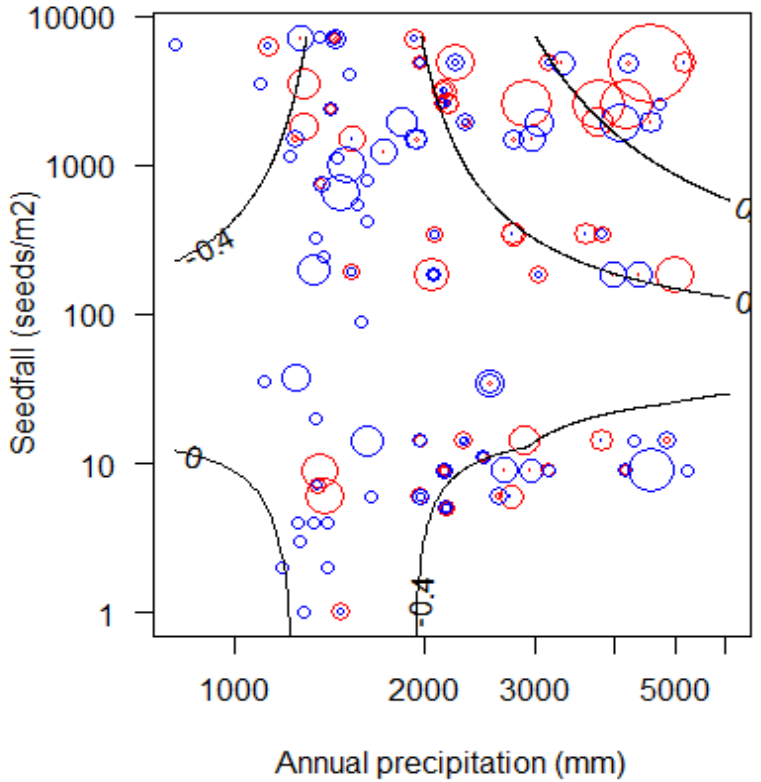


Response surface to seedfall & rain

Δ Kererū (predicted)



Δ Kererū (observed)



Pest Density-Impact Function (conditioned on Seedfall)

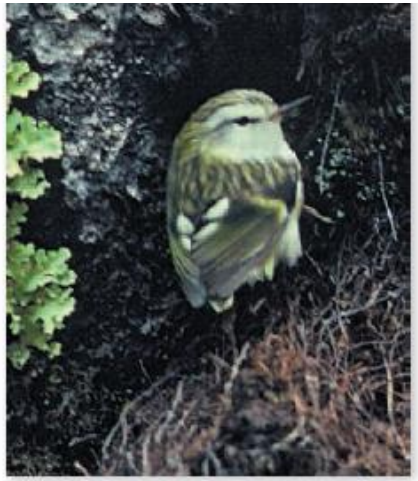
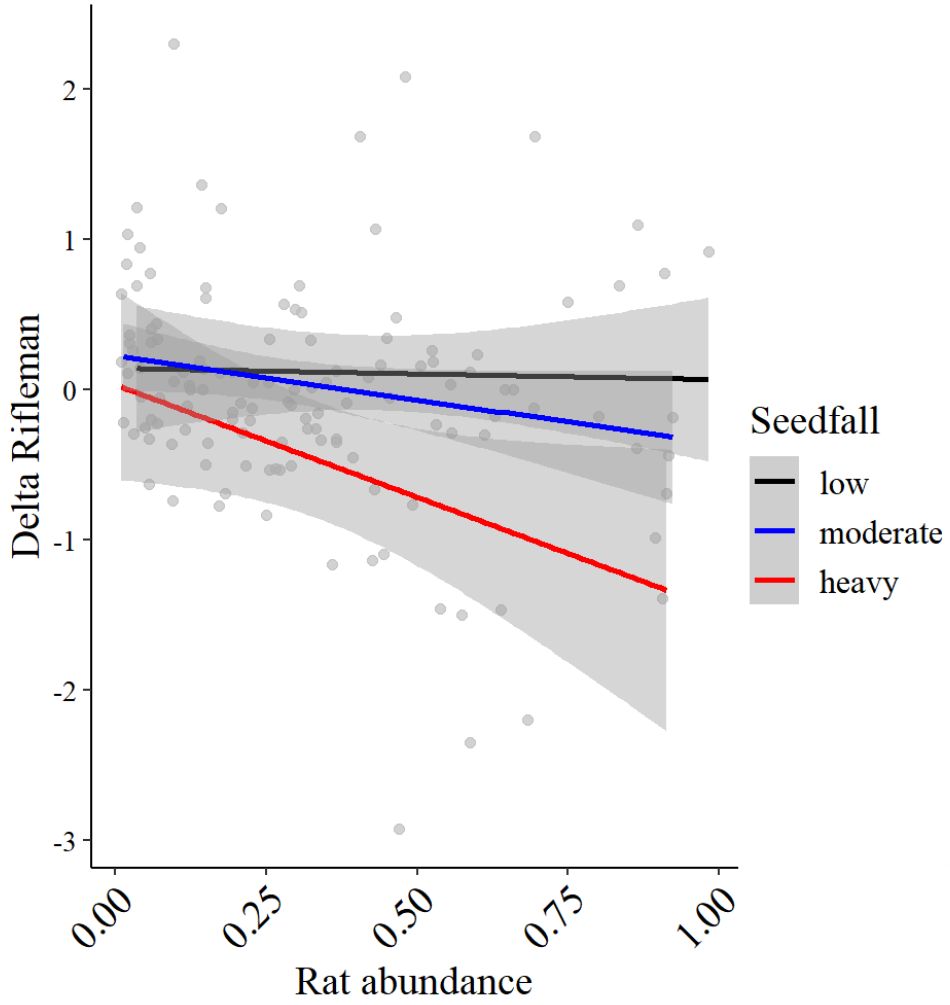
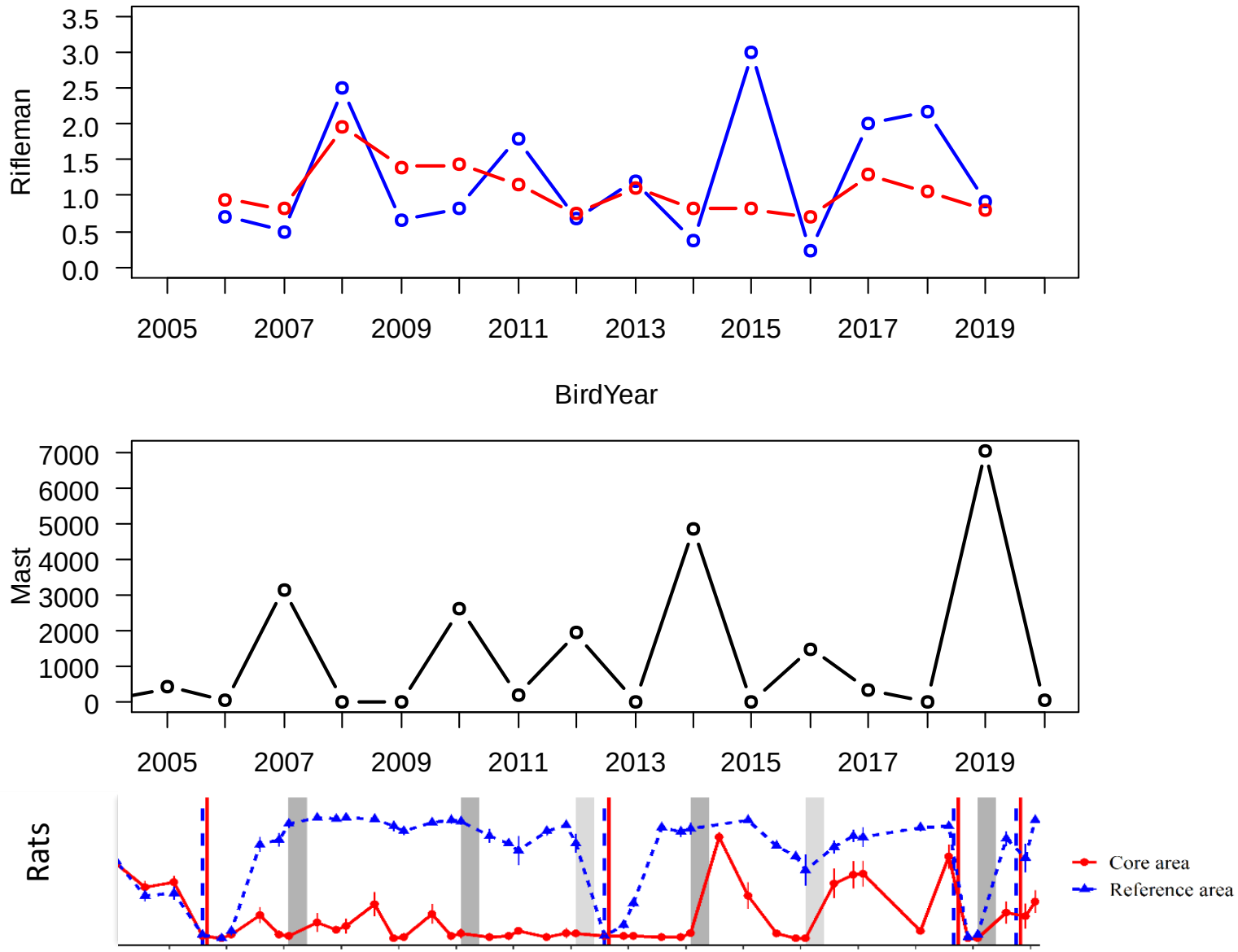


Photo: J.L. Kendrick.

Rifleman / Tītipounamu



Rifleman (core and reference) and Seed from Wainuiomata



Conclusions

- **Rat tracking index** was rarely a predictor of bird population dynamics (only 1 PDIF)
- **Seedfall** was significant for four species, rainfall for two
- **Multifactor** explanations more common than single factor models

Seedfall is possibly a better indicator of how many rats (and stoats) are in the forest than RTI

Annual changes from bird counts are too noisy and/or our time lags aren't quite right

Low counts of birds (e.g. 1→2) are subject to greater stochastic variation which may drown out the more reliable data when counts are moderate to high (e.g.20 → 30). **LRR may need a reliability weighting**?

Acknowledgements

- The many staff of DOC and GWRC who have maintained the management regimes and curated data
  - Philippa Crisp & Roger Uys (GWRC)
- The many staff and volunteers who helped gather the field data
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Thank you!