

Horomaka | Banks Peninsula

# Community Hui

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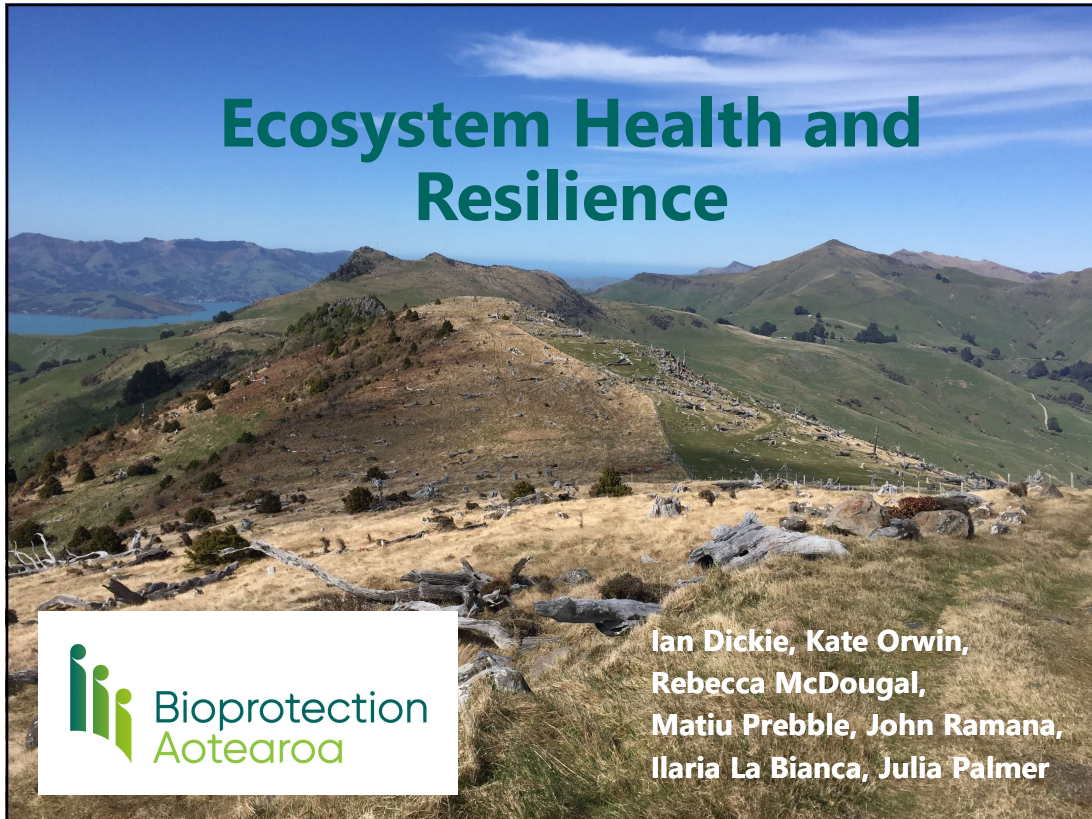


# Presentations

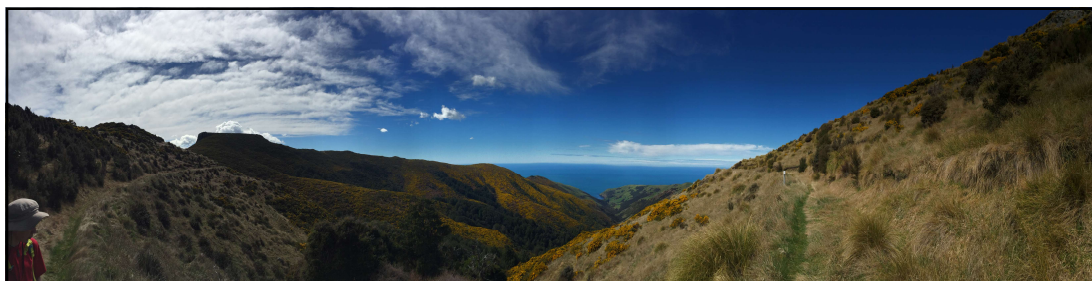


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INFORMATION

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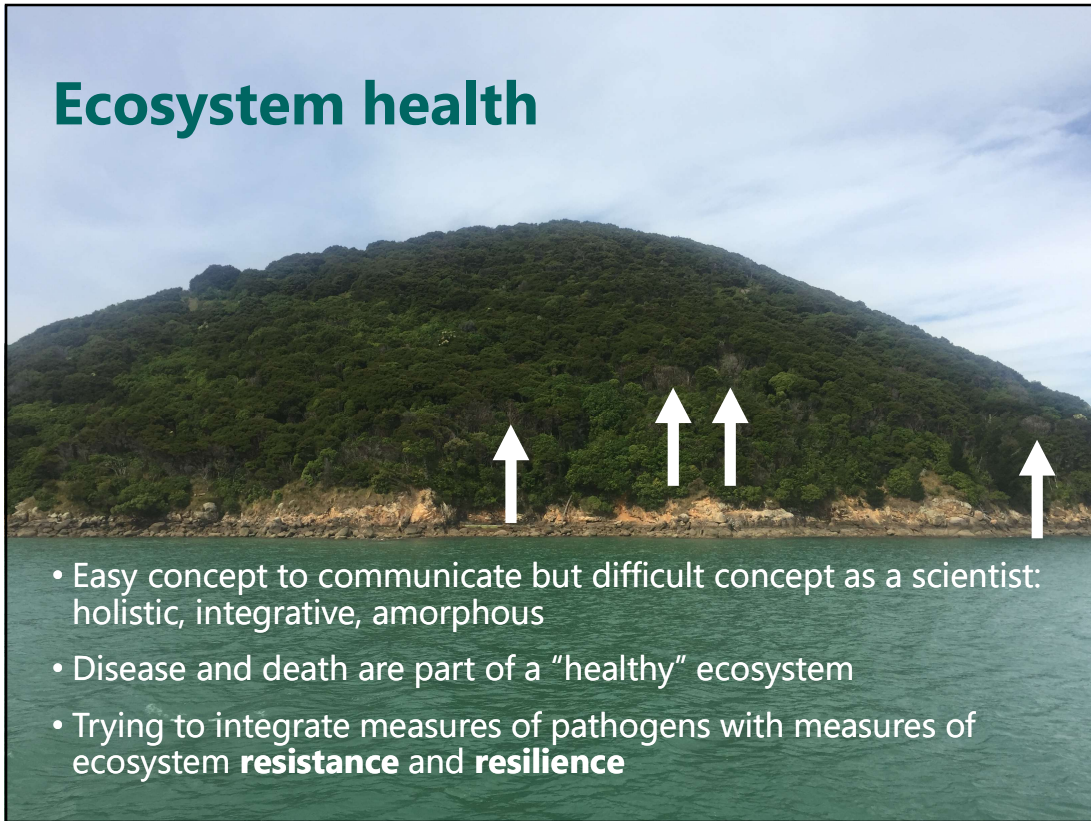
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- Introduce the concepts of ecosystem health and resilience, and our approach to measuring
- **John Ramana:**  
Microbial communities and ecosystem health across Horomaka
- **Ilaria La Bianca:**  
Ecosystem resistance and resilience
- **Julia Palmer:**  
Arthropod communities in forest fragments
- **Next steps:**  
Role of pathogens in past, present and future landscapes

2

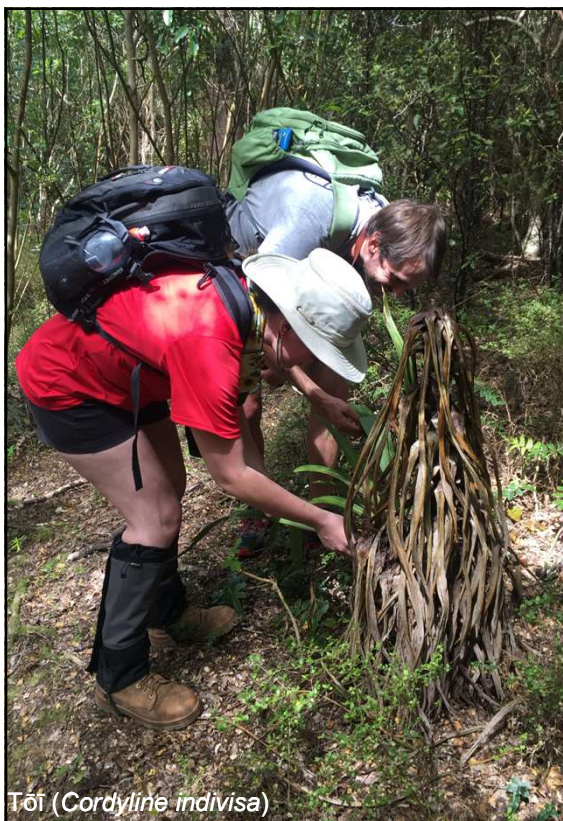
## Ecosystem health



- Easy concept to communicate but difficult concept as a scientist: holistic, integrative, amorphous
- Disease and death are part of a “healthy” ecosystem
- Trying to integrate measures of pathogens with measures of ecosystem **resistance** and **resilience**

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## Pathogens get ignored until they can't be

- Natural tendency to study disease in sick and dying individuals and ecosystems
- Studying the sick and dying can only tell us how to NOT be healthy

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## Pathogen outbreaks not only due to invasion



- Climate change
- Invasive species
- Other environmental changes

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## Pathogen outbreaks



- Often don't know if the pathogen is the cause of dieback, or just responding to something else
- In many cases don't know which pathogens are native or not
- Rarely do we succeed in managing outbreaks once they occur

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## Health is more than just pathogens



- Functioning of ecosystem
- Growth, Carbon storage
- Biodiversity
- Long-term succession
- Resistance and resilience of function to stress

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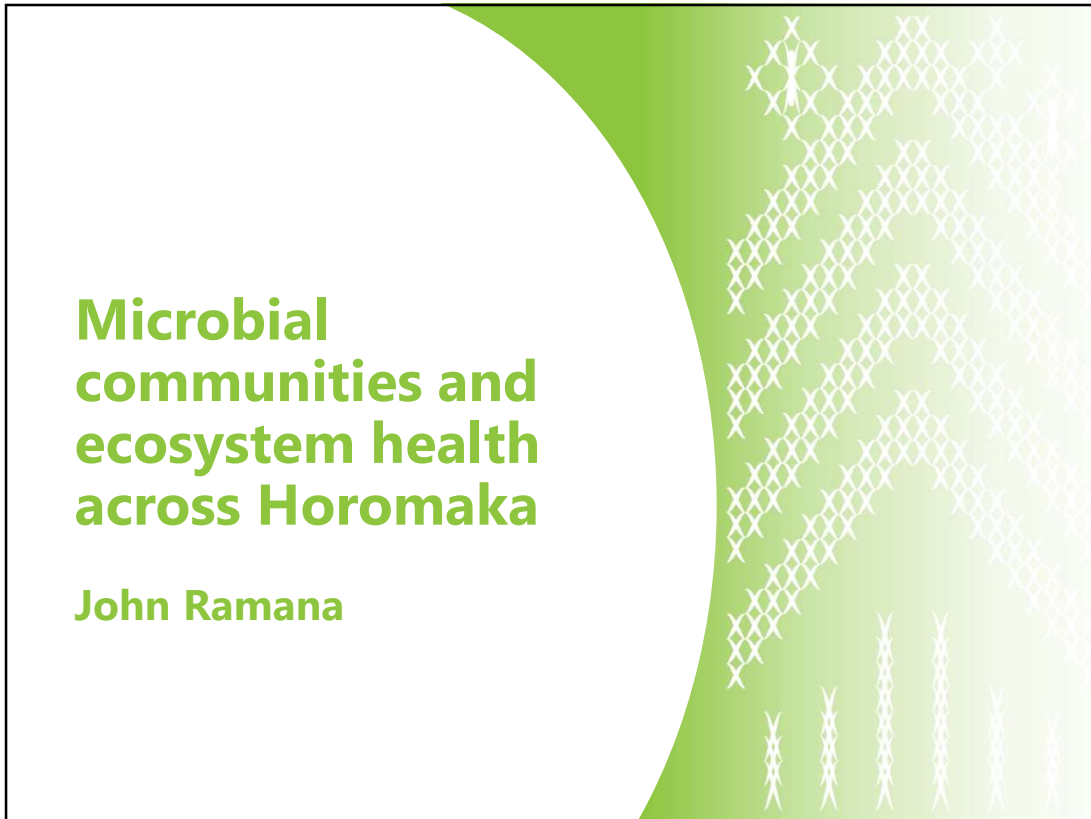


## Focus on healthy ecosystems



- Is there a 'core microbiome' of healthy ecosystems?
- Does microbial community composition determine resistance and resilience?
- What level of pathogens is 'normal'?

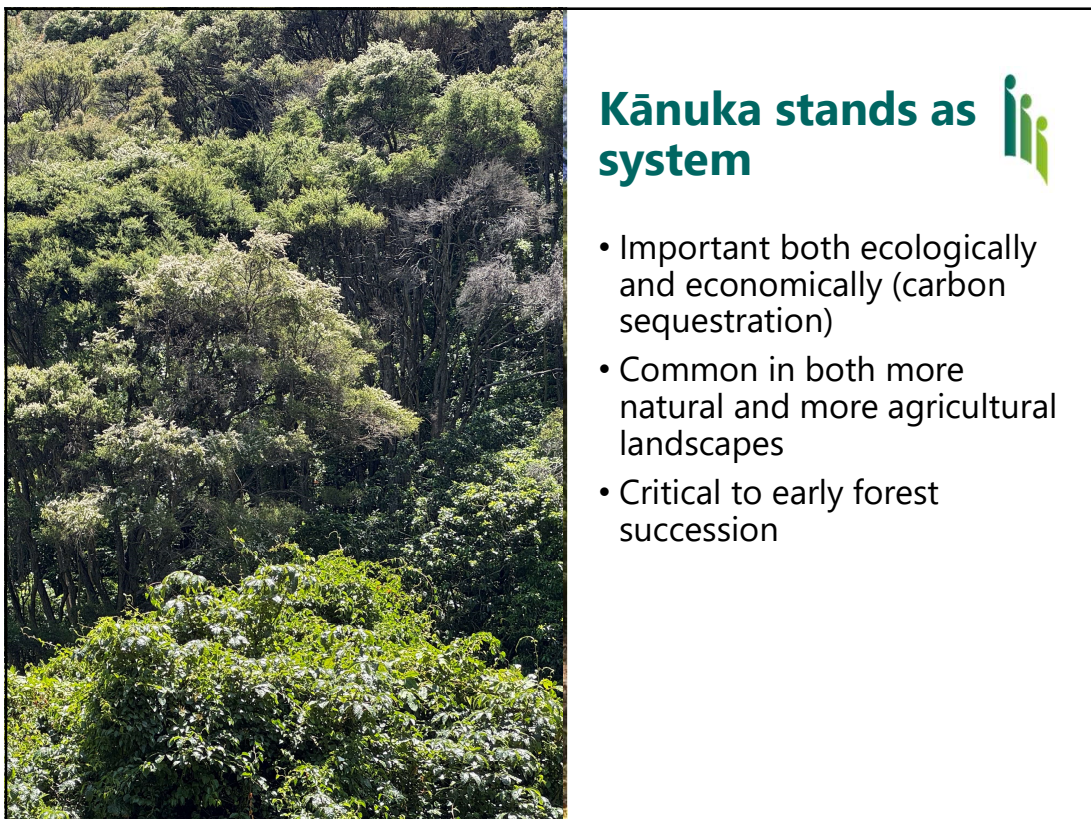

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The slide features a white background on the left and a green background on the right. The green background has a white pattern of interconnected lines forming a grid-like structure. The text is in a bold, green, sans-serif font.

## Microbial communities and ecosystem health across Horomaka

John Ramana

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The slide is split into two sections. On the left is a photograph of a dense forest of tall, thin trees with green foliage. On the right is a white background with text and a logo.

## Kānuka stands as system

- Important both ecologically and economically (carbon sequestration)
- Common in both more natural and more agricultural landscapes
- Critical to early forest succession

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## Fungi



- Range from highly beneficial (mycorrhizas, decomposers) to highly pathogenic
- Vast numbers of indigenous species – only about 10% known to science
- Some notable invasive species — with largely unknown impacts

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## Bacteria




- Again, range from highly beneficial (Nitrogen fixing, decomposers) to highly pathogenic
- Mostly widespread globally
- Often the highest impact species are not the most abundant

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## Oomycetes (water moulds)




- Much less well known
- Major drivers of plant disease
- Also common in fish and other aquatic life



White rust (*Pustula spinulosa*) on thistle

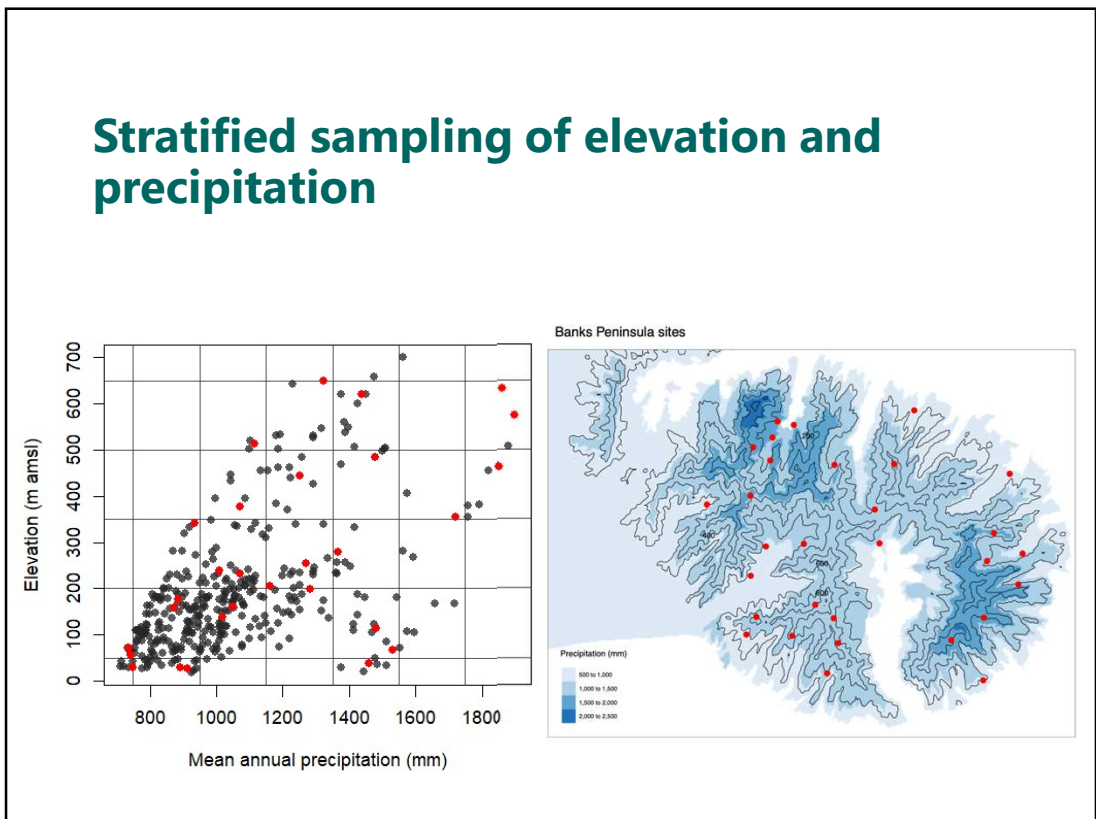


Kauri dieback (*Phytophthora*)



Saprolegnia on tuna (short-finned eel)

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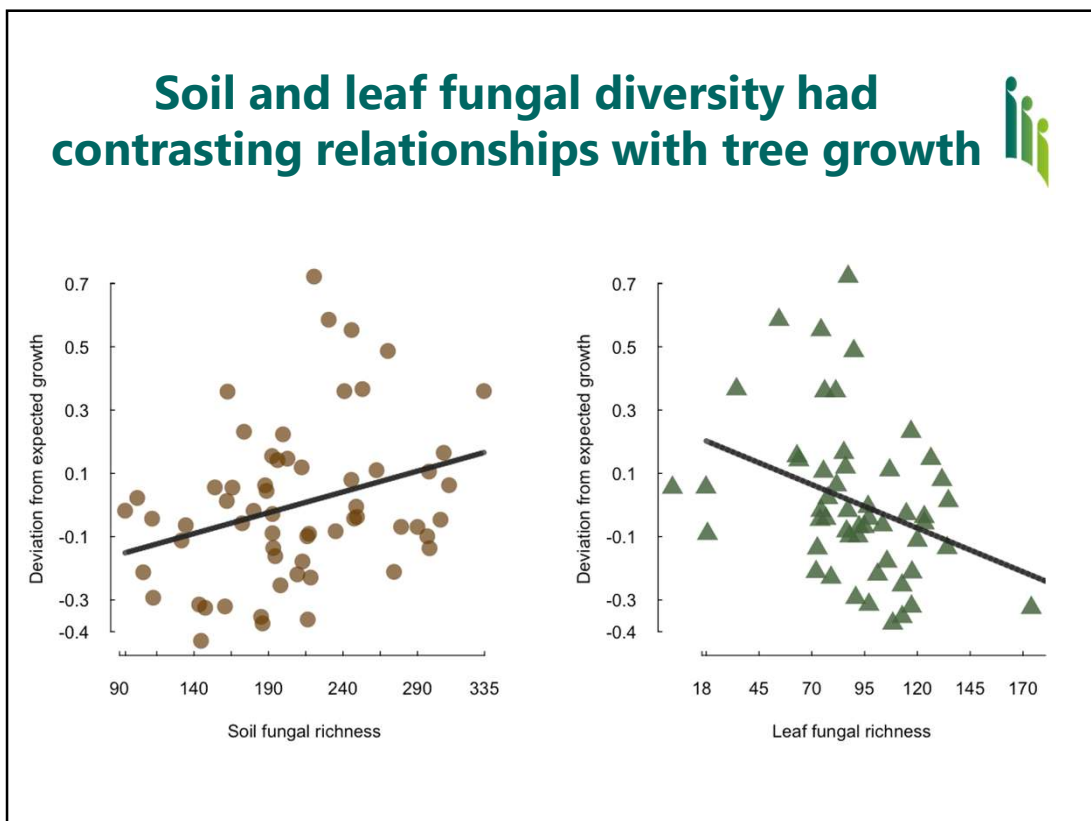
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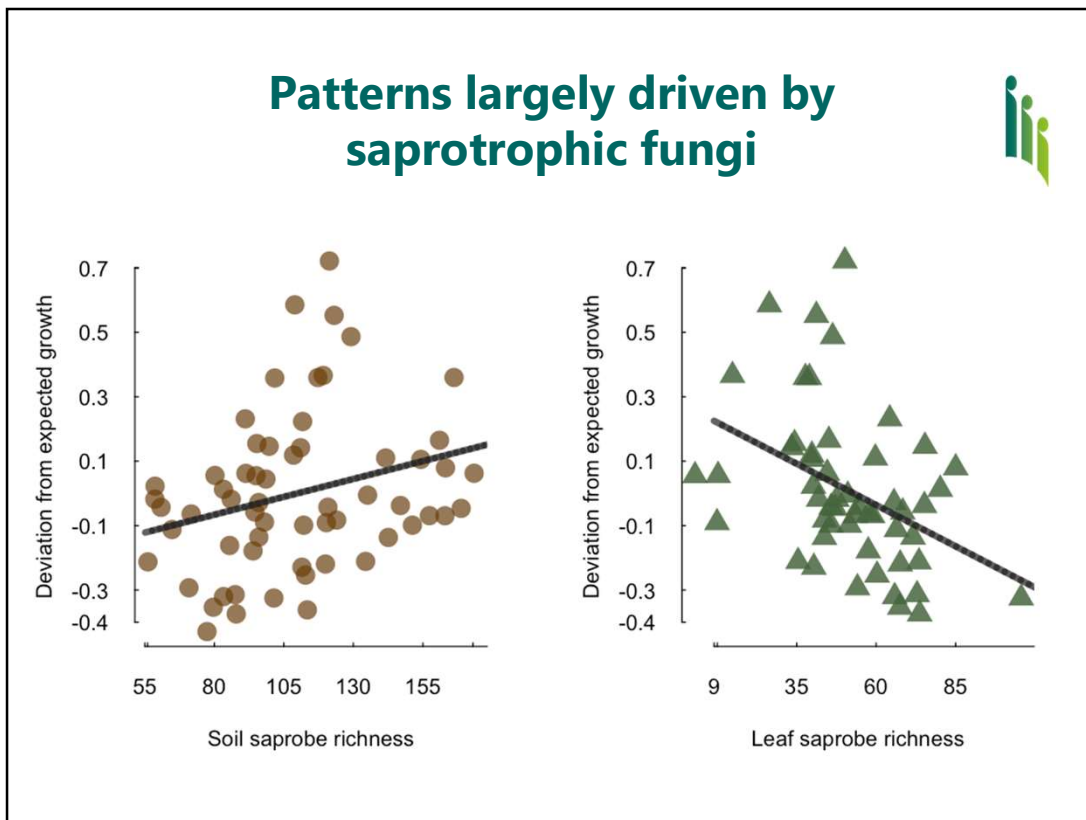
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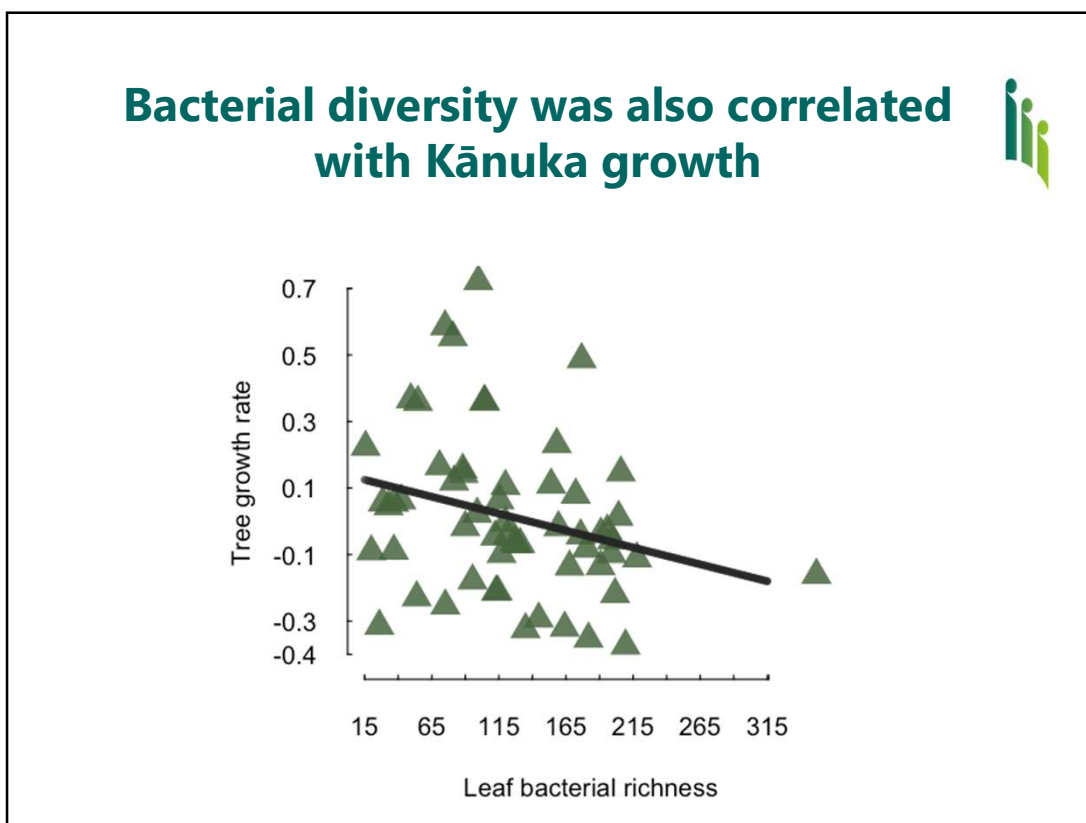
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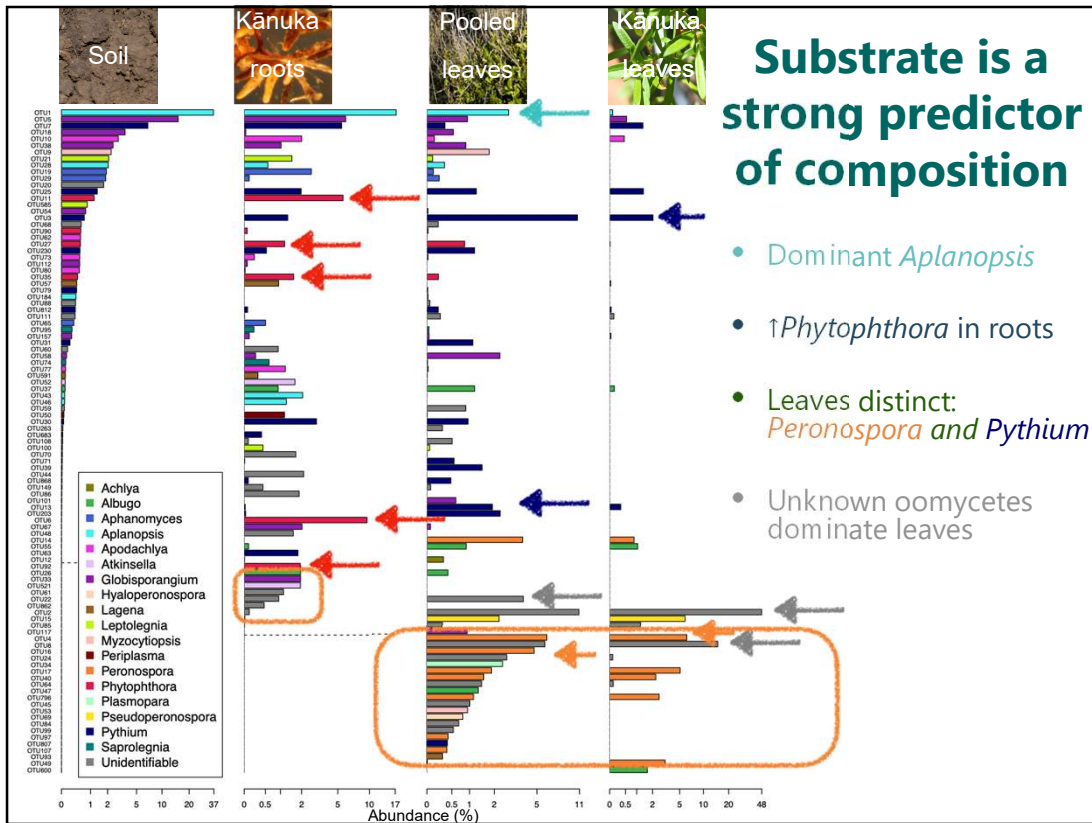
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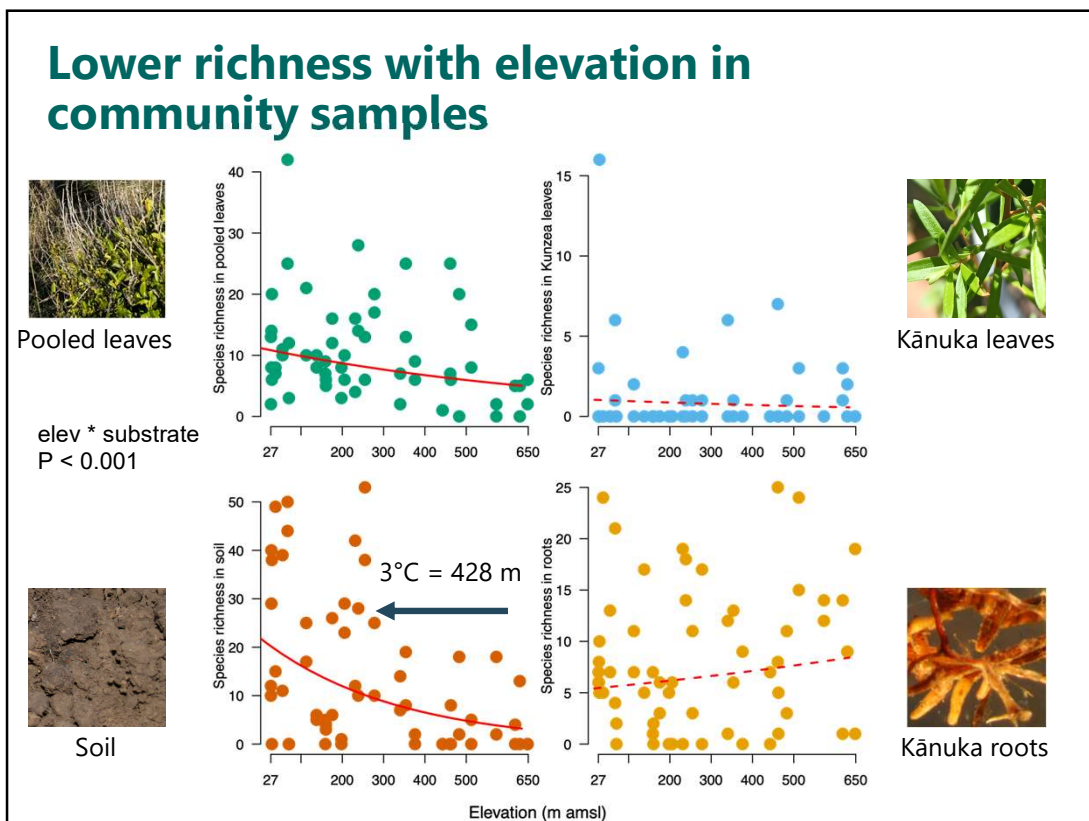
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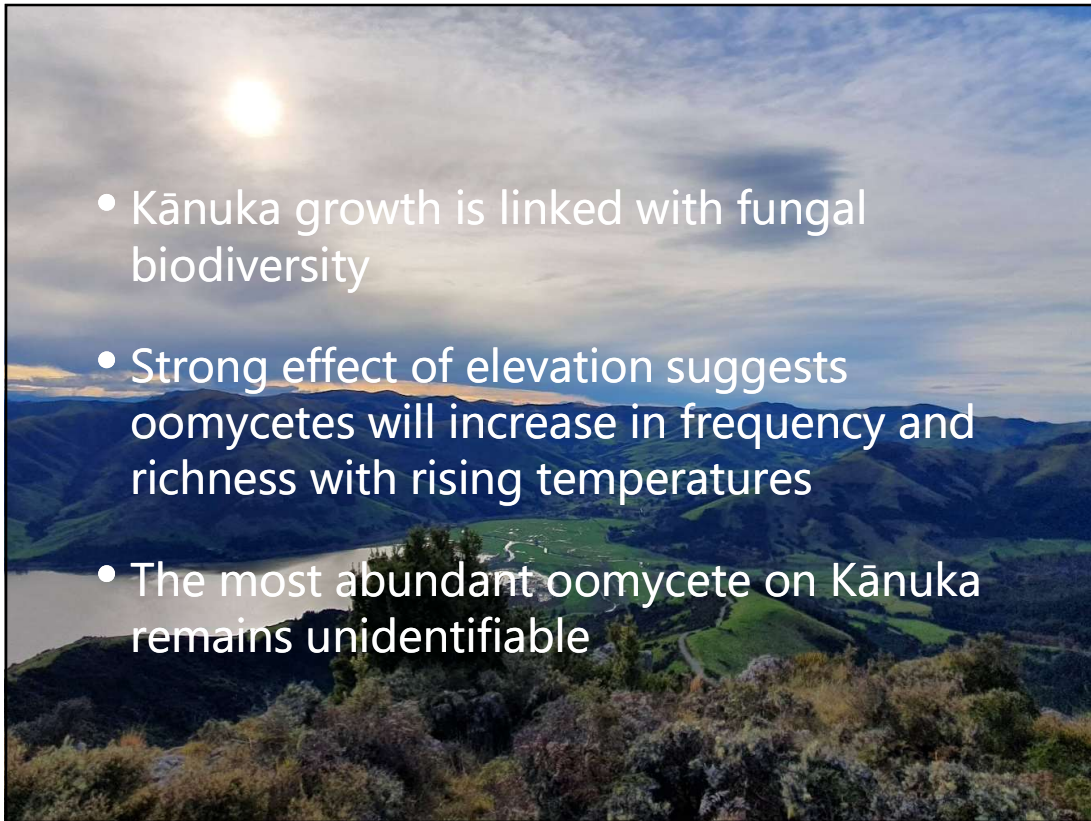
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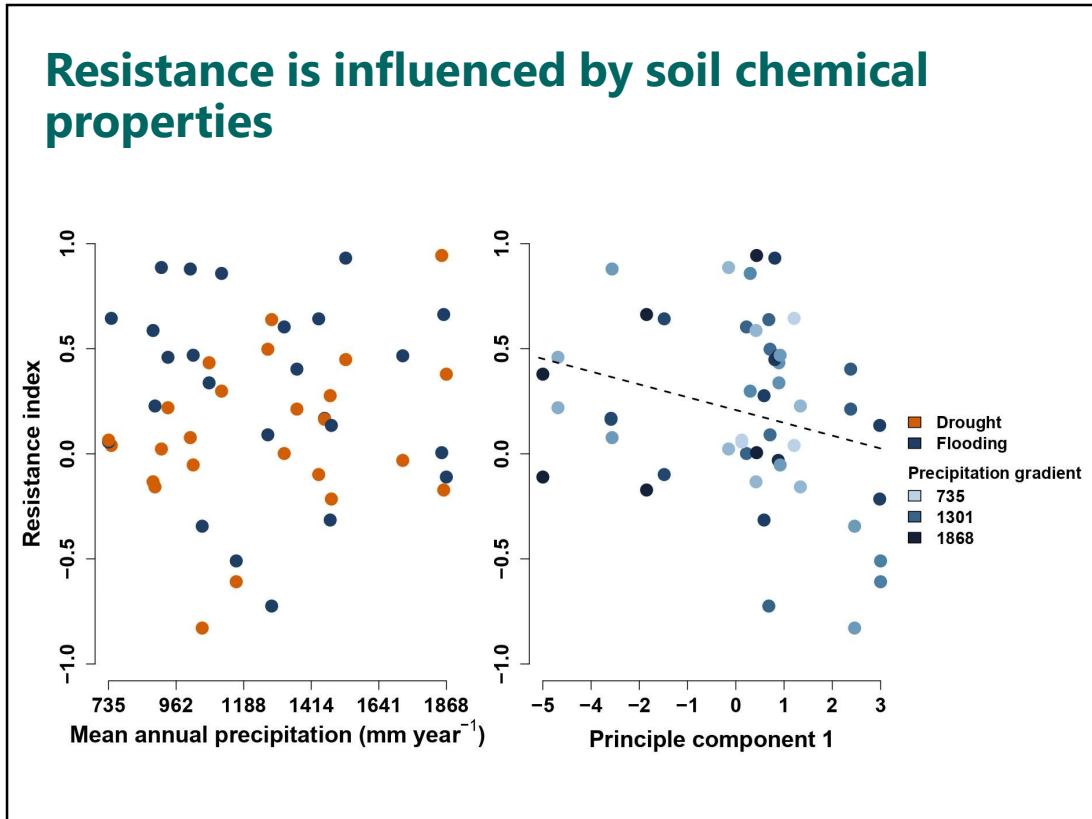
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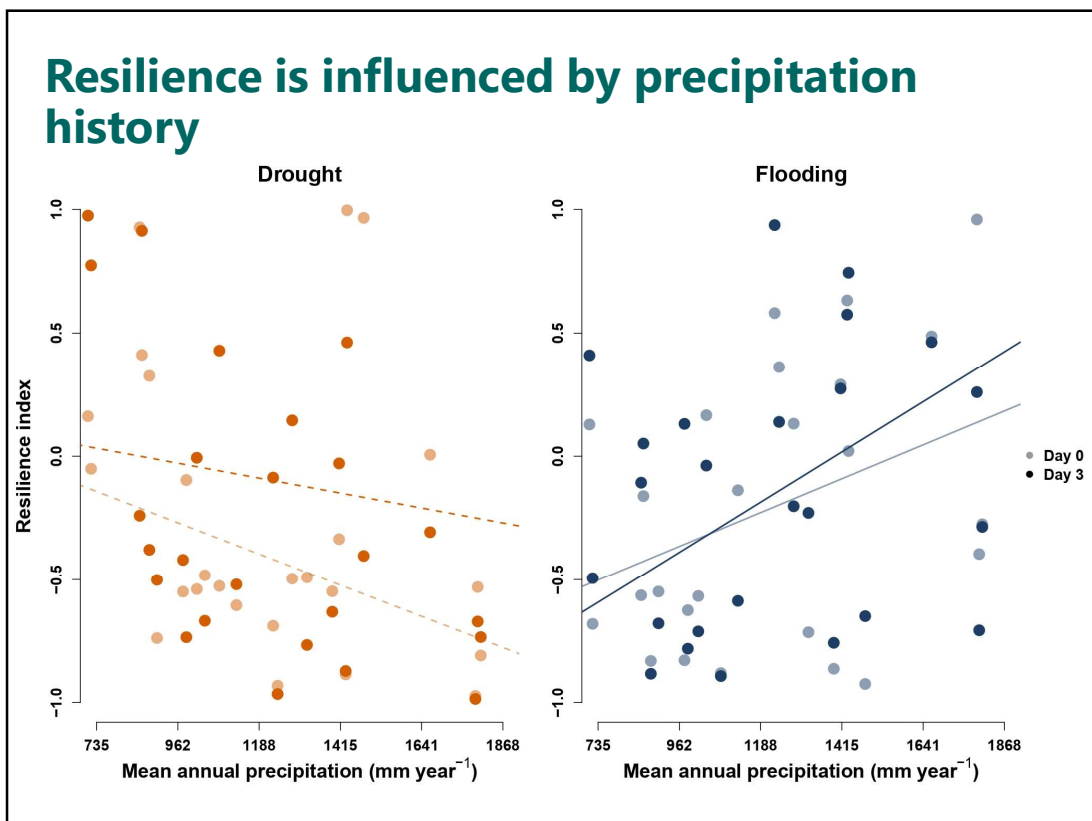
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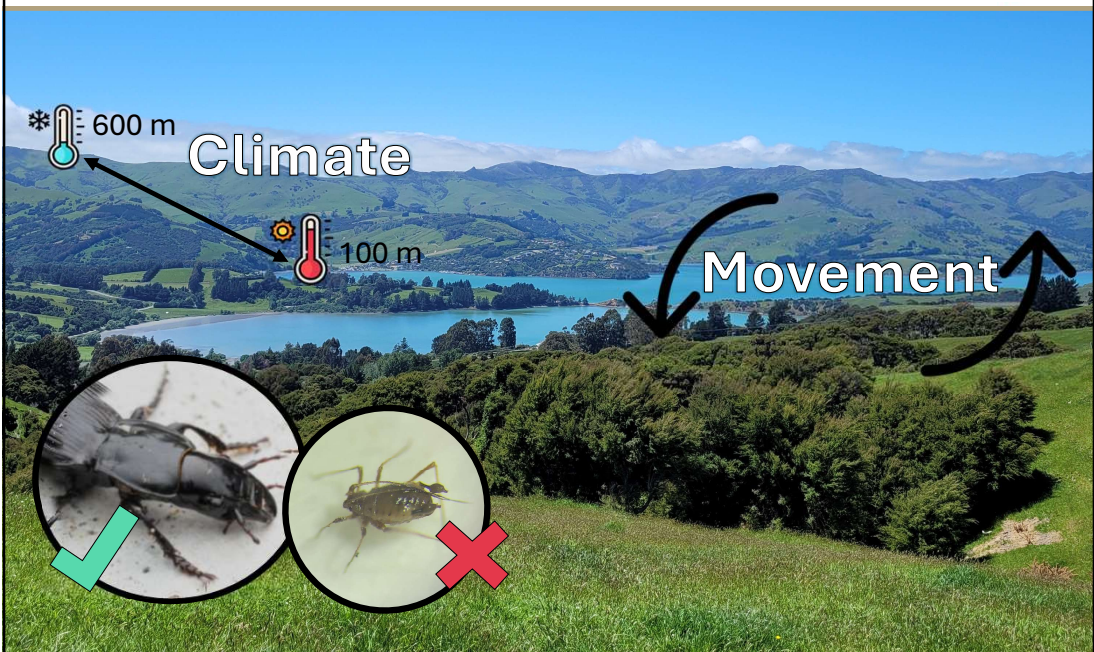
28



## How Arthropods are Changing in The Landscape?

Julia Palmer

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❄️ 600 m

Climate

☀️ 100 m

Movement

✔️

❌

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### Methods:

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Cover Fly Pupae Model Caterpillar

**Sentinel Prey:**  
Measure of predation

**Pitfall Traps:**  
Collection of arthropods

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### Results:

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**Abundance decrease**

↓

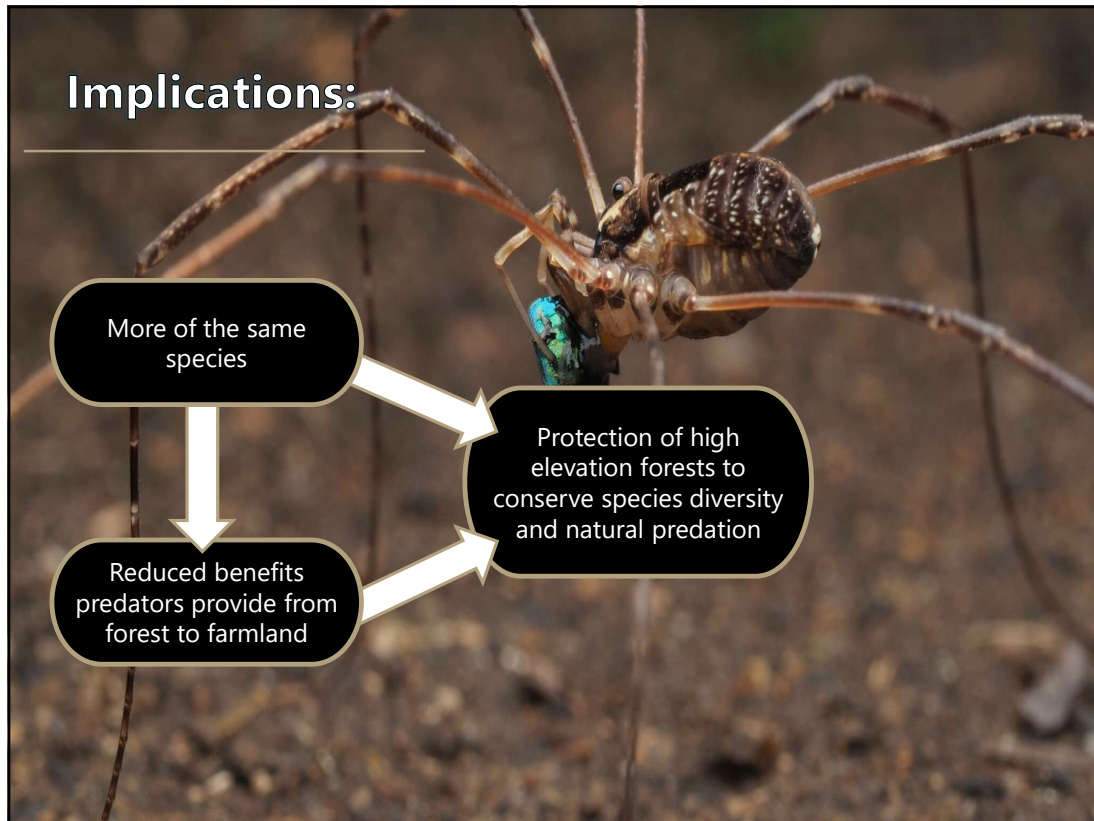
**Species richness increase**

↑

**Results as Elevation ↑**

**Predation changed across edges and elevation**

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**Implications:**

More of the same species

Reduced benefits predators provide from forest to farmland

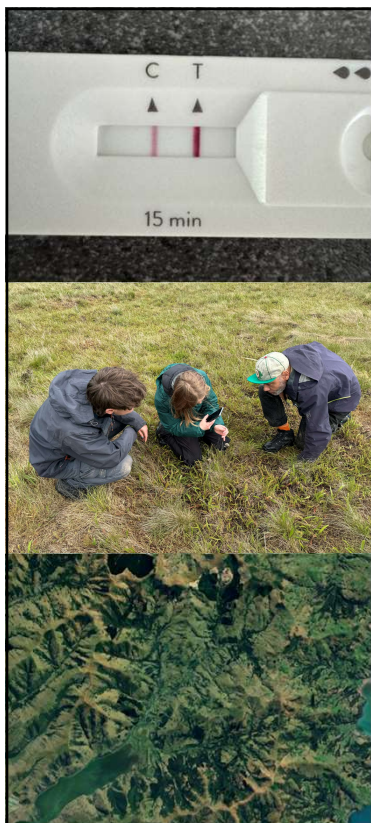
Protection of high elevation forests to conserve species diversity and natural predation

The image shows a large, brown spider with long, thin legs perched on a branch. A diagram with three black rounded rectangular boxes and white arrows is overlaid on the image. The top box contains the text 'More of the same species'. A white arrow points from this box down to a second box containing 'Reduced benefits predators provide from forest to farmland'. Another white arrow points from the top box to a third box on the right containing 'Protection of high elevation forests to conserve species diversity and natural predation'. A white arrow also points from the bottom box to this right-hand box.

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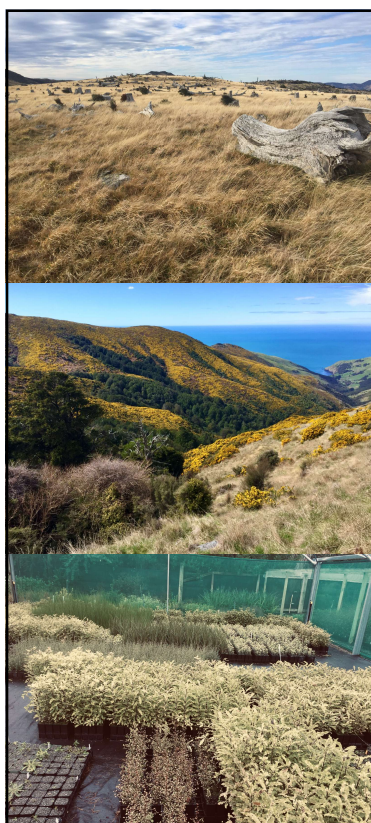


## Improved tools for detection and quantification of pathogens

Led by John Ramana

- Challenge to detect low-abundance but high impact species
- Improved molecular approaches
- Pathogen-focused bioinformatics
- Integrating multiple tools across scales from molecules to landscapes

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## Plant pathogens as long-term ecosystem drivers

Led by Matiu Prebble

## Quantifying the pathogen tax in healthy ecosystems

Led by Ian Dickie and Kate Orwin

## Impact of pathogen “hitch-hikers” on restoration success



Led by Rebecca McDougal (Scion)



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## Drivers of weed invasion in native forest and shrubland

Dr Laureline Rossignaud<sup>1</sup>  
Distinguished Professor Philip Hulme<sup>2</sup>


<sup>1</sup>Manaaki Whenua – Landcare Research  
[rossignaudl@landcareresearch.co.nz](mailto:rossignaudl@landcareresearch.co.nz)

<sup>2</sup>Lincoln University  
[Philip.Hulme@lincoln.ac.nz](mailto:Philip.Hulme@lincoln.ac.nz)

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### Postdoctoral projects on weed invasion at National scale

**1- How native species, landscape features and climate influence weed invasion?**  
Focus on mānuka-kānuka shrubland



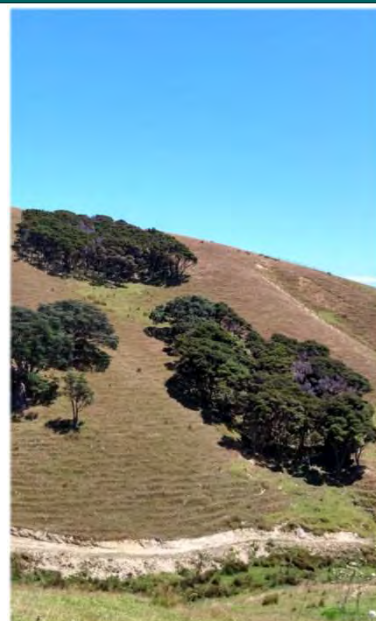
Ragwort, *Jacobaea vulgaris*  
Coromandel, 2022

2

## 1- Weed invasion in mānuka-kānuka shrubland: Key results

- **Native trees** promote resistance against most weed species
- **Climate**, distance to nearest **road** and **river** important earlier stage of establishment
- Greater adjacent **anthropogenic land cover** favours invasion

Mānuka-kānuka shrublands highly fragmented and with low native tree richness more likely to be invaded



<sup>3</sup> Note: Richness: number of species found at a site

## Postdoctoral projects on weed invasion at National scale

### 1- How native species, landscape features and climate influence weed invasion?

Focus on mānuka-kānuka shrubland



Radiata pine, *Pinus radiata*  
Craigieburn, 2023



Ragwort, *Jacobaea vulgaris*  
Coromandel, 2022

### 2- How weed invasion vary across native forests and shrublands?

Focus on distinguishing weeds by:

- **invasion status** (naturalised vs environmental weeds)
- **growth form** (herbaceous vs woody)

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## 2- Weed invasion in native forest and shrubland: Key results

- **Mānuka-kānuka shrublands** and **early successional forests** show higher levels of invasion
- Despite a low richness, **environmental weeds** showed higher cover
- **Native trees** promote resistance against herbaceous weeds but not necessarily woody weeds

Mānuka-kānuka shrublands more at threat if invaded by woody weeds



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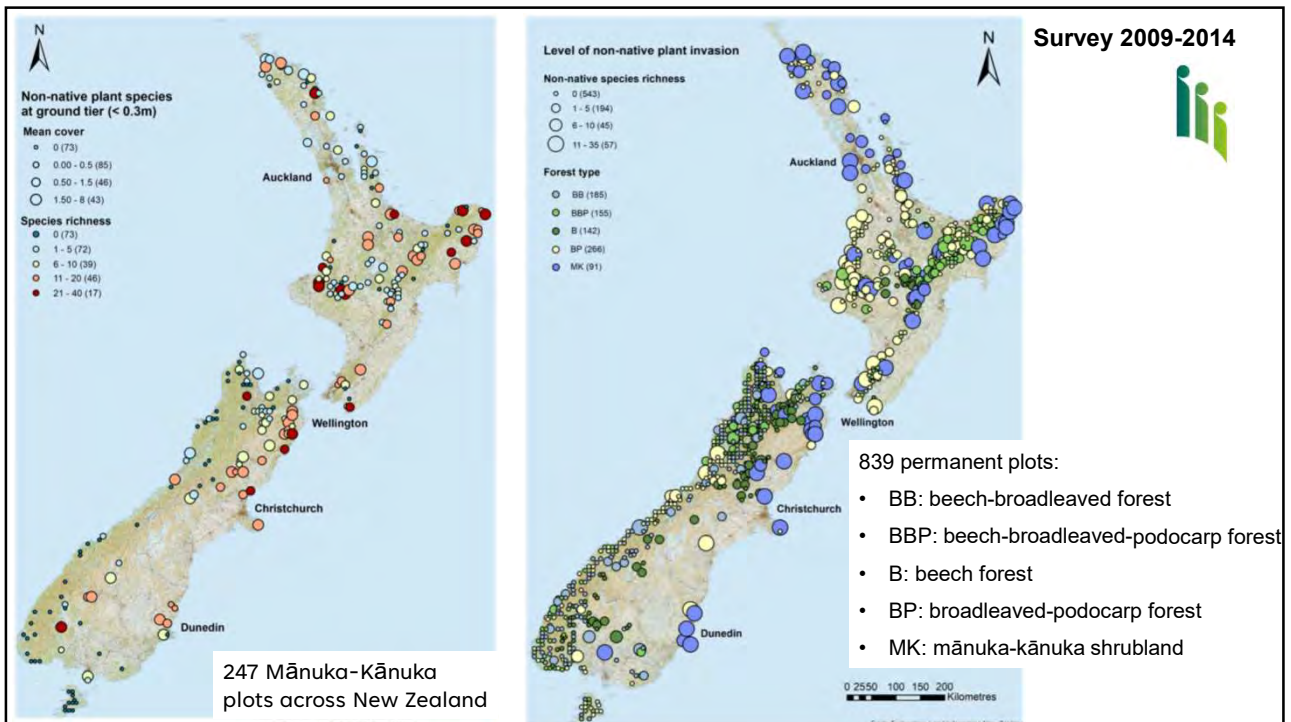


# Thank You

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[Philip.Hulme@lincoln.ac.nz](mailto:Philip.Hulme@lincoln.ac.nz)

[bioprotection.org.nz](http://bioprotection.org.nz)

6



7 Note: Species richness: number of species found in a plot  
 Mean cover: mean % cover of non-native species at a plot

1- Weed species in mānuka-kānuka shrublands (2009-2014)



Common name	Species name	Family	Frequency	Mean Cover	Range
Catsear	<i>Hypochaeris radicata</i>	Asteraceae	93	0.92	0.5 to 15
Sweet vernal	<i>Anthoxanthum odoratum</i>	Poaceae	85	5.80	0.5 to 63
Yorkshire fog	<i>Holcus lanatus</i>	Poaceae	71	2.18	0.5 to 15
Browntop	<i>Agrostis capillaris</i>	Poaceae	70	3.59	0.5 to 38
Lotus	<i>Lotus pedunculatus</i>	Asteraceae	62	1.37	0.5 to 15
Hawksbeard	<i>Crepis capillaris</i>	Asteraceae	51	0.65	0.5 to 3
Wall lettuce	<i>Mycelis muralis</i>	Asteraceae	51	0.55	0.5 to 3
Self-heal	<i>Prunella vulgaris</i>	Lamiaceae	50	1.09	0.5 to 15
<b>Cocksfoot</b>	<b><i>Dactylis glomerata</i></b>	<b>Poaceae</b>	<b>48</b>	<b>3.42</b>	<b>0.5 to 38</b>
<b>Foxglove</b>	<b><i>Digitalis purpurea</i></b>	<b>Plantaginaceae</b>	<b>47</b>	<b>0.55</b>	<b>0.5 to 3</b>
<b>Scotch thistle</b>	<b><i>Cirsium vulgare</i></b>	<b>Asteraceae</b>	<b>45</b>	<b>0.56</b>	<b>0.5 to 3</b>
White clover	<i>Trifolium repens</i>	Fabaceae	42	1.71	0.5 to 15
Mouse ear chickweed	<i>Cerastium fontanum</i>	Caryophyllaceae	42	0.50	0.5 to 0.5
<b>Ragwort</b>	<b><i>Jacobaea vulgaris</i></b>	<b>Fabaceae</b>	<b>35</b>	<b>0.57</b>	<b>0.5 to 3</b>
<b>Gorse</b>	<b><i>Ulex europaeus</i></b>	<b>Fabaceae</b>	<b>32</b>	<b>8.75</b>	<b>0.5 to 63</b>

8 Note: In bold environmental weeds.  
 Range: range of cover across the plots where the species is present

2- Woody weed species in native forest and shrublands (2009-2014)

Common name	Species name	MK		BP		BBP		B	
		Frequency	Cover	Frequency	Cover	Frequency	Cover	Frequency	Cover
Gorce	<i>Ulex europaeus</i>	50	27	24	26	5	3.8	0	0
Blackberry	<i>Rubus argutus</i>	34	52	12	48	1	3.5	0	0
Wild broom	<i>Cytisus scoparius</i>	18	42	3	41	0	0	3	4
Spanish heath	<i>Erica lusitanica</i>	16	62	0	0	0	0	0	0
Radiata pine	<i>Pinus radiata</i>	16	31	9	24	3	4	1	0.5
Prickly hakea	<i>Hakea sericea</i>	13	15	0	0	0	0	0	0
Woolly nightshade	<i>Solanum mauritianum</i>	11	24	2	1	0	0	0	0
Himalayan honeysuckle	<i>Leycesteria formosa</i>	10	62	14	42	1	0.5	0	0
Sweet brier	<i>Rosa rubiginosa</i>	10	46	2	159	0	0	0	0
Tree lupin	<i>Lupinus arboreus</i>	8	27	0	0	0	0	0	0
Cluster pine	<i>Pinus pinaster</i>	8	24	0	0	0	0	0	0
Sycamore	<i>Acer pseudoplatanus</i>	7	83	5	159	1	3.5	0	0
Elderflower	<i>Sambucus nigra</i>	7	54	0	0	0	0	0	0
Grey willow	<i>Salix cinerea</i>	6	87	0	0	0	0	1	0.5
Buddleia	<i>Buddleja davidii</i>	6	76	3	2	0	0	0	0

- 9 Note: Frequency: number of plots where the species was found  
 Cover: maximum % of cumulative cover of the species across all the plots  
 MK: manuka-kanuka  
 BP: Broadleaved-podocarp forest  
 BBP: Beech-broadleaved-podocarp forest  
 B: beech forest



## Weed invasions in New Zealand shrublands

**Friederike Espinoza**

Supervisors: Dist. Prof. Philip Hulme,  
Prof. Amanda Black, Dr. Laureline Rossignaud

Lincoln University, New Zealand

28<sup>th</sup> April 2025

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## Effects of habitat fragmentation on alien plant invasion in native shrublands

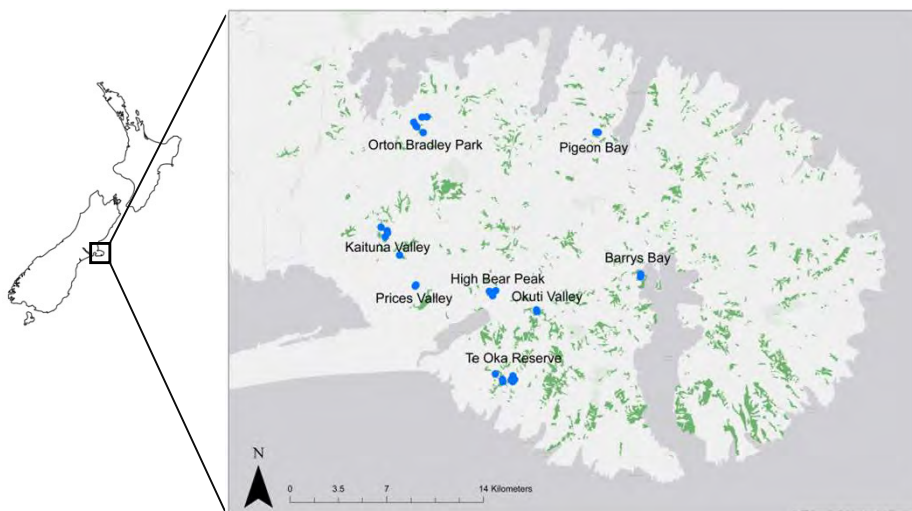


### Key questions:

- To what extent do alien plants ingress into kānuka fragments? Does it vary between alien plant species presenting different biological traits?
- What is the influence of multiple factors on alien plant invasion in a native shrubland ecosystem

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## Study area: Banks Peninsula, Canterbury



■ kānuka

● 30 selected kānuka fragments

### -Grazing

Grazed & ungrazed

### -Fragment size

Half small (<1.5ha)  
half large (>1.5ha)

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## Research findings



- Habitat fragmentation facilitates weed invasions and is a risk for kānuka shrublands
- Fragment size is a key factor for weed invasions
- Grass species were filtered out along the grassland-edge-interior  
shade tolerant woody species establish in the kānuka interior
- Restoration efforts should attempt to increase the size of existing fragments to prevent and limit alien weed invasions



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# Thank You

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## Enhancing the resilience of soil carbon across agricultural landscapes

Dr Alexa Byers (Lincoln University)





1

### *Theme 3 – Pou Nuku-A-Rangi*

## Enhancing the resilience of soil carbon across agricultural landscapes



- Our research aims to study the factors governing the long-term stabilisation and persistence of soil carbon across agricultural landscapes

<p>Dr Alexa Byers, Lincoln University</p>	<p>Dr Nicola Day, Victoria University of Wellington</p>	<p>Prof. Leo Condron, Lincoln University</p>	<p>Dr Shengjing Shi, AgResearch</p>
			

2

## **Farming for Resilience: Primary research aims for Tranche 2 (2025-2028)**



- How does land use impact the long-term storage of soil C? Use a wide range of different tools to quantify the proportion of 'stabilised' soil C
- What underlying mechanisms drive the fate of soil C inputs from different management strategies? e.g., impact of different cover cropping strategies on soil C storage
- How does the proportion of stabilised soil C change with soil depth across agricultural landscapes? What management factors support the accumulation of more persistent deep soil C reserves?
- *We want to hear from you! What are the big issues you want to see addressed in our research on soil C across Horomaka?*

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## **Presentation of research findings from Tranche 1 (2022-2024)**

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## The influence of agricultural land use and management on soil microbial C cycling

Dr Alexa-Kate Byers  
Postdoctoral Research Fellow  
Lincoln University  
[Alexa.byers@lincoln.ac.nz](mailto:Alexa.byers@lincoln.ac.nz)

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### Introduction

- Healthy soil is the foundation of agricultural productivity
- Soil carbon (C) is an important indicator for monitoring soil quality and productivity
- Soils are the largest terrestrial store of soil C and strongly influence the global C budget and climate regulation
- Soil microorganisms are major drivers of soil C cycling
- Studying the impacts of land use and management on soil microbes is essential to understand long-term impacts on soil C cycling



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## Study aims

- Examine the impacts of land use and management on soil and microbial C cycling dynamics across an agricultural landscape
- Study site – Kaituna Valley and Prices Valley (Banks Peninsula, Canterbury)
- Both valleys contain a diverse mosaic of land uses with contrasting land use histories and management regimes
- The land uses are typical of agroecosystems in the wider Banks Peninsula region and New Zealand more generally



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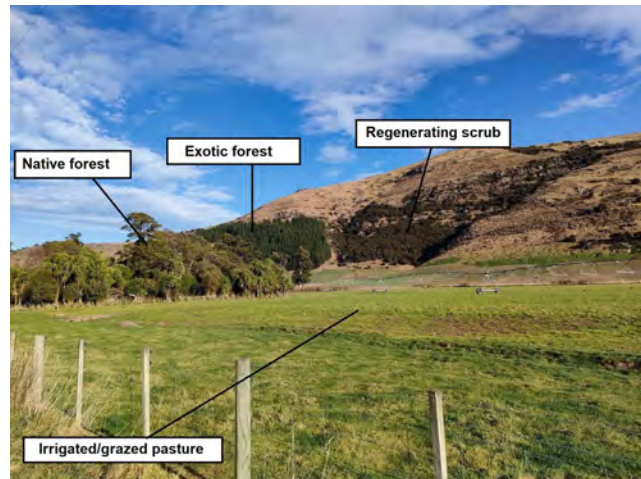
## Methods

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## Sampled soils from 5 different land uses:



- 1) Exotic forest – former pasture converted to *Pinus radiata* plantation
- 2) Native forest – remnant stands of podocarp forest containing species such as tītoki, māhoe, mataī, and kahikatea
- 3) Dryland pasture – sheep and dairy grazing
- 4) Irrigated dryland pasture – sheep and dairy grazing
- 5) Regenerating scrub – former pasture now regenerating with plant species such as kānuka



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## Methods for soil analysis



### Chemical analysis

- Soil pH, phosphorus, total C & N, bioavailable N, soil moisture, calcium, magnesium, potassium, and sodium

### Microbiology analysis

- Basal microbial respiration to measure microbial activity
- PLFA analysis to estimate microbial biomass, including the fungal: bacterial biomass ratio

### Genomic analysis

- Metagenomic DNA sequencing on soil DNA samples
- Functional profiling of microbial genes related to soil C & N cycling
- Use gene profiles to understand the functional activity of soil microbes

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# Results

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## No major effects of land use on soil C

- Overall, there were no major differences in soil C content between land uses
- The largest differences in soil C were observed between regenerating scrub vs dryland pasture
- Dryland and irrigated pasture sites had the lowest soil C content
- Regenerating scrub and native forest had the highest soil C content

**Total C (%)**

Land Use	Total C (%)	Significance
Native forest (NF)	~5.0	ab
Regenerating bush (RB)	~5.3	a
Exotic forest (EF)	~4.5	ab
Dryland pasture (DP)	~3.5	b
Irrigated pasture (IP)	~4.1	ab

**Labile C (mg/kg)**

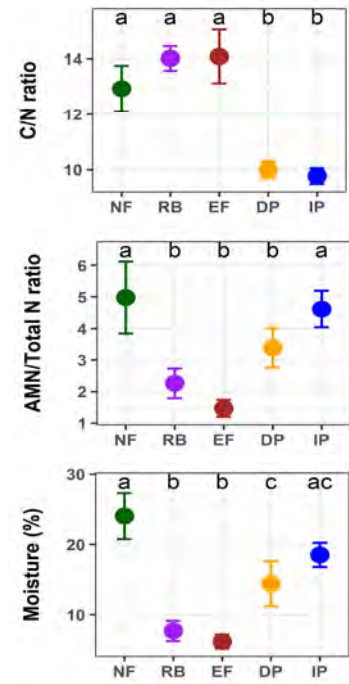
Land Use	Labile C (mg/kg)	Significance
Native forest (NF)	~2400	a
Regenerating bush (RB)	~2500	a
Exotic forest (EF)	~2150	a
Dryland pasture (DP)	~1900	a
Irrigated pasture (IP)	~2100	a

● Native forest  
 ● Regenerating bush  
 ● Exotic forest  
 ● Dryland pasture  
 ● Irrigated pasture

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## Effects of land use on soil quality

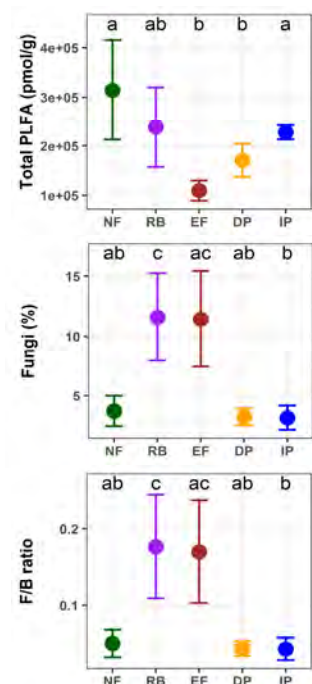
- Dryland and irrigated pasture soils had a low soil C/N ratio– an important marker of soil quality
- Low soil C/N ratio in pasture sites may be due to greater removal of above-ground plant biomass
- Native forest and irrigated pasture had a high proportion of plant bioavailable N
- Plant bioavailable N mirrored patterns in soil moisture, which was very low in regenerating bush and exotic forest



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## Effects of land use on soil microbial biomass

- Soil microbial biomass was highest in native forest and lowest in exotic forest
- Fungal biomass and the ratio of fungal: bacterial biomass was highest in regenerating bush and exotic forest
- High fungal biomass and fungi: bacteria ratio may be a response to low soil moisture conditions in exotic forest and regenerating scrub, as bacteria are more sensitive than fungi to low moisture conditions

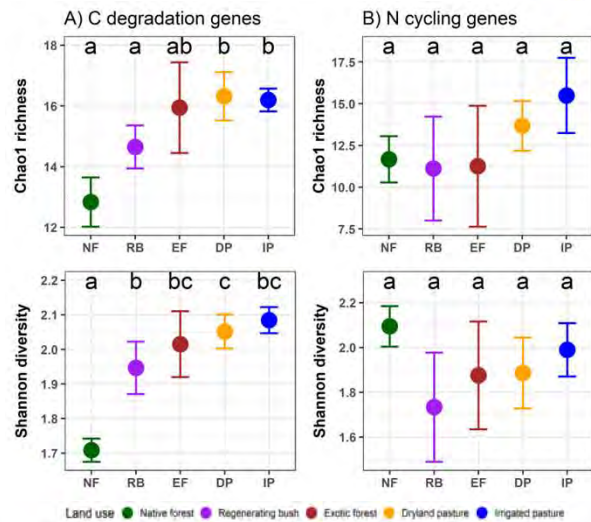


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## Native forest had a very low diversity of soil microbial C-degrading genes

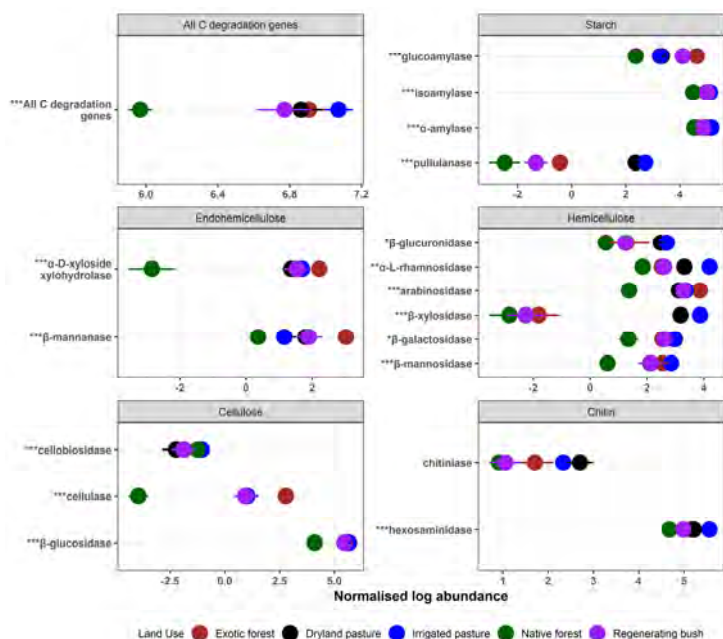


- The greatest diversity of microbial C-degrading genes was observed in the most intensively managed land uses - agricultural pasture and exotic forest
- No differences in diversity of microbial N cycling genes between land uses
- Land use had a more selective impact on soil C cycling than soil N cycling



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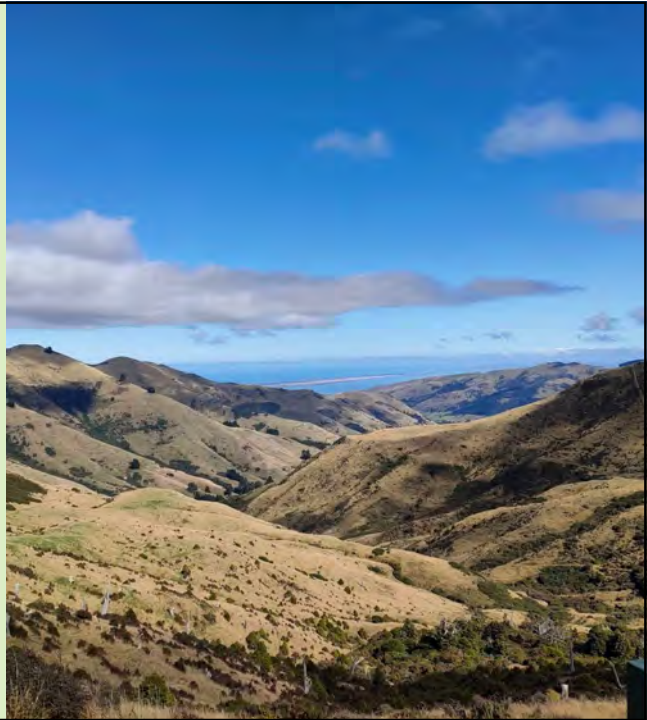
## Native forest soils had a very low abundance of soil microbial C-degrading genes



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## Summary

- No major differences in soil C content between land uses
- Agricultural land uses had significantly higher diversity and abundance of microbial C-degrading genes
- Native forests had the lowest diversity and abundance of microbial C-degrading genes
- Large-scale changes in land use intensity **may** increase the functional **potential** of the soil microbiome to degrade soil C
- This has important implications for how land management may influence the long-term soil C sequestration capacity across agricultural landscapes



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## Acknowledgements



Thank you to –

- Willesden Farms for permitting us to conduct research across the study area
- Project team: Dr Steve A. Wakelin, Prof. Leo Condrón, and Prof. Amanda Black
- New Zealand eScience Infrastructure (NeSI) and Genomics Aotearoa for bioinformatics support

This project was funded by the New Zealand Tertiary Education Commission CoRE grant to the Bioprotection Aotearoa

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# Thank You

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