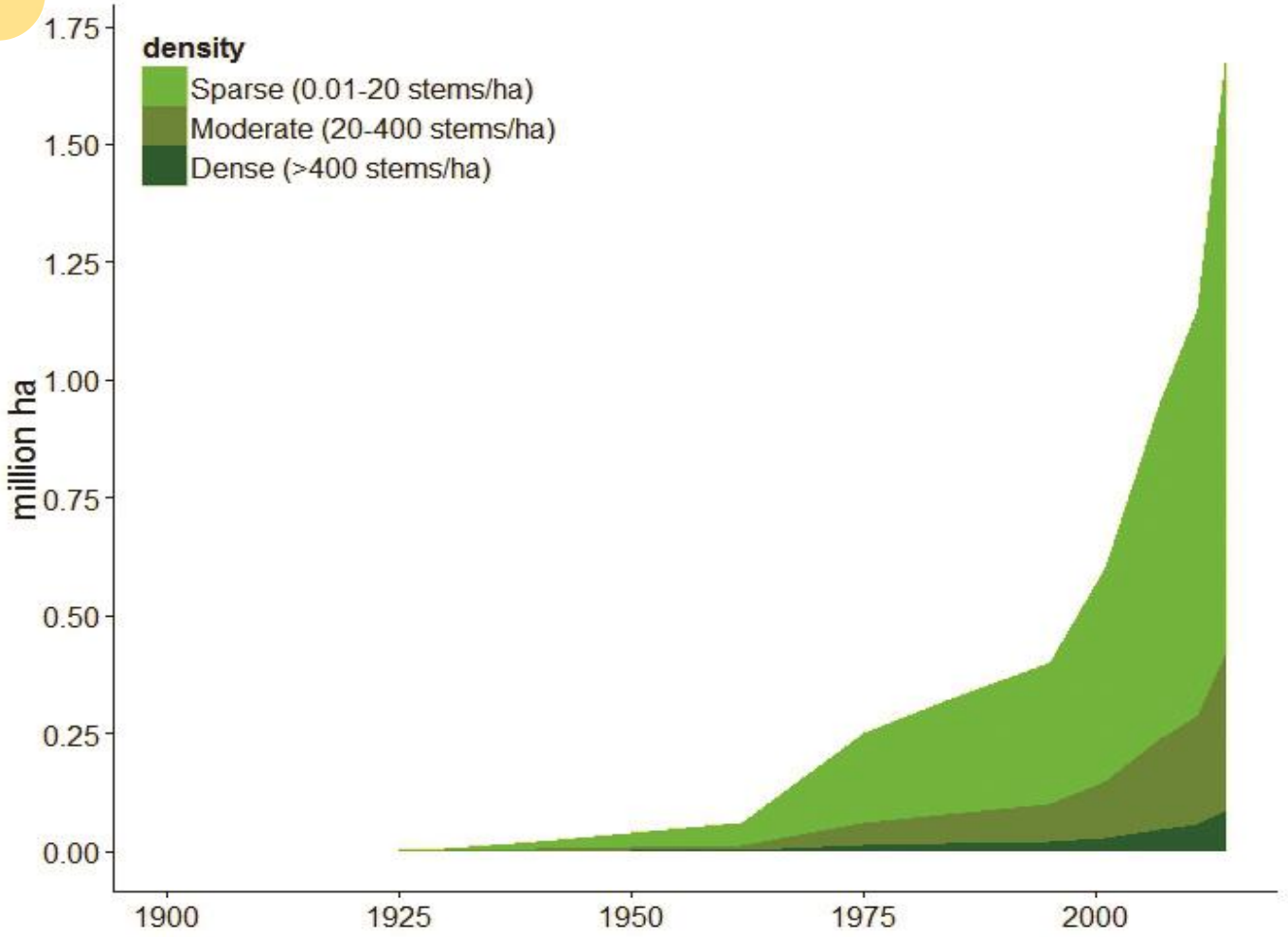
Manaaki Whenua
Landcare Research

Wilding Conifers
Progress on a National Issue

Sherman Smith, MPI
Thomas Paul, Scion
Duane Peltzer, Manaaki Whenua- Landcare Research

Growing problem

PREVENT THE SPREAD
National Wilding Conifer Control Programme



National Strategy

PREVENT THE SPREAD
National Wilding Conifer Control Programme

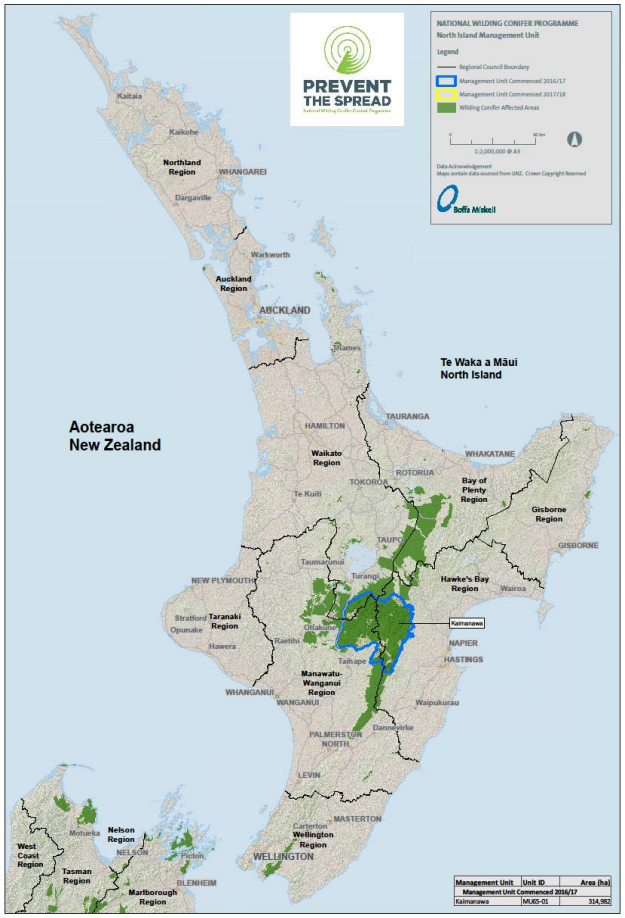
- Provides context for each aspect
- Complex issue, requires coordination

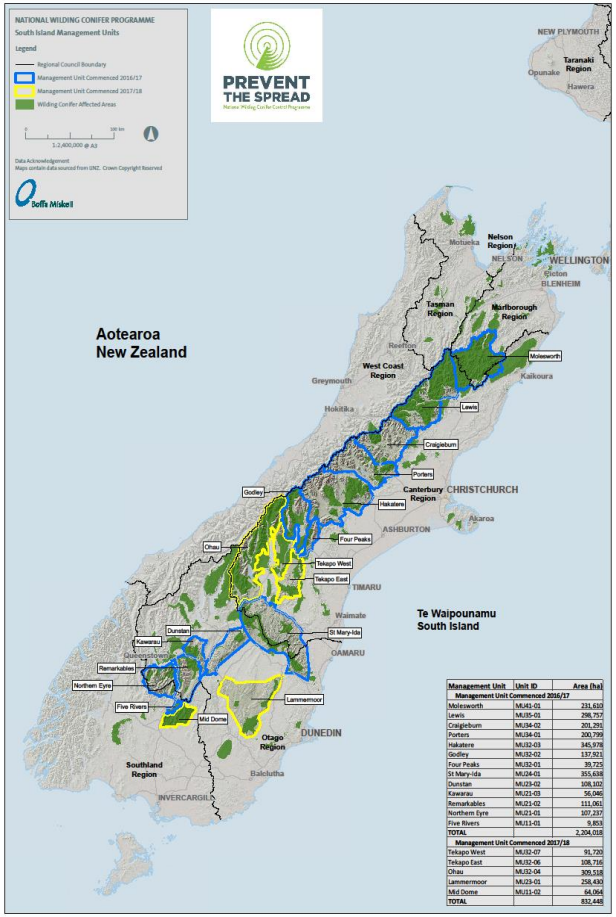
Control programme - Phase 1

- Budget 2016 - $16m over 4 yrs
- Highest priority areas
- Coordinated approach (shared funding)
- All land tenure
- Contiguous areas
- National mapping

PREVENT THE SPREAD
National Wilding Conifer Control Programme

Programme Structure



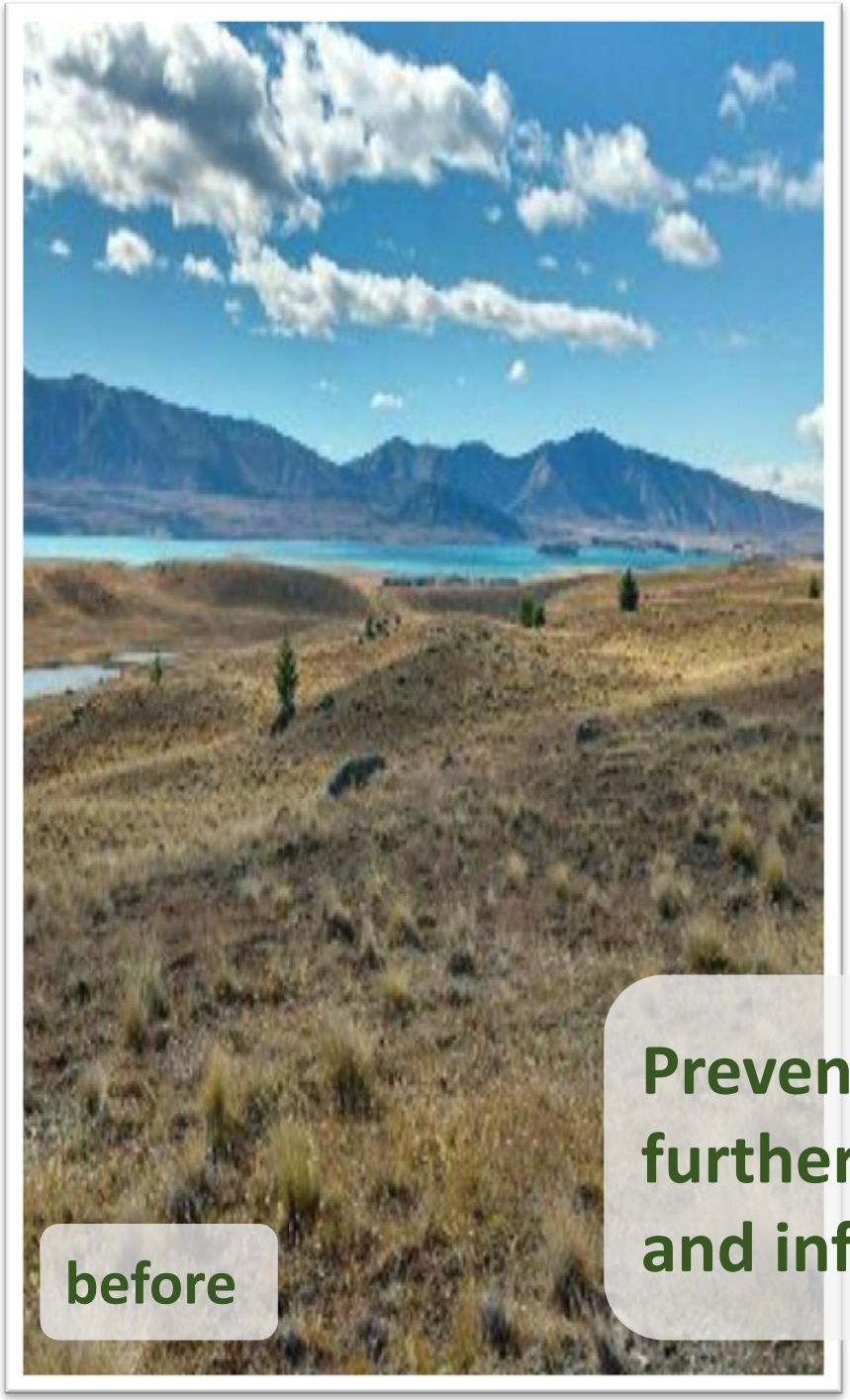


Year 1 (2016-17)

- Around 1.2 million ha
- 14 MUs

Year 2 (2017-18)

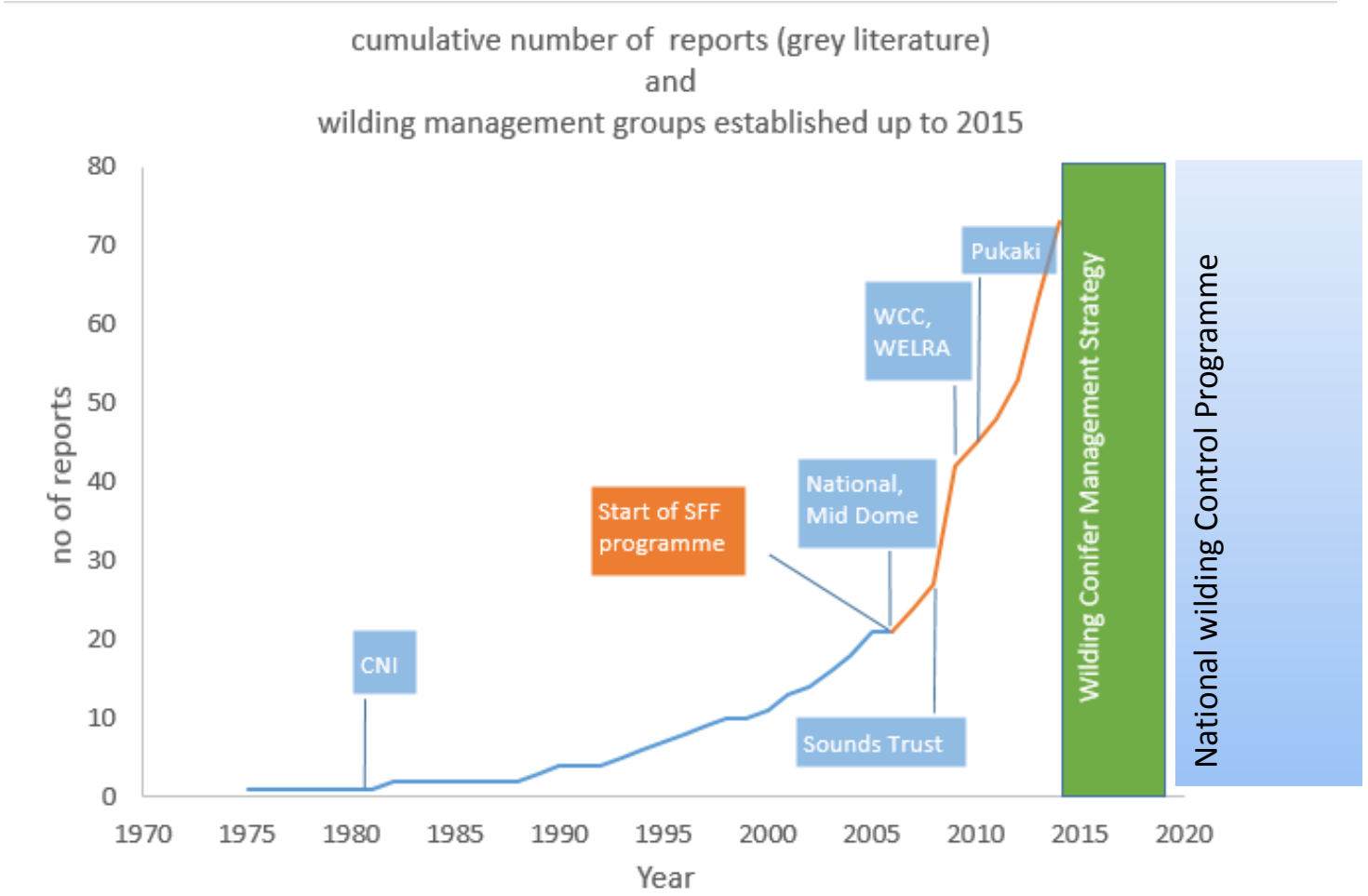
- Anticipated at least 400 thousand ha
- 5 additional MUs



Preventing
further spread
and infilling


Still a long way to
go and we need
everyone to play
their part.

Increasing awareness of the problem results in regional efforts

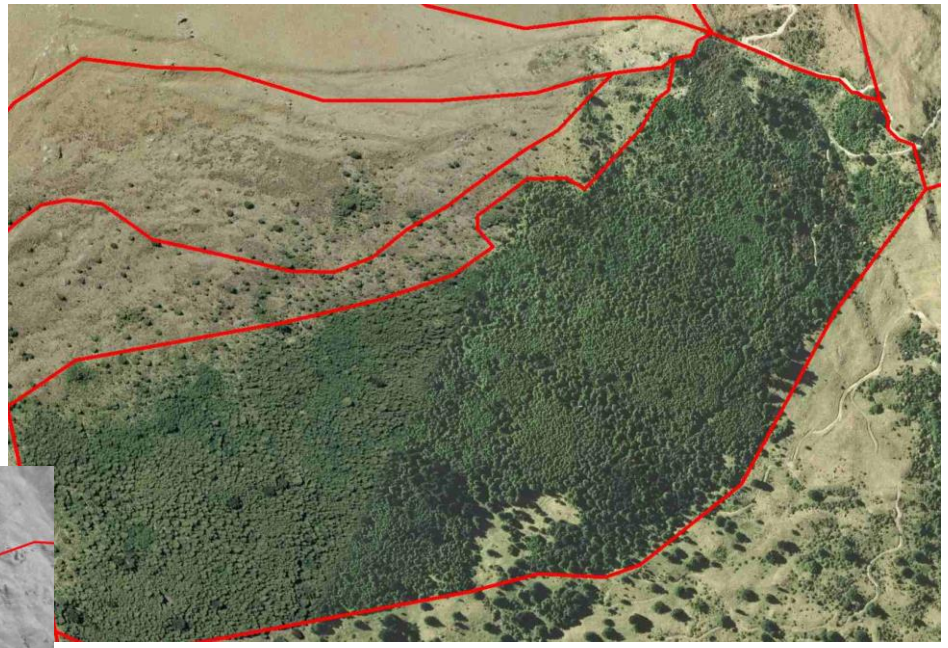


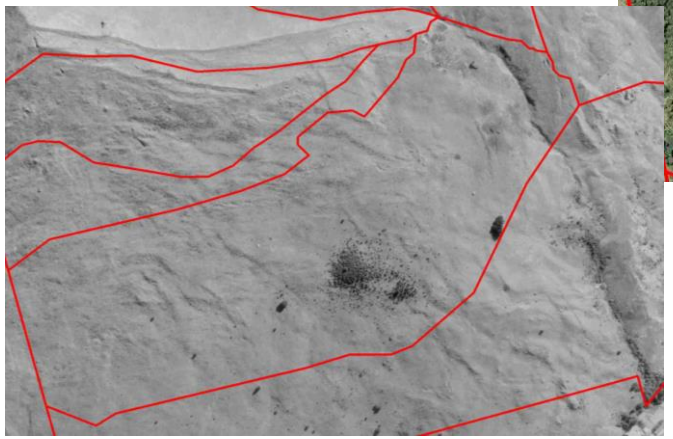
What is required for good national management and control and how can research assist

SCION
FORESTS ▪ PRODUCTS ▪ INNOVATION

Good Collaboration

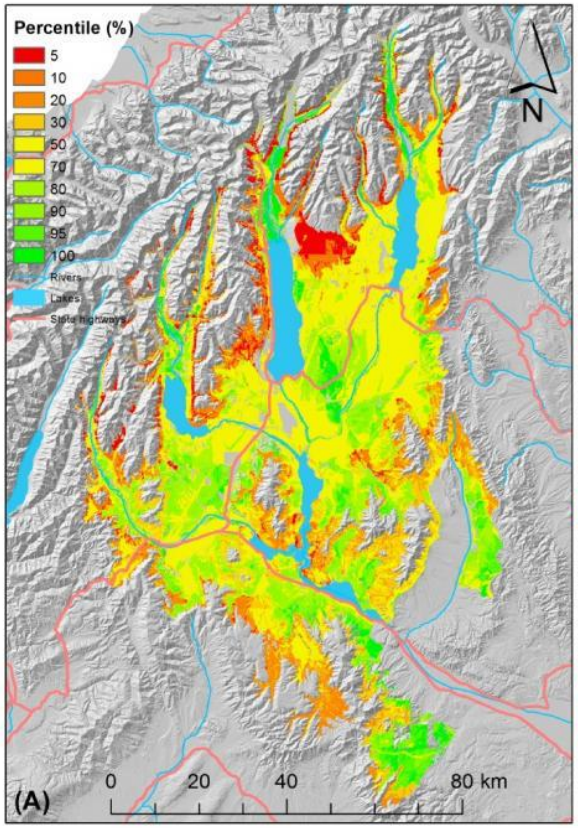
- Developing an understanding of spread
- Assist in identifying the important drivers of spread

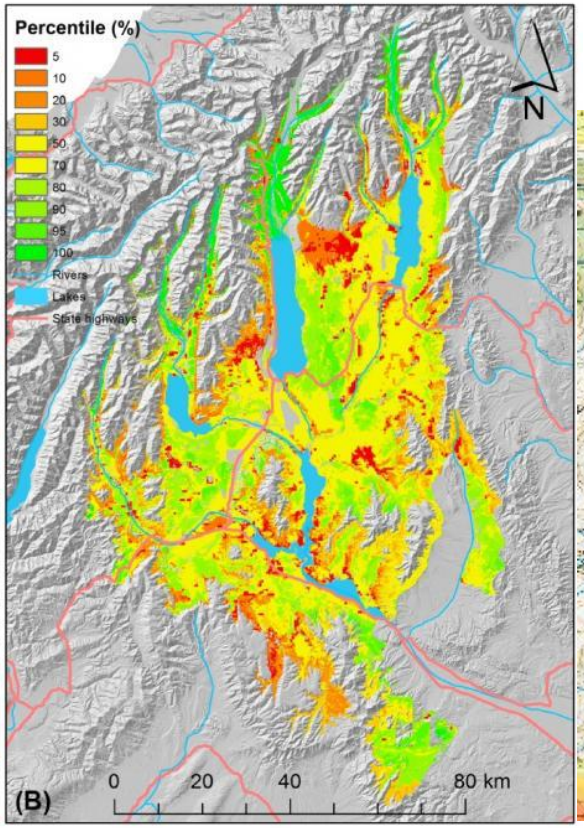


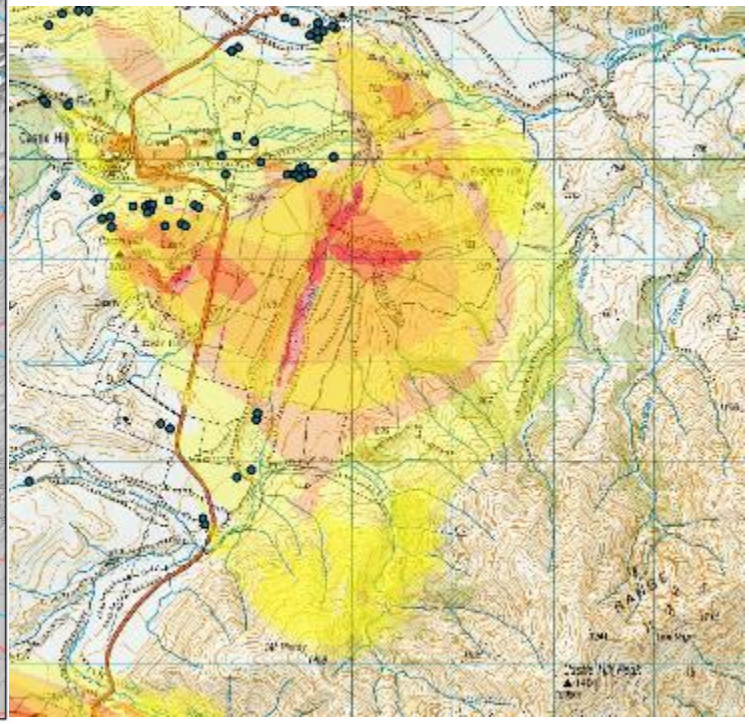


Objective Prioritisation

- What is at risk?
- What do people value?
- How high is the risk of spread?

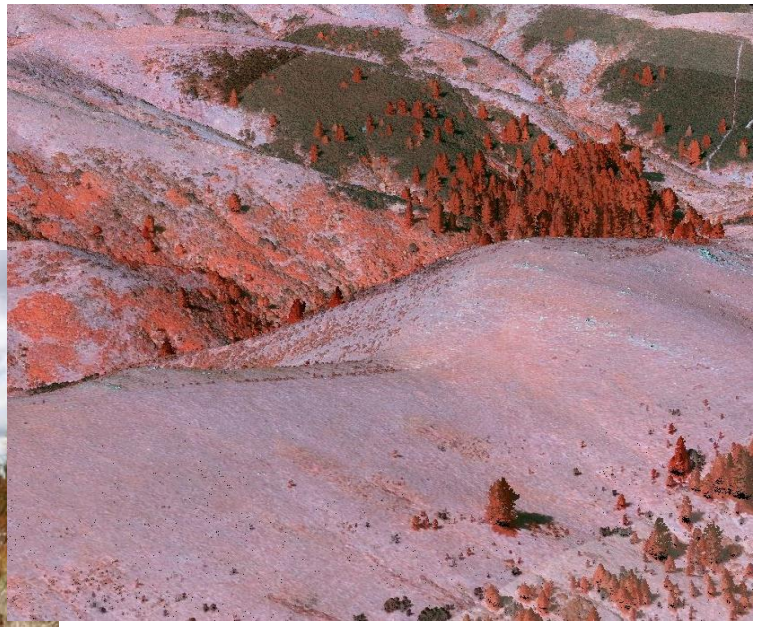






Monitoring of infestations and management success

- Just control effort?
- What should we measure?
- Legacy effects -how does it relate to the state the area is in?



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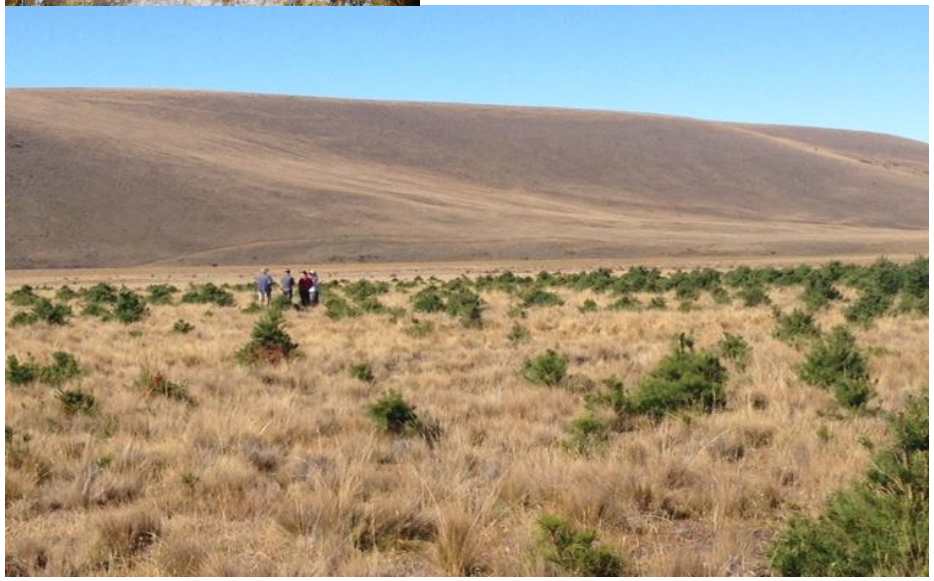
FORESTS ▪ PRODUCTS ▪ INNOVATION

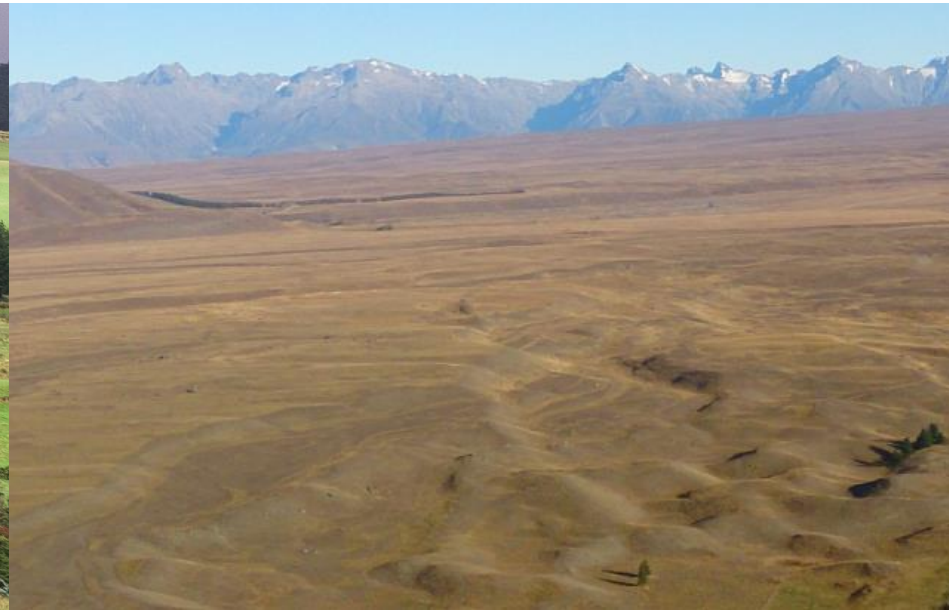
Efficient control across NZ

- Optimising the efficacy of herbicides
- Improving targeting efficiency for clumped & dispersed conifer populations using aerial vehicles (helicopters & UAVs)



Prevention

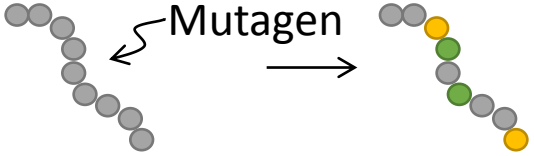
- The right tree in the right place
  - The perfect production tree? – Sterility
  - Plantations have their place in New Zealand – where the spread of the planted tree species is minimised!



Wilding Conifer Research at Scion

- Programmes:
- Winning against wildings programme (MBIE)
  - Manaaki Whenua, Scion, UC, Bioprotection
  - Wilding conifer Ecology (Dispersal, Impacts, Legacies)
  - How to manage existing infestations (Detection + Control) - Scion
  - Prevention (minimising risk from valuable conifer plantations) -Scion
  - **The right tree in the right place**
- Conifer Control and beyond (SFF)
  - Herbicide persistence (does herbicide based wilding control poses a long term problem?
  - Restoration (what succession is initiated after control – manipulation)

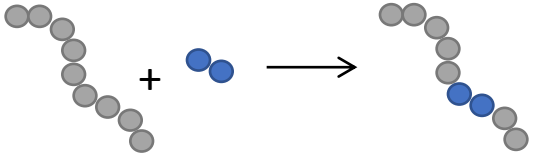
Different methods to engineer sterility



Random Mutagenesis

- Host organism subjected to radiation or chemicals
- Random mutations in DNA

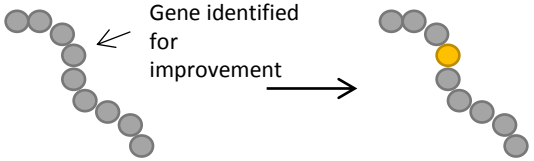
X



Transgenic Genetic Modification

- Selected genes inserted into host genome
- Used extensively throughout the world

✓



Modern Gene Editing Technology

- Selected gene of host genome altered
  - Precise
  - Predictable
  - Safe

✓

scion

Outlook: “The right tree in the right place”

What does that mean if achieved:

- Current wilding conifer infestations are successfully managed, adverse effects minimised (total eradication is not possible) and potentially used to reintroduced native woody vegetation.
- Valuable plantations are placed in the right sites (minimum risk of spread and of off-site adverse effects)
- Tree species selection (and tree sterility) minimises spread risk and allows plantations co-exists beside high spread-prone ecosystems for better landscape diversity (not achieved by any other large scale land use)

Sterile conifer mutants can be found in nature

- Cannot use for breeding – they are sterile!
- Use Biotechnology to create new sterile mutants
- Use cell culture to propagate – clonal propagation

ORIGINAL ARTICLE

Vivienne R. Wilson · John N. Owens

Histology of sterile male and female cones in *Pinus monticola* (western white pine)

Received: 5 November 2002 / Accepted: 3 February 2003 / Published online: 15 March 2003

Sex Plant Reprod (2005) 18: 81–89
DOI 10.1007/s00497-005-0003-3

ORIGINAL ARTICLE

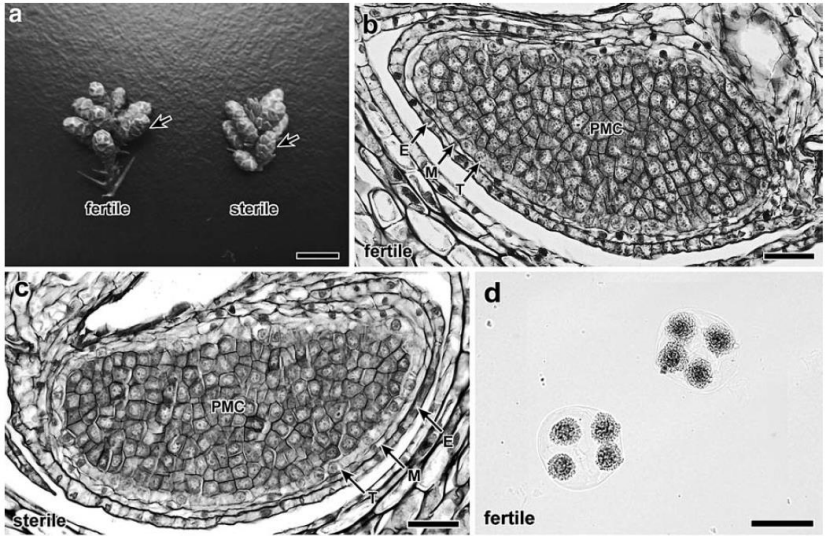
Yoshihiro Hosoo · Eri Yoshii · Kenji Negishi
Hideaki Taira

A histological comparison of the development of pollen and female gametophytes in fertile and sterile *Cryptomeria japonica*

Received: 14 March 2005 / Accepted: 17 June 2005 / Published online: 2 August 2005

Differential Expression of *SLOW WALKER2* Homologue in Ovules of Female Sterile Mutant and Fertile Clone of *Pinus tabulaeformis*[1]

Ai Guo, Cai Xia Zheng, and Yuan Yuan Yang
College of Biological Sciences and Biotechnology, Beijing Forestry University, NO.35 Qing Hua Dong Lu Hai Dian district, Beijing, 100083 P.R. China
e-mail: zhengcx@bjfu.edu.cn
Received April 4, 2013; in final form, September 19, 2013



Regulation of gene editng
(where no use of DNA)

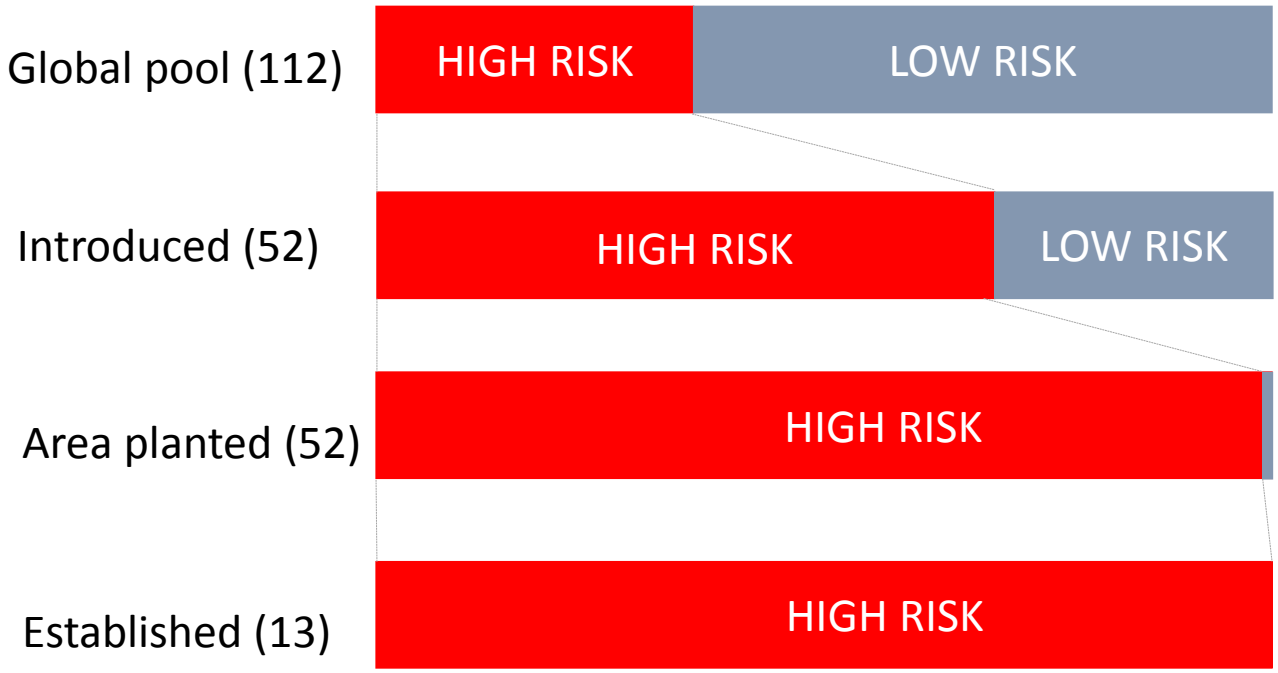
- Argentina excludes gene editing from GMO Regulation
- USA, Canada exclude gene editing from GMO Regulation
- Sweden, UK, Finland, Danish Ethical Council (November 2016) all decide gene editing outside regulations. Italy consulting, Germany discussion.
- Australia currently reviewing regulations. Proposal to exclude gene editing currently undergoing public consultation.
- FSANZ decision - gene edited food not regulated
- EU bodies considering gene editing – date of final decision unclear.
- New Zealand currently not excluded, Austria not excluded.
- Others still to decide

How have pines become so invasive?

contorta, Kawekas

Historic bias in introduction effort

Wilding pines are a major conservation problem in New Zealand but should we be surprised?



McGregor KF, Watt MS, Hulme PE & Duncan RP (2012) What determines pine naturalization: species traits, climate suitability or forestry use? *Diversity & Distributions,* **18***,* 1013–1023.

Anthropogenic landscapes affect the mechanisms by which plants become invasive.

Kueffer (2017) Science 358:724


1998


2004


2015

"Winning against wildings"

- A 5 yr MBIE research programme
- **Integrates** ecology, management and modelling
- An overall goal is to improve management across all stages of invasion
- Tightly linked to national efforts

Manaaki Whenua Landcare Research

SCION FORESTS • PRODUCTS • INNOVATION

Lincoln University Te Whare Wānaka o Aoraki CHRISTCHURCH • NEW ZEALAND

UC UNIVERSITY OF CANTERBURY Te Whare Wānanga o Waitaha

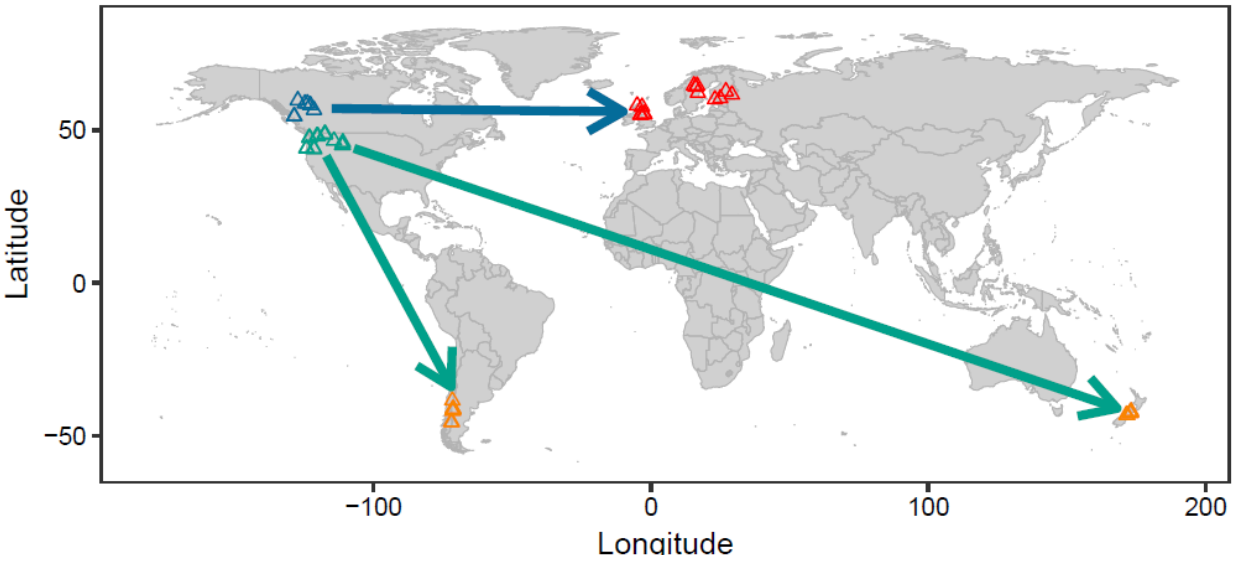
Determinants of wilding species in NZ

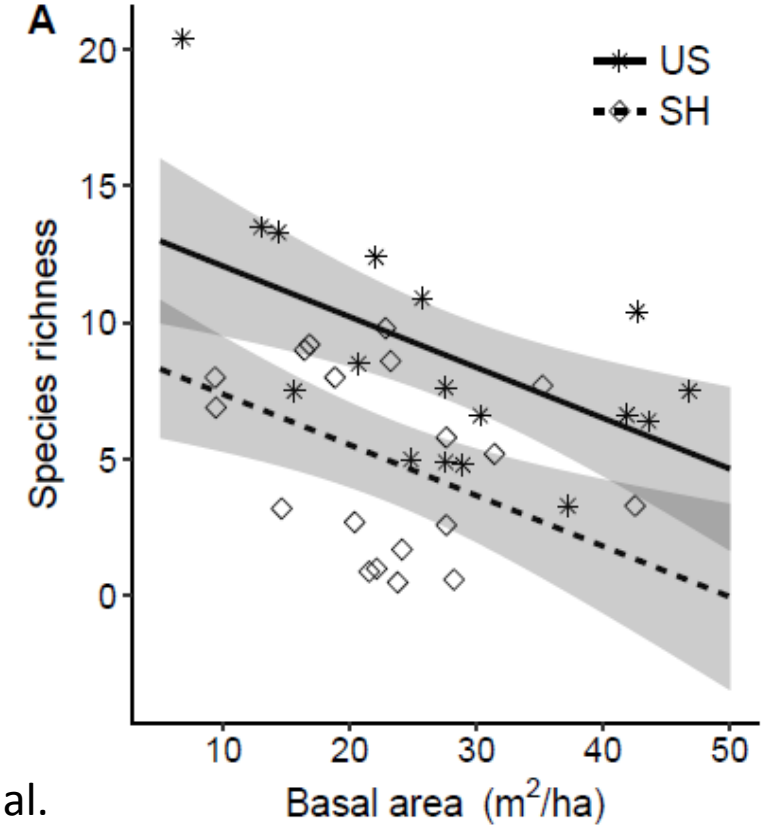
Variable	Importance
Climate suitability	29.1
Forestry use	21.1
Area planted	19.1
Years to maturity	9.5
Native range size	6.4
Introduction date	4.1

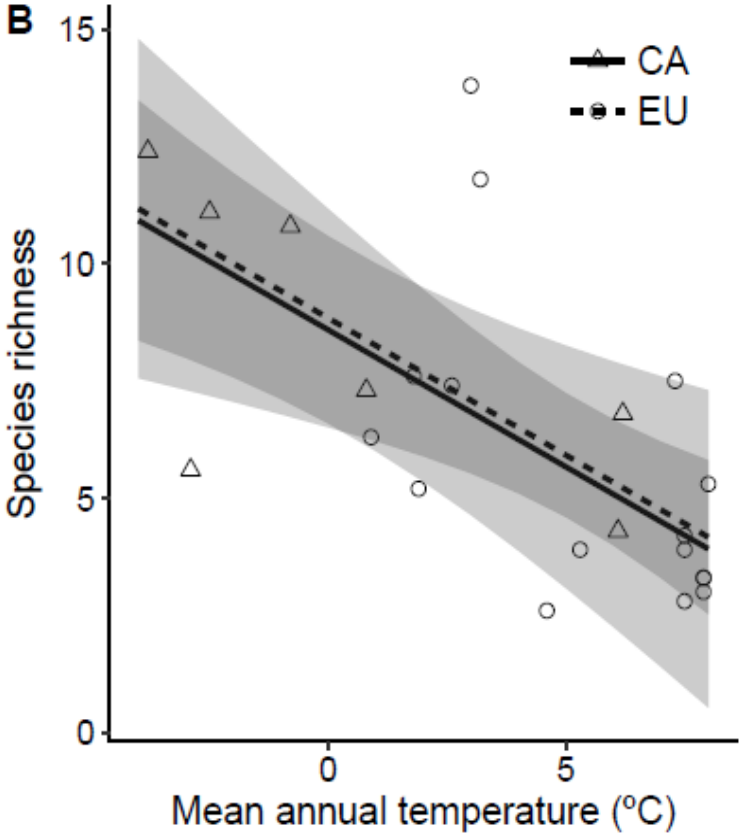
But what about seed dispersal?

McGregor KF, Watt MS, Hulme PE & Duncan RP (2012) What determines pine naturalization: species traits, climate suitability or forestry use? *Diversity & Distributions,* **18**, 1013–1023.

High variation in cone and seed traits







Taylor-Davis et al.

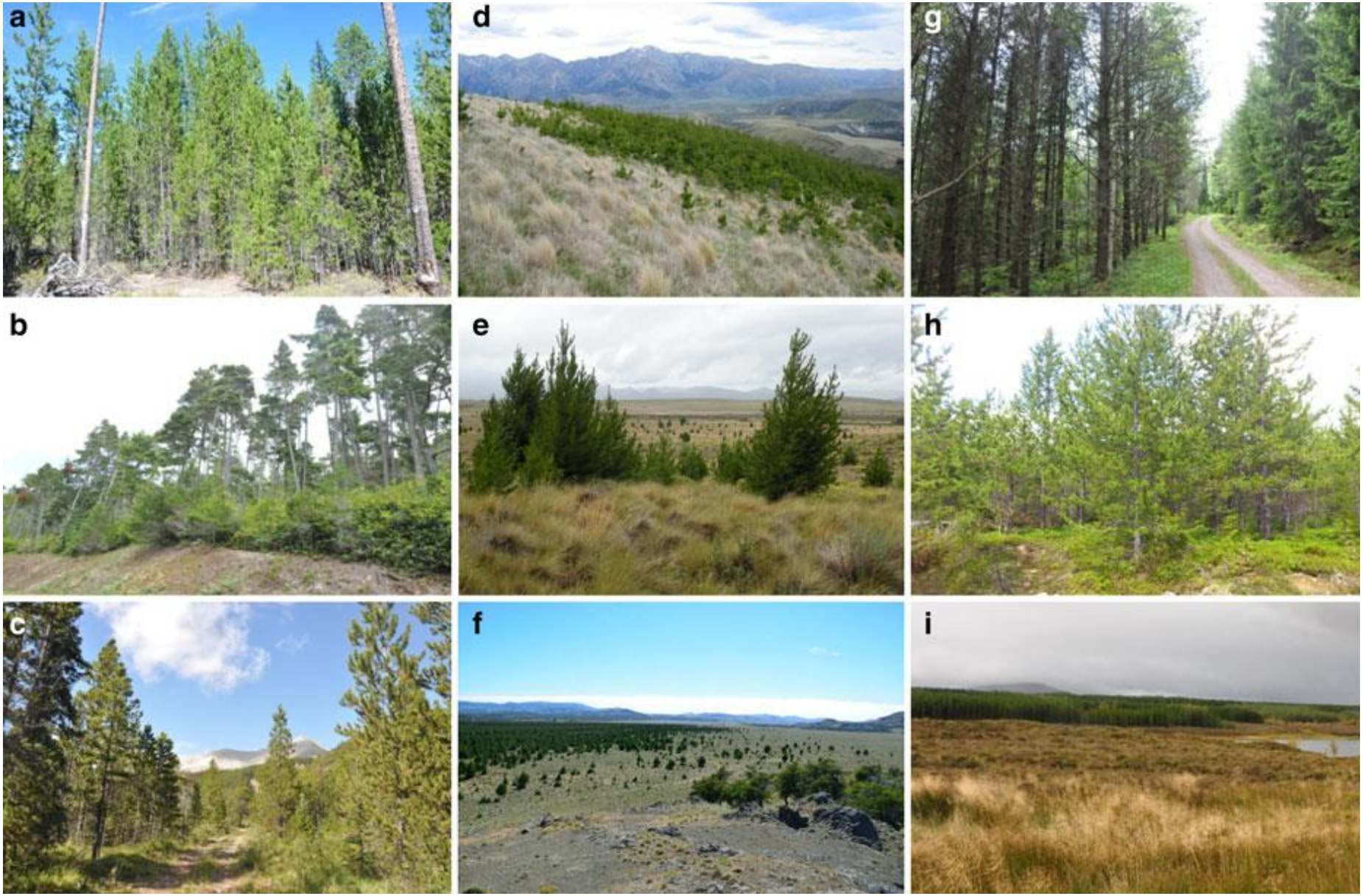
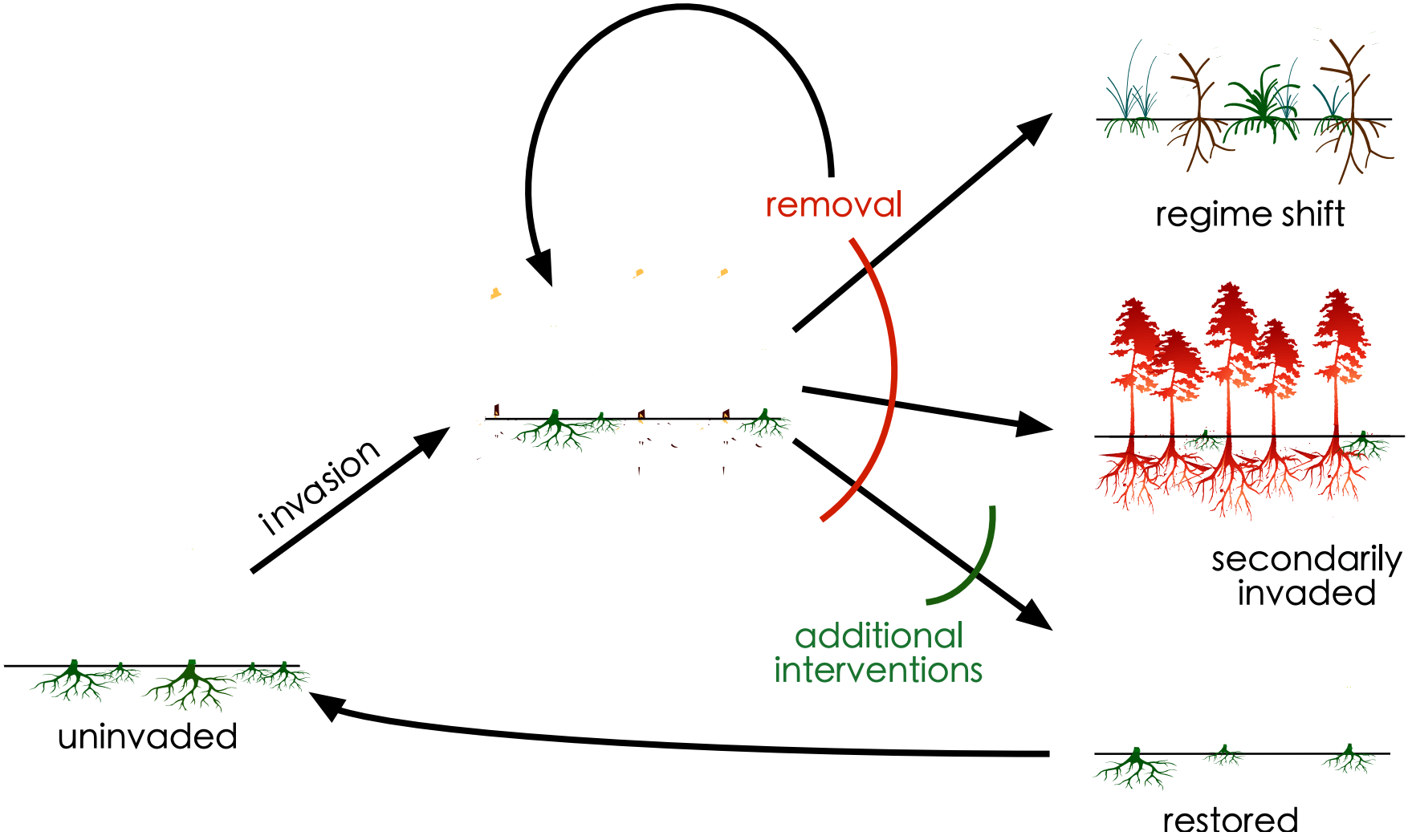
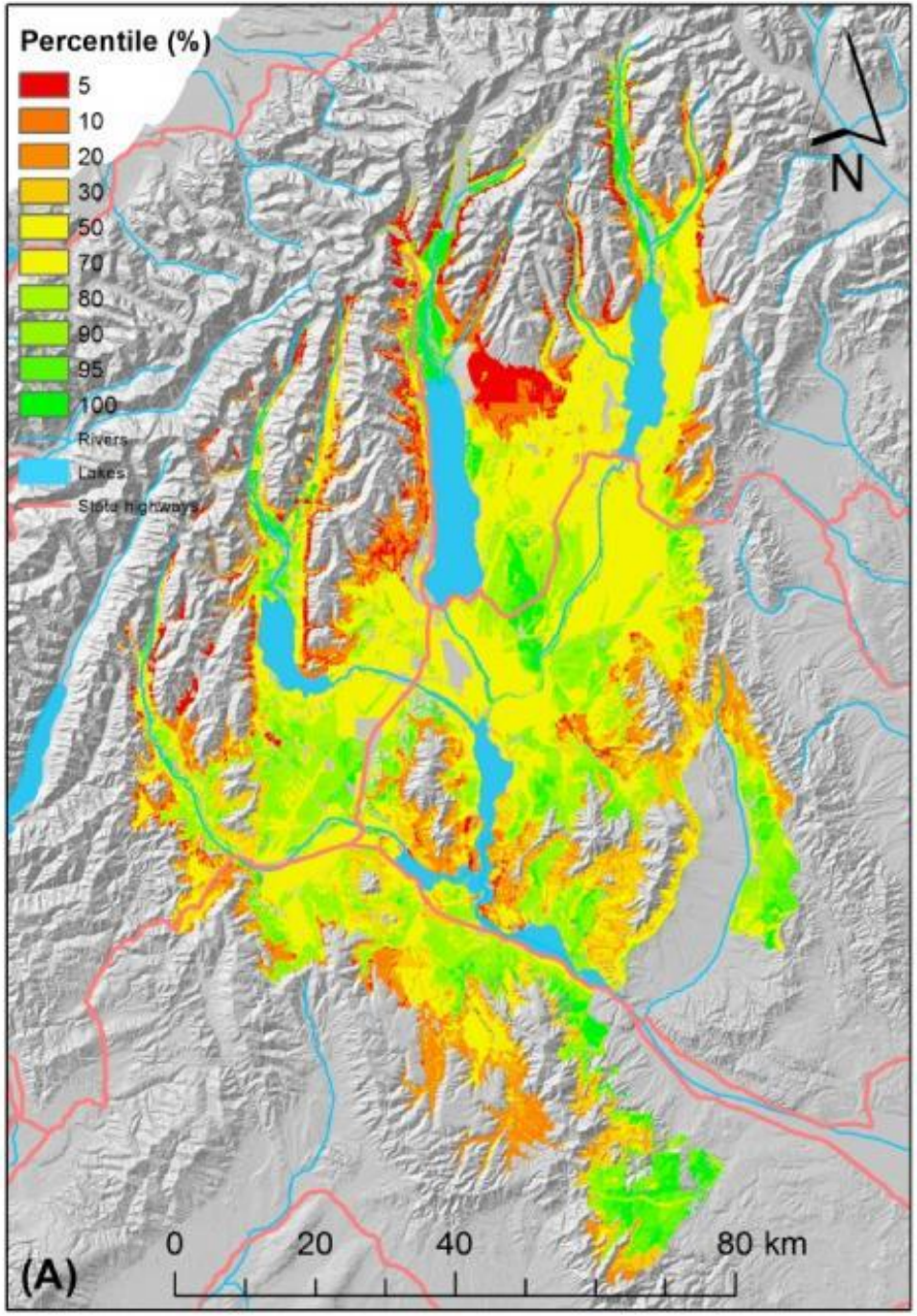


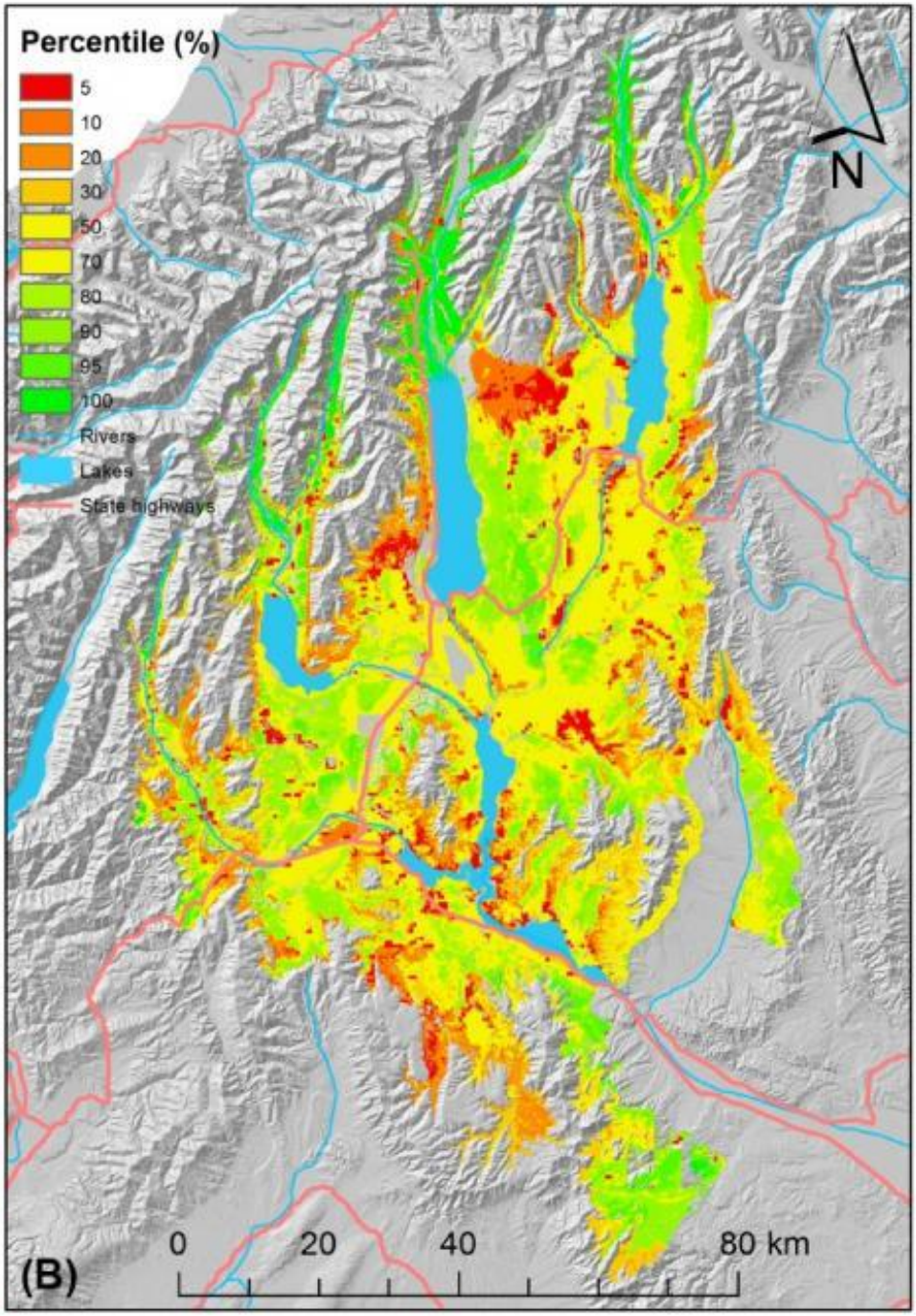
Fig. 1 *Pinus contorta* in its native (**a–c**) and introduced ranges in the Southern Hemisphere (**d–f**) and Europe (**g–i**). Native range photos depict three distinct *Pinus contorta* subspecies, including subspecies *murrayana* on the east slope of the Cascade Mountains, Oregon (**a**), subspecies *contorta* near Pacific coast, Oregon (**b**), and subspecies *latifolia* in northern British Columbia (**c**). Southern hemisphere photos show active *P. contorta* invasions in New Zealand (**d**), Argentina (**e**), and Chile (**f**). European photos show *Pinus contorta* plantations in southern Finland (**g**), Northern Sweden (**h**), and northwest Scotland (**i**). Photos **a–c**, **g**, **h**, and **i** were taken by M. Gundale; photo **d** was taken by D. Peltzer; Photo **e** was taken by M. Nunez; and photo **f** was taken by A. Pauchard

The final frontier?



Wardle & Peltzer 2017 Biol. Inv.


Percentile (%)
5
10
20
30
50
70
80
90
95
100
Rivers
Lakes
State highways
N
0
20
40
80 km
(A)


Percentile (%)
5
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Rivers
Lakes
State highways
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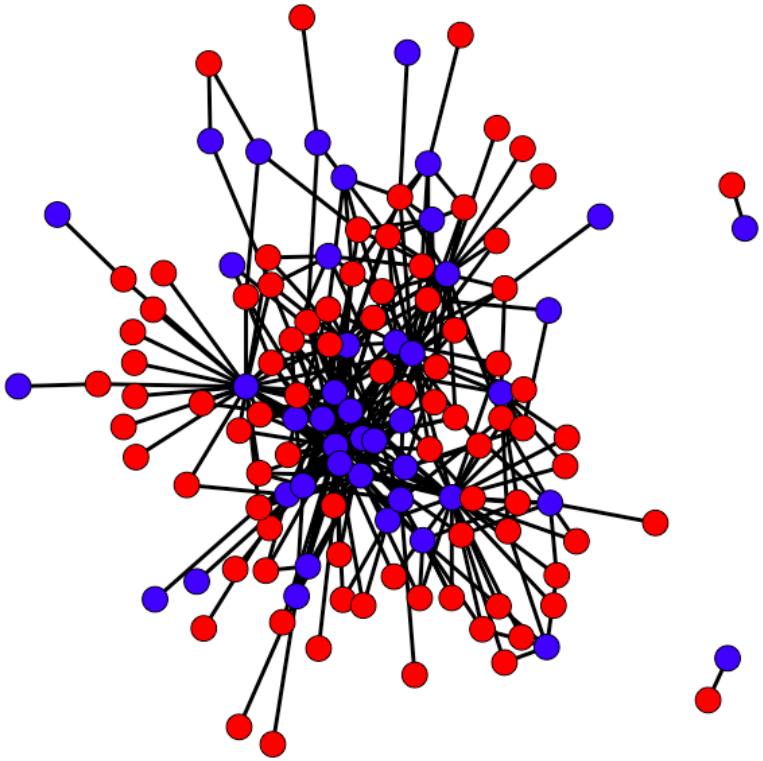
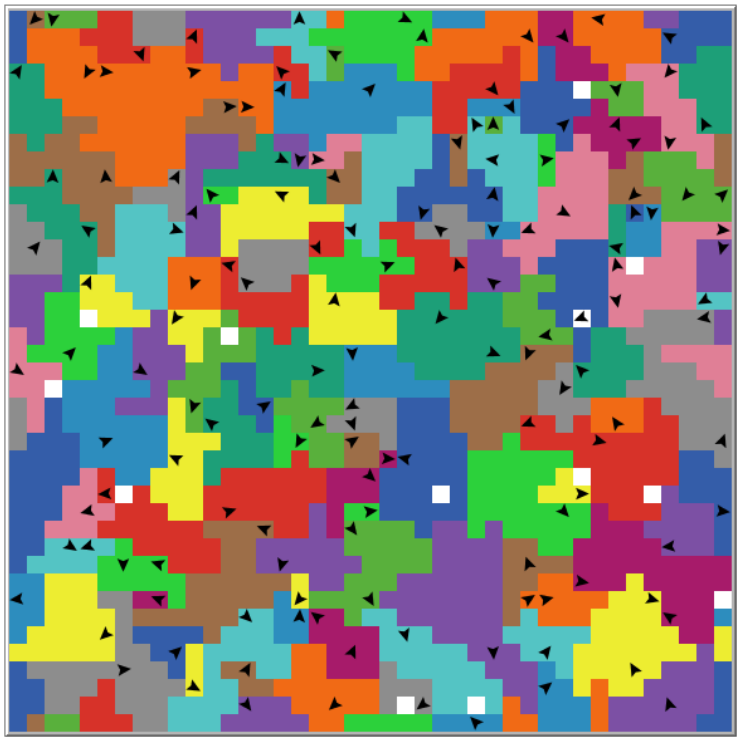
80 km
(B)

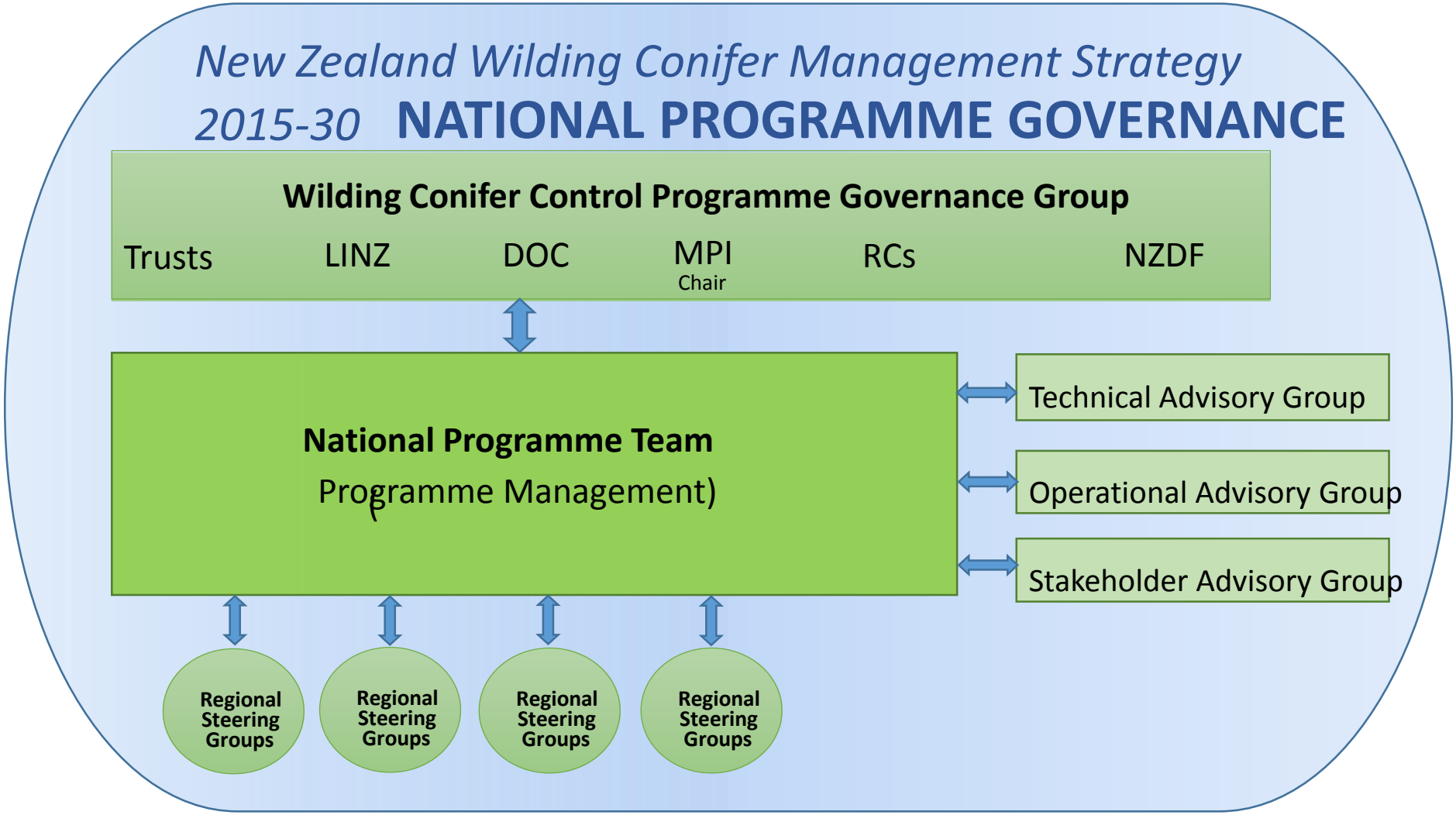
Rural Decision Makers

SURVEY2015





Programme Structure



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Te Whare Wānanga o Tāmaki Makaurau

GNS SCIENCE
TE PŪ AO

Wider contribution..

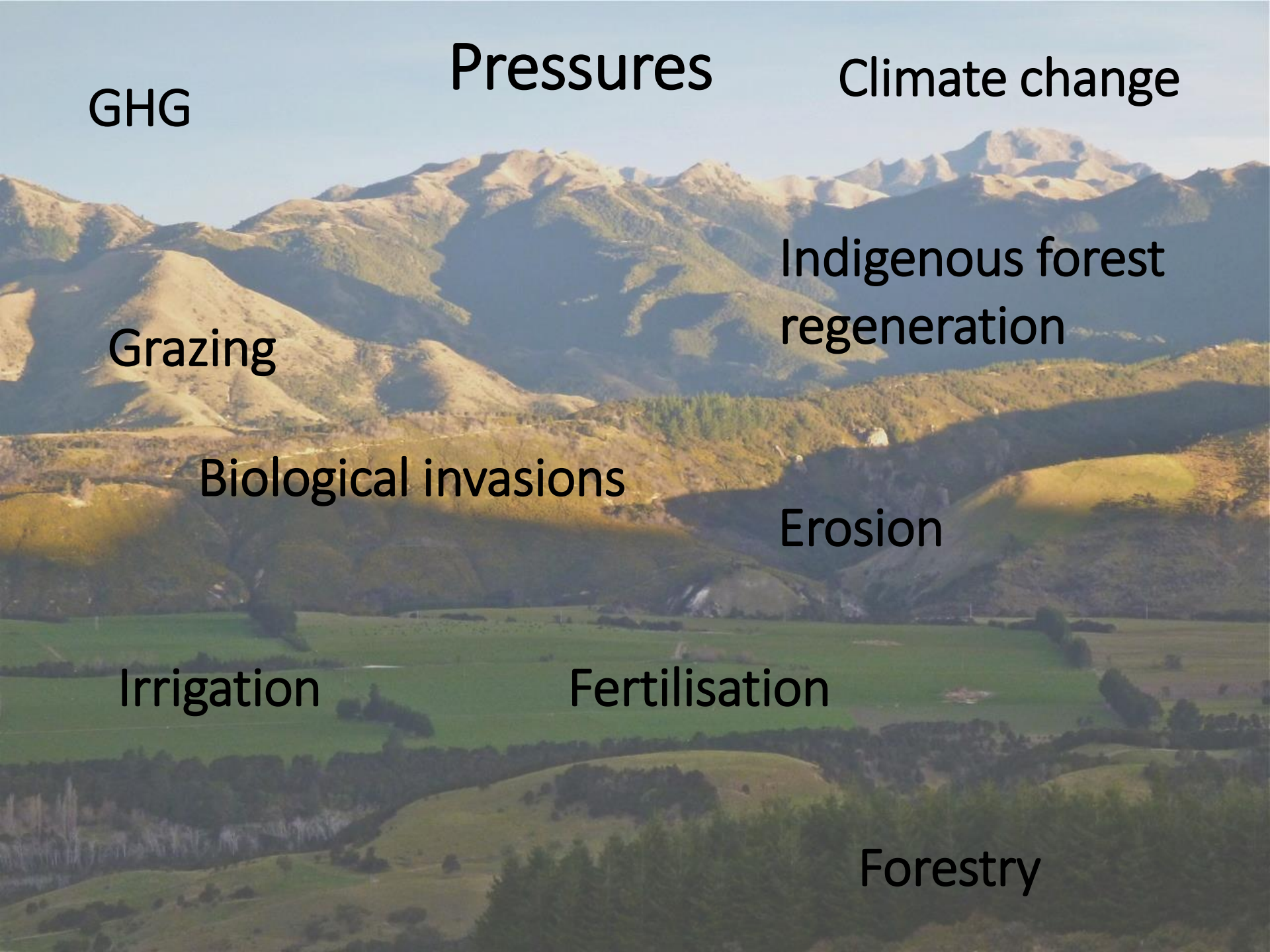
- Addresses the call for social-ecological and social approaches on biodiversity and conservation research

REVIEW

Beyond the roots of human inaction: Fostering collective effort toward ecosystem conservation

Elise Amel,[1*] Christie Manning,[2] Britain Scott,[1] Susan Koger[3]

Science 2017


Pressures
GHG
Climate change
Indigenous forest regeneration
Grazing
Biological invasions
Erosion
Irrigation
Fertilisation
Forestry

- Wildings are major invaders in NZ and overseas
- NZ leads the way in terms of management and organising at a national scale
- A more integrated partnership model has been developed to link research, policy and management
- Now we’re faced with how to sustain this approach to ensure long-term benefits