Landcare Research
Manaaki Whenua

Department of Conservation
Te Papa Atawhai

Climate change, ‘mega-masts’ and pests

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Climate is predicted to warm

Photo: DOC: Astrid van Meeuwen-Dijkgraaf

Increased pest pressure with warming temperatures

Photo: andrewwalmsleyphotography.com

Photo: andrewwalmsleyphotography.com

Photo: DOC, David Mudge

Photo: DOC: Astrid van Meeuwen-Dijkgraaf

Mast systems & predator cycles


Photo: DOC, Don Merton


Photo: DOC, David Mudge


Photo: DOC, J E Dowding


Photo: DOC, Herb Christophers

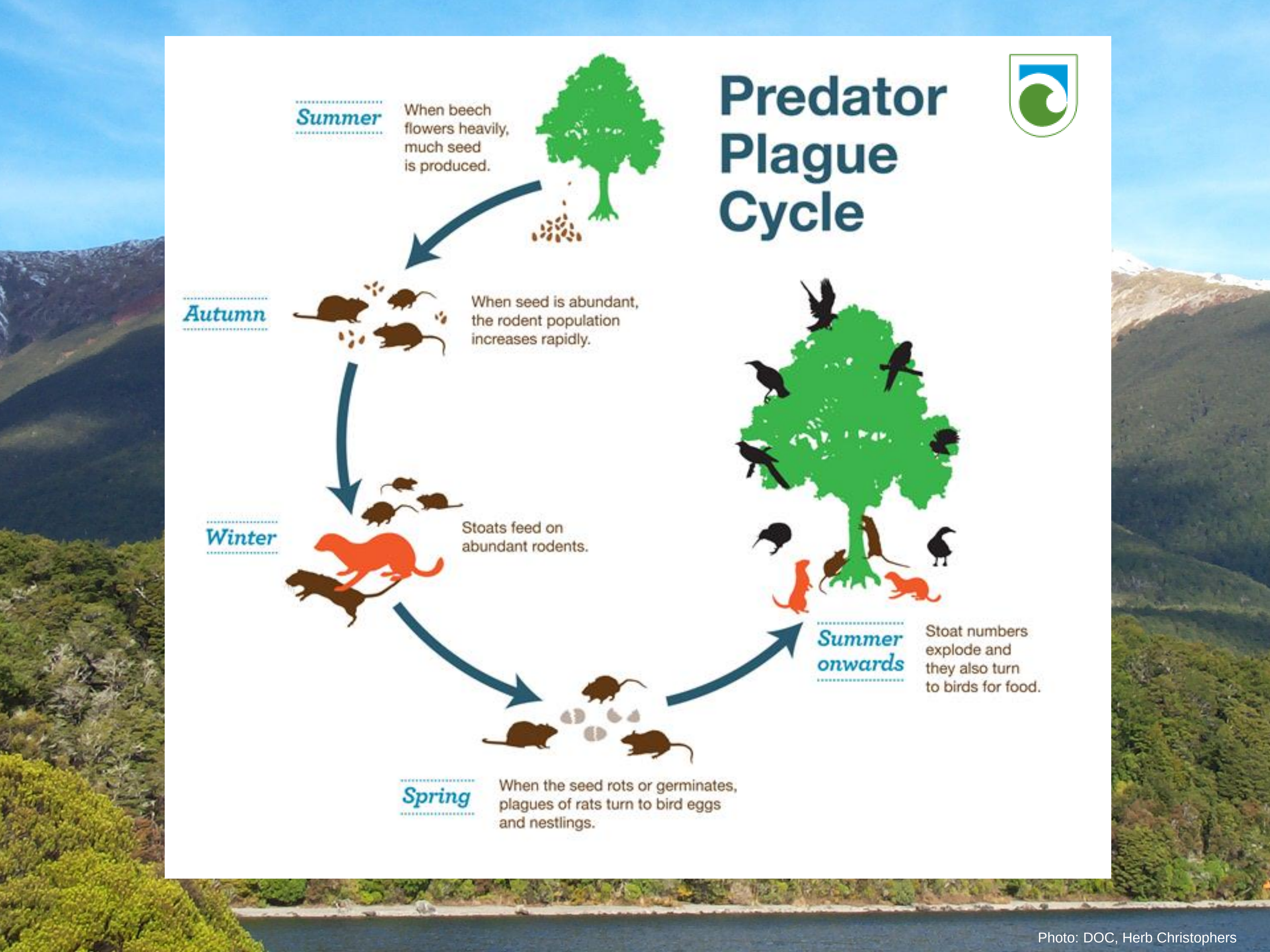


Photo: DOC, Herb Christophers

Predator control

Photos: DOC, Herb Christophe

Predicting mast events
- the traditional method

ECOLOGY LETTERS
Ecology Letters, (2012) doi: 10.1111/ele.12020

LETTER

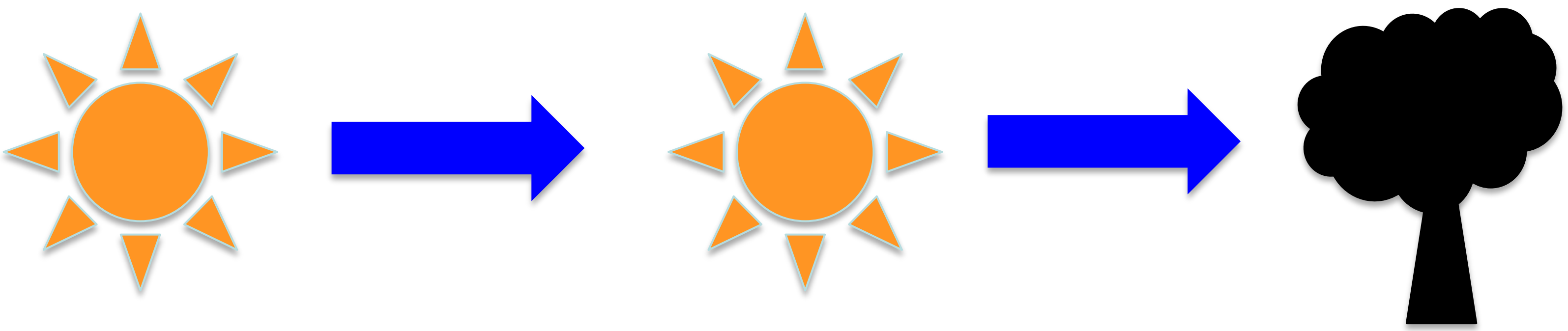
Of mast and mean: differential-temperature cue makes mast seeding insensitive to climate change

Dave Kelly,[1]* Andre Geldenhuis,[2] Alex James,[2] E. Penelope Holland,[3] Michael J. Plank,[2] Robert E. Brockie,[4] Philip E. Cowan,[3] Grant A. Harper,[5] William G. Lee,[3,8] Matt J. Maitland,[5] Alan F. Mark,[6] James A. Mills,[7] Peter R. Wilson[3] and Andrea E. Byrom[3]

The ΔT model

Difference in average summer temperature

$$\Delta T_t = T_{t\text{-}1} - T_{t\text{-}2}$$



$T_{t\text{-}2}$ — *2 years ago*

$T_{t\text{-}1}$ — *Last year*

Seed this year

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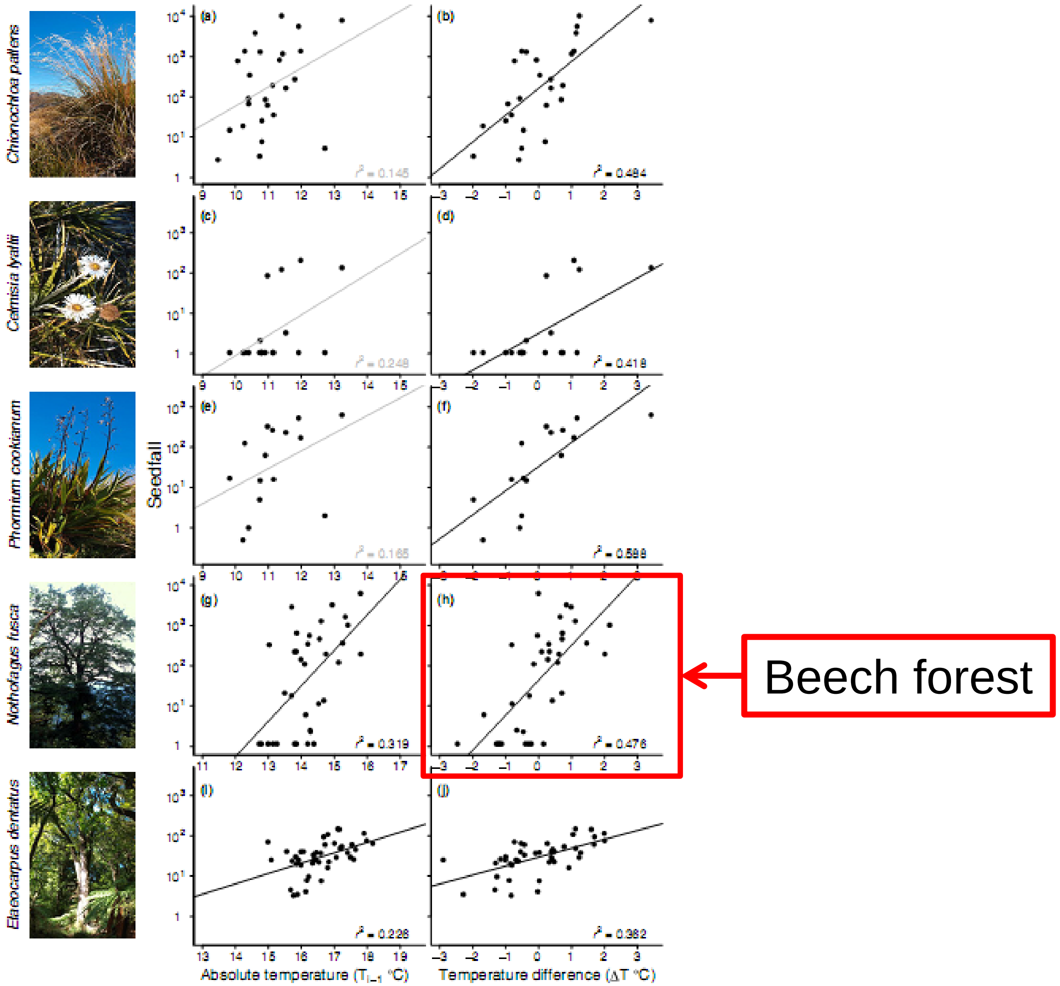
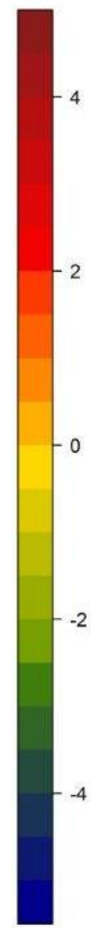


Figure 1 In five diverse plant families, seed crops were better predicted using temperature differential ΔT (summer temperature in the previous year minus summer temperature 2 years before, right column) than previous summer absolute temperature T_{i-1} (centre). The horizontal axes have different minima, but identical ranges. Light grey r^2 values and regression lines were not significant. Summer is January–March in all cases. For information on all 26 datasets see Table 2.

ΔT



High probability of a mast

Low probability of a mast

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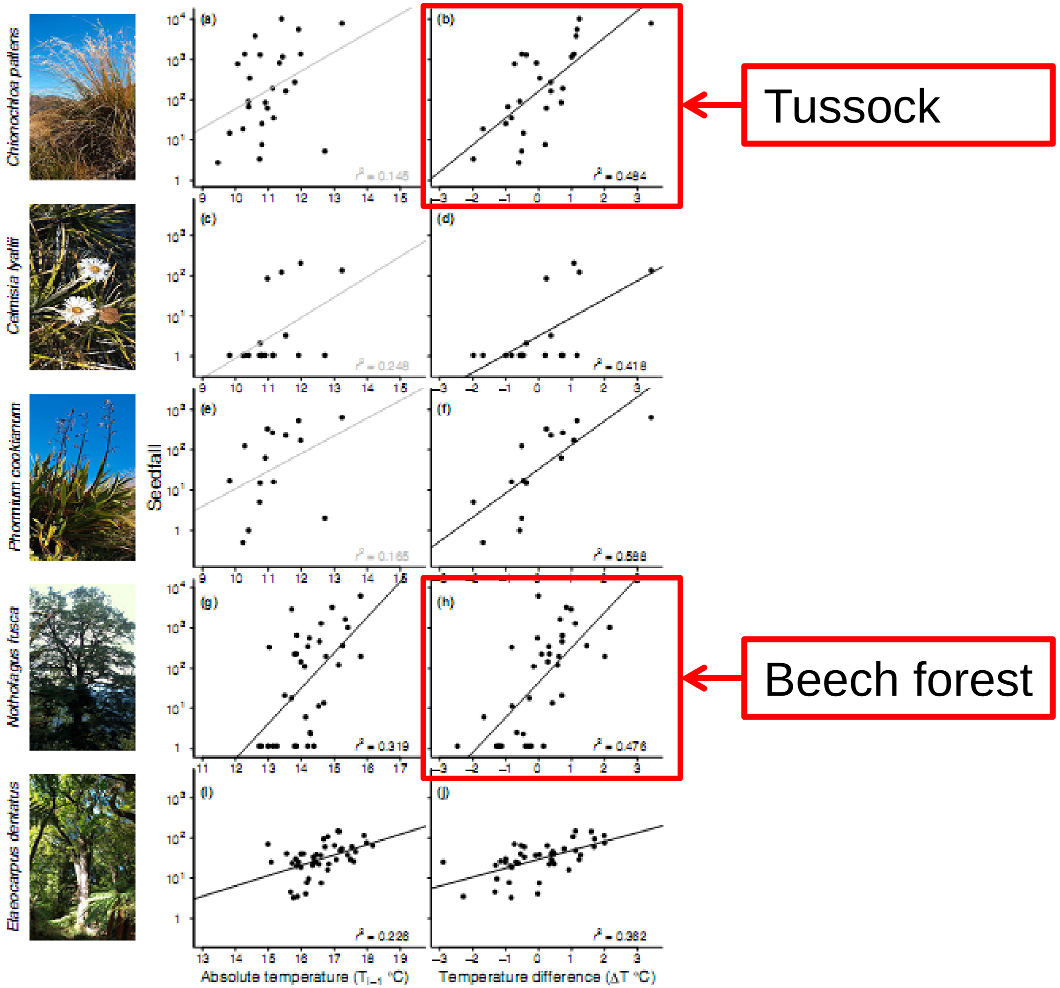

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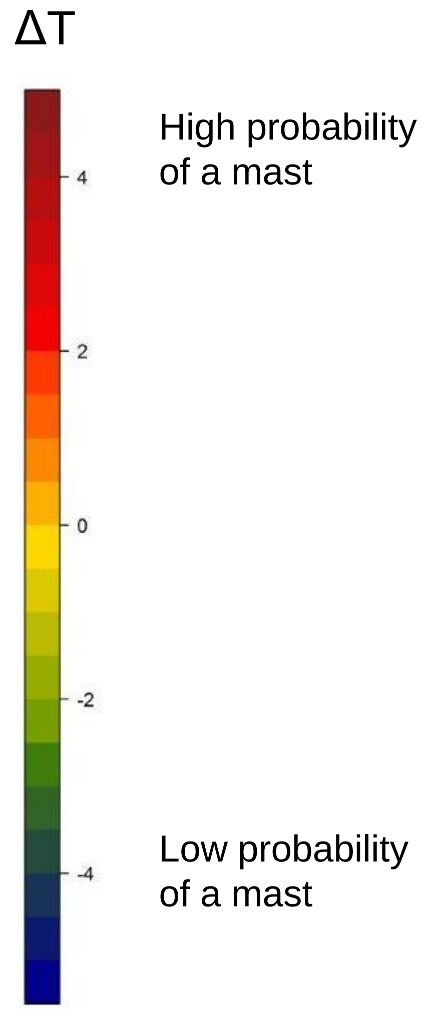
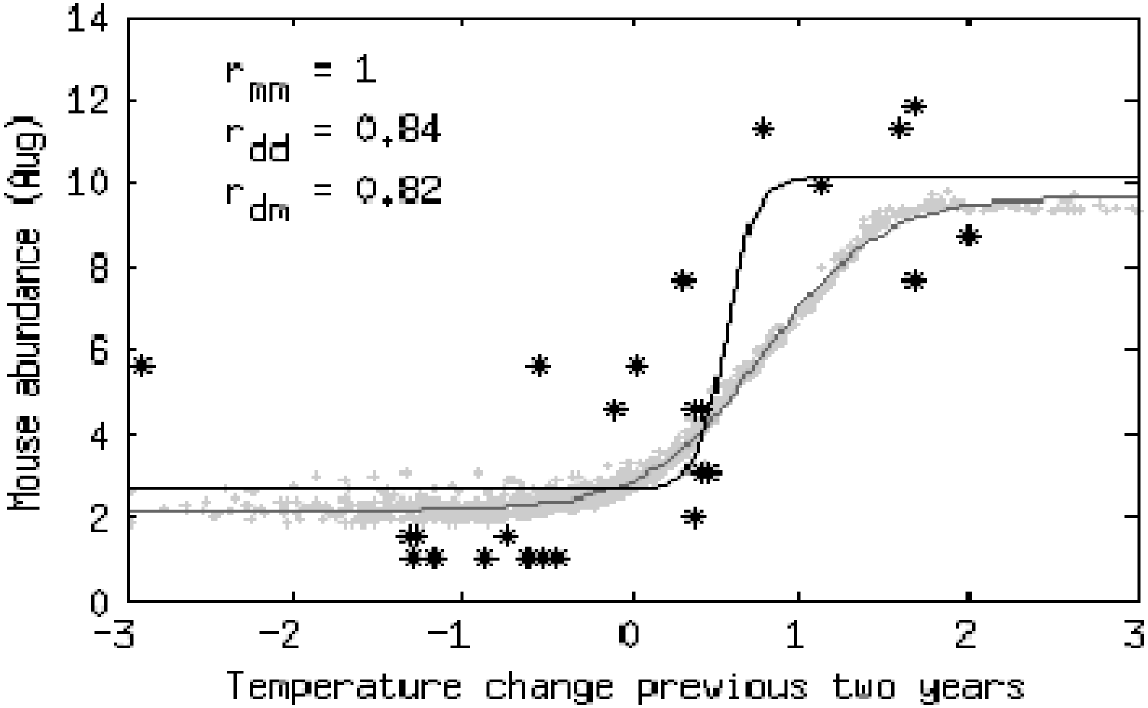


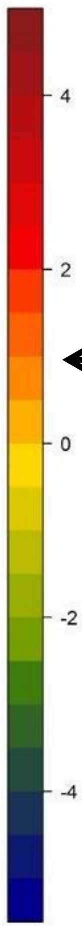
PLOS | ONE

RESEARCH ARTICLE

Climate-Based Models for Pulsed Resources Improve Predictability of Consumer Population Dynamics: Outbreaks of House Mice in Forest Ecosystems



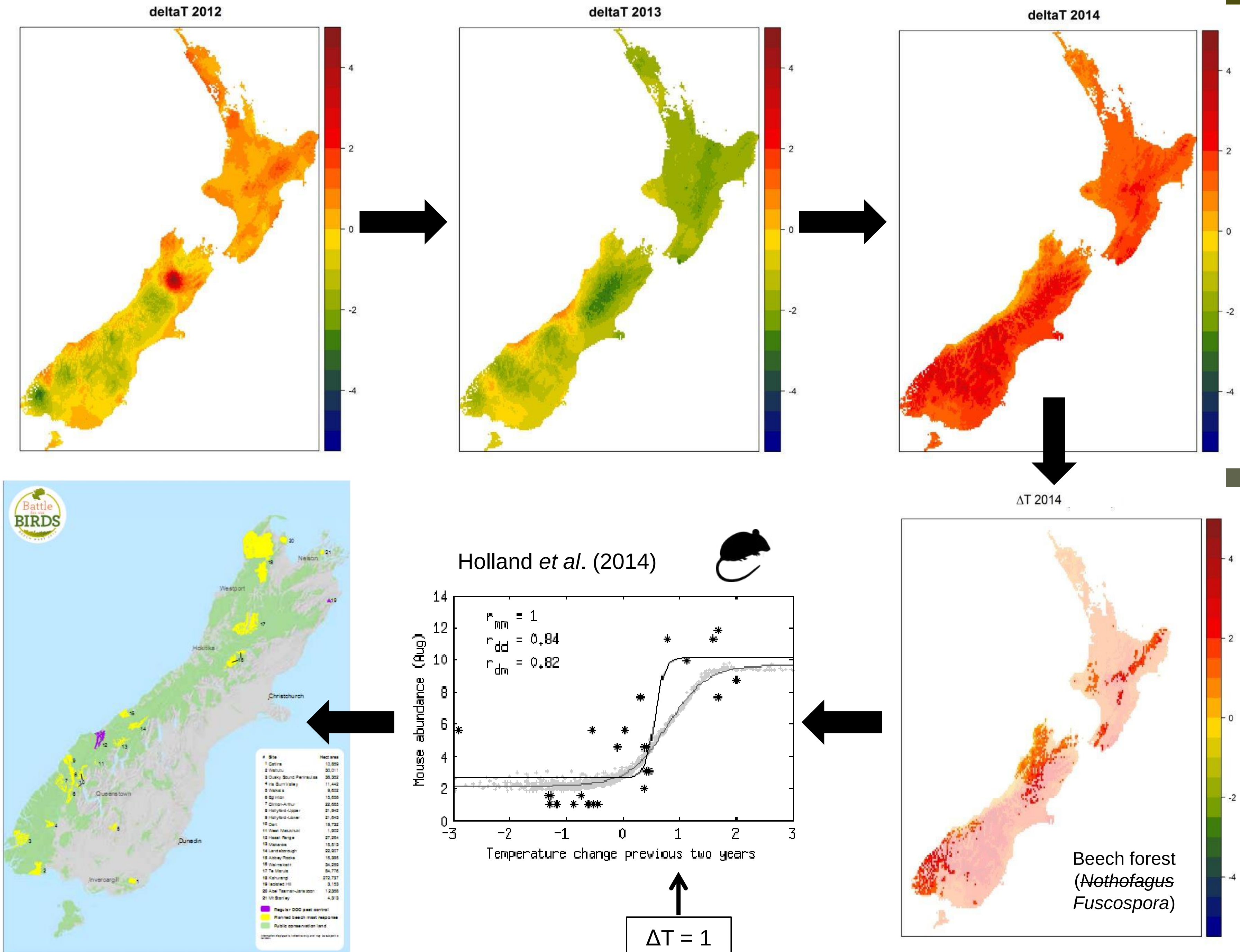
ΔT



High probability of a mast

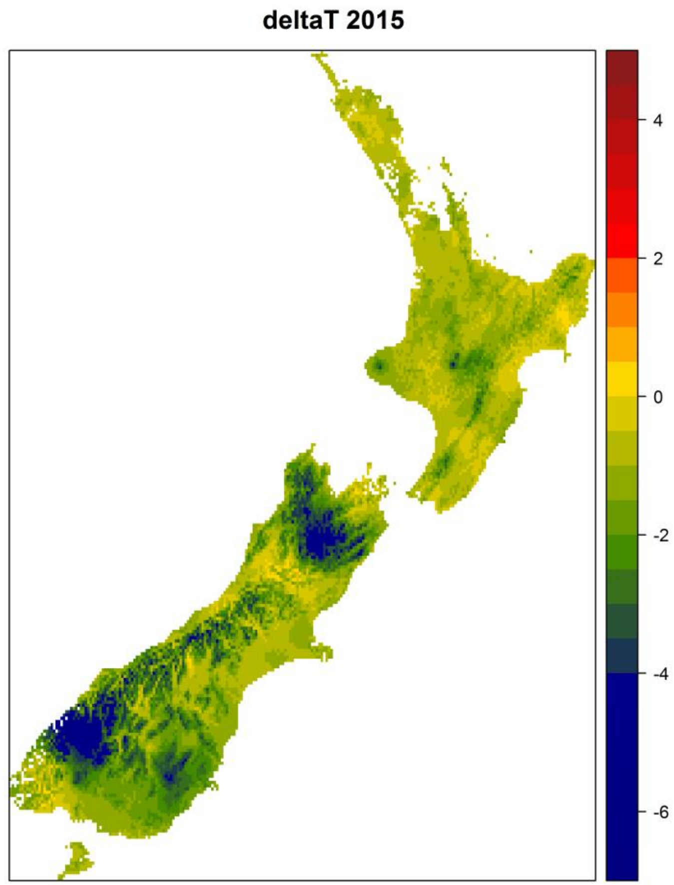
ΔT = 1

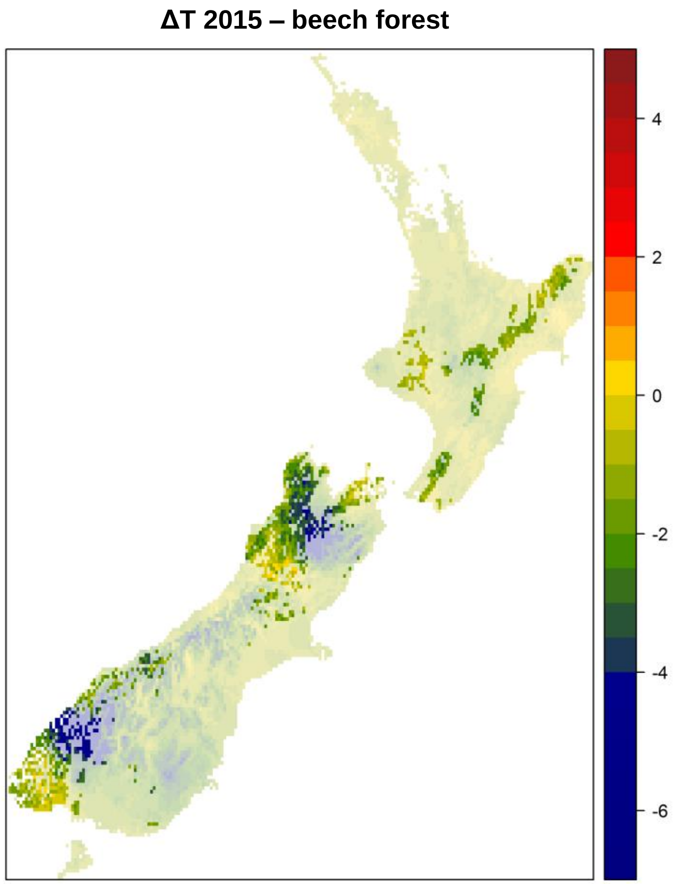
Low probability of a mast


deltaT 2012
deltaT 2013
deltaT 2014
ΔT 2014
Beech forest
(Nothofagus
Fuscospora)
Holland et al. (2014)
r_mm = 1
r_dd = 0.84
r_dm = 0.82
Mouse abundance (Aug)
Temperature change previous two years
ΔT = 1
Battle for the BIRDS
Nelson
Westport
Hokitika
Christchurch
Queenstown
Dunedin
Invercargill

No mast forecast for 2015

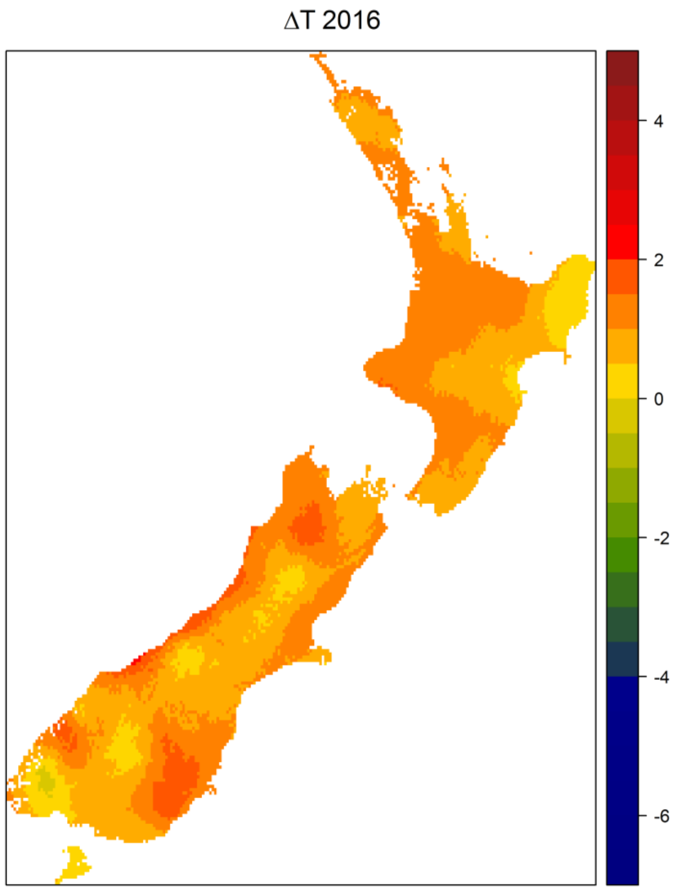
$\Delta T\ 2015 = T_{summer\ 2014} - T_{summer\ 2013}$

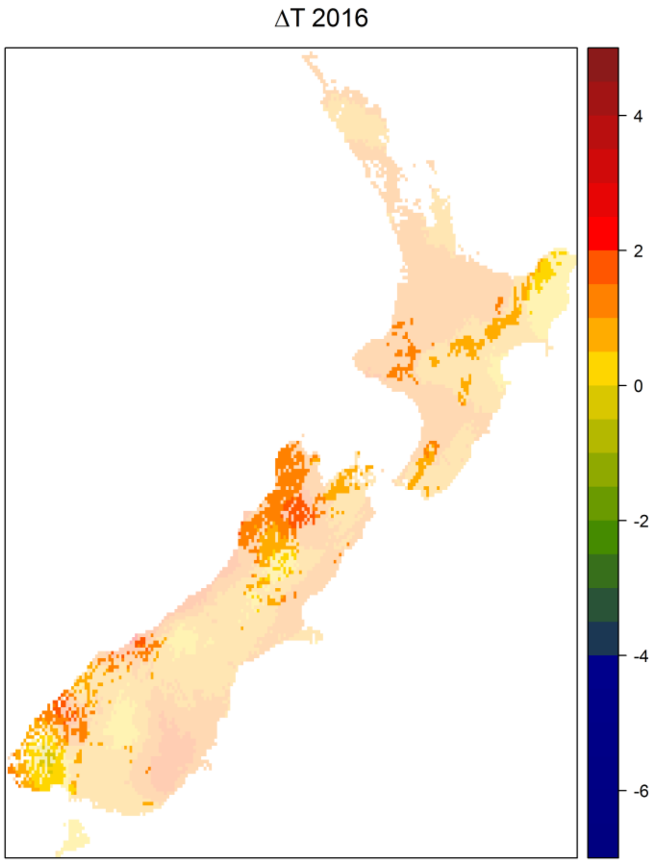




Mast prediction for 2016

$\Delta T\ 2015 = T_{summer\ 2014} - T_{summer\ 2013}$



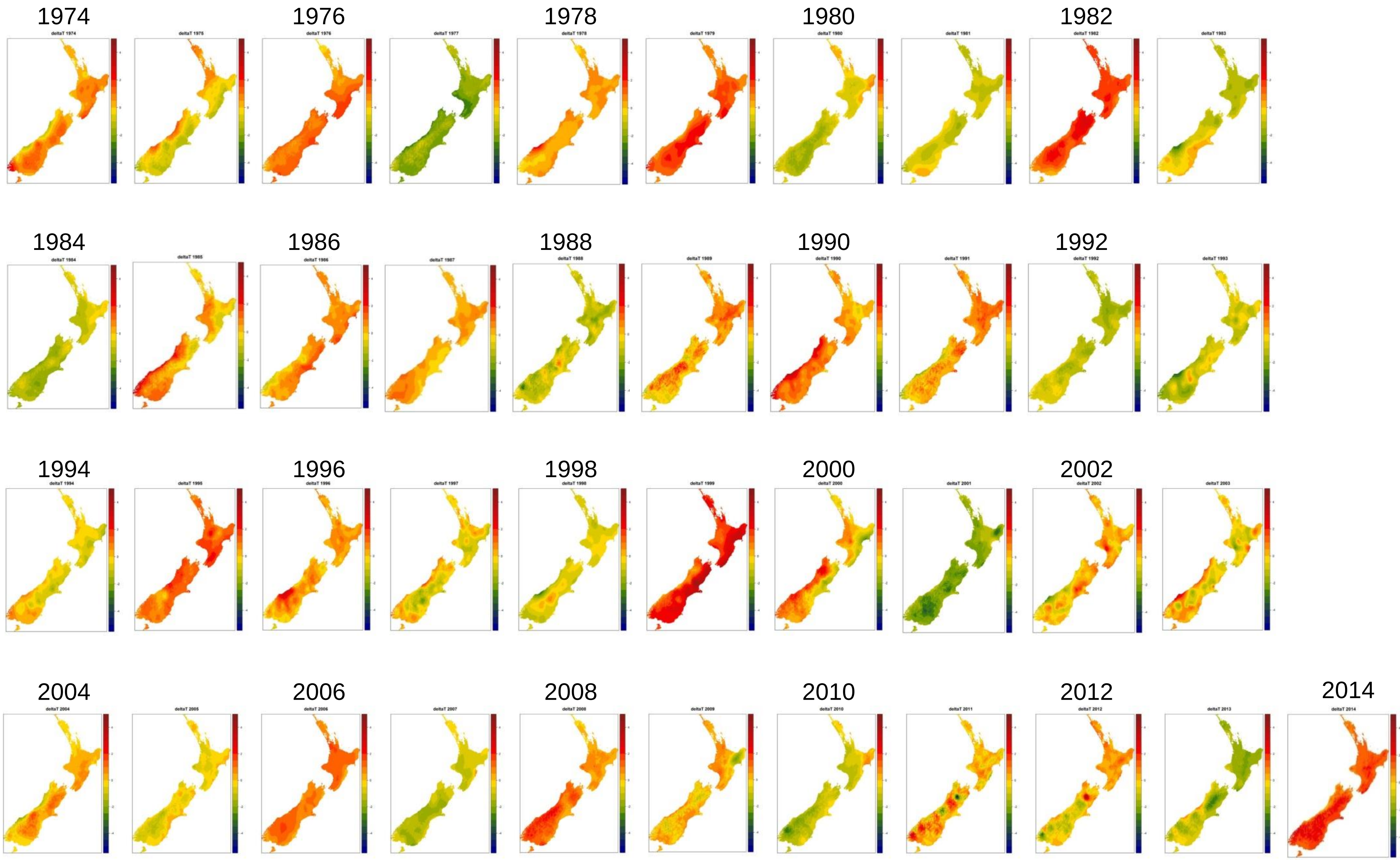


Key questions

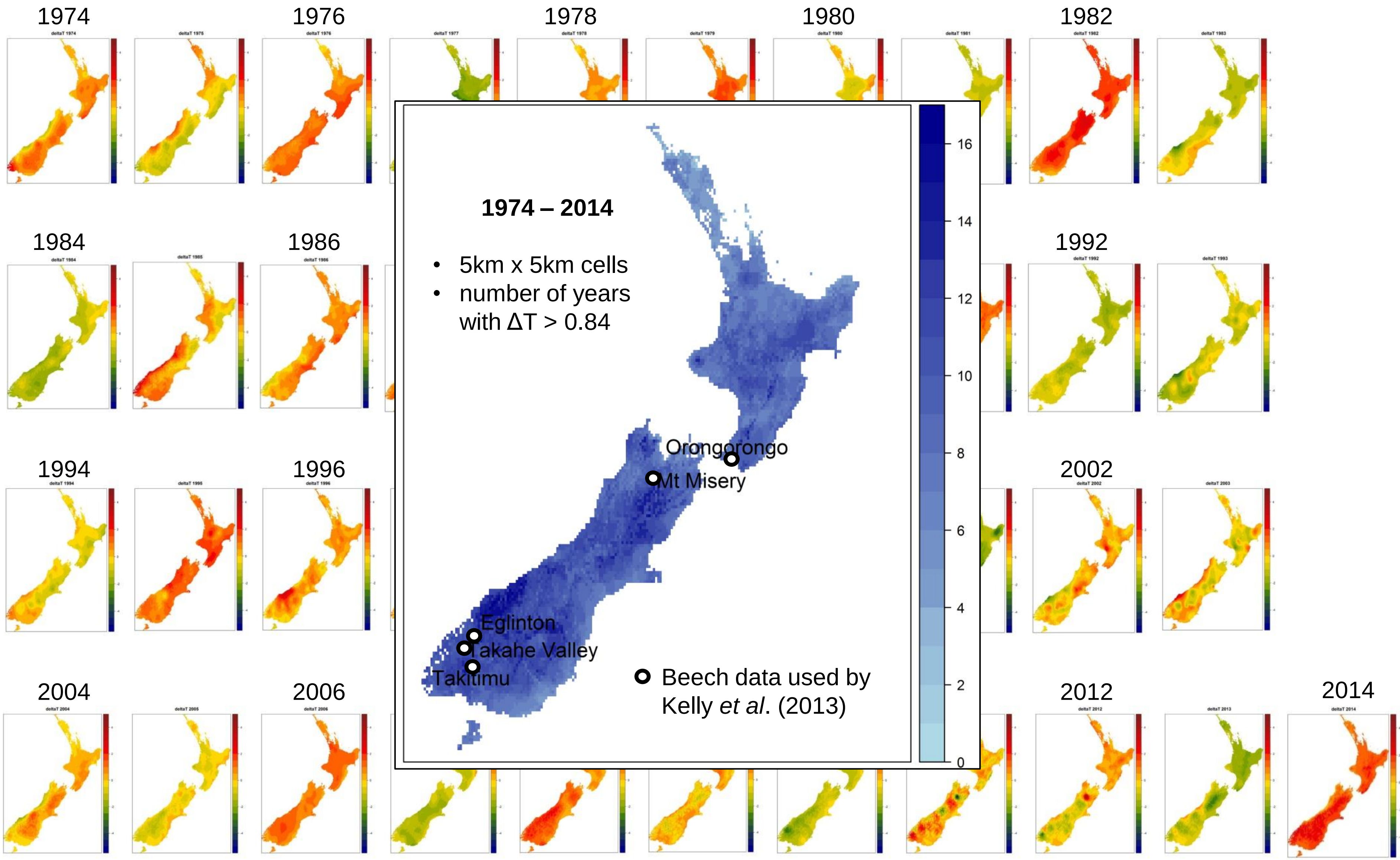
1. Are some areas in New Zealand more prone to masts? Are masts always widespread?
2. How often have mega-masts happened in the past?
   (‘mega-mast’: > 50% of beech forest predicted to experience a mast)
3. Will the frequency of mega-masts increase in the future?
4. How do mega-masts affect the cost of controlling invasive mammals?

Occurrence of masts

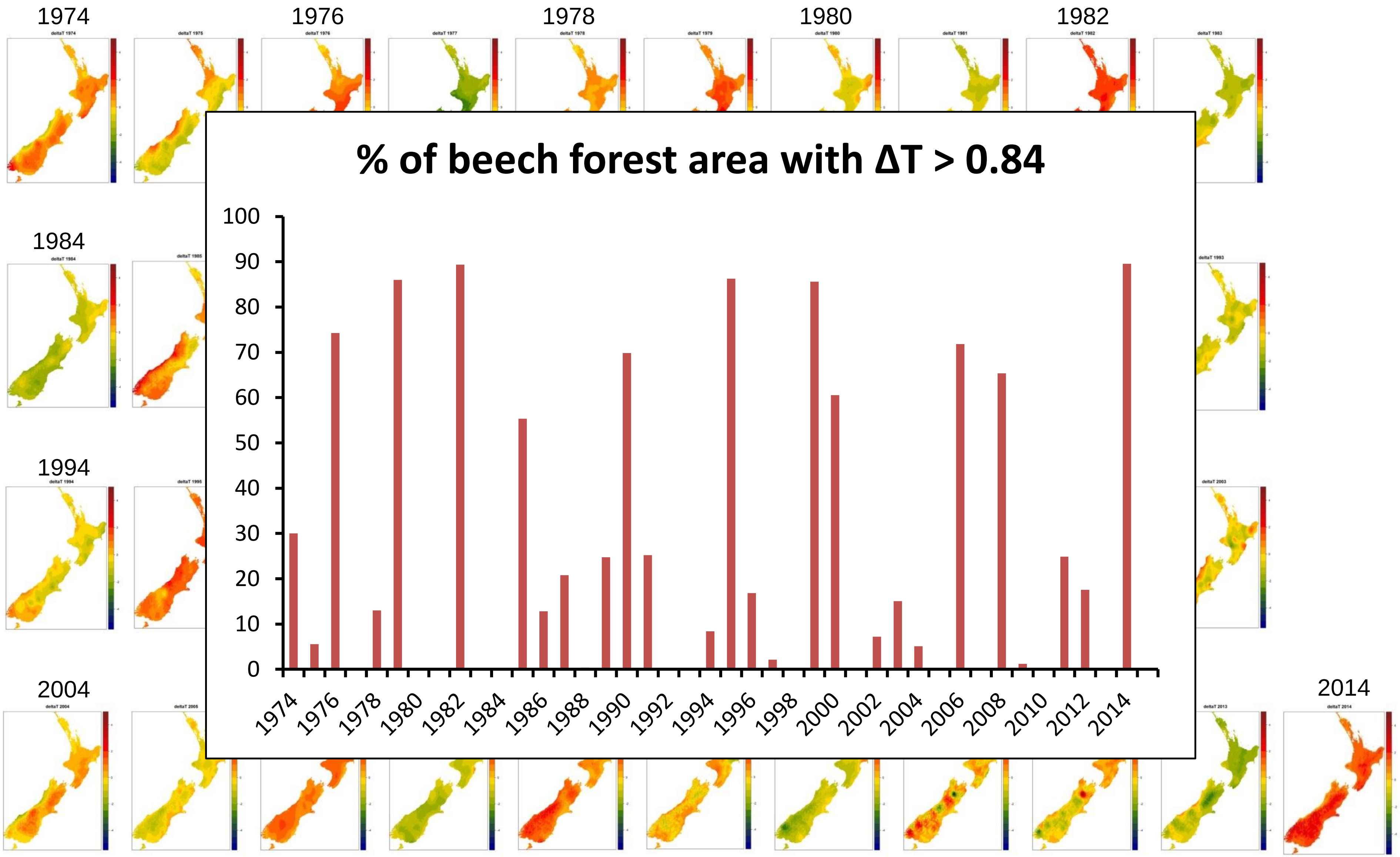
ΔT maps for 1974-2014



1a. Some areas are mast-prone



1b. Mast area is highly variable



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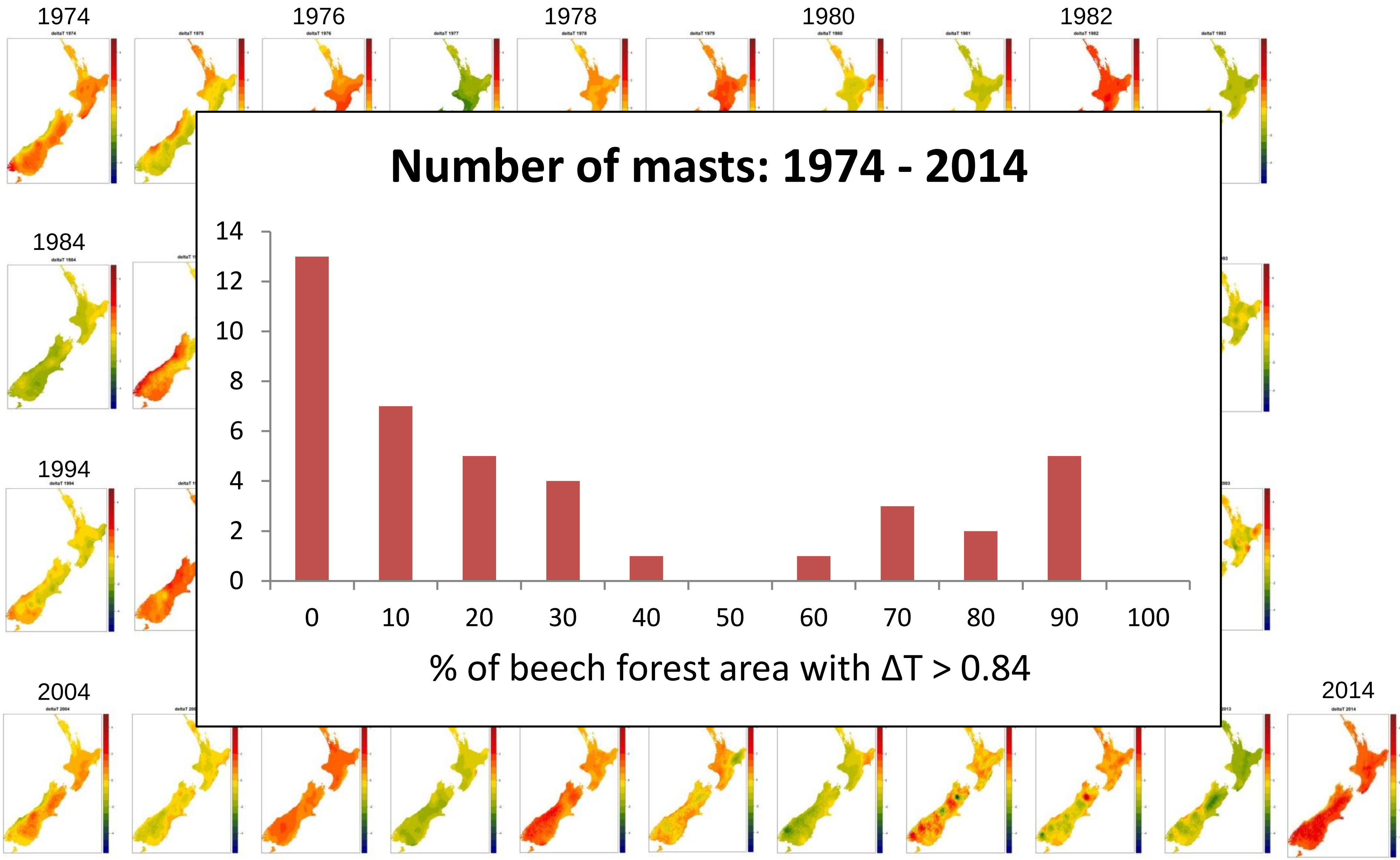
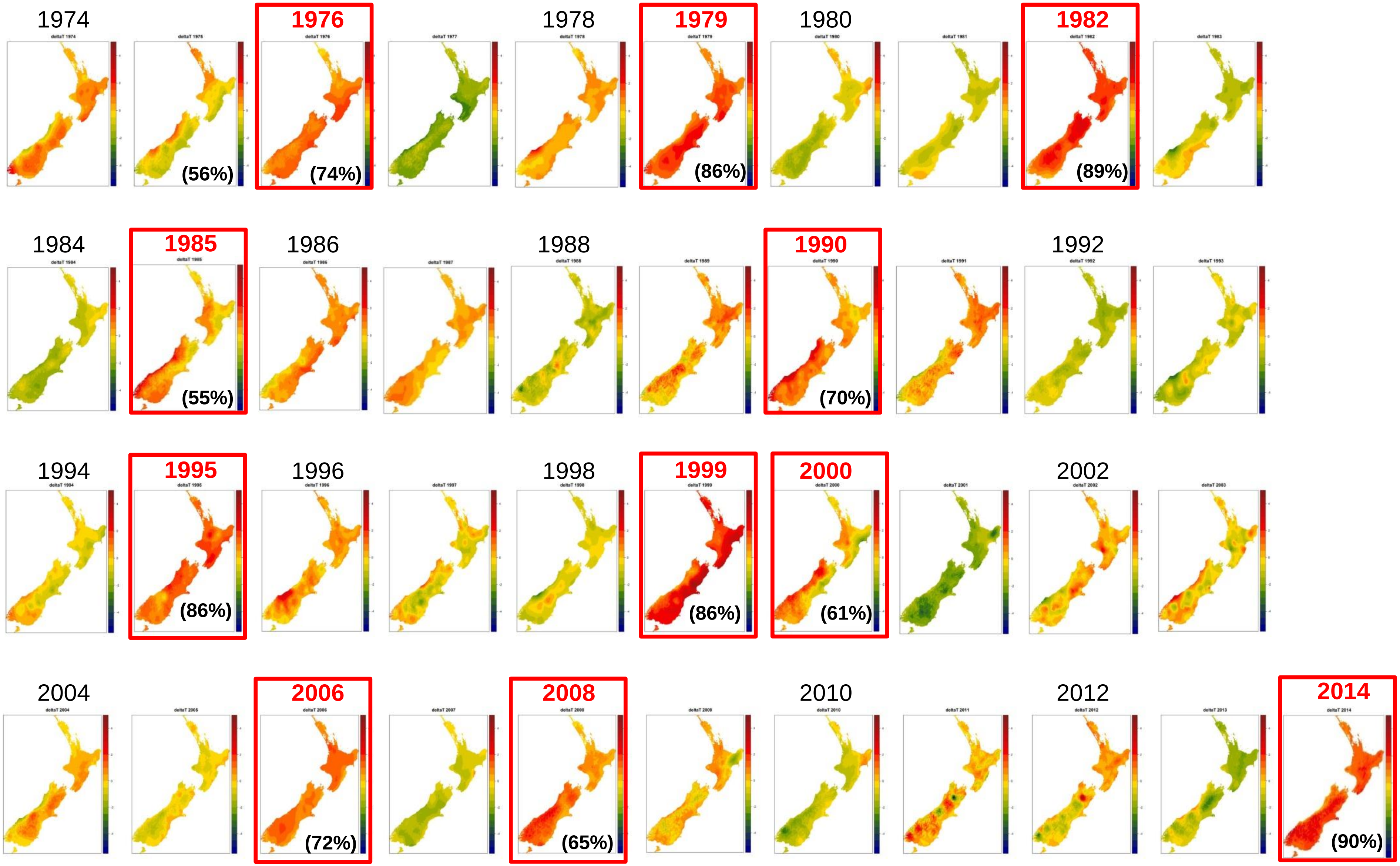


2. Mega-masts during 1974-2014

Years with 'predicted' beech mega-masts (>50% beech forest with ΔT>0.84)



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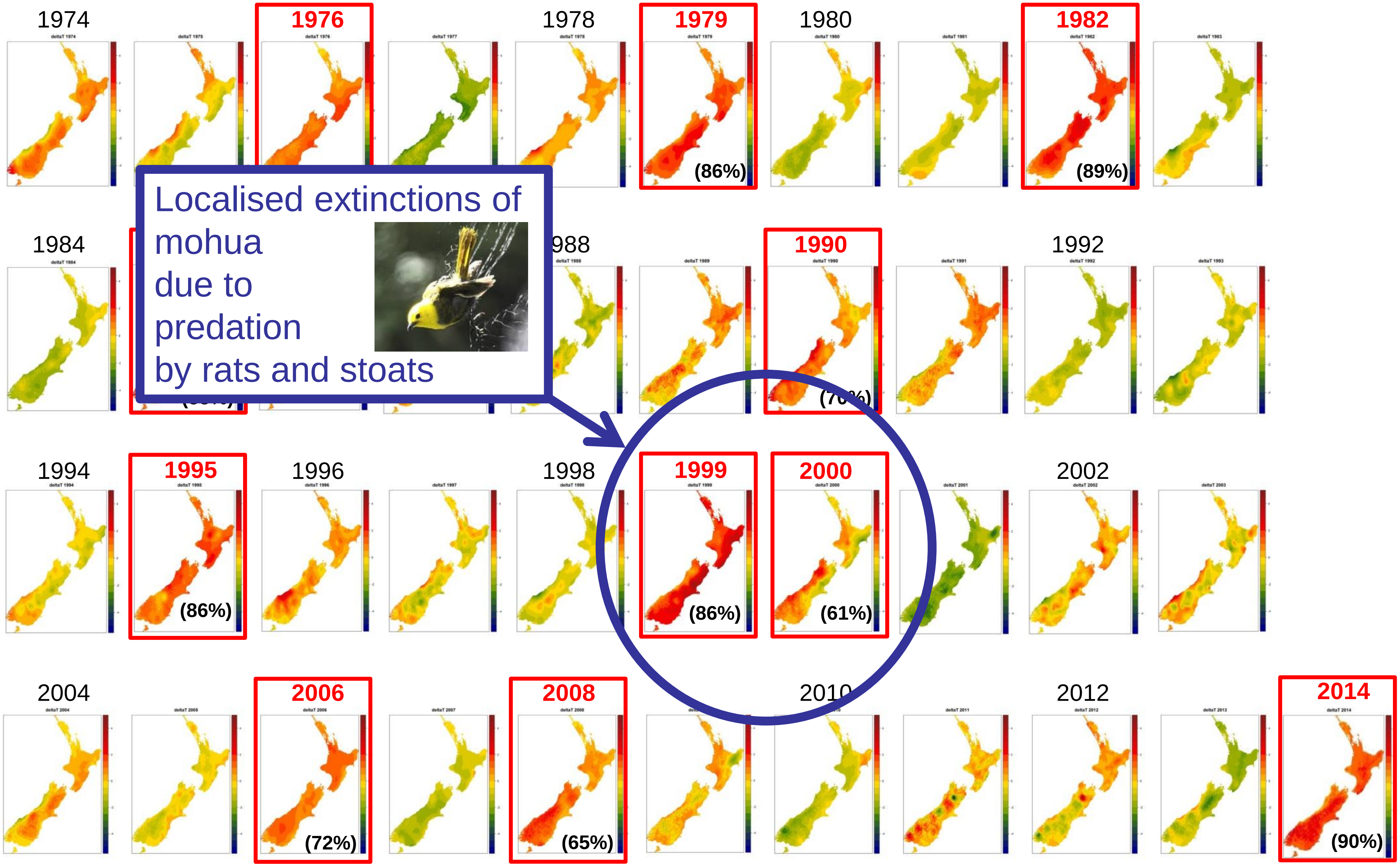

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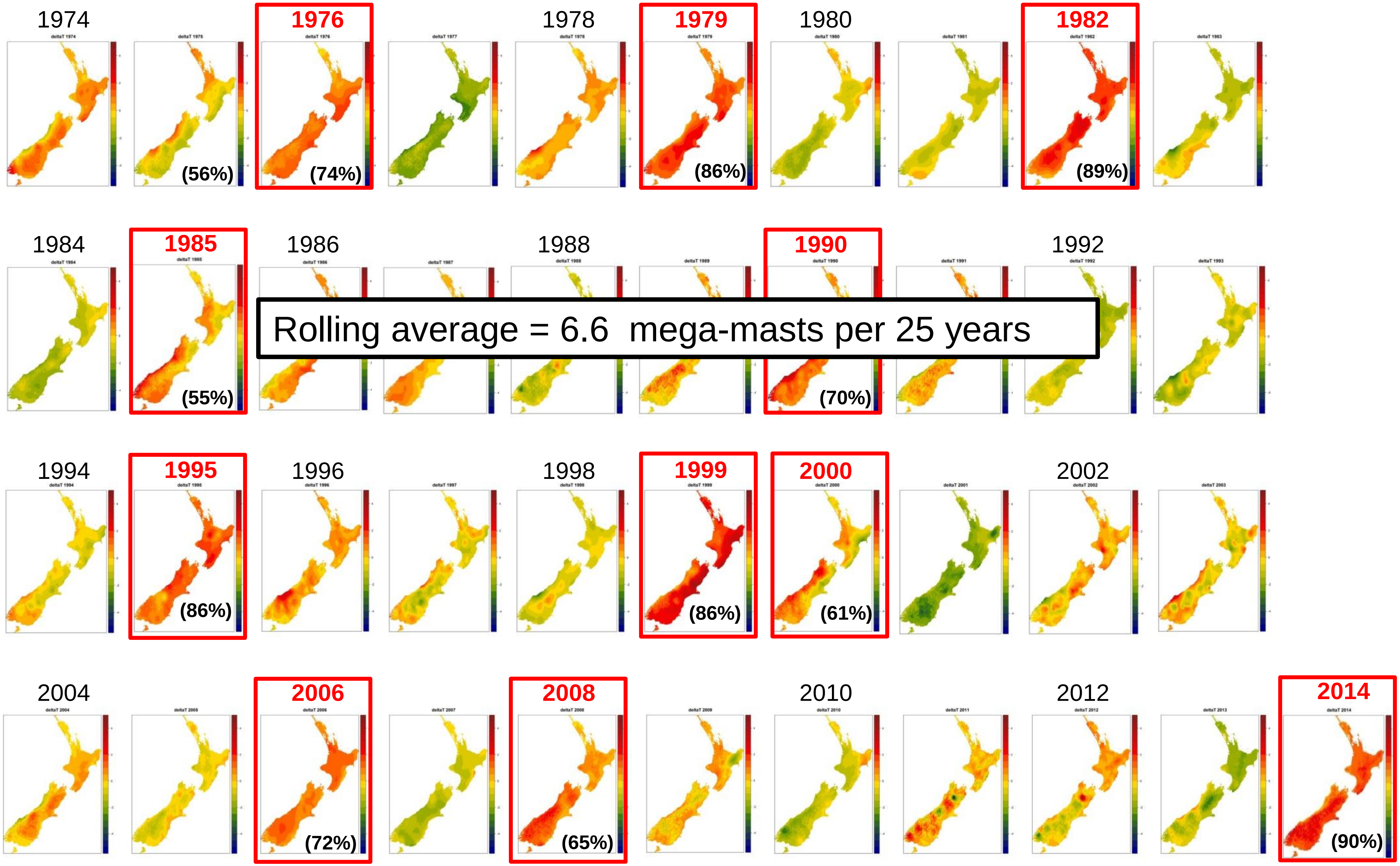
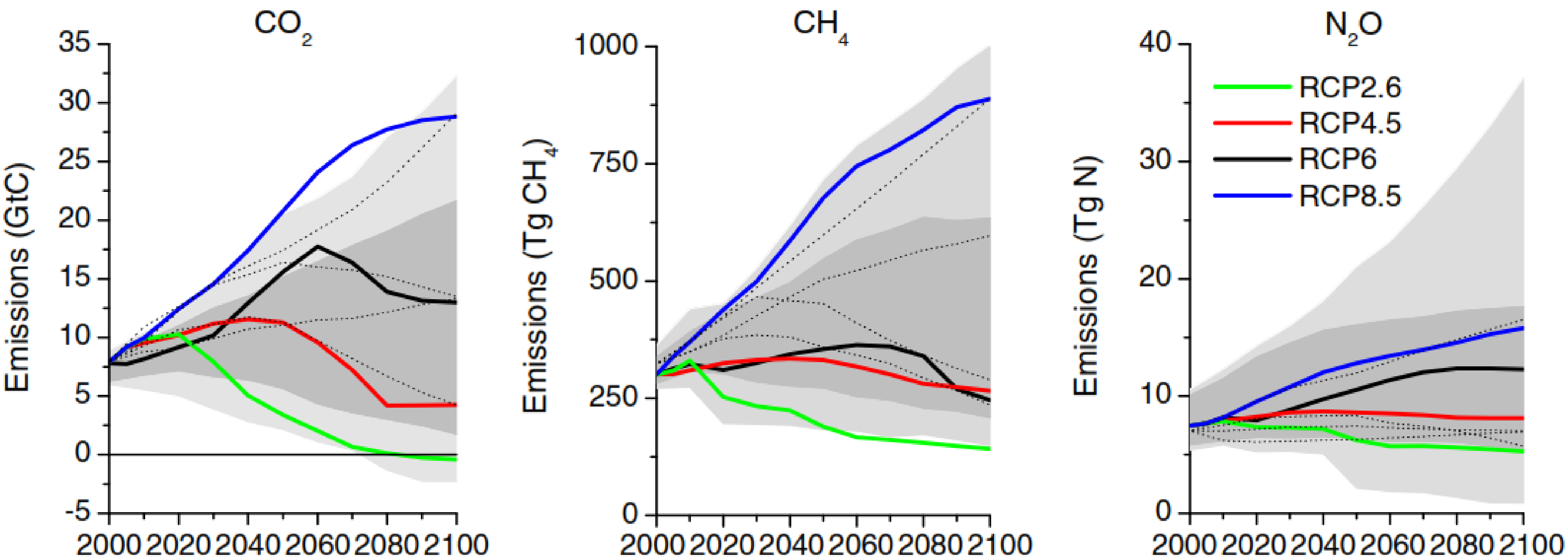




Van Vuuren *et al. Climate Change* (2001) 109:5–31

3. Global climate change to 2100

ΔT projections for 4 climate-change scenarios:

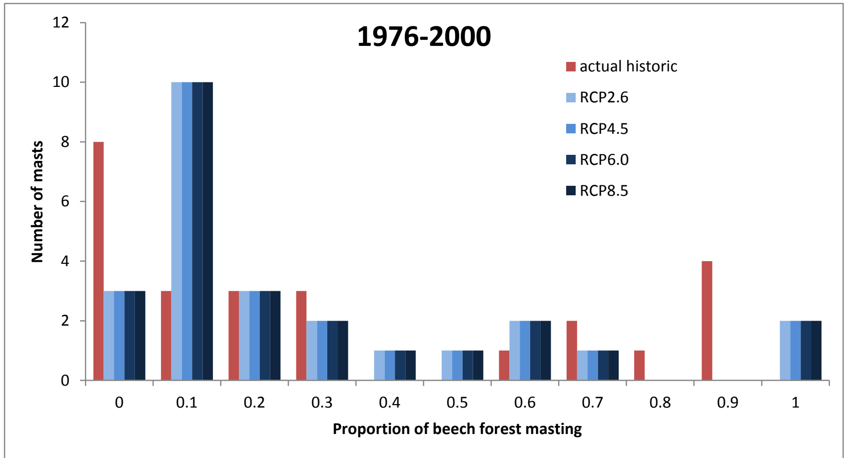
- **RCP 8.5** = very high greenhouse gas emissions
- **RCP 6** = high level stabilisation
- **RCP 4.5** = intermediate stabilisation
- **RCP 2.6** = declining greenhouse gas emissions

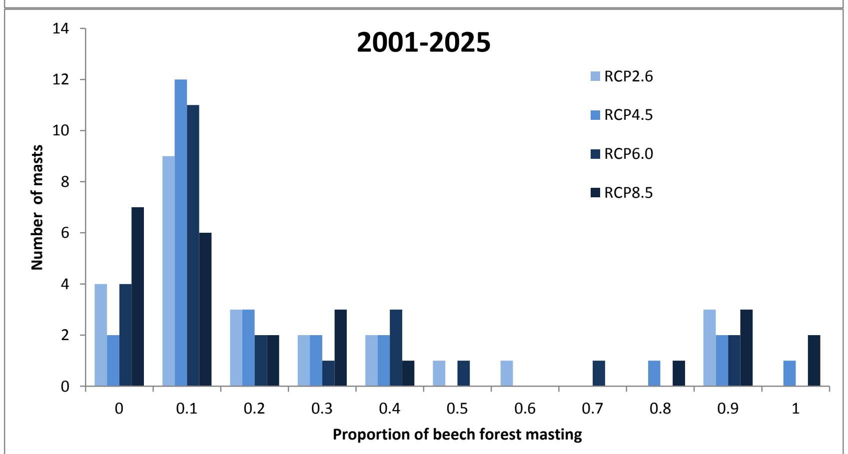
3. Frequency of mega-masts: 2001 – 2100

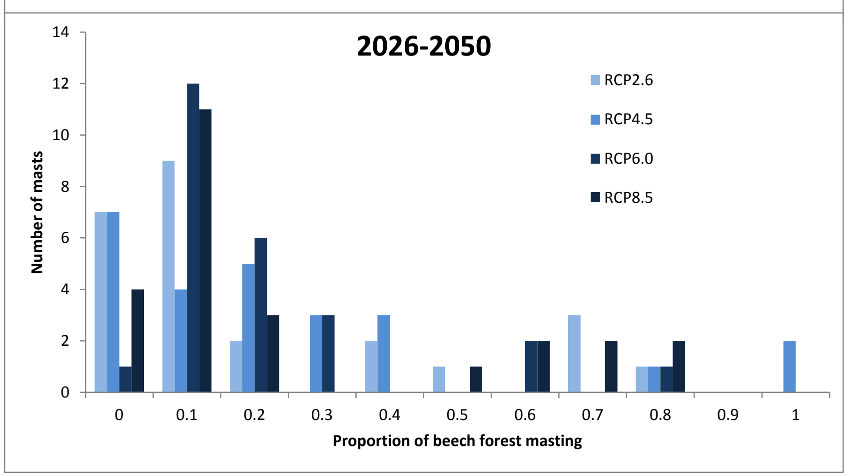
Time period	Number of mega-masts per 25 years				
	RCP 2.6	RCP 4.5	RCP 6	RCP 8.5	Historic data
	Declining emissions	Intermediate stabilisation	High level stabilisation	Very high emissions	
1976 – 2000	5	5	5	5	8
2001 – 2025	4	4	3	6	
2026 – 2050	4	3	3	6	
2051 – 2075	4	2	3	5	
2076 – 2100	2	3	1	0	
2001 - 2100	14	12	10	17	

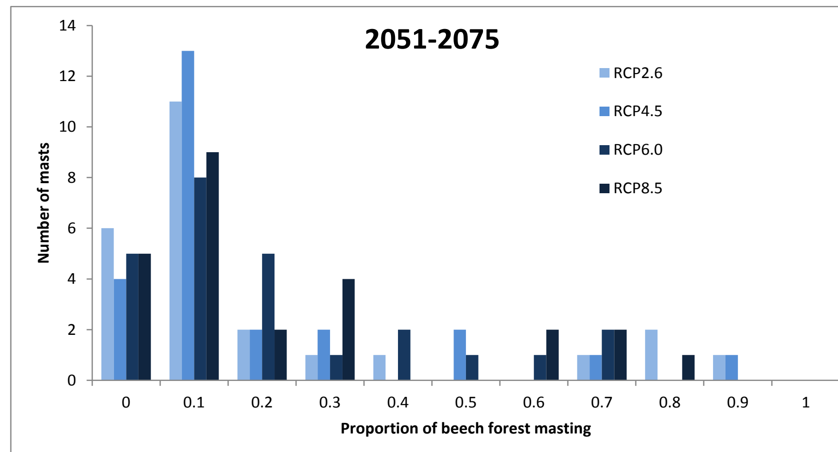
- Mega-mast: >50% beech forest with $\Delta T>0.84$
- Results are based on NIWA projections using the UK Hadley Centre atmospheric general circulation model

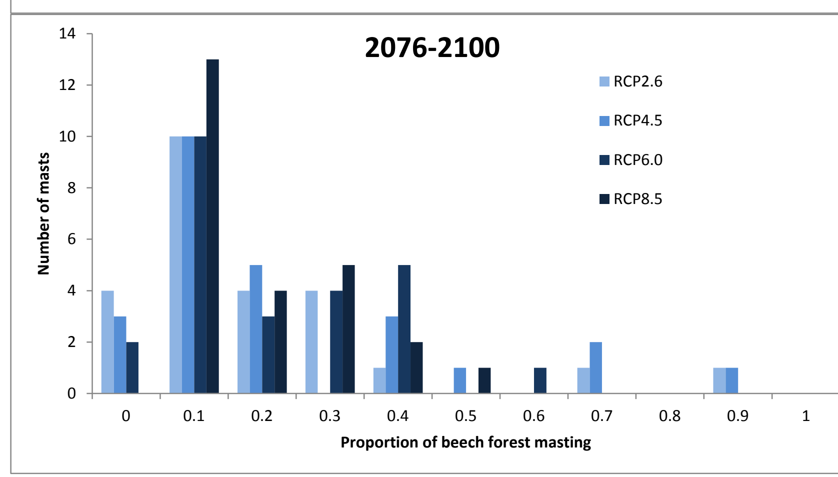
3. Frequency distribution of masts





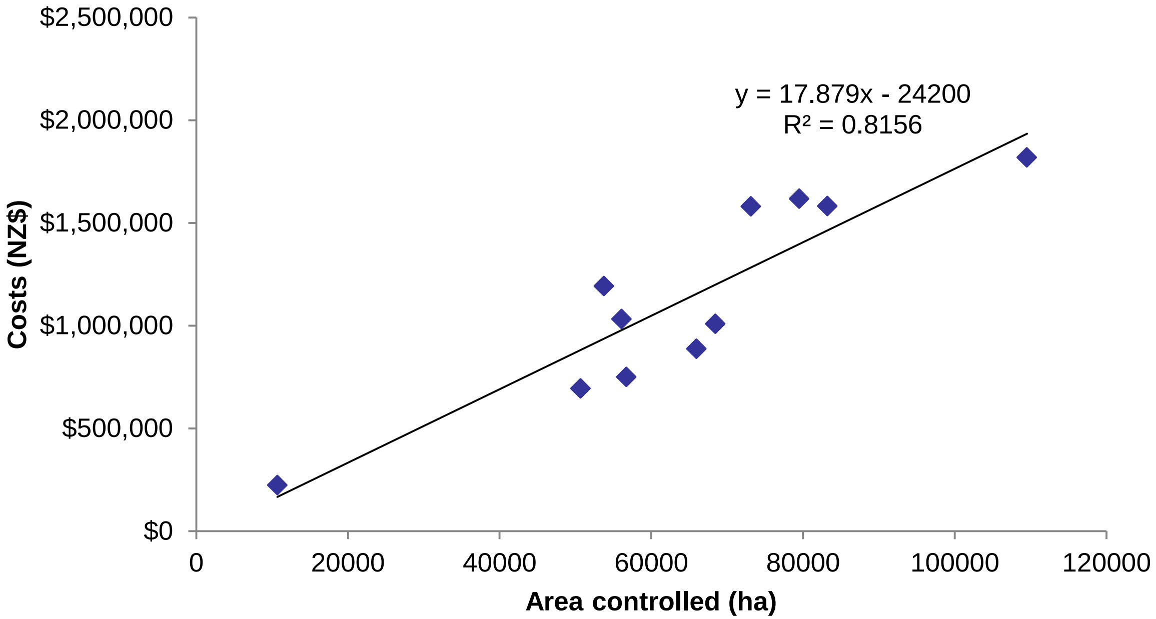


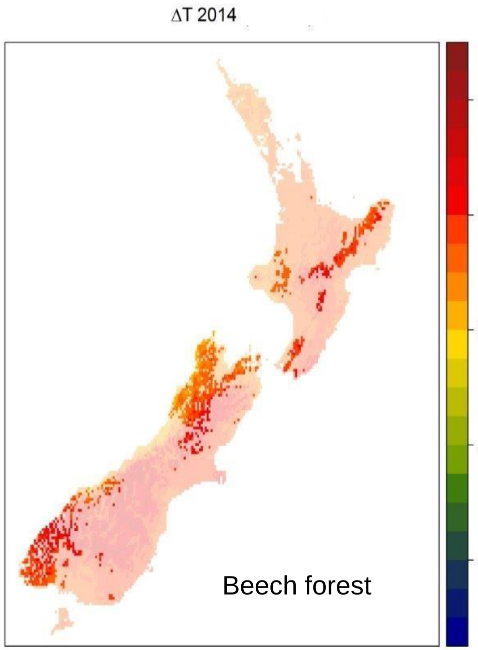




4. Mega-masts & the cost of pest control

Expenditure on aerial control (Department of Conservation, 2003-2013)



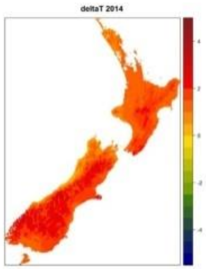


For the 2014 mega-mast:

- 90% of beech forest had ΔT > 0.84
- 3,812,500 ha of beech forest had high probability of a mast
- estimated cost of aerial baiting for *all* predicted beech-mast areas = $68M

Summary

ΔT model



Ecology:

- Masts are correlated with summer temperatures
- Masts result in outbreaks of invasive mammals
- Predation by invasive mammals can be catastrophic for native fauna

Management:

- ‘Battle for our Birds’: approx. $12M for pest control
- 11 ‘mega-masts’ in beech forest in the last 40 years
- Potential costs of pest control: $42M - $68M *per event*

Climate change could:

- affect the frequency of ‘mega-masts’ in NZ forests
- result in more (**RCP 8.5**), or similar (**RCP 2.6**, **RCP 4.5**, **RCP 6**), episodic high costs of pest control

Summary

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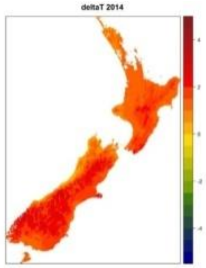

Ecology:

- Ma
- Ma
- Pre native fauna

Question: Can meta-populations of indigenous species/communities survive widespread threats such as those following 'mega-masts'?

Management:

- 'Ba
- 11
- Pot

Question: How well does annual fiscal planning cope with costly episodic threats, or should DOC take out insurance for 'mega-masts'?

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