Future proofing plantation forests from pests
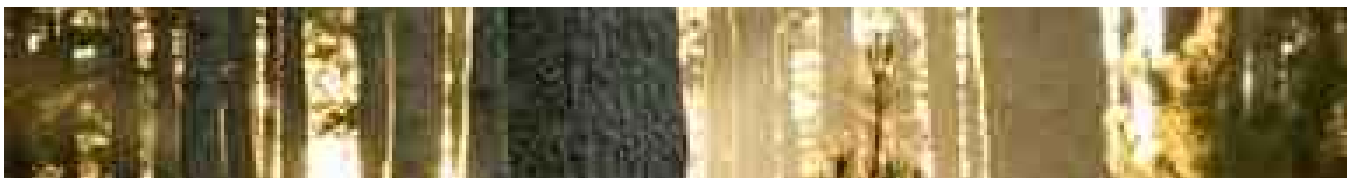
Michael Watt, Rebecca Ganley, Darren Kriticos,
Karina Potter, Lucy Manning, Graeme Bourdot, Nita Tallent-Halsell

# Plantation forests within New Zealand

Distribution of Pine Plantations

- New Zealand has 1.8 million ha in plantations (6.7% land area)
- Comprise ~90% *Pinus radiata*
- *Pinus radiata* susceptible to many insects, pathogens
- Lack of species diversification high risk to NZ economy

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Pest impact to the forest industry

- Several important forest pests already established in NZ
- Losses to industry high
- Large potential for greater losses under climate change
- Sub-tropical pests often very invasive

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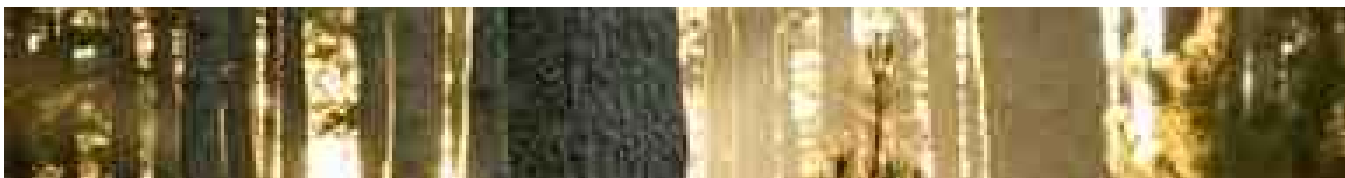
Objectives

- Determine climatic suitability for three key plantation pests under current and future climate
  - *Fusarium circinatum* (pitch canker), devastating disease
  - Pine processionary moth - defoliating insect
  - *Buddleja davidii* – highly invasive weed
- Determine potential impact of pine processionary moth on plantation forests
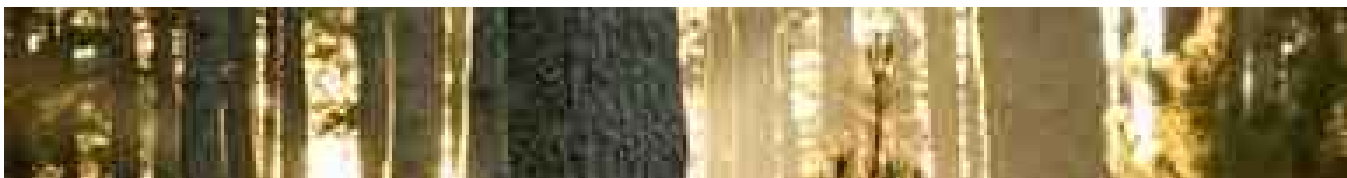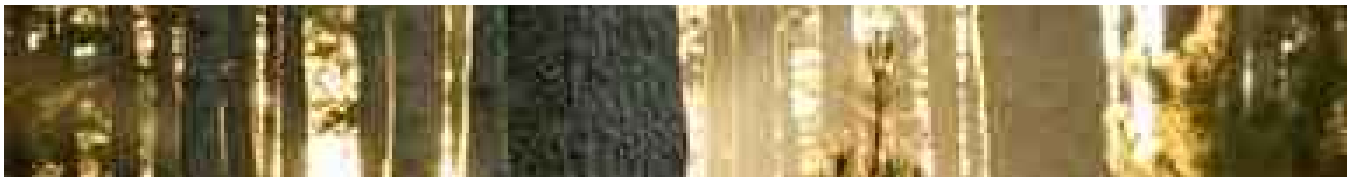
The model

- CLIMEX, a process based distribution model

- Projecting potential distribution of invasive pests

- Global meteorological database
    - ~50 km^2 grid resolution,
   - Generated from 1961 to 1990 climate normals
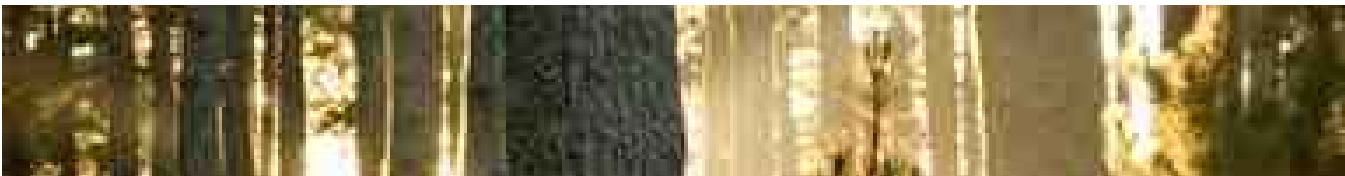
The model

- Climate linked to distribution through process-based algorithms

- Integrates a population's response to climate via:
  - Growth index and eight stress indices

- Indices parameterised from presence data or laboratory measurements

- Model outputs Ecoclimatic Index, that indicates the suitability of climate for the pest.

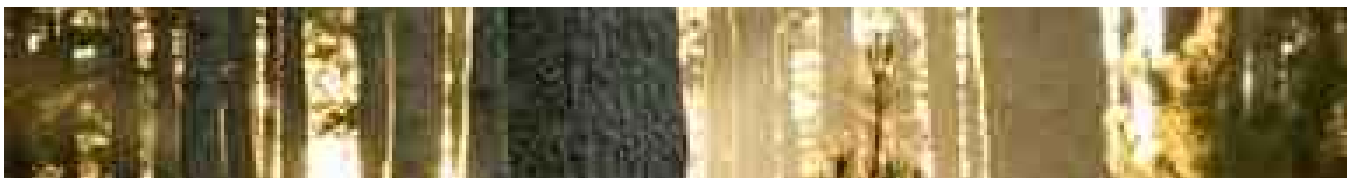# Climate change scenarios

- Six scenarios (to 2080's) covering a range of climate sensitivity
  - Three Global Climate Models
    - CSIRO Mark 3.0 (2.11 ⁰C)
    - NCAR-CCSM (2.47 ⁰C)
    - MIROC-H (4.13 ⁰C)
  - Two standard IPCC scenarios
    - Medium emissions (A1B)
    - High emissions (A2)

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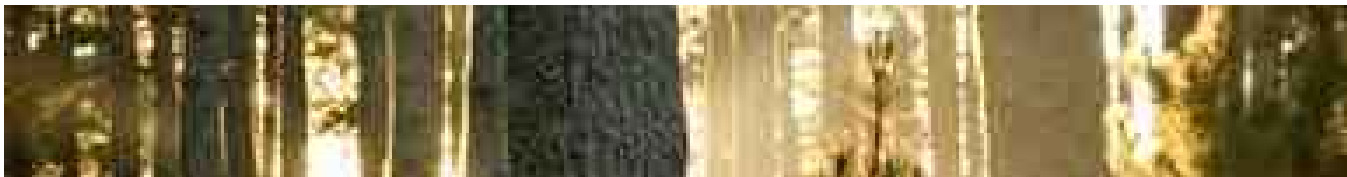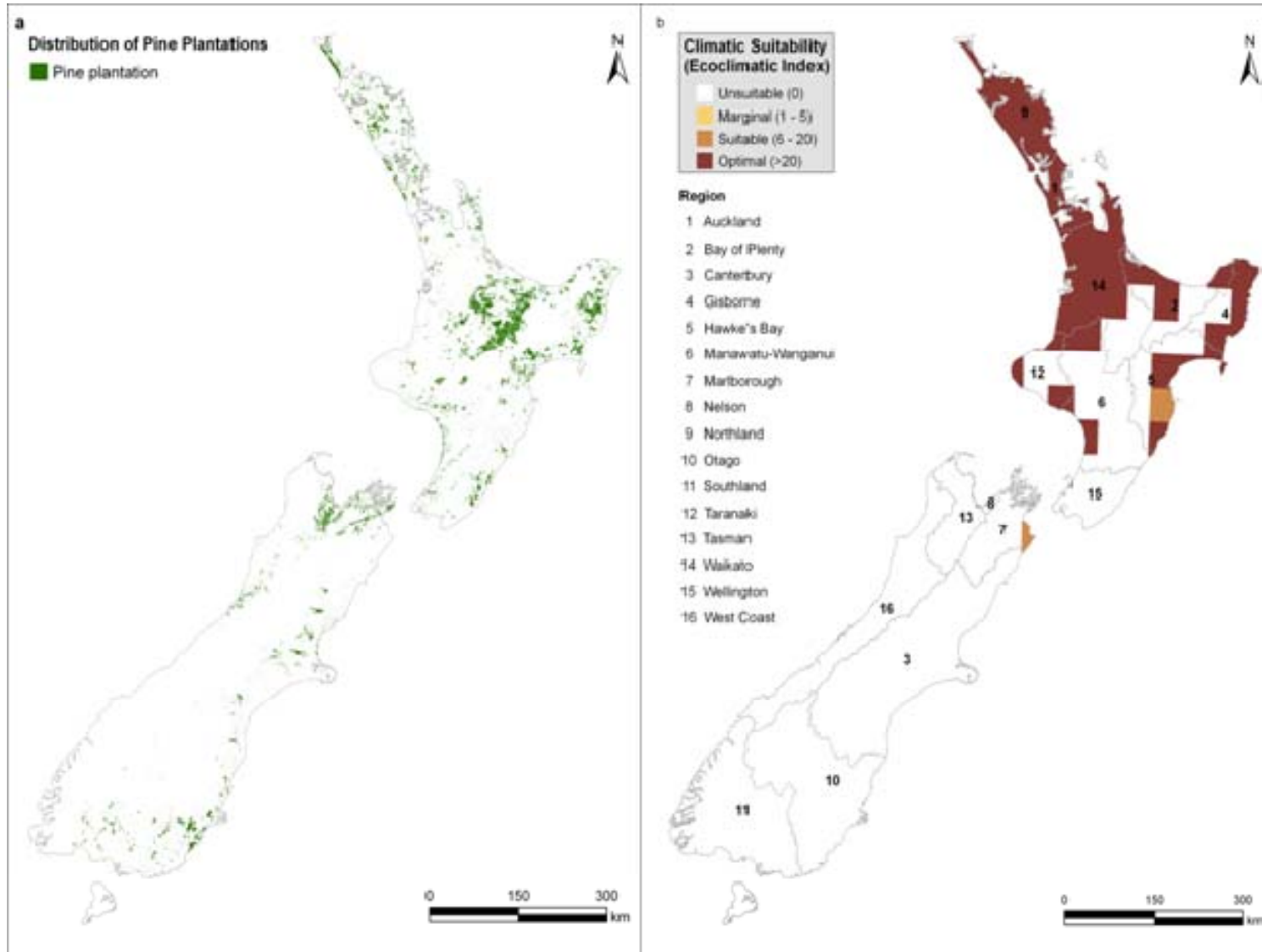
Pitch canker

- **Not currently in NZ**, but problematic in USA, Spain

- Devastating disease of pines - can suppress growth or kill the tree

- *Pinus radiata* considered the most susceptible pine species

- Most unwanted disease in many countries with plantation pines
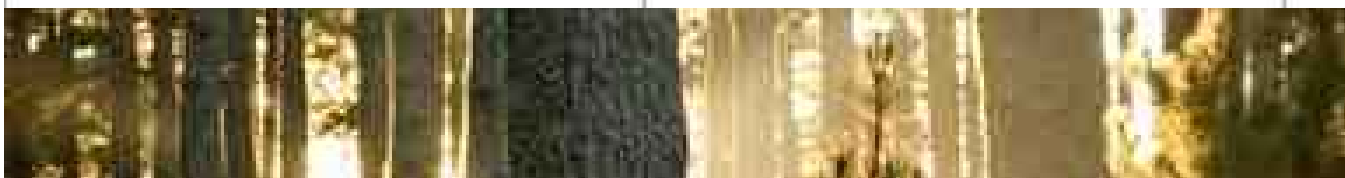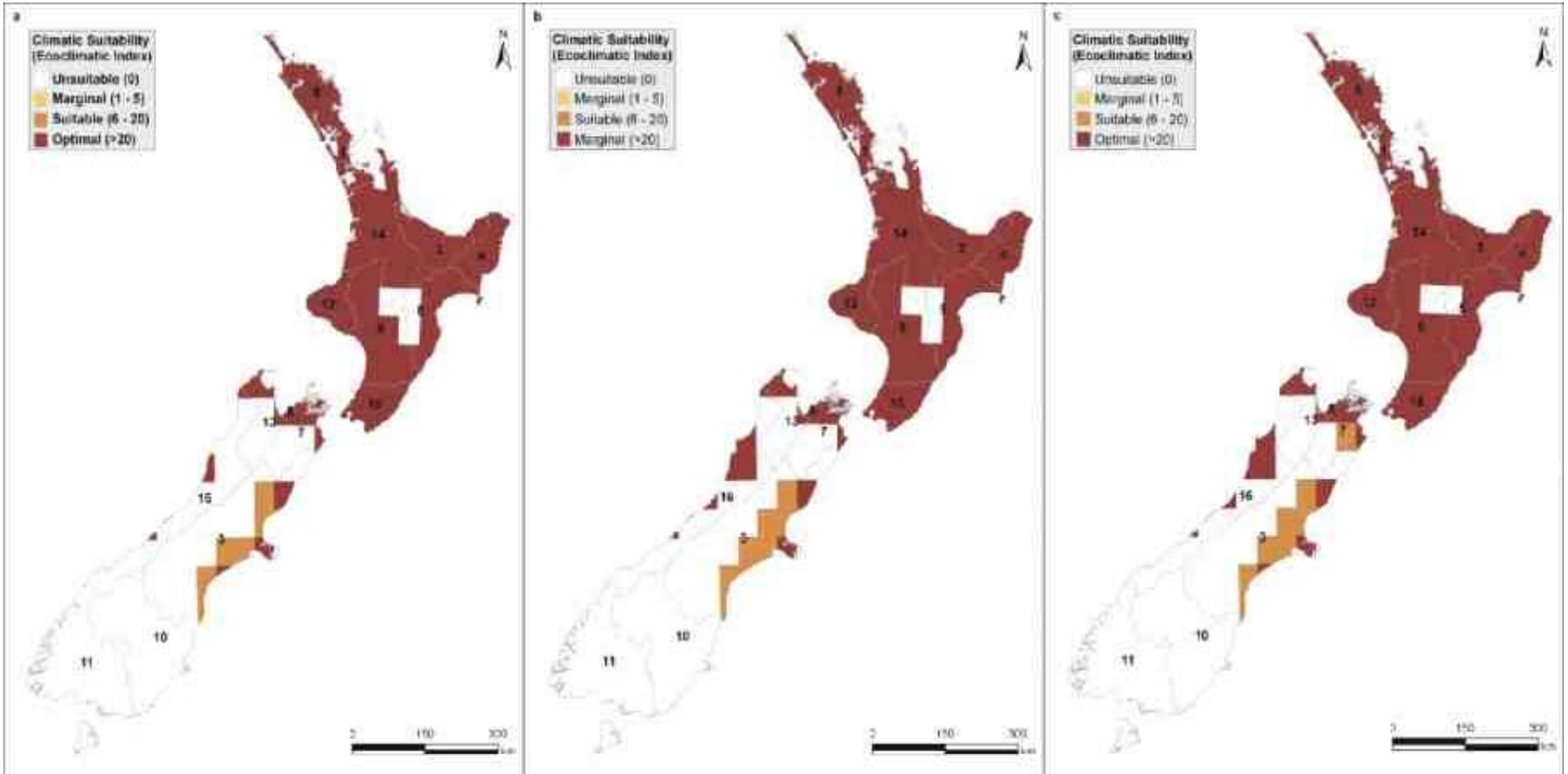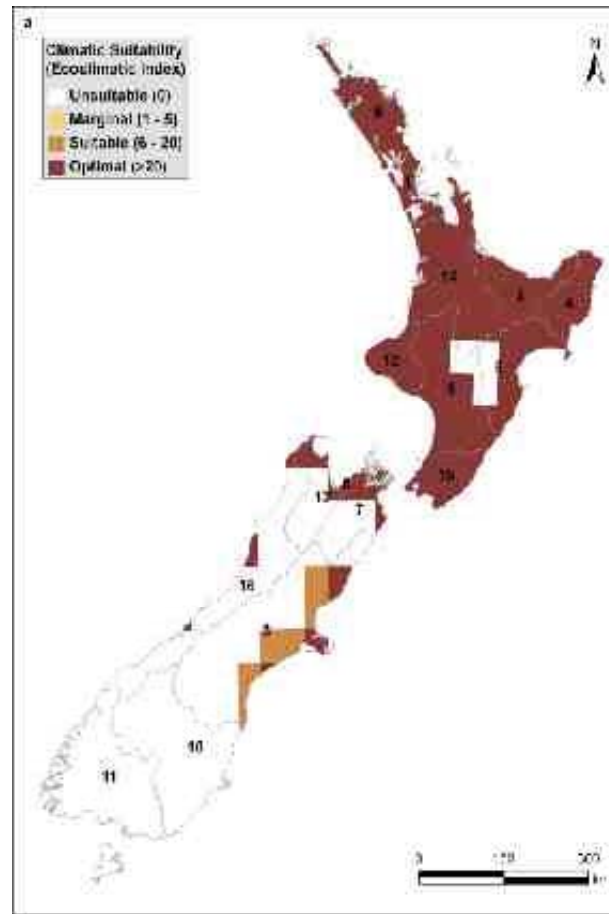
Pine plantations

Current climate EI

a

Distribution of Pine Plantations
- Pine plantation

b

Climatic Suitability (Ecoclimatic Index)
- Unsuitable (0)
- Marginal (1 - 5)
- Suitable (6 - 20)
- Optimal (>20)

Region
1 Auckland
2 Bay of Plenty
3 Canterbury
4 Gisborne
5 Hawke's Bay
6 Manawatu-Wanganui
7 Marlborough
8 Nelson
9 Northland
10 Otago
11 Southland
12 Taranaki
13 Tasman
14 Waikato
15 Wellington
16 West Coast

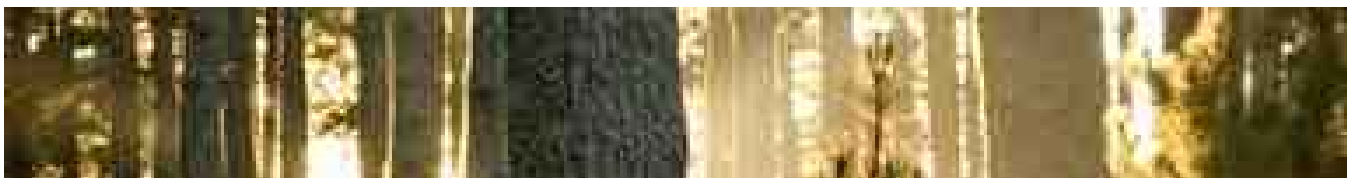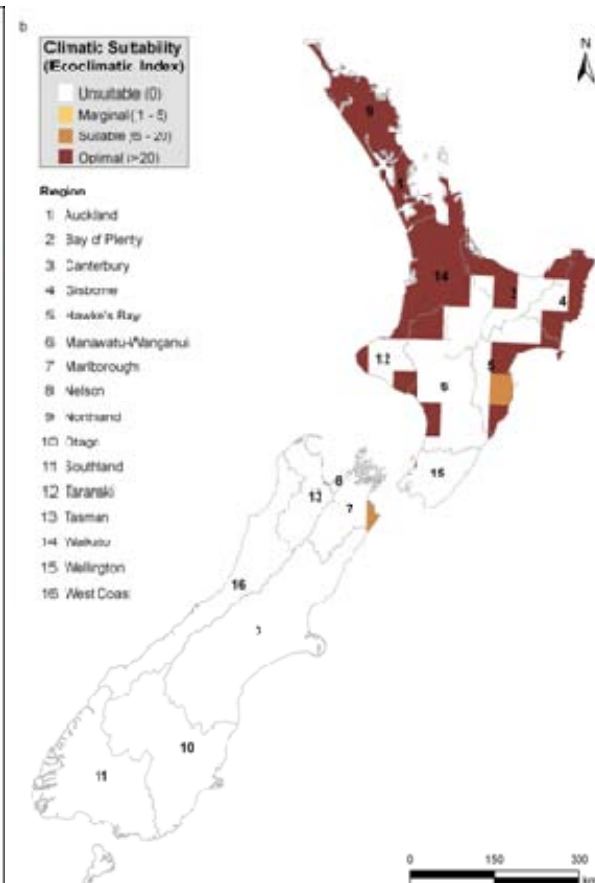# Future climate scenarios

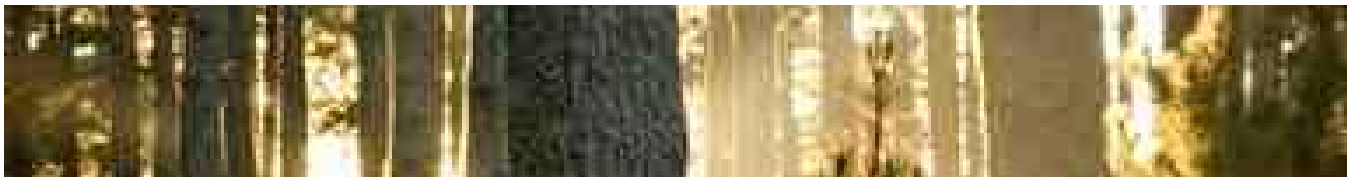CSIRO   NCAR   MIROC

Future climate

Current climate

# *Buddleja davidii* (butterfly bush)

- **Current weed in New Zealand**

- Very popular, attractive garden plant

- Also, high impact weed, fast growth, prolific seed production

- Rated most problematic weed in central North Island

- Competes strongly with trees, particularly during juvenile period

Current and potential *B. davidii* distribution
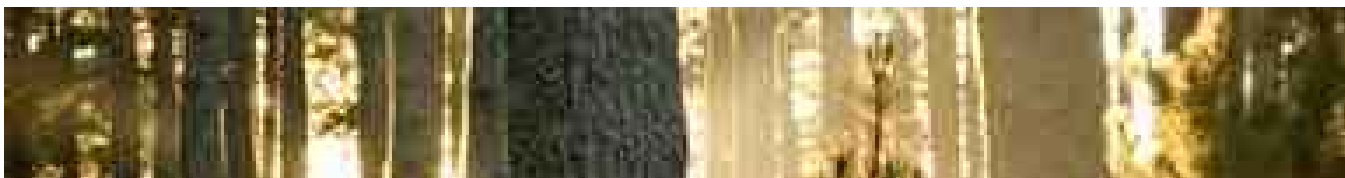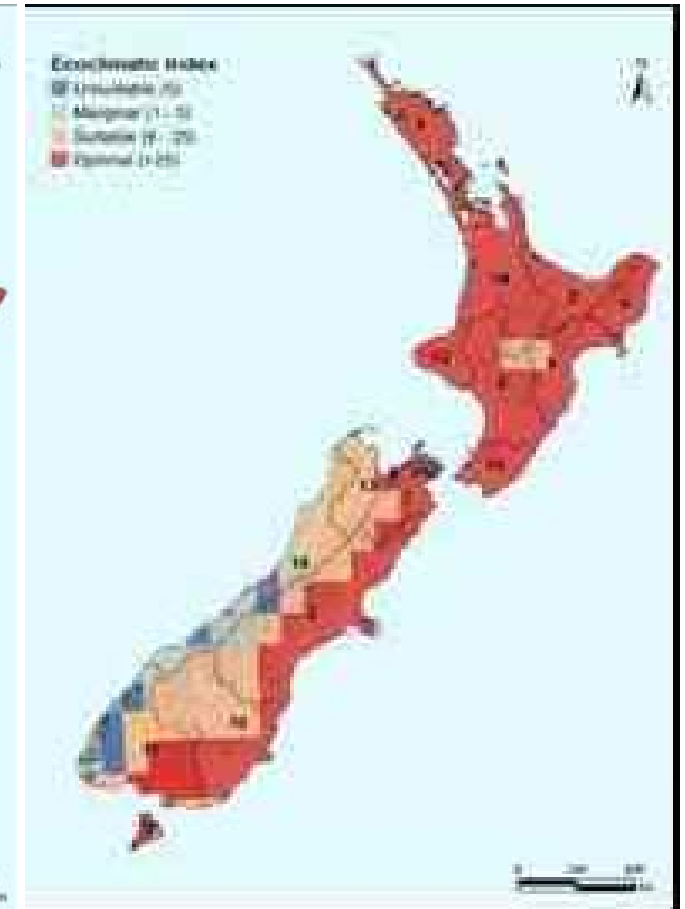
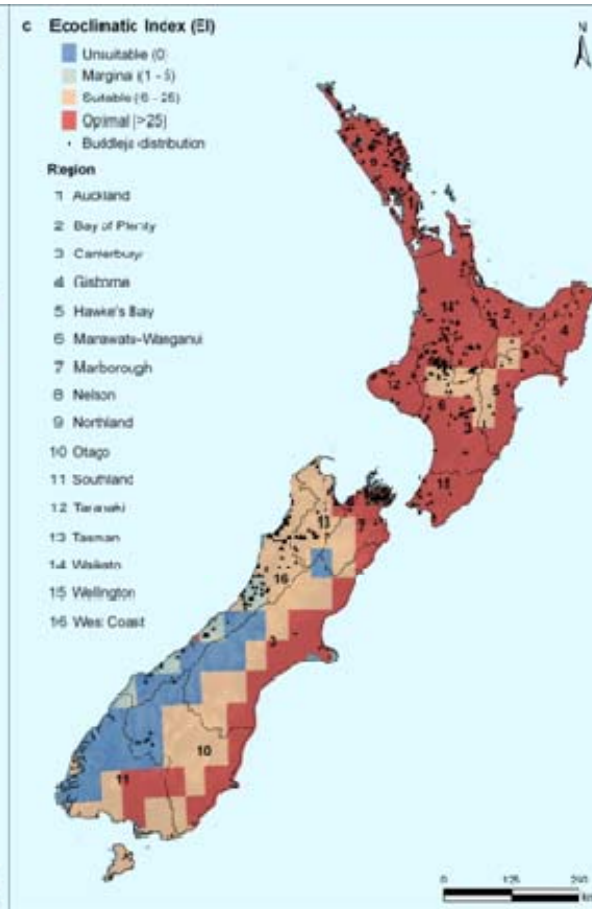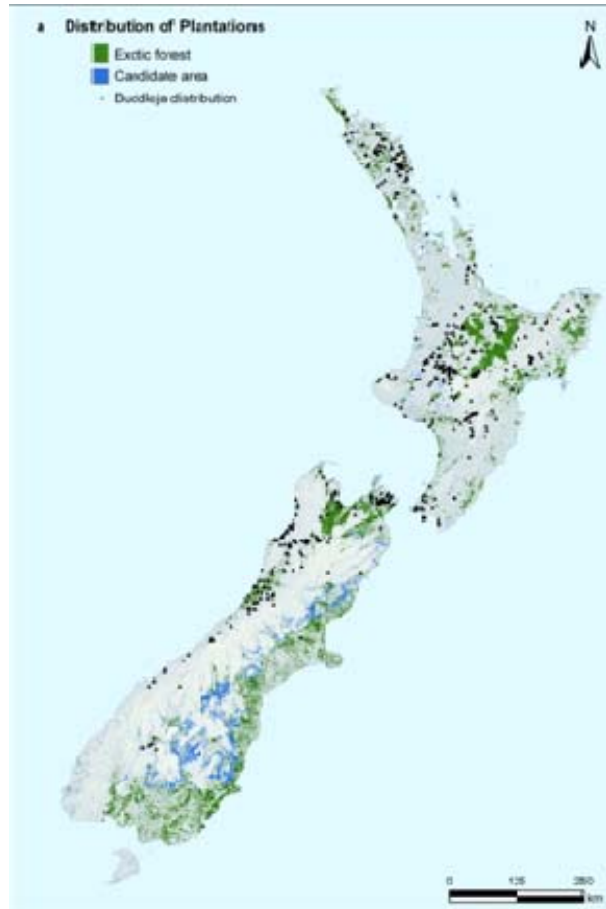*B. davidii* distribution   Current climate EI
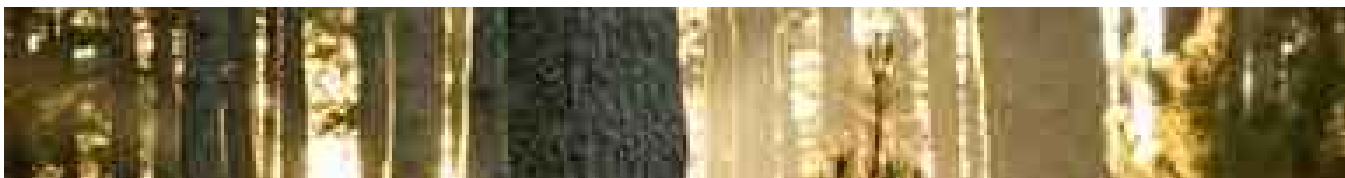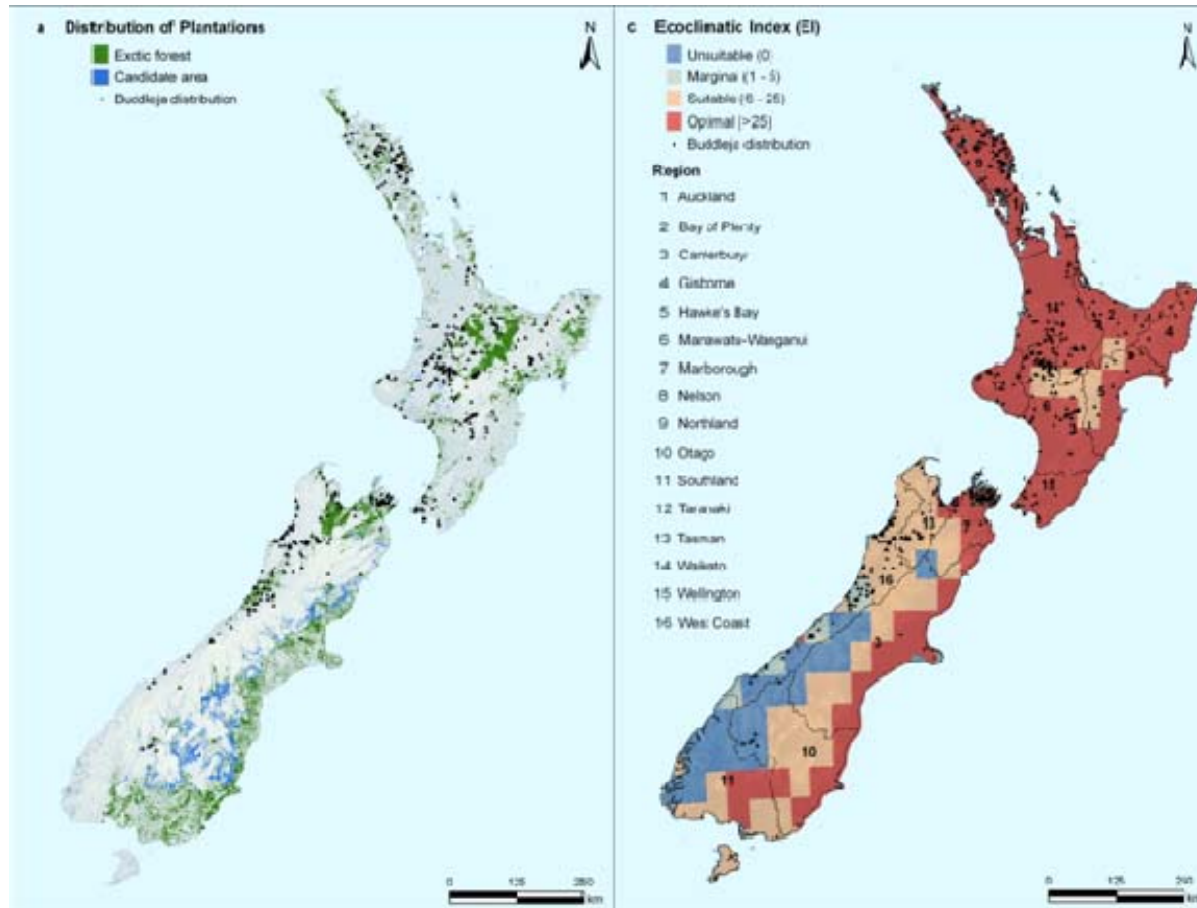
Future climatic suitability

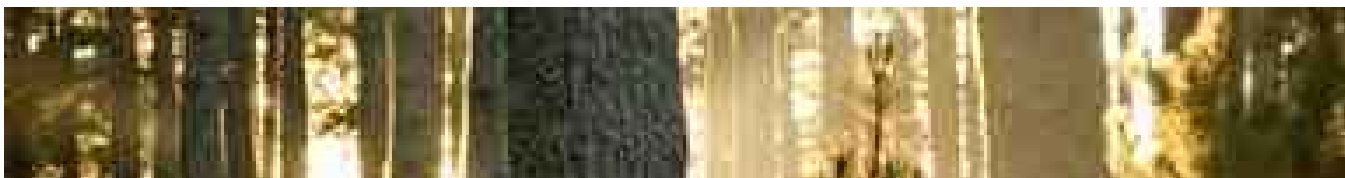### *B. davidii* distribution

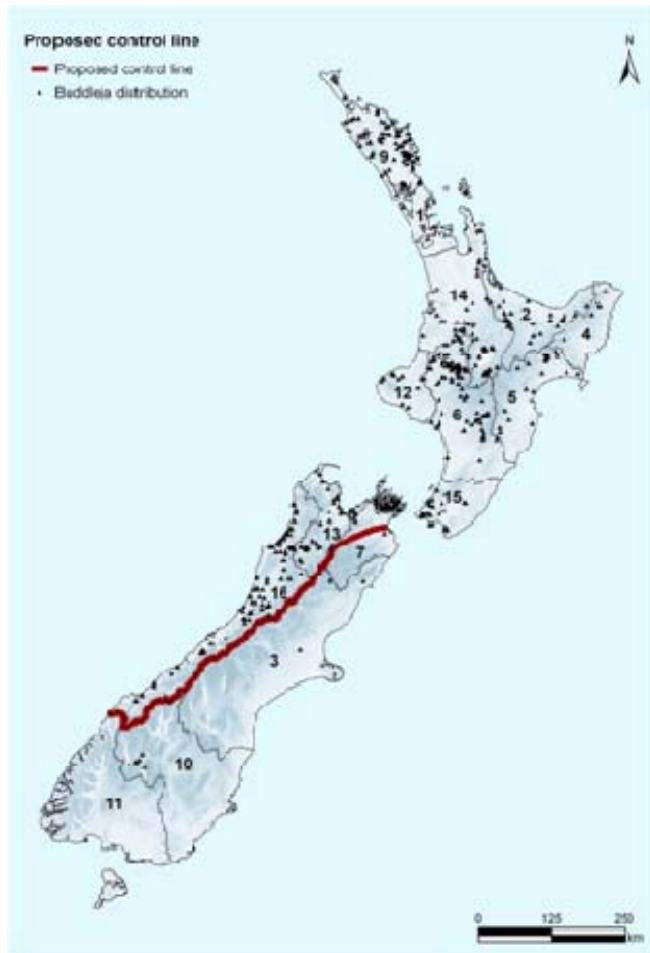### Current climate EI

### **MIROC**

Climate matching

- UK has been extensively invaded

- Matches climate in Southland, Otago, Canterbury to UK

- Match in terms of min., max., temp, rainfall quantity and pattern

- CMI > 0.7 biologically relevant, >0.8 close match

Composite Match Index
- < 0.7
- 0.701 - 0.8
- 0.801 - 0.9

0   100   200
km

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Control measures

- Include on RPMS Canterbury, Otago, Southland, Marlborough
- Remove horticultural threats
- Prevent spread into strategic exclusion zone
- Biological control
  - Preliminary success with *Cleopus japonicus*
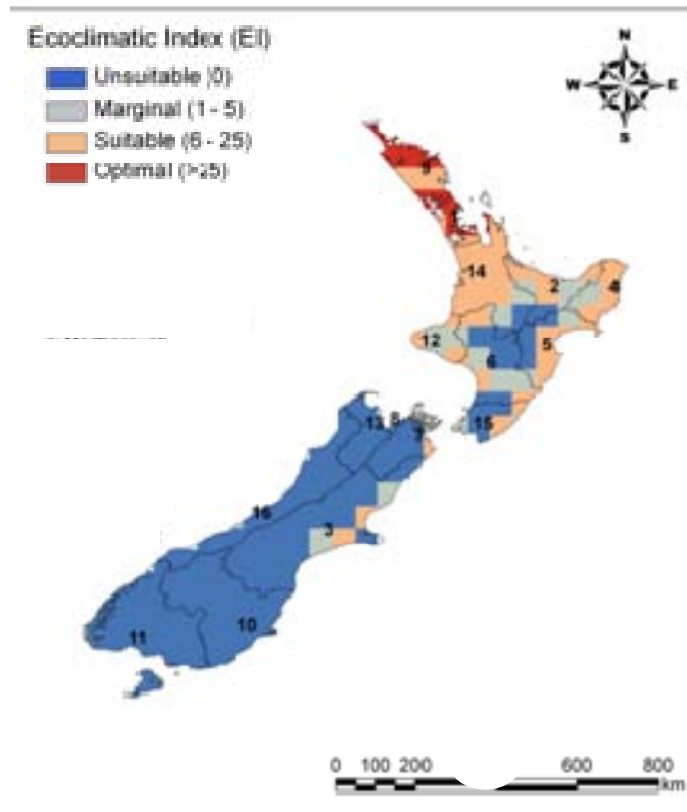
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Next generation biomaterials
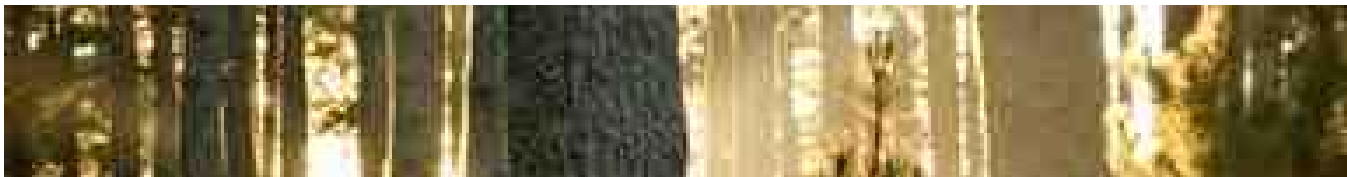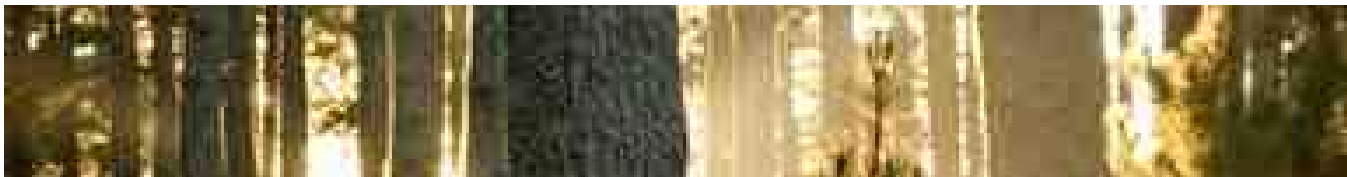
Pine processionary moth

- **Not currently in New Zealand**
- Pine processionary moth significant defoliator of pines in Europe
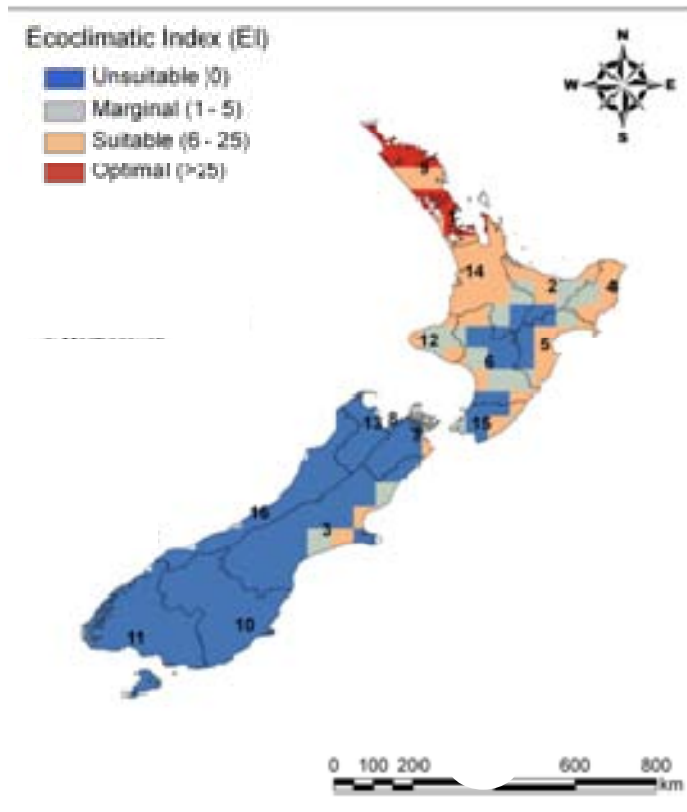- Of interest as radiata pine is a preferred host
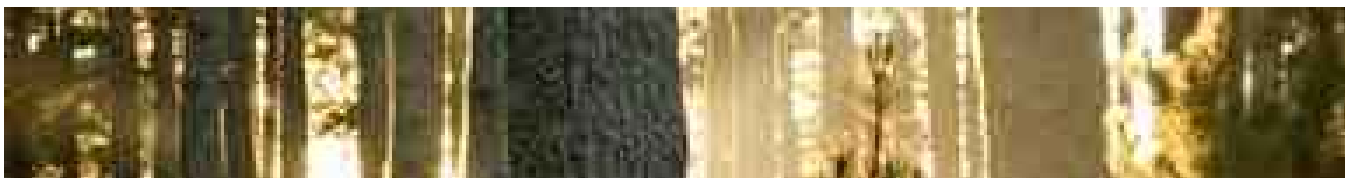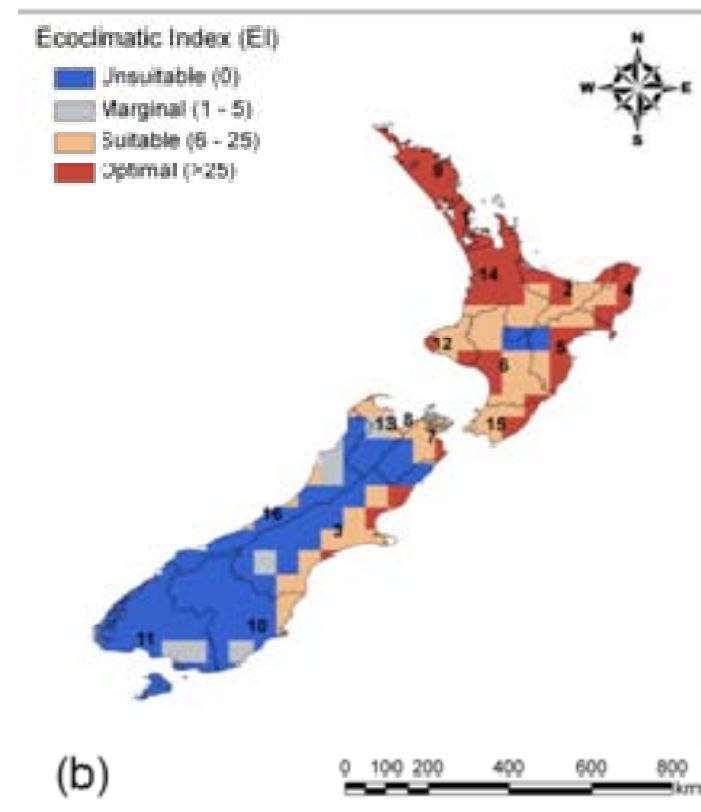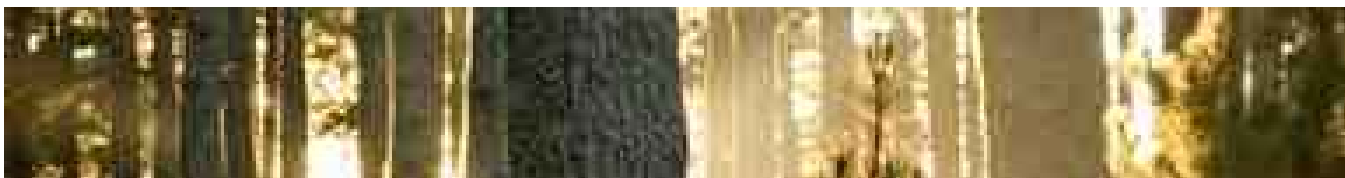
Projected potential distribution

Current climate

Projected potential distribution

Current climate

Future climate

Linking climate suitability to plantation growth losses
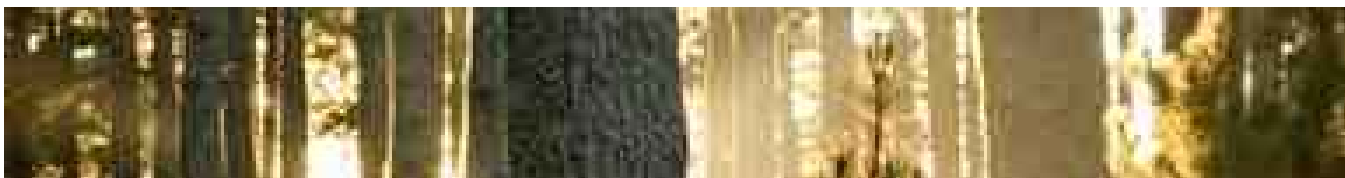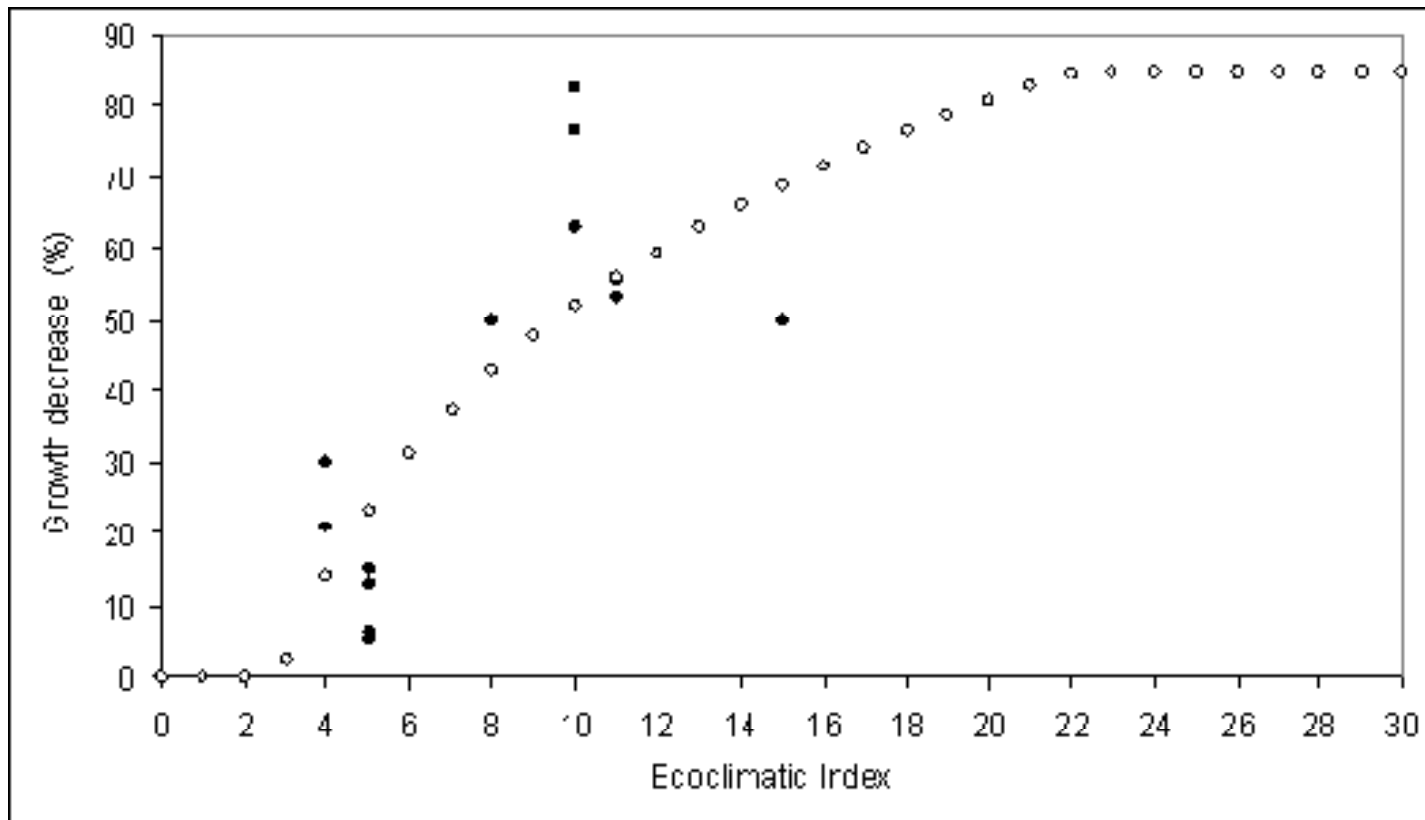
Plantation productivity under current and future climate

- Simple empirical model used
- Mean national projected merchantable volume
  - 566 m^3 ha^{-1} under current climate
  - Range 512 to 531 m^3 ha^{-1} under climate change
- Model only accounts for effects of climate change on air temperature and water balance

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Effect of pine processionary moth on volume production under current and future climate
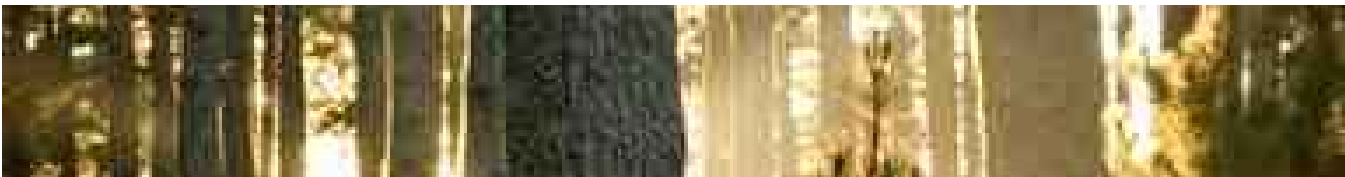
- Assuming PPM dispersed throughout NZ
  - Under current climate projected mean volume reductions of 16%
  - Under climate change mean volume reductions of 31%
  - Range of 29% to 33% between scenarios

scion
Next generation biomaterials
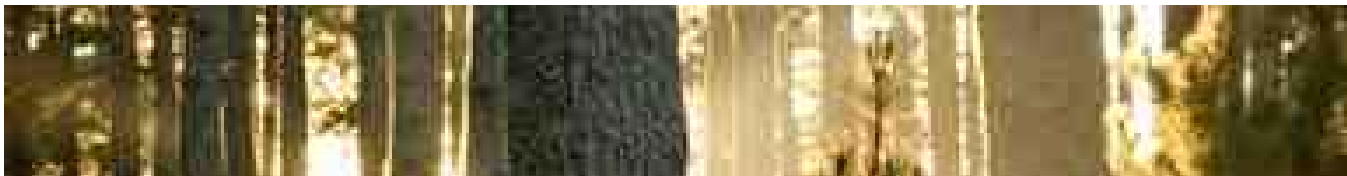
Further work

- Three year MAF SLMACC project 2009 -2012

- Develop DSS that accounts for both direct (environment) and indirect effects (biotic, abiotic factors) of climate change on growth and rate of return

- DSS will possibly provide impetus to diversify the plantation estate
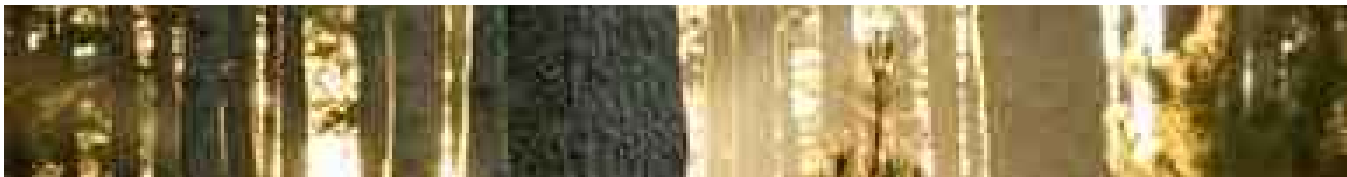
Acknowledgements

MAF for funding the 1 year "Future proofing plantation forests from pests project"

Papers, popular articles from project

- Watt, M.S., Kriticos, D.J., Potter, K.J.B., Manning, L.K., Tallent-Halsell, N., Bourdot, G.W. (in press) Using species niche models to inform strategic management of weeds in a changing climate. Biological Invasions.

- Watt, M.S., Kriticos, D.J., Bourdôt, G.W. 2010 Nothing pretty about *Buddleia*. MAF Biosecurity 97, 30-31

- Watt, M.S., Ganley, B.J., Kriticos, D.J., Manning, L.K. Dothistroma needle blight and pitch canker: the current and future potential distribution of two devastating diseases of *Pinus* species. Submitted Canadian Journal of Forest Research February 2010.

- Kriticos, D.J., Watt, M.S., Potter, K.J.B., Manning, L.K., Alexander, N.S., Tallent-Halsell, N. Managing invasive weeds under climate change: Considering the current and potential future distribution of *Buddleja davidii*. Submitted to Weed Research December 2009.

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