Deployment of Alternative Species in Planted Conifer Forests as a Strategy for Adapting Forests to Climate change: case studies from Scotland and New Zealand

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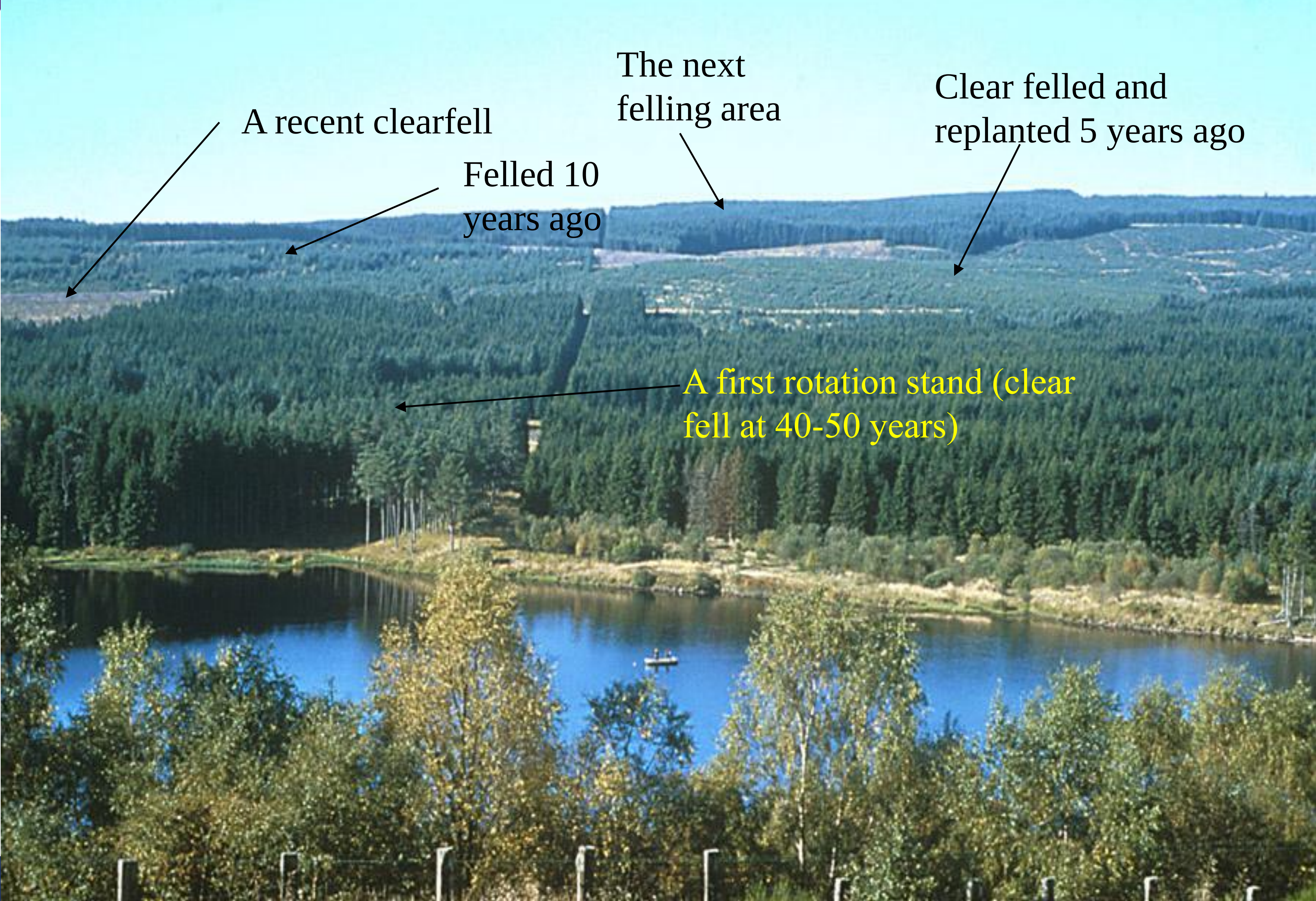
Issues in adapting planted forests to climate change

1. Projections suggest that planted forests may prove increasingly vulnerable to the impacts of climate change (e.g. drought, pests, wind, fire);
2. However, managers of planted forests frequently show a reluctance to diversify species or silviculture as a means of adapting to projected change;
3. This reluctance is most apparent in planted forests managed on short to medium rotations (i.e. up to 40-50 years)

Basic statistics and main silvicultural features

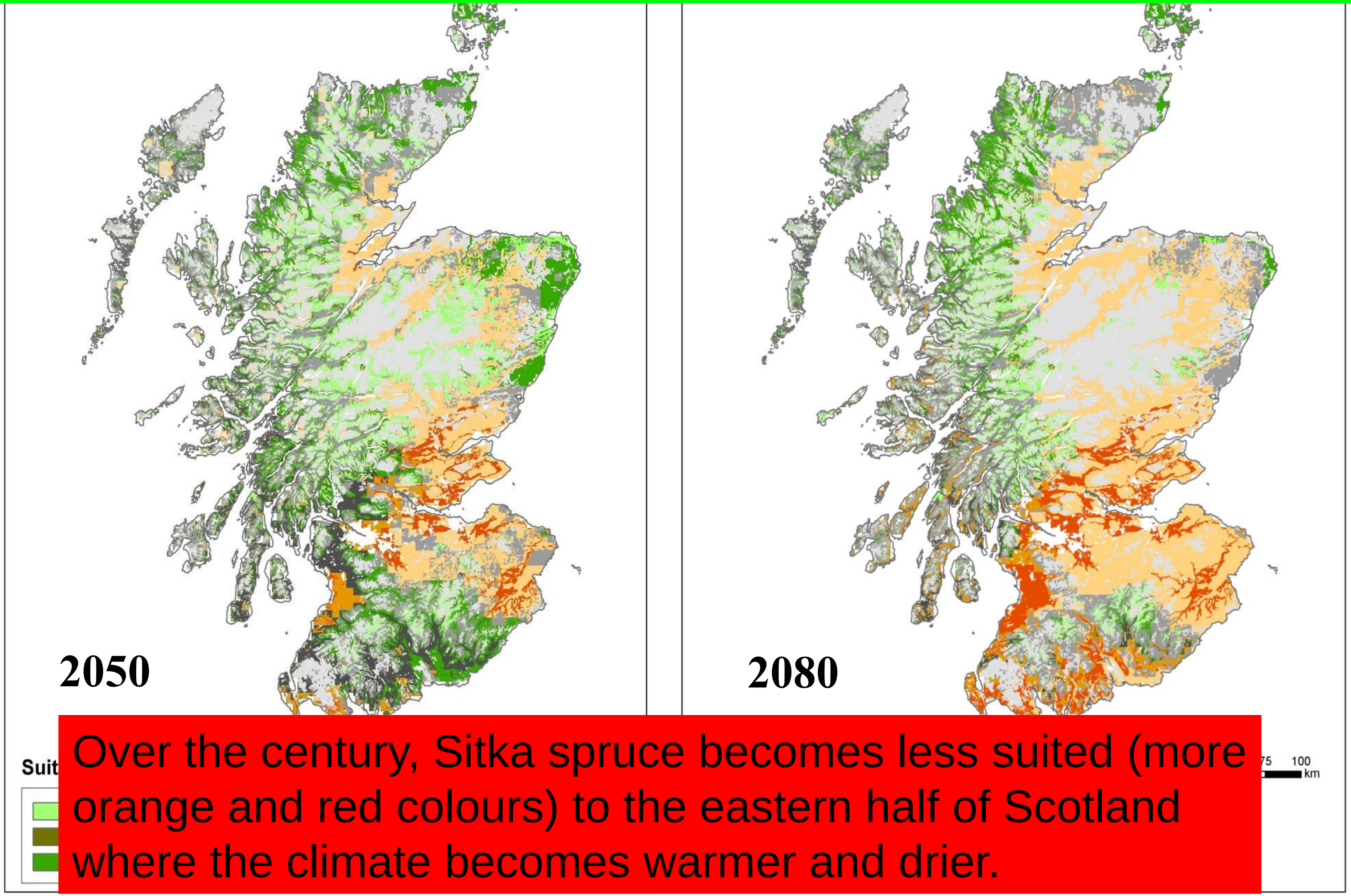
	Scotland	New Zealand
Planted forest (M ha)	1.1	1.8
Main species (%)	*Picea sitchensis* (52)	*Pinus radiata* (90)
	Pinus sylvestris and *P. contorta* (24)	*Pseudotsuga menziesii* (6)
Initial spacing (m)	2.0	2.5-3.5
Thinning	2-4 times (50 % of sites)	2-3 times
Silvicultural system	Patch clearfelling and replanting	
Rotation (yrs)	40-50	25-35
Current hazards	Wind, *Elatobium abietinum* (spruces), *Dothistroma* needle blight (pines)	Wind, *Dothistroma* needle blight (pines)

Standard management of Sitka spruce forests in northern Britain



A plot of clonal *Pinus radiata* at about 20 years of age.

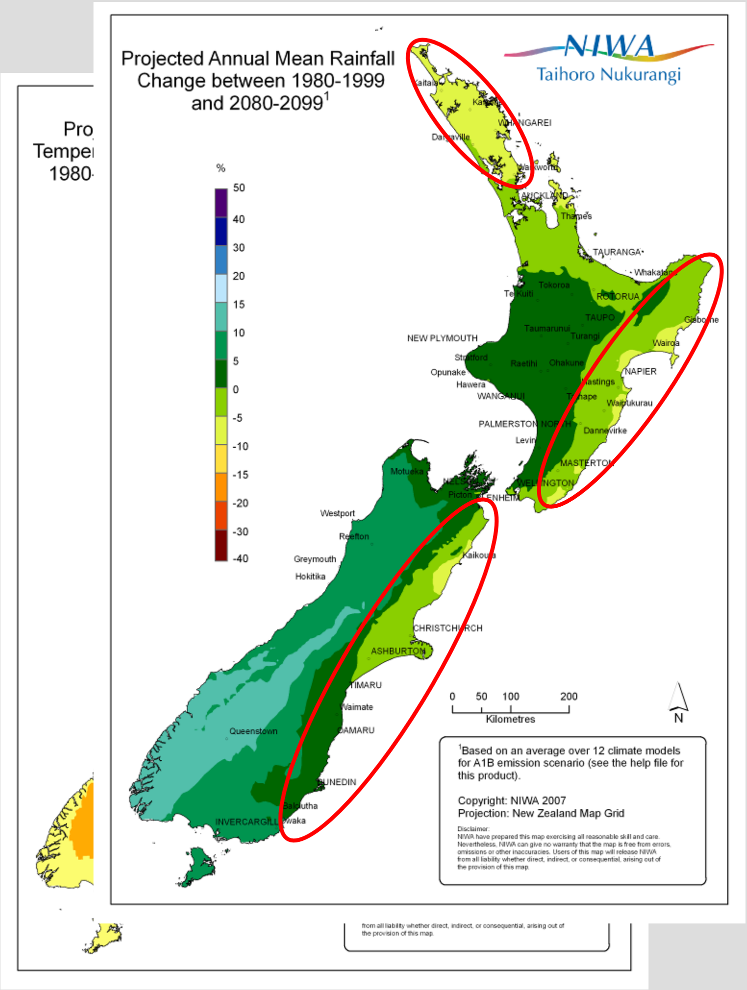
Changes in climatic suitability for Sitka spruce in Scotland from 2005 to 2050 and 2080 (Ray, 2008)



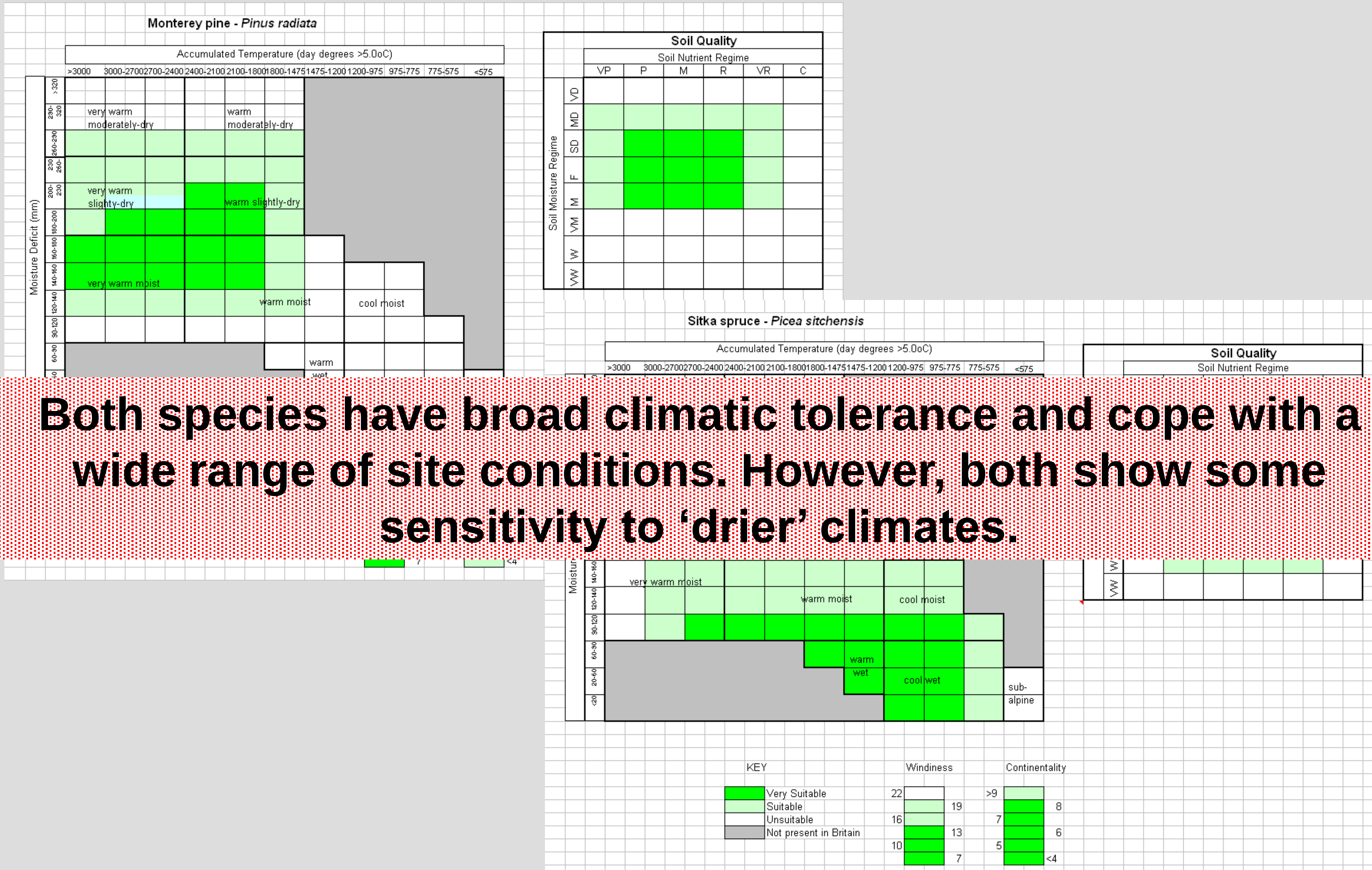
Over the century, Sitka spruce becomes less suited (more orange and red colours) to the eastern half of Scotland where the climate becomes warmer and drier.

Climate Change in New Zealand

- Temperature rises
    - 1.6 to 2.0°C in 2080
- Rainfall changes
    - -10 to +15% in 2080
- High variability and uncertainty
- Northern and Eastern areas appear to be at greater risk because of a combination of warming temperatures and proportionately lower rainfall



Climate matching for radiata pine and Sitka spruce



Both species have broad climatic tolerance and cope with a wide range of site conditions. However, both show some sensitivity to 'drier' climates.

Potential alternative species for planted forests

Scotland	New Zealand
Abies alba, A. amabilis	*Pseudotsuga menziesii*
Cryptomeria japonica	*Sequoia sempervirens*
Picea orientalis	*Cupressus macrocarpa, C. lusitanica*
Sequoia sempervirens	*Agathis australis*
Thuja plicata	*Podocarpus totara*
and others	

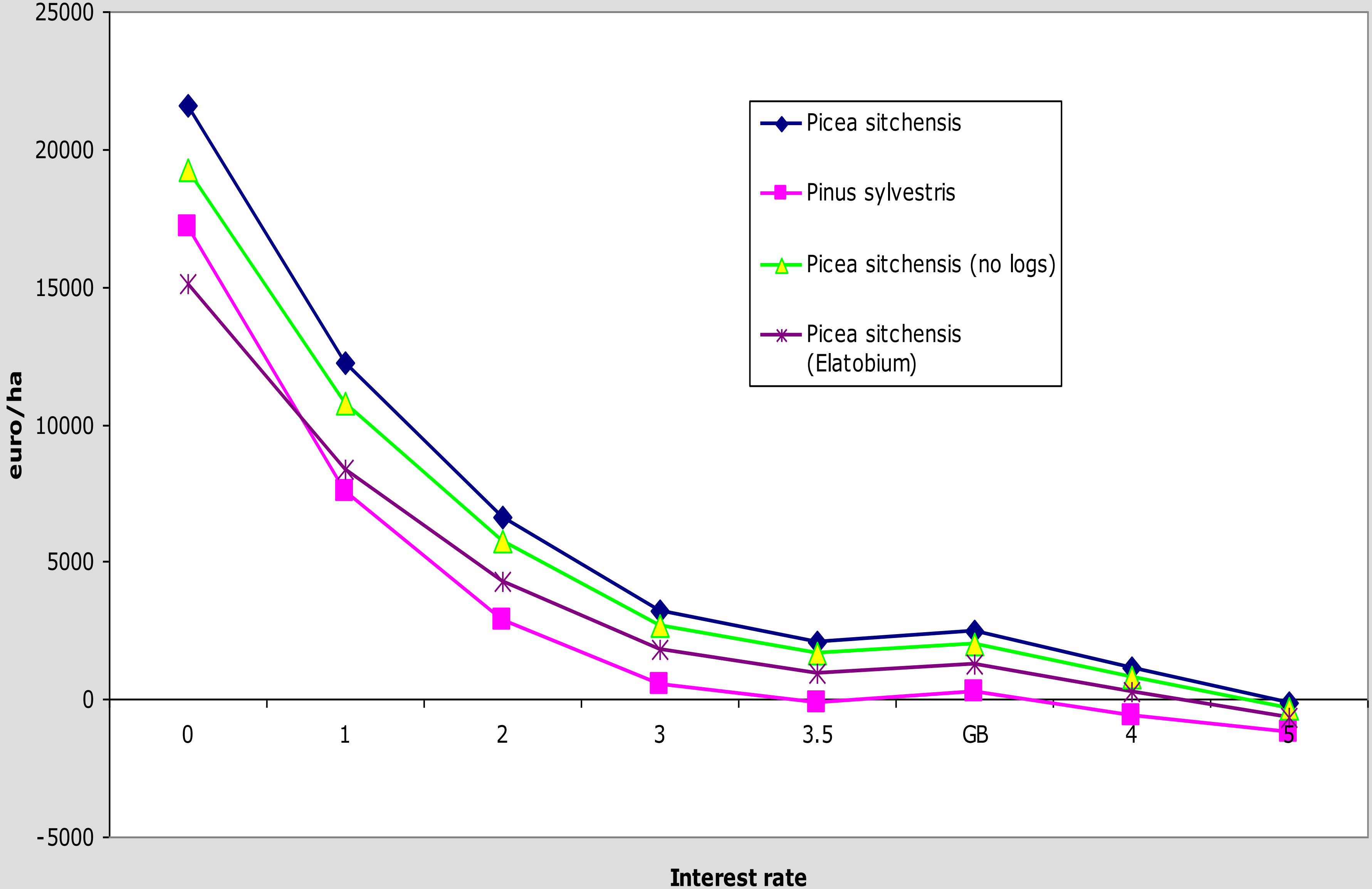
Most of these species are more sensitive to climate and site than Sitka spruce or radiata pine

What scenarios might influence managers to deploy alternative species?

Methodology

	Scotland	New Zealand
Location	East Scotland	Canterbury, South Island
Species	*Picea sitchensis* vs *Pinus sylvestris*	*Pinus radiata* vs *Eucalyptus fastigata*
Evaluation criterion	Net Present Value (NPV)	
Climate scenarios	IPCC medium	
Options considered	Normal even-aged management	
	Elatobium abietinum and 10% volume loss	*Fusarium circinatum* and 20% volume loss
	Drought and quality loss (no sawlogs)	*Fusarium circinatum* and quality loss
Modelling	Forest Yield plus 3PGN	3PGS2 Spatial

Scotland - comparison of *Picea sitchensis* and *Pinus sylvestris* at different interest rates



Changes in suitability: baseline to 2050s

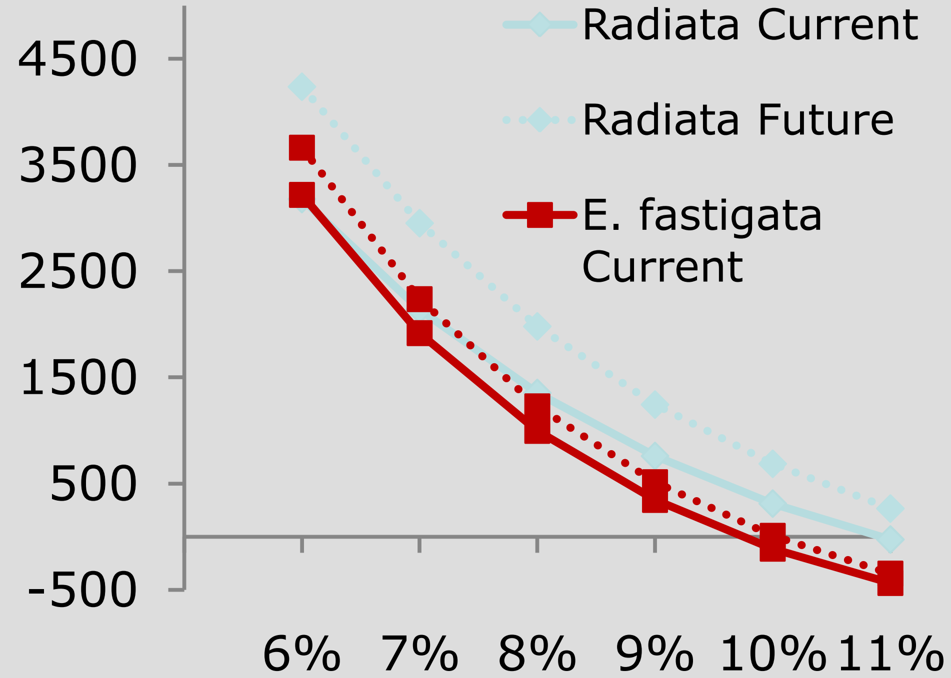
1= very suitable; 3=unsuitable.

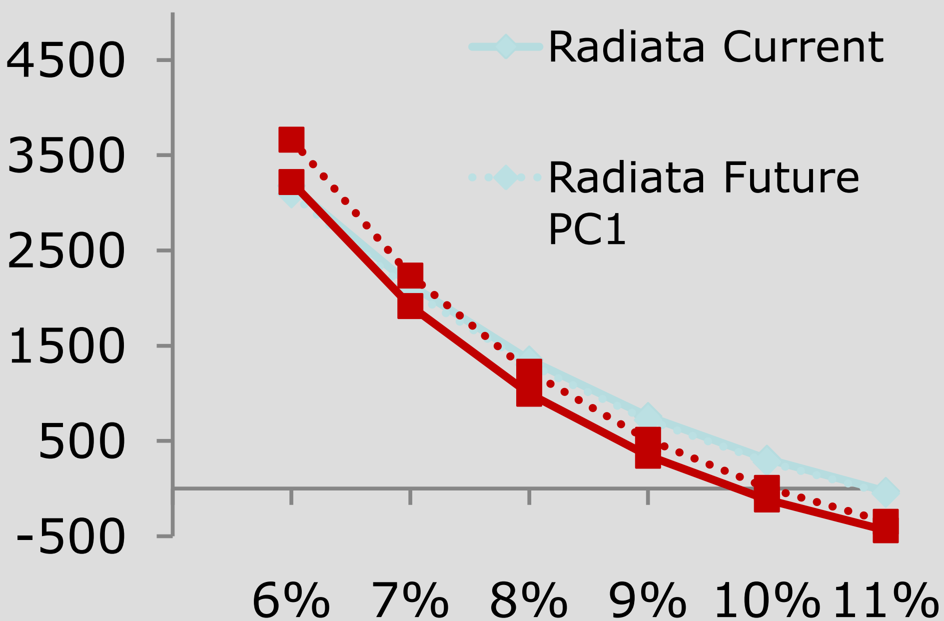
Species	Baseline	2050s -		ESC
		median	90^{th} pertile	Limiting factor
Picea sitchensis	1.7	1.7	3.0	Moisture
Picea abies	2.2	2.2	2.2	Soil nutrients
Pinus sylvestris	2.4	2.3	2.2	Exposure
Pinus contorta	2.0	1.6	1.6	Exposure
Larix kaempferi	2.0	1.9	3.0	Moisture
Abies procera	1.8	1.9	3.0	Moisture
Abies grandis	2.8	2.7	3.0	Moisture
Tsuga heterophylla	2.7	2.7	2.9	Soil nutrients
Populus tremula	2.0	2.0	2.2	Soil nutrients

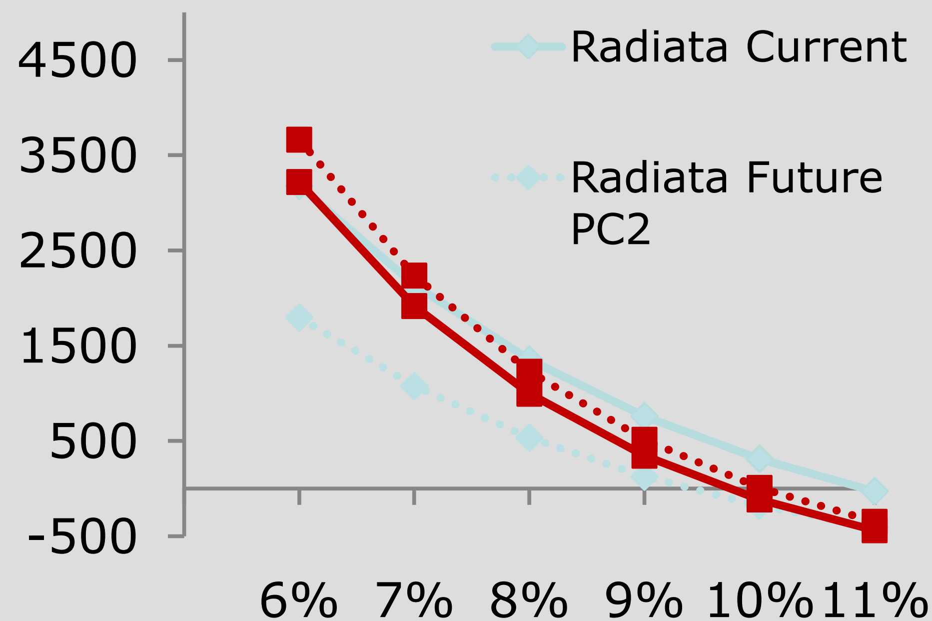
Species for which extreme events project major changes in suitability are those likely to be limited by moisture deficit; other species show less sensitivity.

Results of New Zealand simulation (euros ha^{-1}):

1. **BAU;**
2. **volume loss;**
3. **quality loss.**







Preliminary Observations

1. Current species continue to perform well under less extreme climate scenarios, partially explaining managers reluctance to change;
2. Need better data on climatic and **particularly site limitations** on species performance
3. Alternative species are also subject to risks (e.g. impact of Dothistroma needle blight on *Pinus sylvestris*);
4. Alternative species should be deployed at an operational scale to provide an adequate test bed, and act as a source of future germplasm;
5. Differential subsidies for planting alternative species might change the balance between current and alternative species.

Conclusion

"A major question [is] whether a deliberate policy of species diversification is adequate insurance against the hazard of unknown pathogens. The general opinion is that extreme diversification is unwise, limited generic diversification is reasonable, and the best course would be careful choice of a few well-researched species".

Forest Research Institute Symposium 10, Rotorua, New Zealand, 1971.

Thank you for your attention