Ecosourcing for resilience in a changing environment

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Ecosourcing for resilience in a changing environment

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ABSTRACT
Ecosourcing seed of 'local genetic stock' for ecological restoration has been practiced in New Zealand for about 50 years. However,

ARTICLE HISTORY
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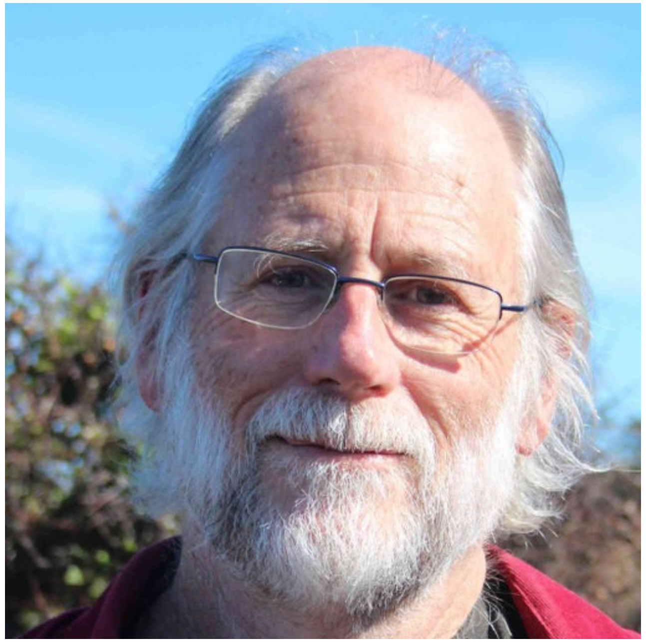

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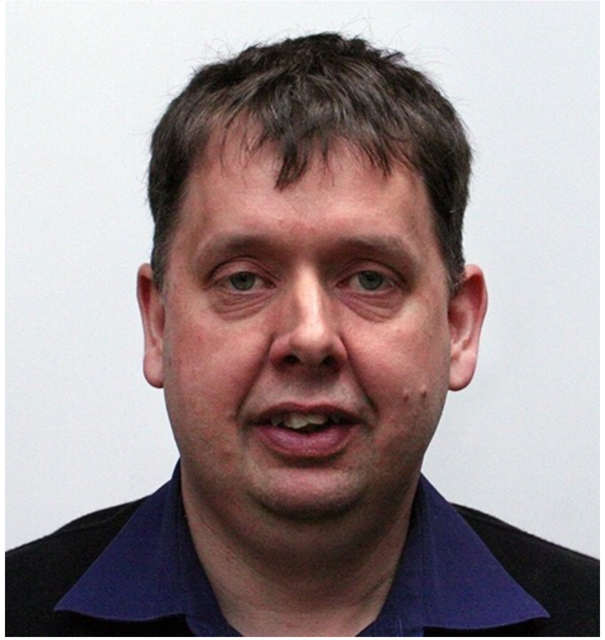

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Matt Larcombe

Peter Heenan

Outline

- Background
- Issues
- What does the science say?
- Eco-evolutionary approach
    - ➢ Nine regions

"... in their natural state"

Does Planting Achieve its Purpose?

PLANTING "natives" in the wild is a popular activity in New Zealand; but it is also an activity that can seriously reduce the scientific value of our reserves, or of any area of indigenous vegetation for that matter. Why is this? The answer is simple: People are putting plants where they do not belong.

THERE are three main ways in which enthusiasts interfere with the pattern of distribution and evolution of our native plants.

- They plant species outside their natural geographical range.
- They plant species within their natural geographical range, but in unnatural habitats.
- They plant species within their natural

By E. J. Godley,
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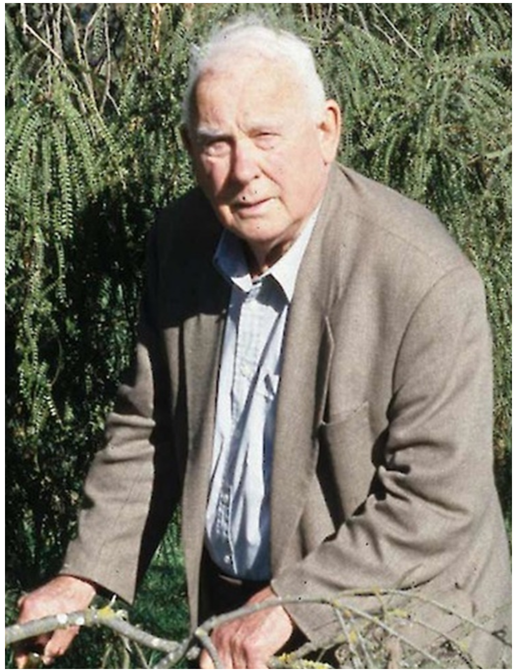


- In future I hope that the authorities concerned will be very strict about planting in reserves and national parks and that readers of this article will make it their business to discourage "illegitimate" plantings in other areas of native vegetation.

'... source of plants [no] more than 3 miles away'

Forest & Bird, 1972

Regional Council Policy Statements on ecosourcing

'The closer the seed source to the restoration project, the better (in most cases)' (ECan undated; DOC)

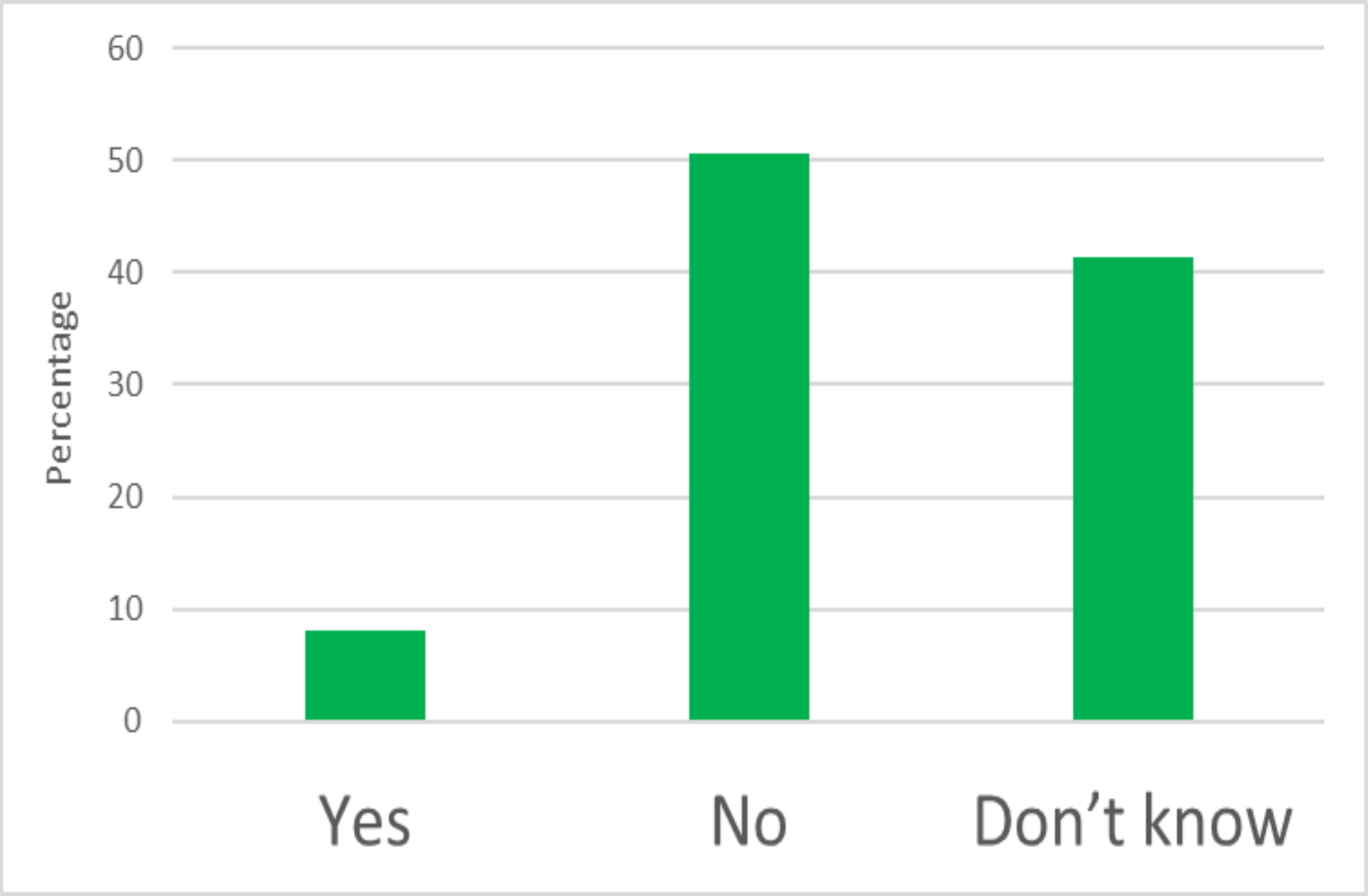
'Select plants grown from seeds collected as close as possible to where you plan to plant' (Auckland Council)

Use locally ecosourced plants to 'prevent genetic contamination of Taranaki stock' (Taranaki Regional Council)

Taranaki
Regional Council

At Tāne’s Tree Trust national conference 2009 it was asked:

Are current ecosourcing policies and practice scientifically valid?



How have we approached the topic?

1. What are some of the issues relating to ecosourcing?
   - Five issues

2. What does the science say?
   - Five lines of evidence

Issues

1. *Irrelevant conservation objectives for dynamic environments*

Local extinctions are problematic as missing functional groups, species, successional stages etc are often not considered

Creating copies of 'local' ecosystems of yesterday and today is considered a desirable outcome with local ecosourcing

No consideration of future states …

2. *Environmental shifts & climate adjusted provenancing*

Climate change and anthropogenic habitats often not considered with local ecosourcing

Warmer winters, fewer frosts, and wetter western and drier eastern areas associated with steepened orographic precipitation gradients

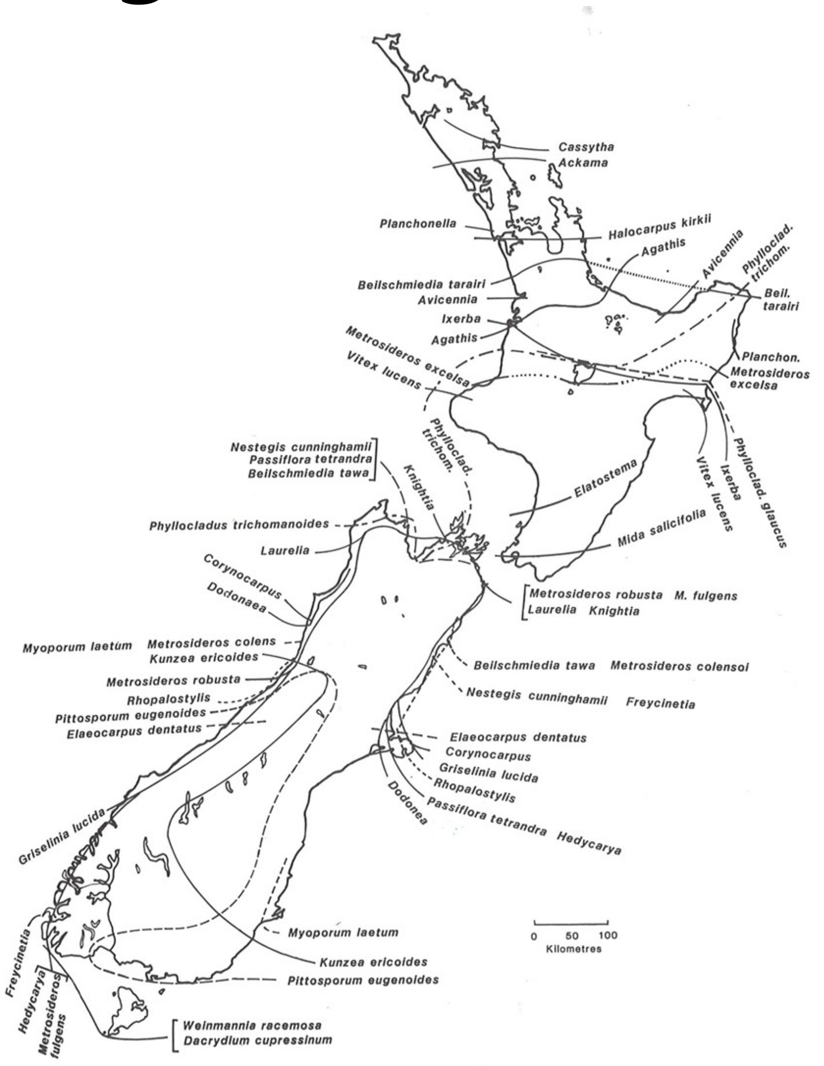
Issues

3. *Expanding distributional ranges*

Estimated < 25% of species occupy their potential range – expansion not all negative

Disturbed / anthropogenic habitats can facilitate establishment of native species outside of their typical habitat

What about 'naturalising natives' outside their current range?



Trees southern limits (Wardle 1991)

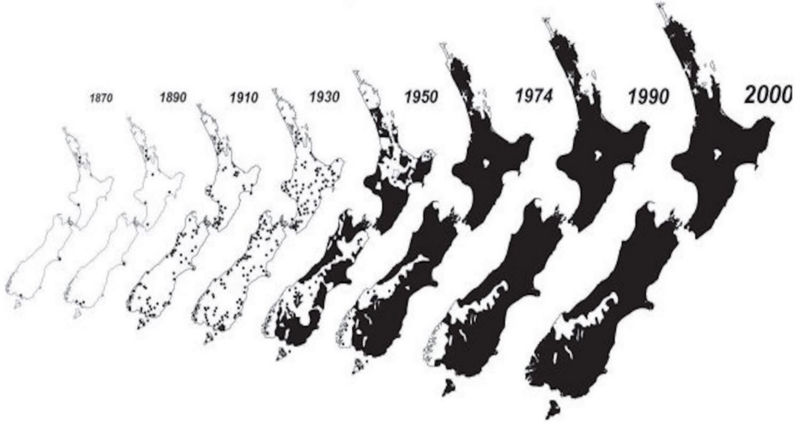
Issues

4. *Novel ecosystems*

Novel guilds of grazing, browsing and carnivorous mammals, nitrogen fixing shrubs

Fire 'may have shifted large areas into successional 'traps' from which … escape from fire-prone … successional communities to more resistant tall forest is difficult' (Perry et al. 2014)

Possum distribution 1870-2000



Issues

5. *Threatened species management*

Move rare plants to places where the risks are reduced. Perhaps to sites outside of the natural range

Populations mixed to increase mating options, plant numbers & genetic diversity

Threatened animals often relocated well outside their historic ranges; why not plants?

Olearia hectorii

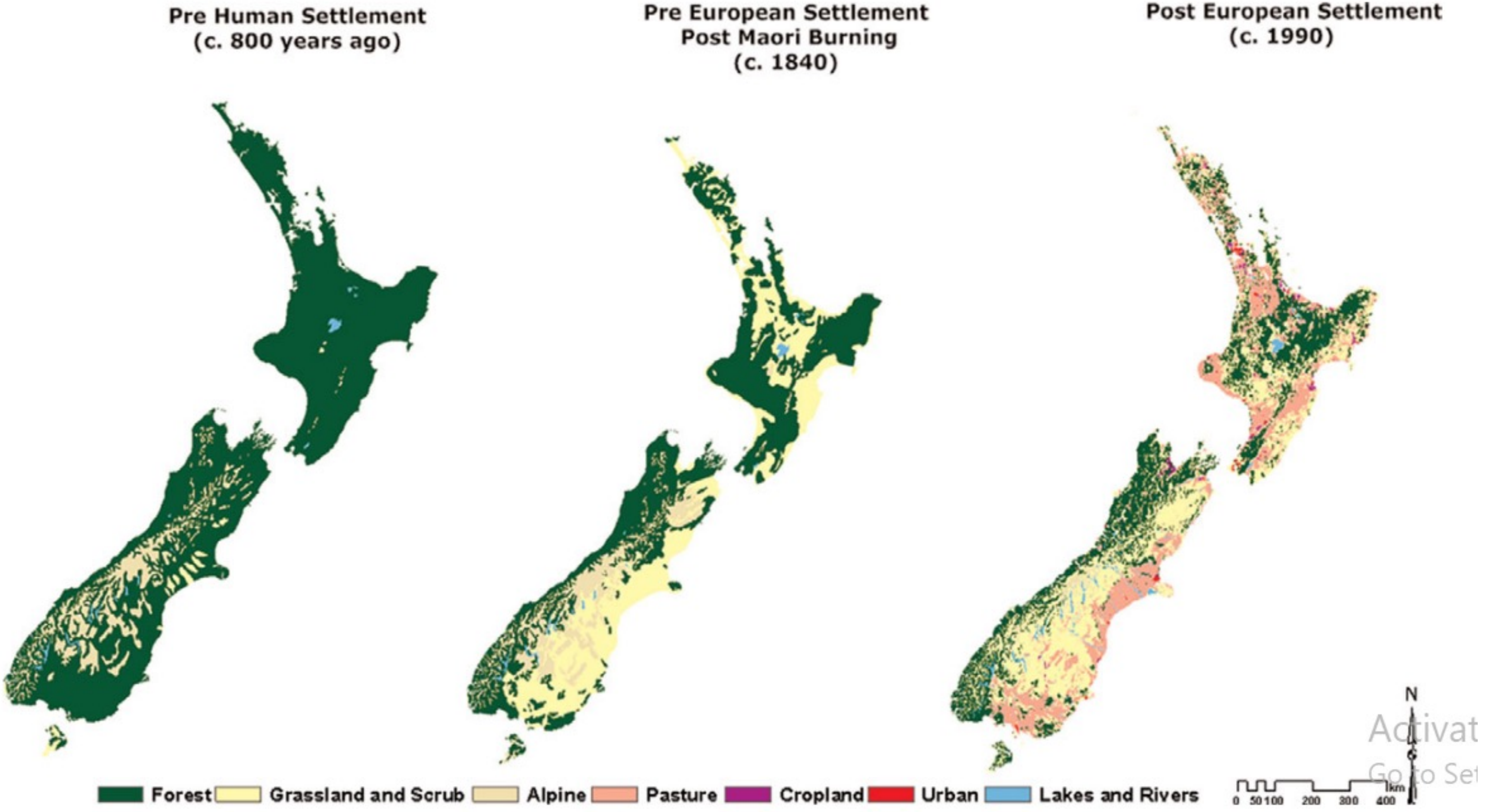
What does the science say?

Science

1. *Forest clearance and remnants*

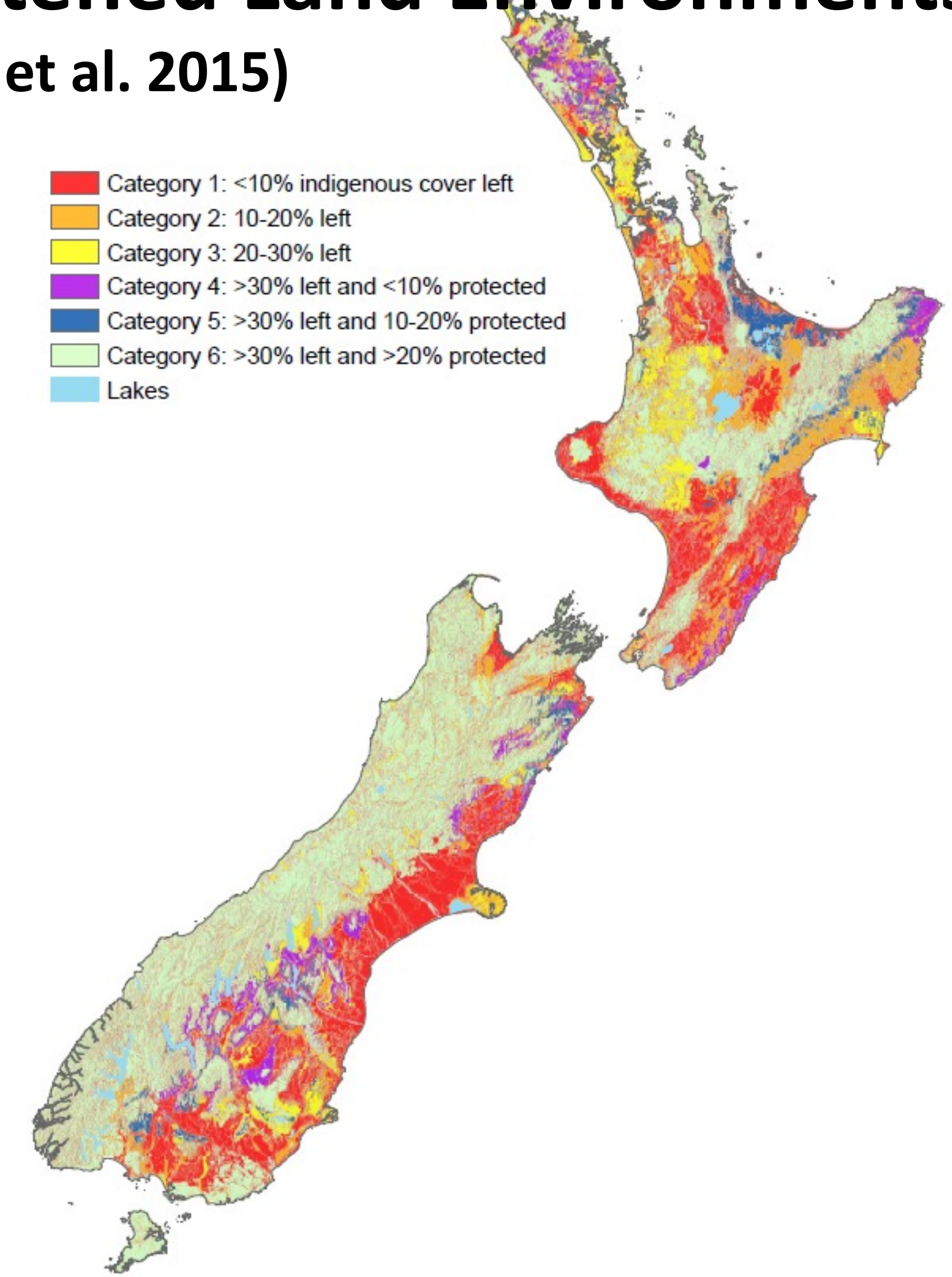
- Extensive deforestation has reduced indigenous forests to approximately 30% of pre-human forests
- Threatened Land Environments
- Depleted dryland zone
- Lost connectivity
- Many small, isolated, disturbed, unrepresentative, unplanned remnants – especially coastal/lowland

New Zealand Forests (Weeks et al. 2012)



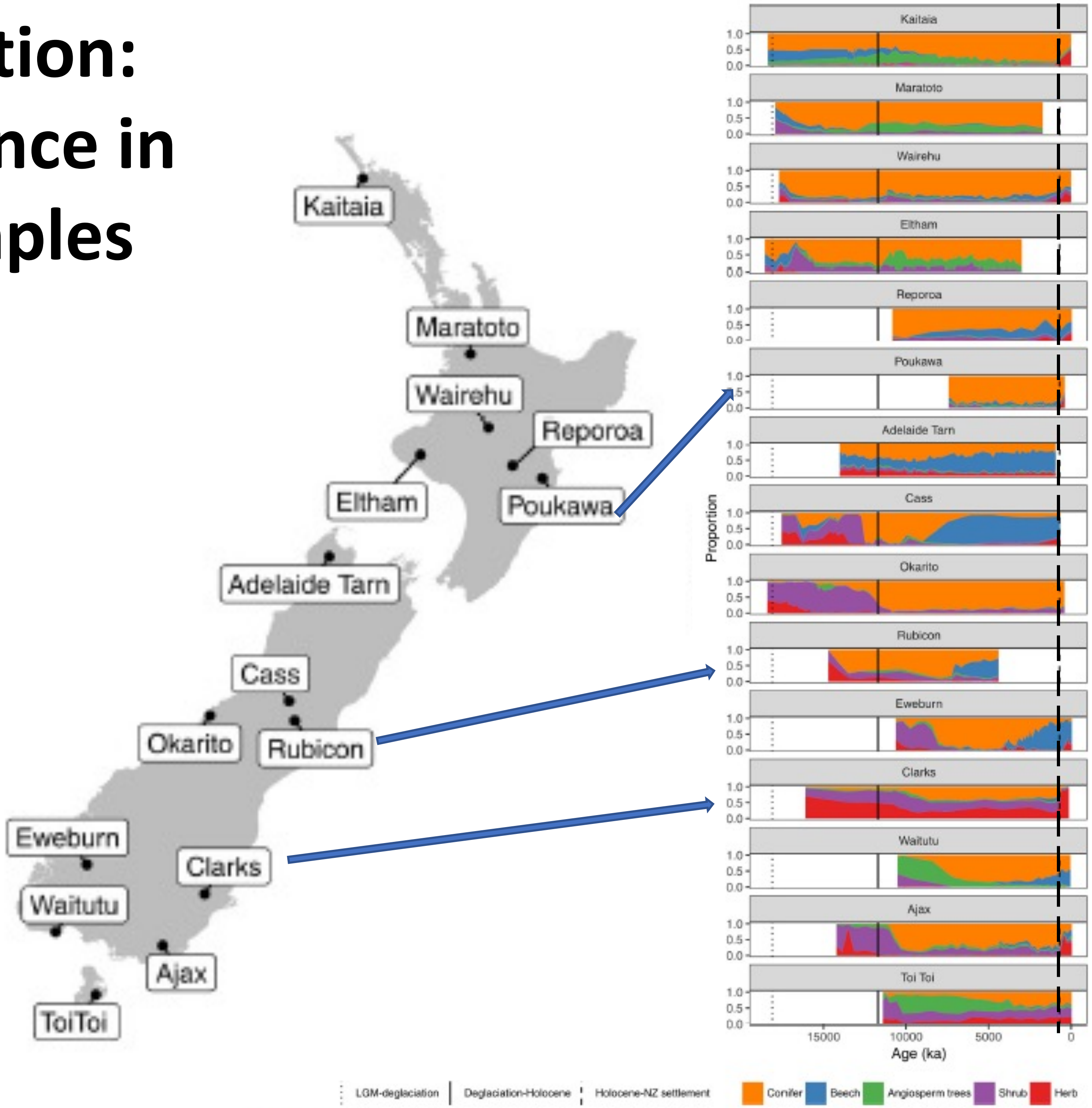
Threatened Land Environments

(Cieraad et al. 2015)



Forest composition: conifer abundance in palynology samples

(McGlone et al. 2017)



2. *Genetic variation and phylogeography*

Ecosourcing at the ‘local’ geographic scales that have been applied assumes extensive fine-scaled genetic variation

Trees & shrubs with widespread distributions do not (in general) support this notion as they have very broad regional to national patterns of genetic variation

Genetic variation is often uniform, clinal north to south, or with as few as 2-5 regional variants

Science

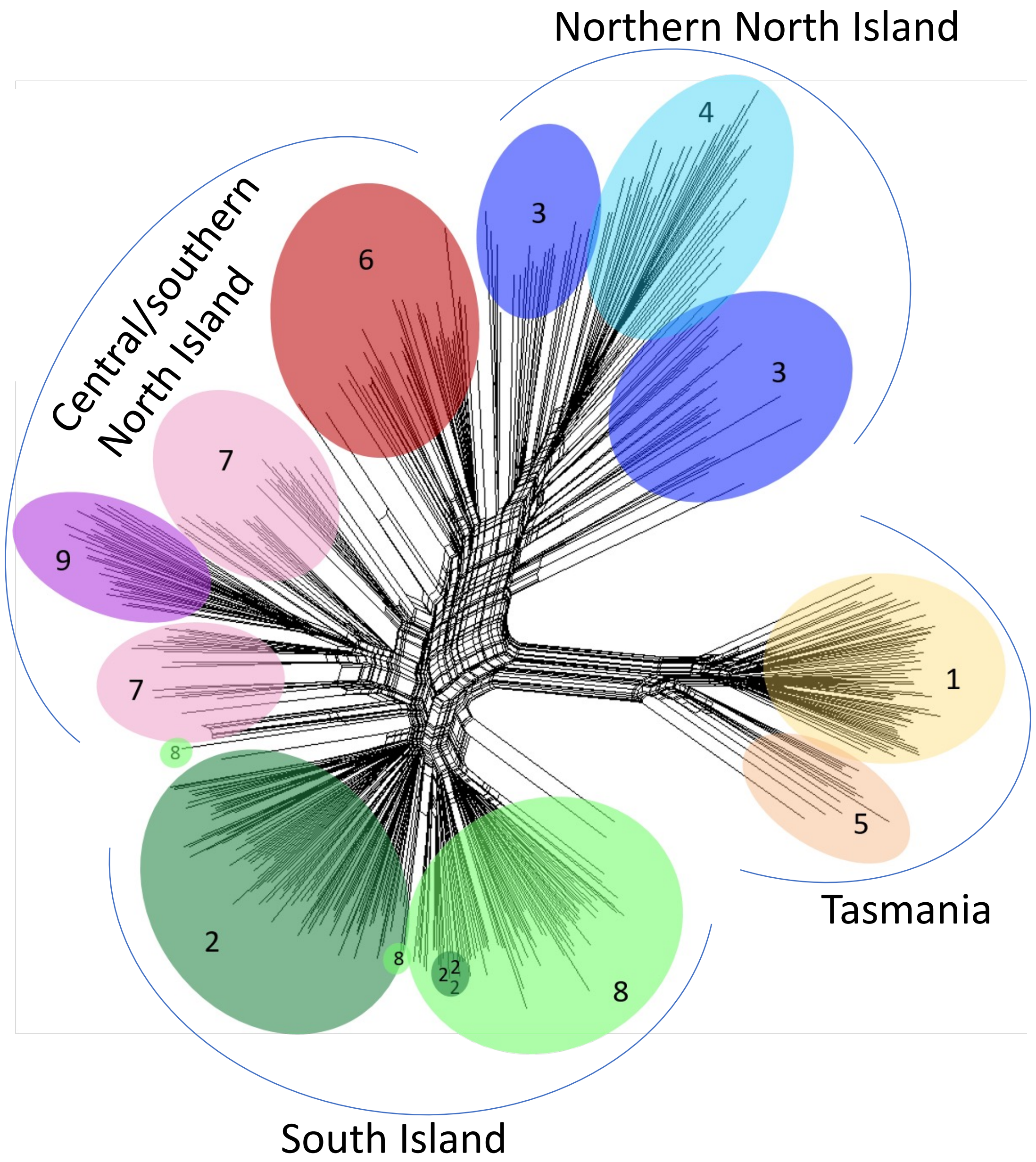
2. *Genetic variation and phylogeography* (cont.)

Landscape-scale phylogeographic patterns (of individual species) are often consistent with major biogeographic regions and their boundaries (representing multiple species)

Cook Strait is an important phylogeographic boundary

A few species with widespread distribution and disjunct local populations that are genetically discrete

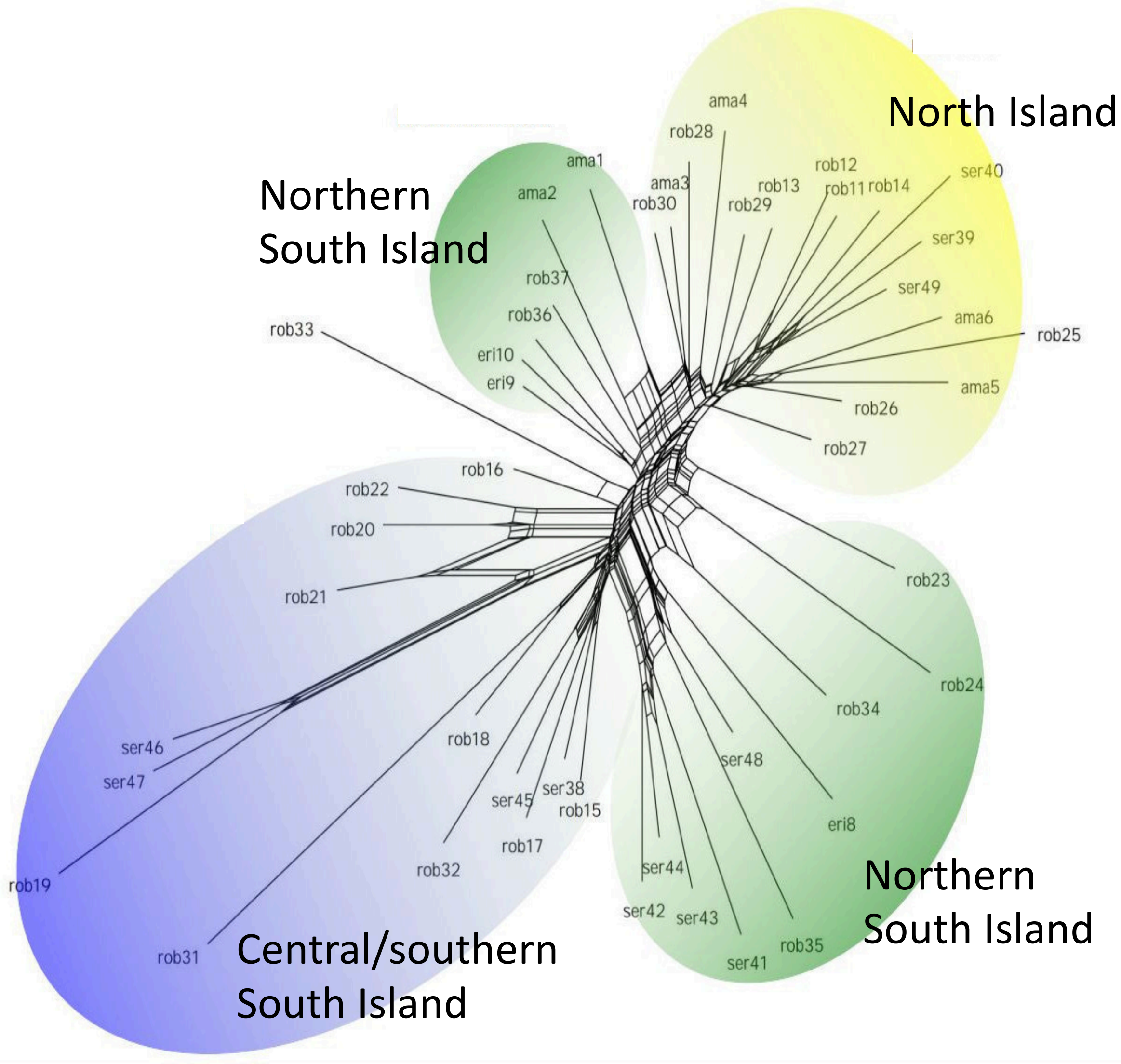
Leptospermum: Chagne et al. 2023



North

South

Kunzea: Heenan et al. 2023

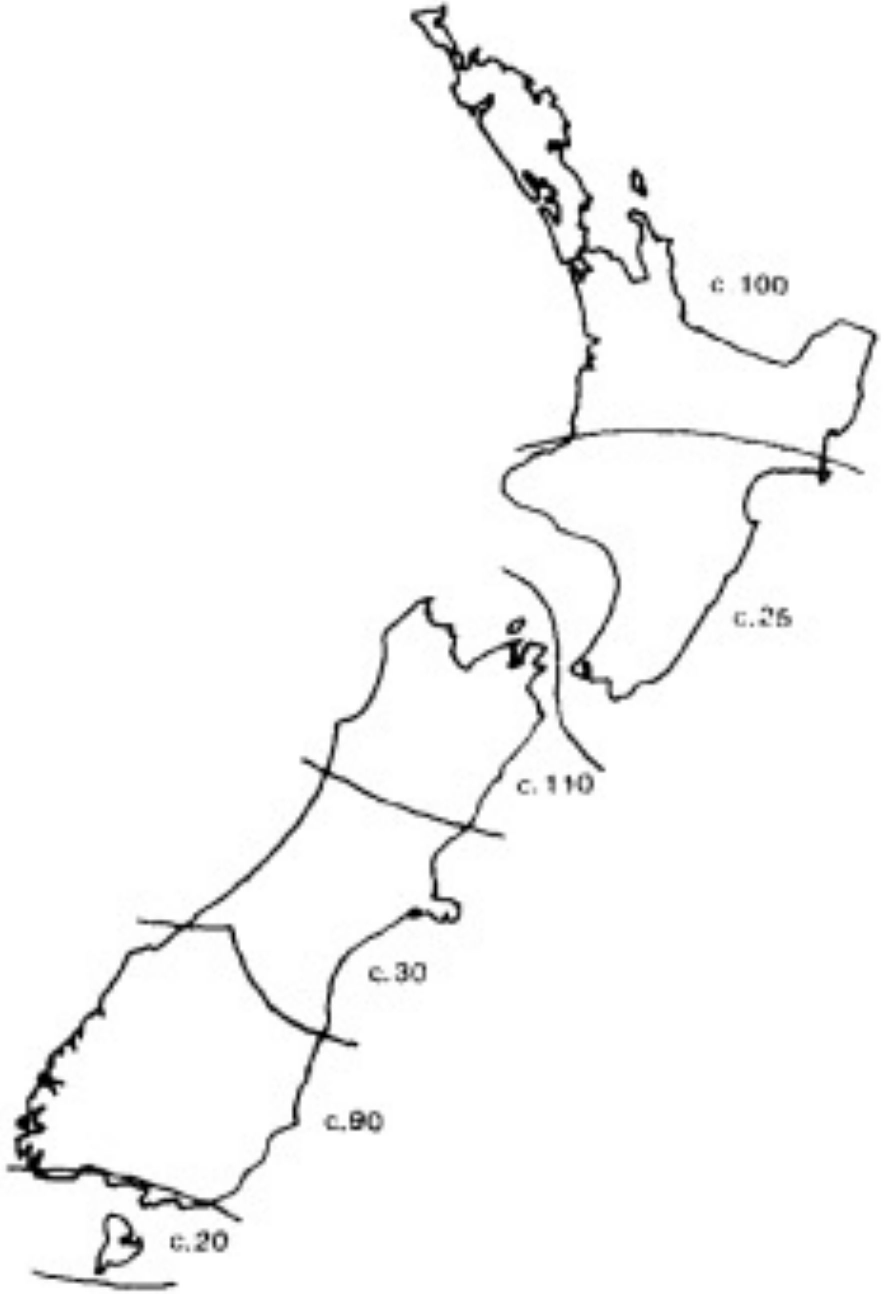


3. *Biogeographic regions*

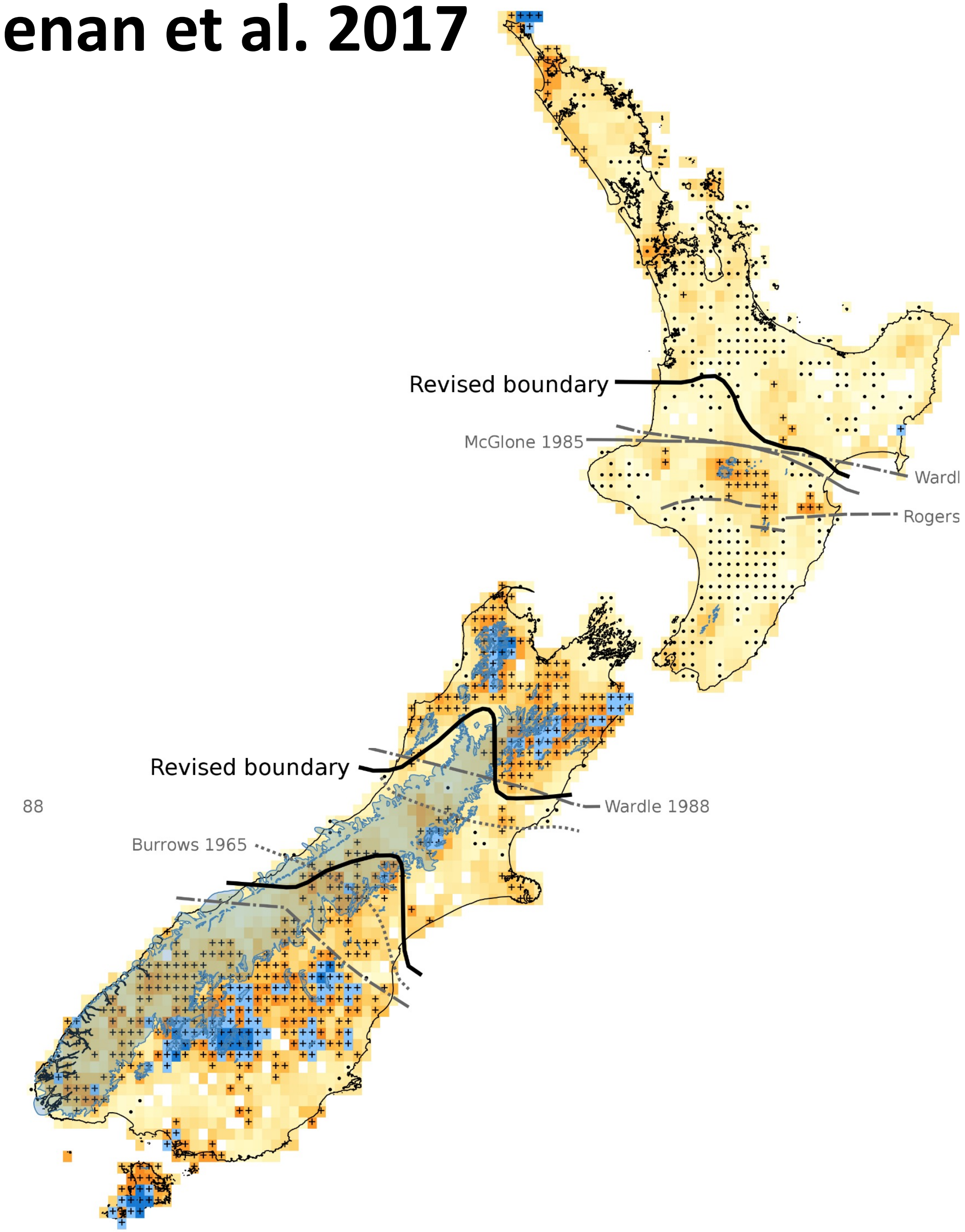
Major biogeographic boundaries and smaller regions of endemism have been defined for vascular plants by common distributional patterns shared by multiple taxa

For ecosourcing, large biogeographic regions can be recognised that share a common biodiversity, ecological, environmental, and evolutionary history

Wardle 1963



Heenan et al. 2017



4. *Inbreeding depression*

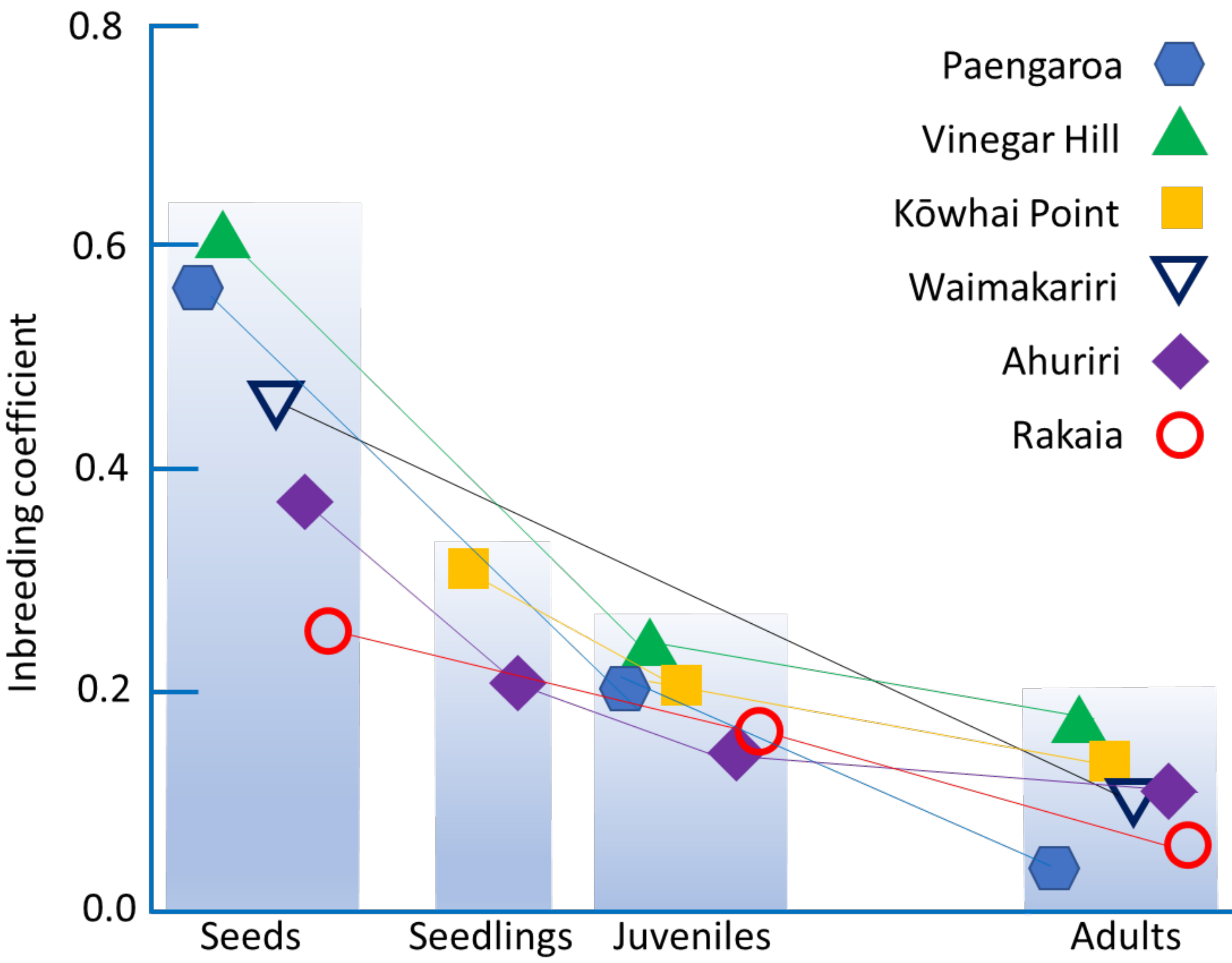
Occurs when selfed seed is ecosourced from small populations with limited mate choice and loss of pollinators causing pollen limitation

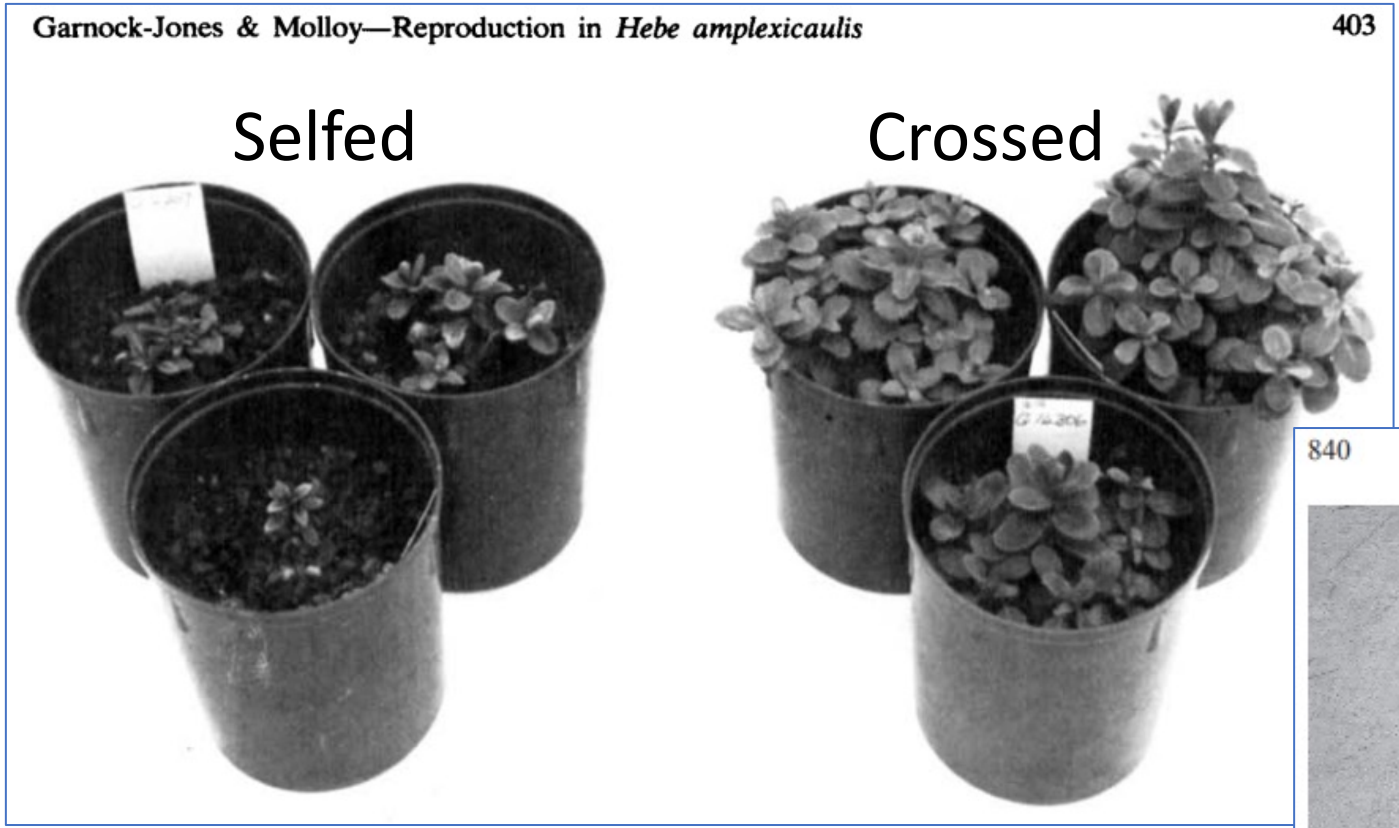
Has negative effects on plant performance and may result in unhealthy, doomed plants and cryptic recruitment failure

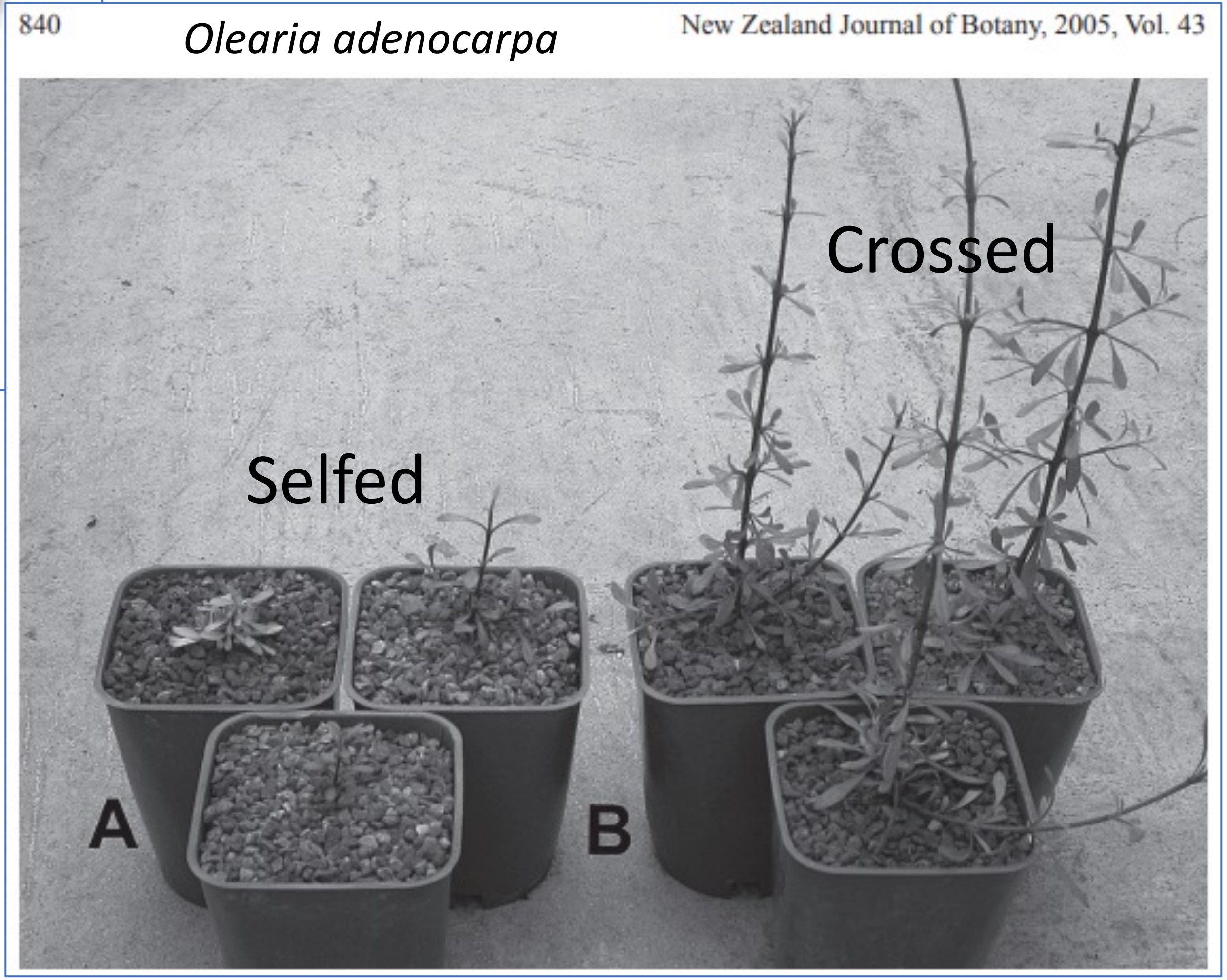
Seed should be ecosourced from large and healthy populations even if distant from the restoration site

Kōwhai inbreeding

van Etten et al. 2015




Garnock-Jones & Molloy—Reproduction in *Hebe amplexicaulis*
403
Selfed
Crossed


840
Olearia adenocarpa
New Zealand Journal of Botany, 2005, Vol. 43
Crossed
Selfed
A
B

5. *Environmental shifts and climate-adjusted ecosourcing*

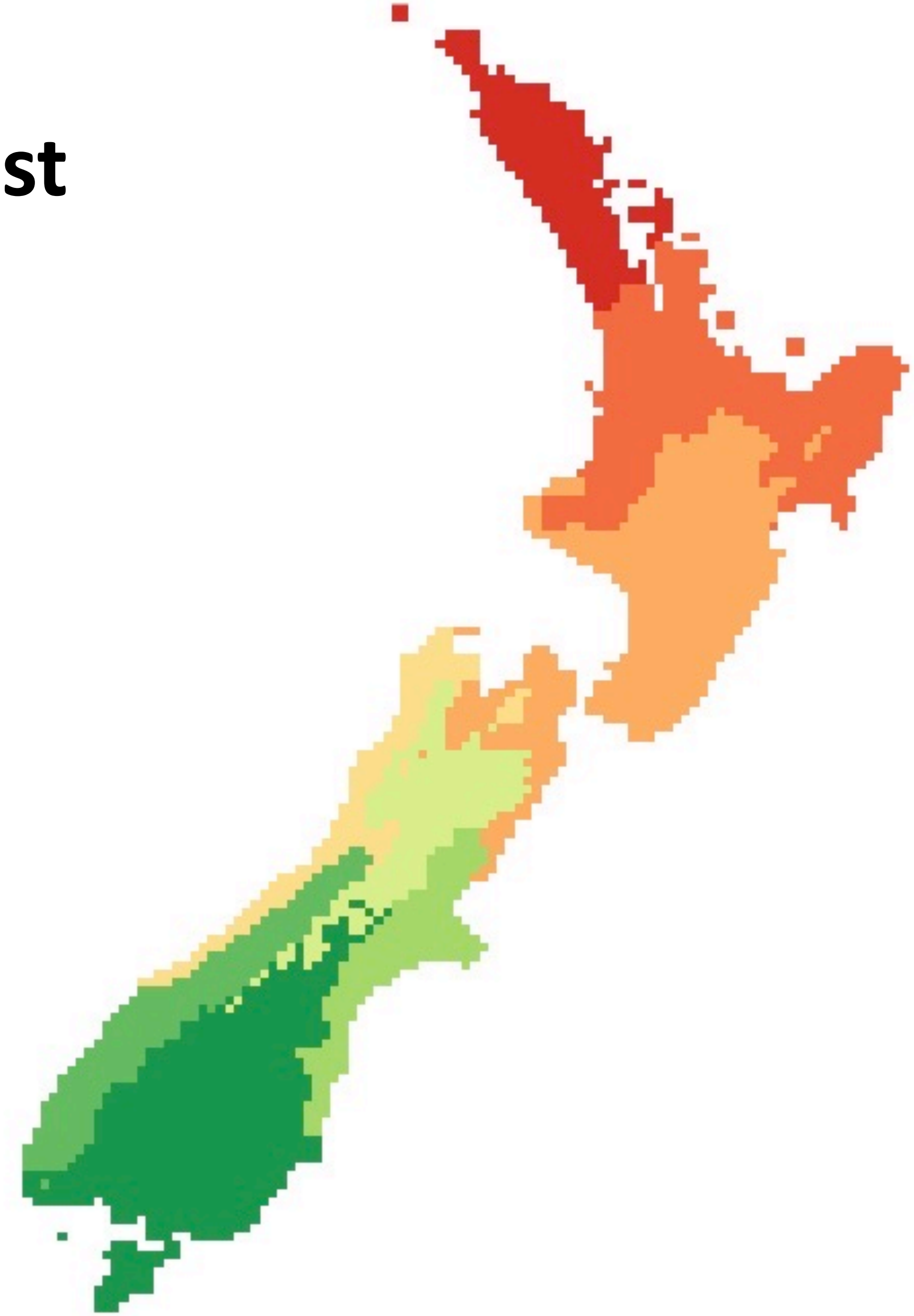
Ecosourcing of species & genotypes adapted to future environmental states (e.g., wetter, drier, warmer)

(future research)

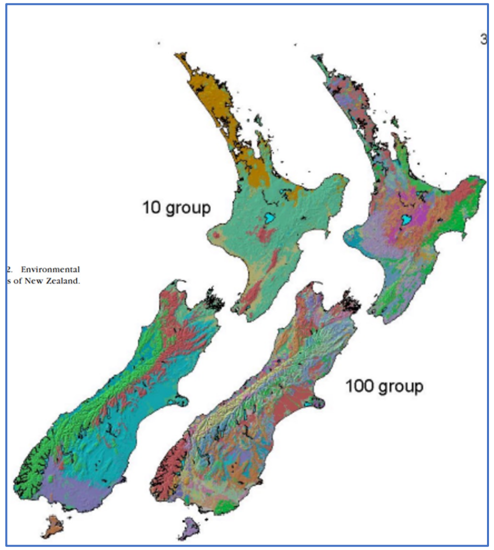
NZ-wide environmental assessments to distinguish major ecoregions

Our modelling = 8 regions model

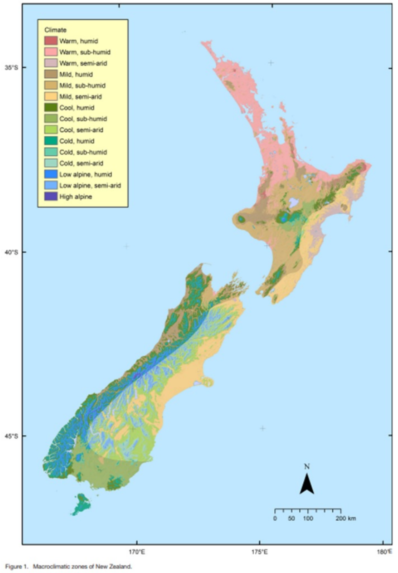
- **mean temperature of the coldest quarter**
- **annual precipitation**



10 and 100 group domains (Overton & Leathwick 2001)



15 climatic zones (Singers & Rogers 2014)



5. *Environmental shifts and climate-adjusted ecosourcing*

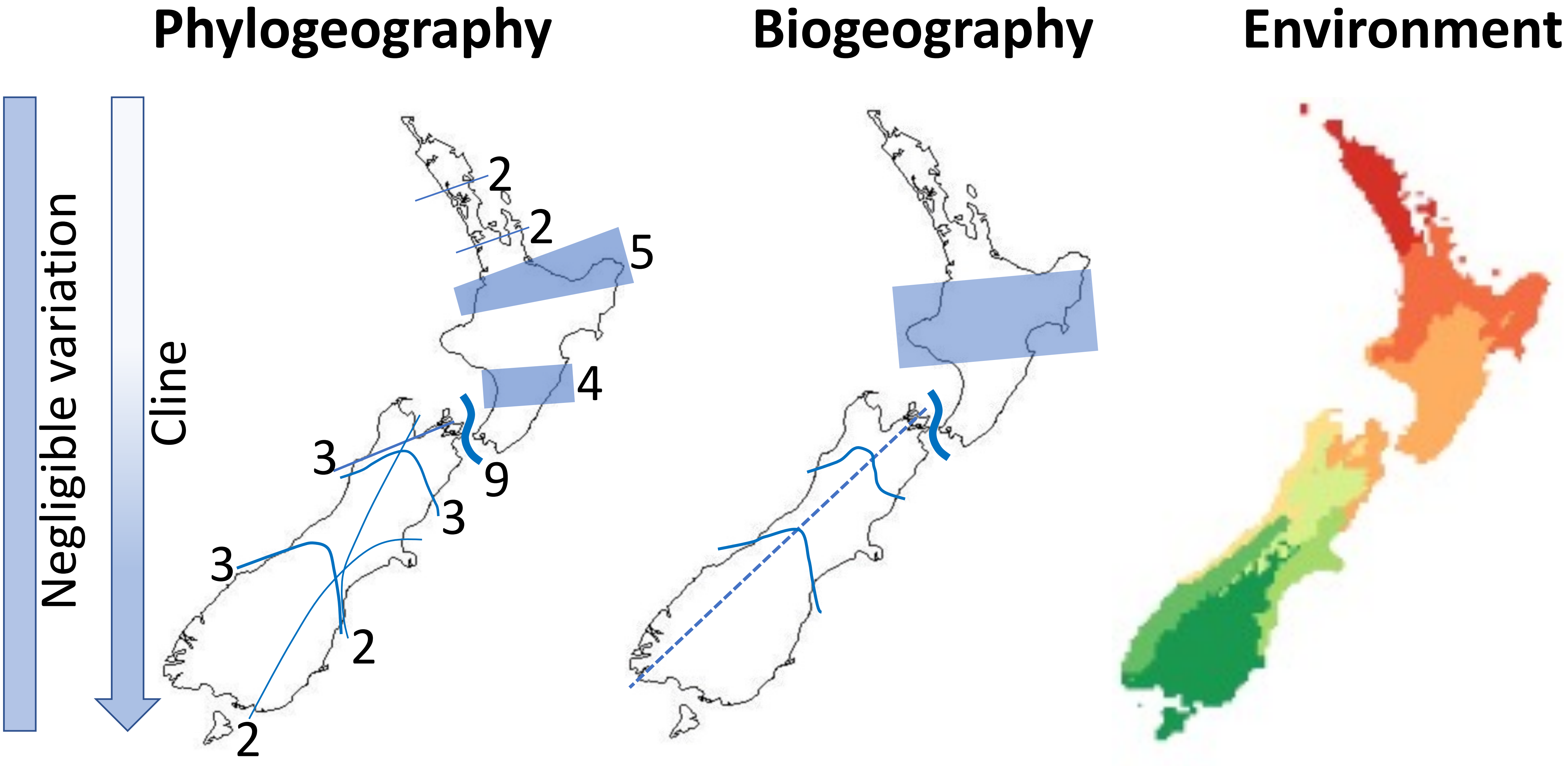
BUT …. ecotype / niche / habitat matching

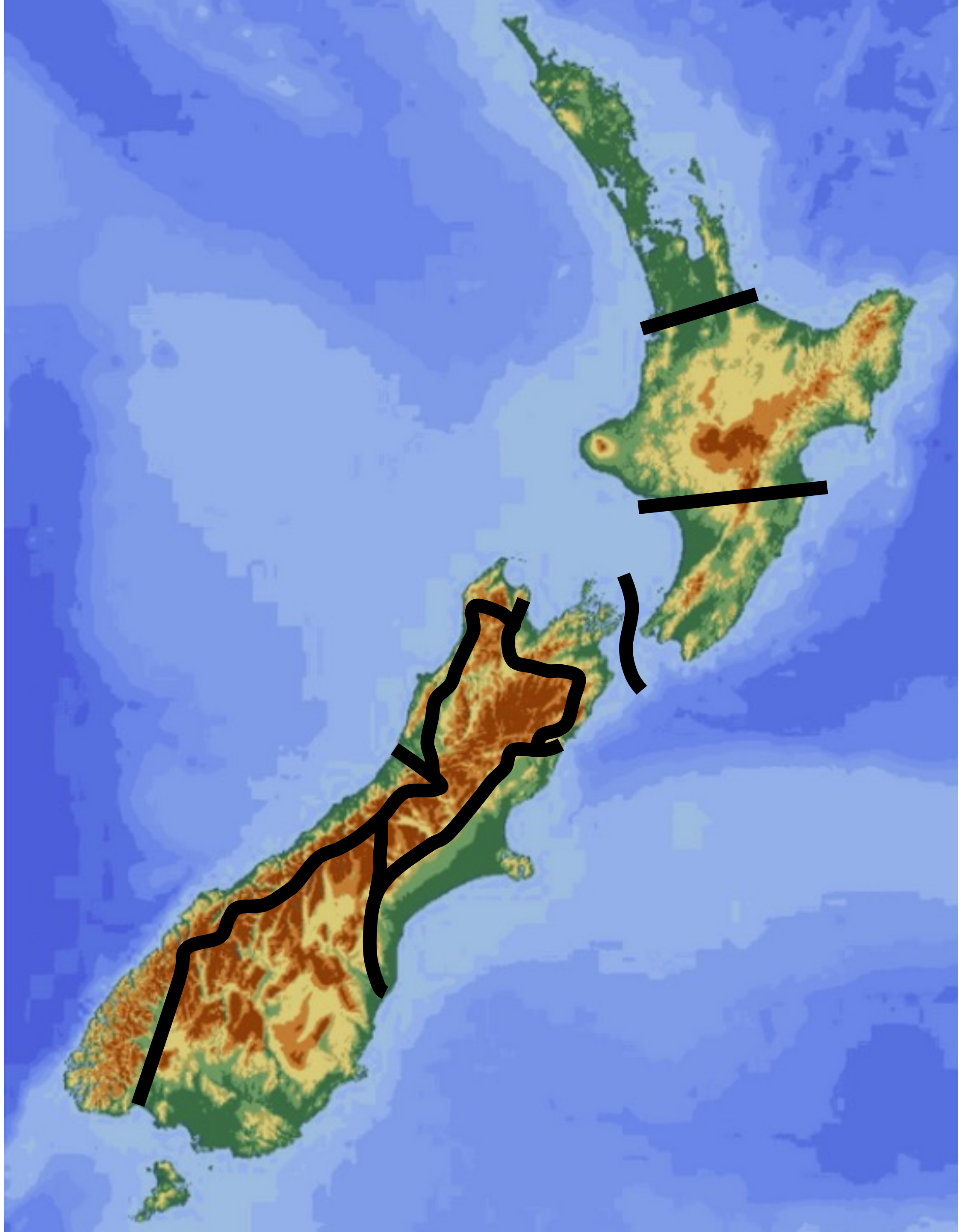
Seed ecosourcing sites are similar to the restoration site

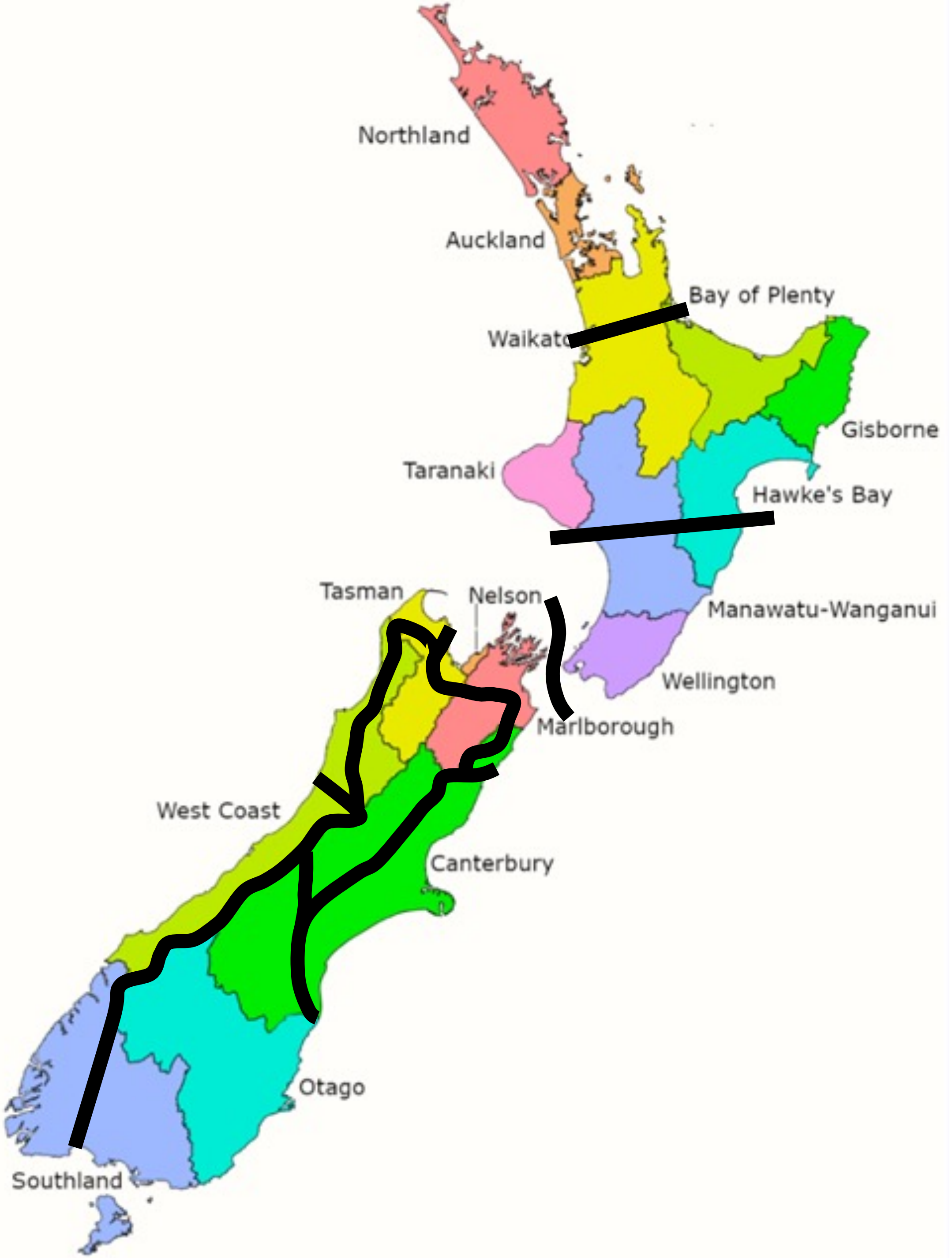
Eco-evolutionary ecosourcing considerations

Why eco-evolutionary ecosourcing?

- **Major loss of forests: larger area for seed sources**
- **Inbreeding depression: large populations provide healthy progeny**
- **Phylogeography: few widespread genotypes**
- **Biogeography: established boundaries**
- **Environmental matching: 1) biomes and 2) ecotypes**


Phylogeography
Biogeography
Environment
Negligible variation
Cline
2
2
5
4
9
3
3
3
2
2




Northland
Auckland
Bay of Plenty
Waikato
Gisborne
Taranaki
Hawke's Bay
Tasman
Nelson
Manawatu-Wanganui
Wellington
Marlborough
West Coast
Canterbury
Otago
Southland

Need to enlarge areas for ecosourcing

- **Novel ecosystems require ‘strongest’ indigenous elements e.g., fire resistant species**
- **Threatened species into secure sites**
- **Overcome local extinctions: e.g., conifers**
- **Assisted expansion of distributional ranges**

Need to enlarge areas for ecosourcing

- Concept of larger areas that is important
- Do not be wedded to boundaries of major areas
  - Don’t stress near boundaries
- Prioritise ecotypes / habitats
- Be practical, will be better, but not ‘perfect’

Future Research

- Phylogeographic and genetic variation of key restoration species
    - Kōhūhū, *Pittosporum tenuifolium*
    - Karamū, *Coprosma robusta*

- Ecotypic and phenotypic variation for climate change

- Impacts (negative and positive) of ‘weedy’ natives