

The background of the entire page is a close-up photograph of tree bark, showing intricate, wavy patterns and textures in shades of brown and tan. Overlaid on this background are several thin, white, wavy lines that meander across the page, creating a sense of movement and organic flow.

# COMBATING CLIMATE CHANGE

## A ROLE FOR UK FORESTS

An assessment of the potential of the UK's trees and woodlands to mitigate and adapt to climate change

# How can UK forestry adapt to and improve its contribution to mitigating climate change?

We were asked to:

- Review and synthesise existing knowledge of the impacts of climate change on UK forests.
- Provide a baseline of the potential of UK forests to mitigate and adapt to climate change.
- Identify gaps and weaknesses in our understanding so as to determine research priorities for the next 5 years.

# Contents 1

## **Forests & Climate**

P. Snowdon

C.C. West, J.I.L. Morison

P.G. Jarvis, R.J. Clement, J. Grace and K.A. Smith

## **Impacts**

M.S.J. Broadmeadow, M.D. Morecroft and J.I.L. Morison

J.F. Webber, D. Ray and P.M. Berry

## **Mitigation**

W.L. Mason, B.C. Nicoll, M. Perks

E. Suttie, G. Taylor, K. Livesey and F. Tickell

R.W. Matthews and M.S.J. Broadmeadow

# Contents 2

## **Adaptation**

K.J. Kirby, C.P. Quine and N.D. Brown

J.F. Handley and S.E. Gill

## **Sustainable Development**

P. Snowdon

M. Nijnik, J. Bebbington, B. Slee and G. Pajot

A. Lawrence and C. Carter

## **Overview and Research Priorities**

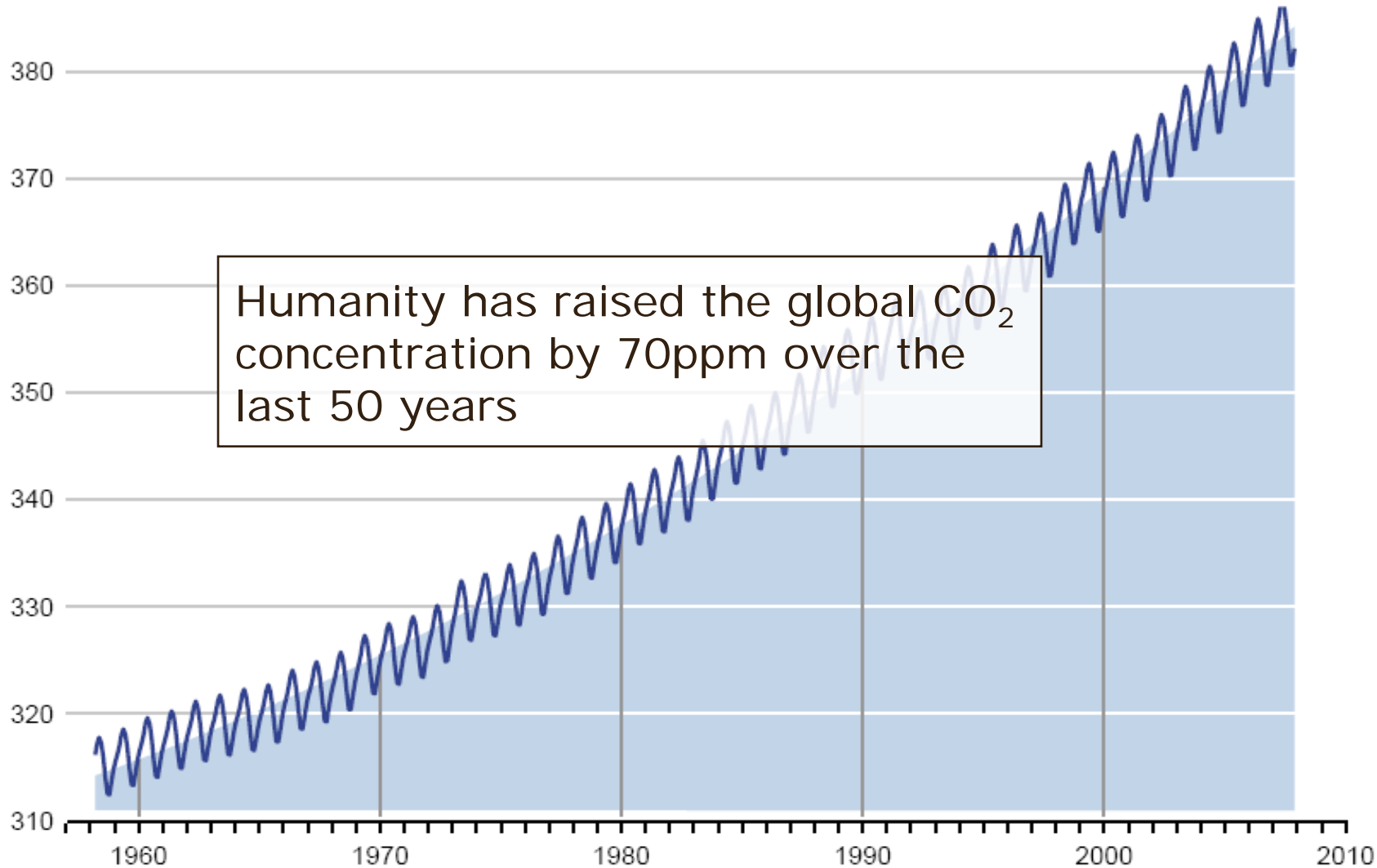
D. J. Read and P.H. Freer-Smith

Steering Group and international reviewers.

Setting out the science

# Monthly carbon dioxide concentration

parts per million

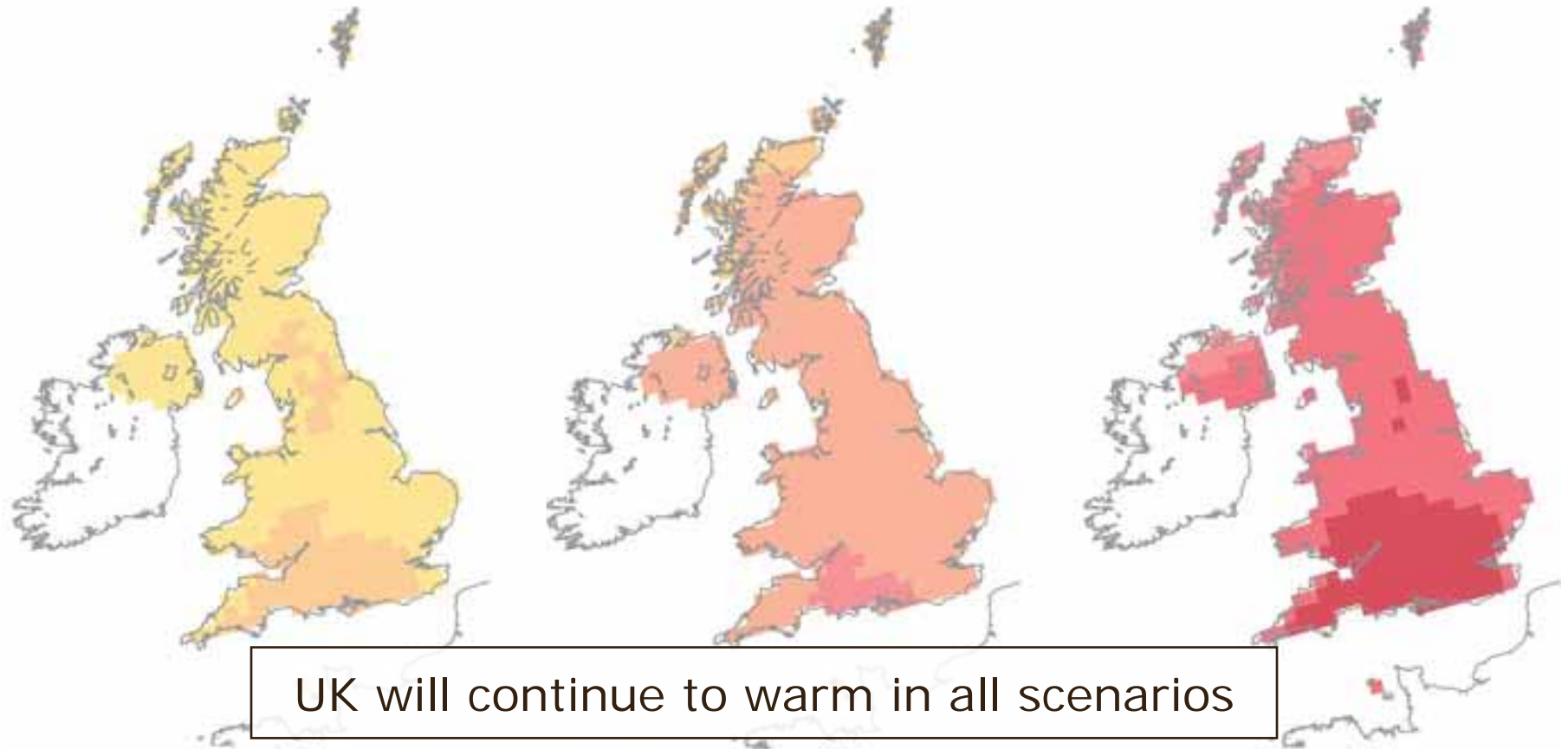


Mean summer temperature change (June, July, August), relative to 1961–90 means. Data are for 2080s under the 'medium' (SRES A1B) emissions scenario. The change at 50% probability level, called the central estimate, is that which is as likely as not to be exceeded by 2080.

10% = very likely to be exceeded

50% = central estimate

90% = very unlikely to be exceeded

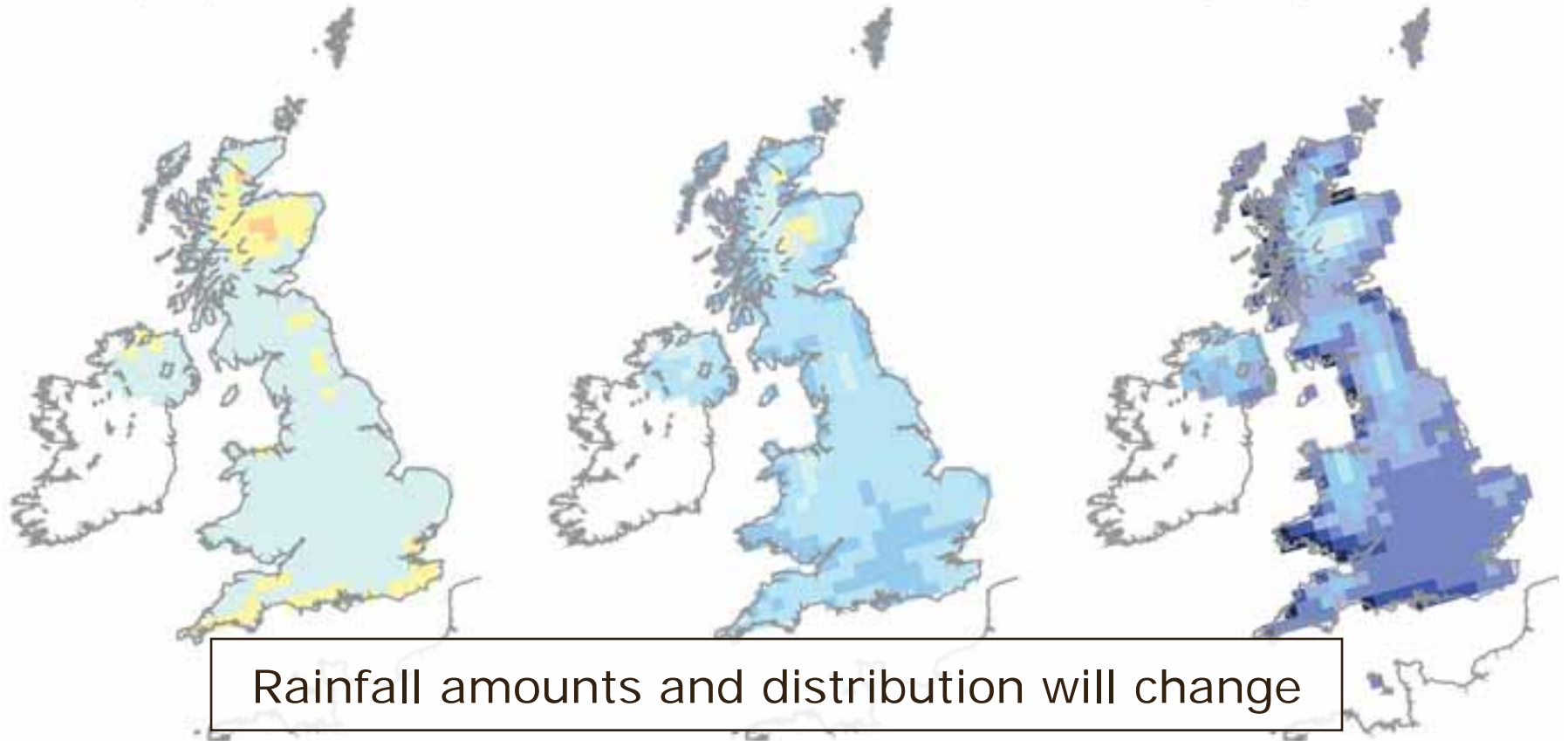


Mean winter precipitation change (December, January, February), relative to 1961–90 means. Data are for 2080s under the 'medium' (SRES A1B) emissions scenario. The change at 50% probability level, called the central estimate, is that which is as likely as not to be exceeded by 2080.

10% = very likely to be exceeded

50% = central estimate

90% = very unlikely to be exceeded



Rainfall amounts and distribution will change



# IMPACTS – FC bulletin 125

Leaving date of oak in Ashstead, Surrey between 1950 and 2009.



Data courtesy of Jean Coombs and Tim Sparks. See also Sparks and Gill, 2002.

# Tree pests and diseases



Pine lappett moth



Pk infected beech



Acute oak decline



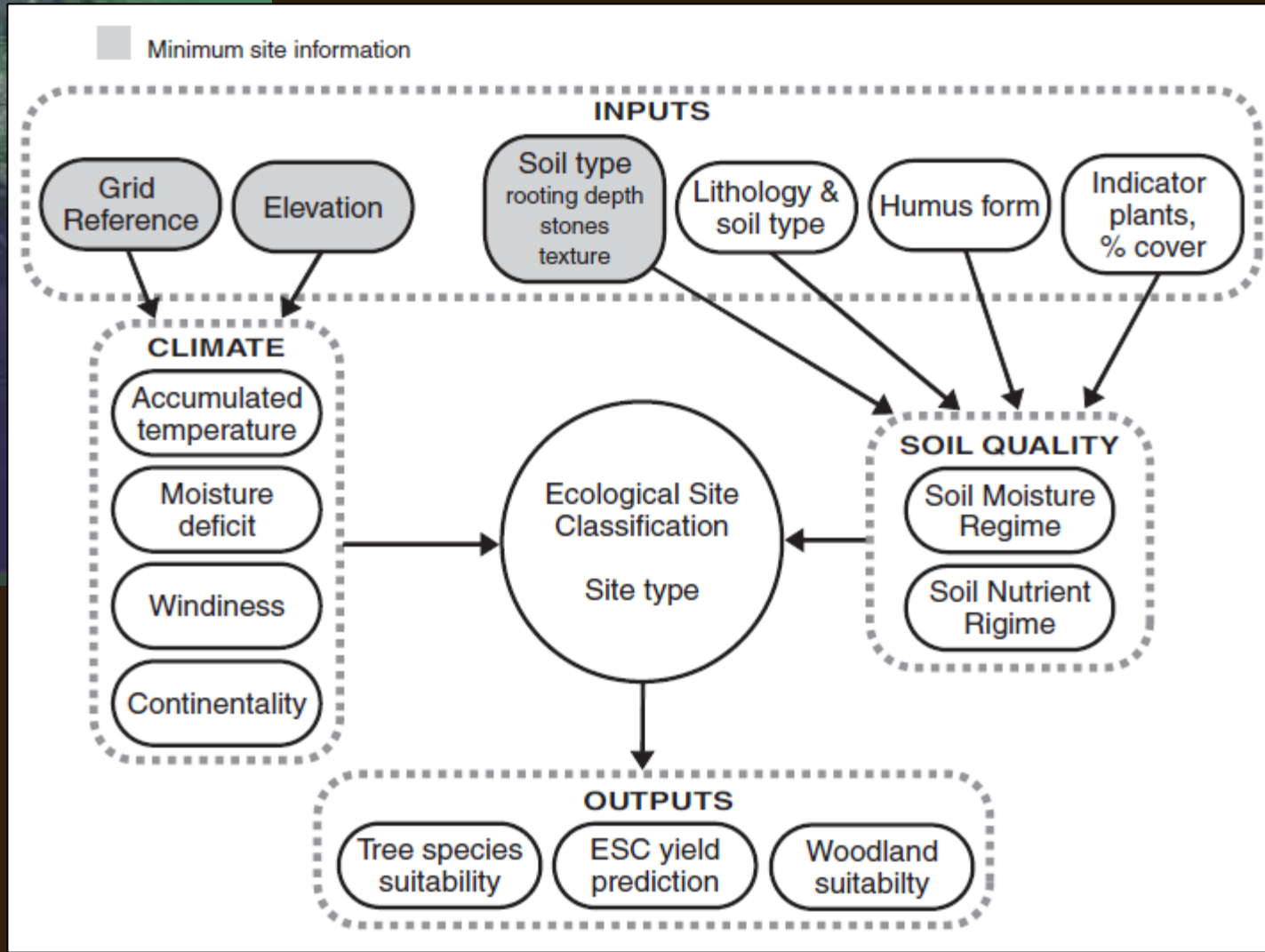
Pk infected rhododendron

Phytophthora on Larch

# An Ecological Site Classification for Forestry in Great Britain

Geocham Pyatt, Duncan Bay and June Fletcher

# Adaptation

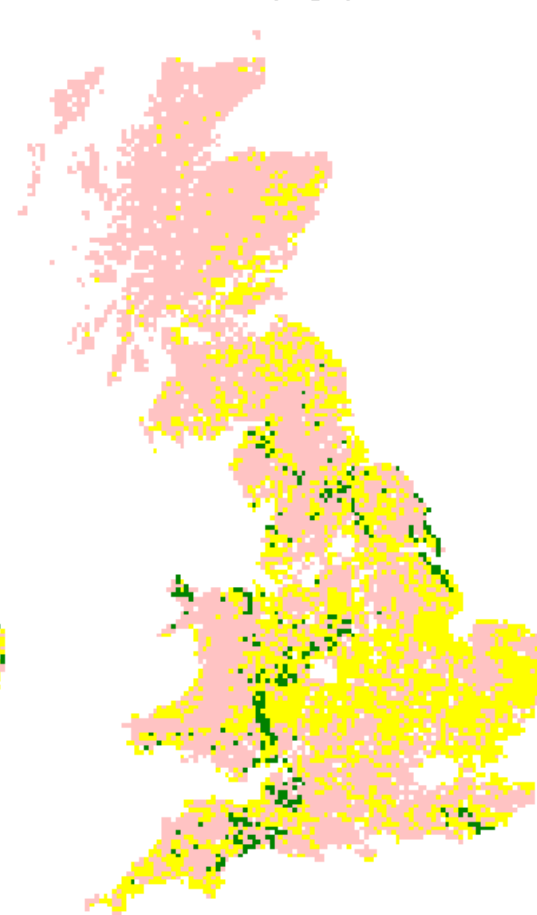
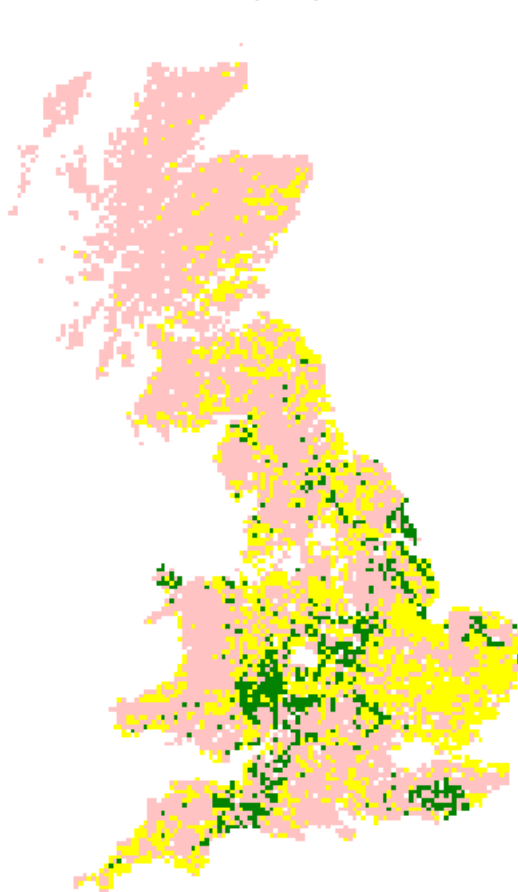
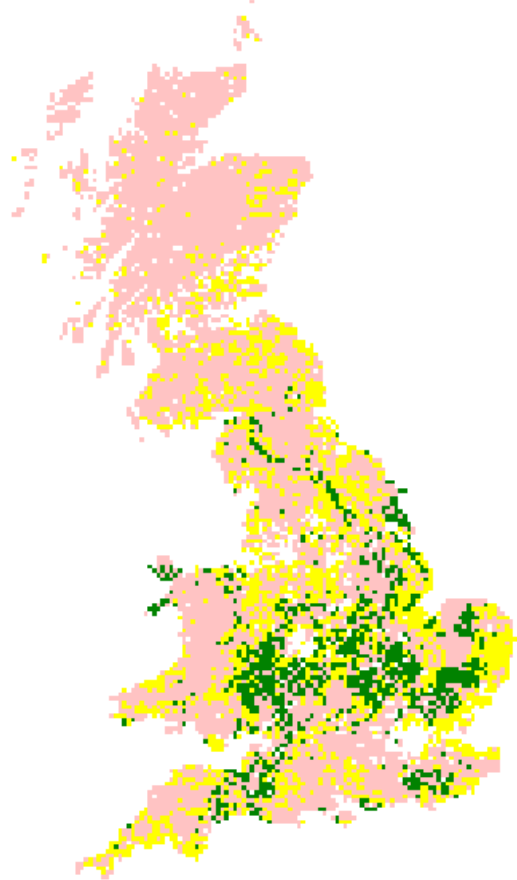


# Oak – NVC W10 lowland oak community

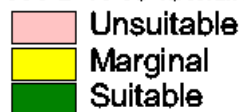
Baseline 1961-1990

2050 (low)

2050 (high)



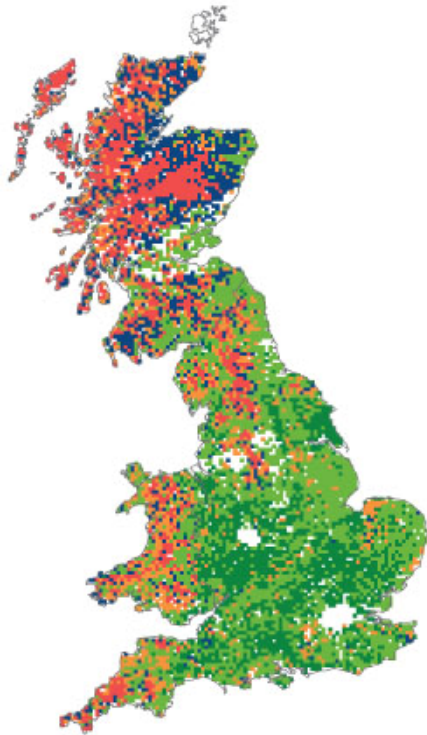
NVC W10 lowland oak community



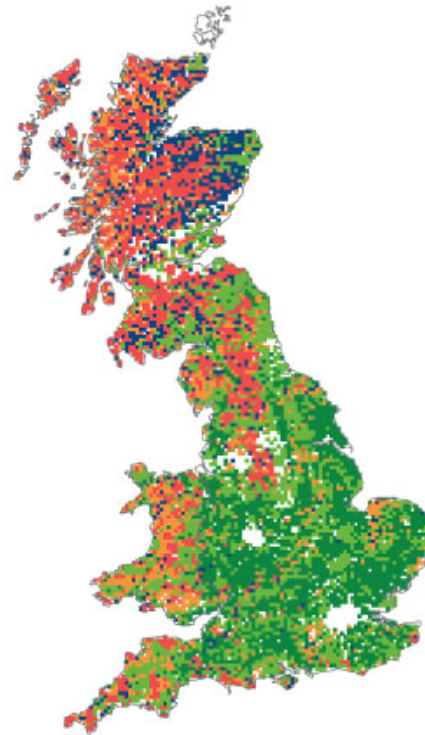
Scale: 1 grid cell = 5km

# Oak – suitability relative to maximum productivity (greens = suitable)

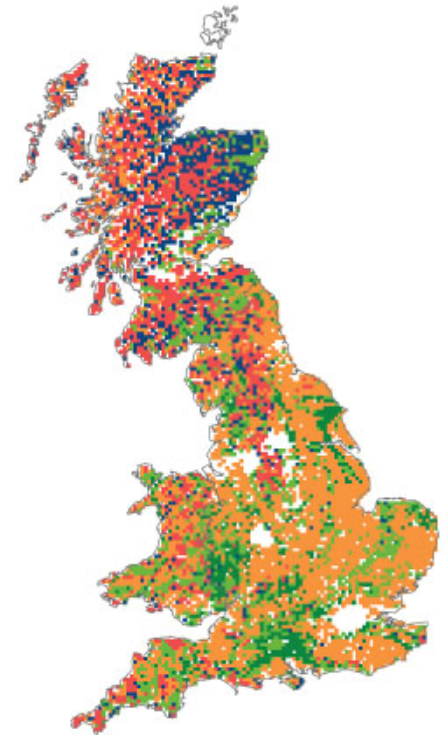
(a) Pedunculate oak



Baseline



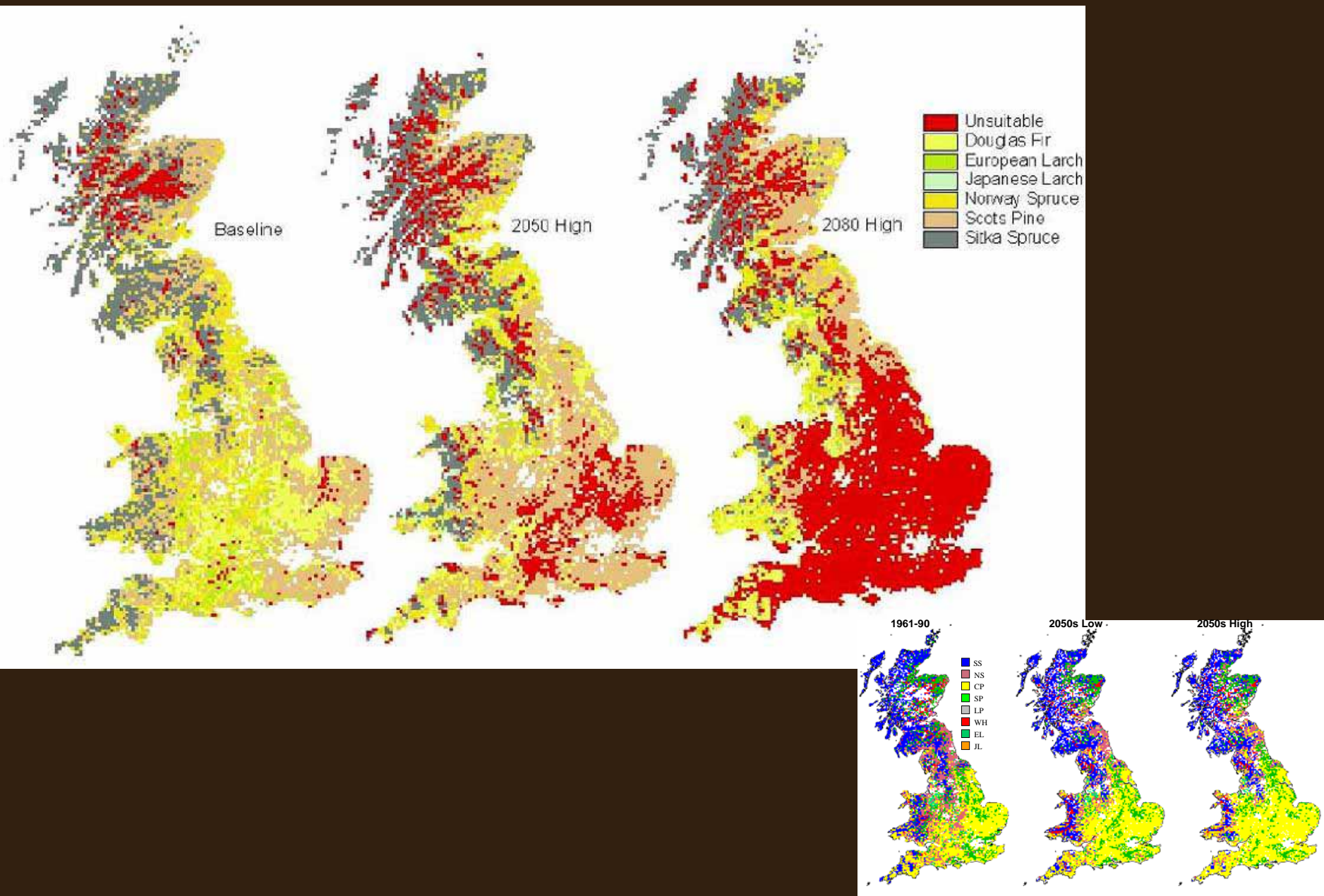
2050 Low emissions scenario



2050 High emissions scenario

Changes will impact on species choice  
and composition in native woodlands

# Adaptation: predicting tree species suitability



# Potential broadleaved spp for production forestry in Britain.

## with knowledge of performance

*Acer macrophyllum*  
*Acer saccharinum*  
*Alnus rubra*  
*Alnus viridens*  
*Eucalyptus gunnii*  
*Eucalyptus nitens*  
*Juglans regia*  
*Nothofagus obliqua*  
*Nothofagus alpina* (syn. *N. procera*)  
*Nothofagus pumilio*  
*Platanus* spp.  
*Populus* spp.

## no UK trials data

*Betula papyrifera*  
*Carya ovata*  
*Eucalyptus* spp  
*Fagus orientalis*  
*Fraxinus americana*  
*Fraxinus angustifolia*  
*Fraxinus pennsylvanica*  
*Juglans nigra*  
*Liriodendron tulipifera*  
*Quercus alba*  
*Quercus frainetto*  
*Quercus pubescens*  
*Quercus pyrenaica*

# Continental European tree spp not native to the UK that warrant consideration as 'alternative species' in cc adaptation strategies

## **Broadleaf species**

*Acer monspessulanum*

*Acer opalus*

*Alnus cordata*

*Castanea sativa*

*Celtis australis*

*Fagus orientalis*

*Fraxinus angustifolia*

*Juglans regia*

*Ostrya carpinifolia*

*Platanus orientalis*

*Populus alba*

*Quercus faginea*

*Quercus ilex*

*Quercus pyrenaica*

*Quercus pubescens*

## **Conifer species**

*Abies alba*

*Abies borisii-regis*

*Abies cephalonica*

*Abies cilicica*

*Abies pinsapo*

*Picea omorika*

*Pinus brutia*

*Pinus pinaster*

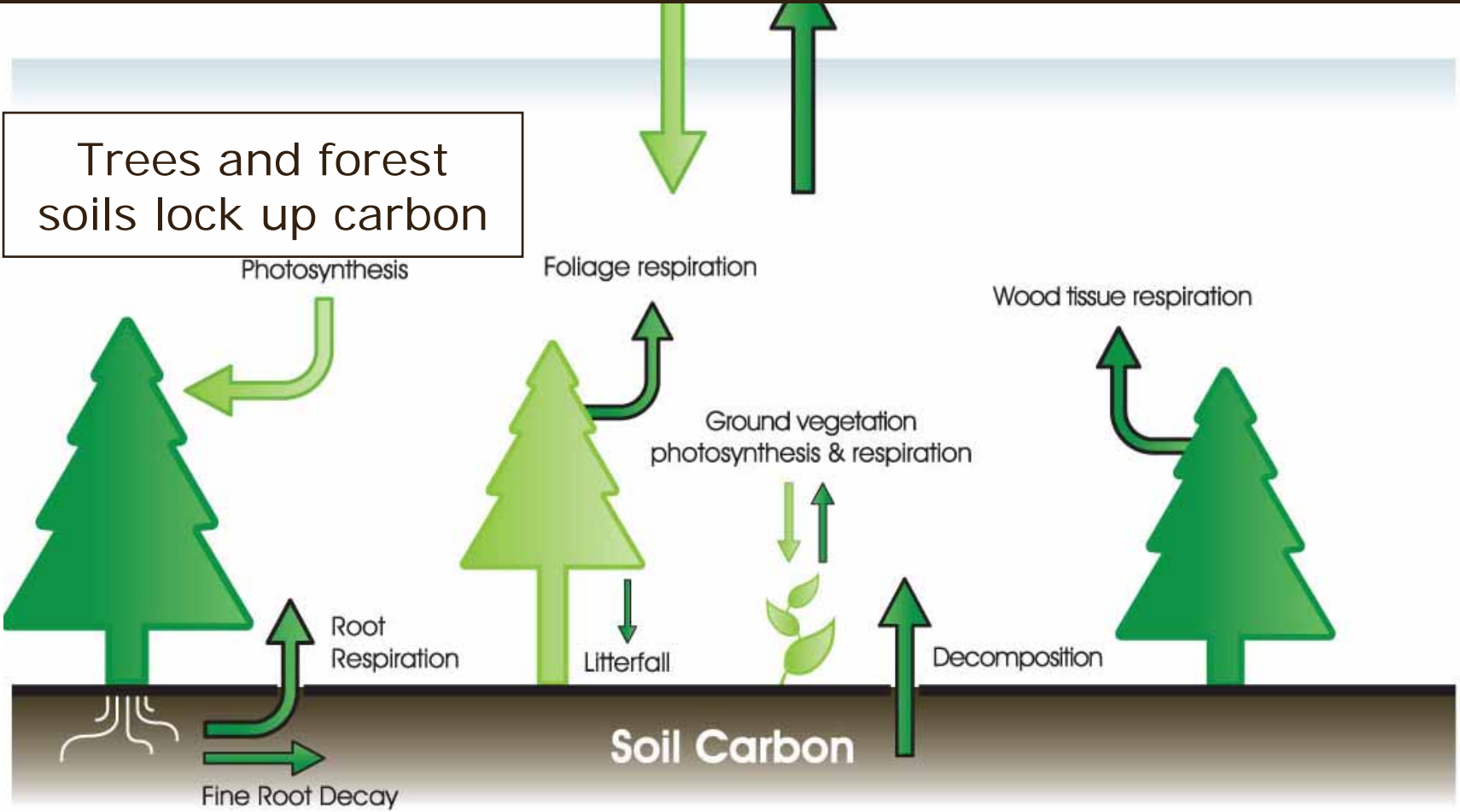
*Pinus pinea*

*Pinus peuce*

**Over the near future the range of species currently considered suitable for use in woodland creation in the UK remains the same. Exceptions to this general situation are likely to be found in south and east England and more widely in the latter half of the century with serious impacts occurring on drought sensitive tree species on shallow freely draining soils. The planning of which species and species mixtures to plant on particular sites will be the challenge for forest managers.**

**However by the middle of the century under high emission scenario or end of the century under low emission scenario, an extended range of species will have to be considered, Further research is needed to establish which tree species will be most suitable for specific requirements.**

# Mitigation: Net Ecosystem Production C uptake $\text{kg CO}_2 \text{ ha}^{-1} \text{ h}^{-1}$

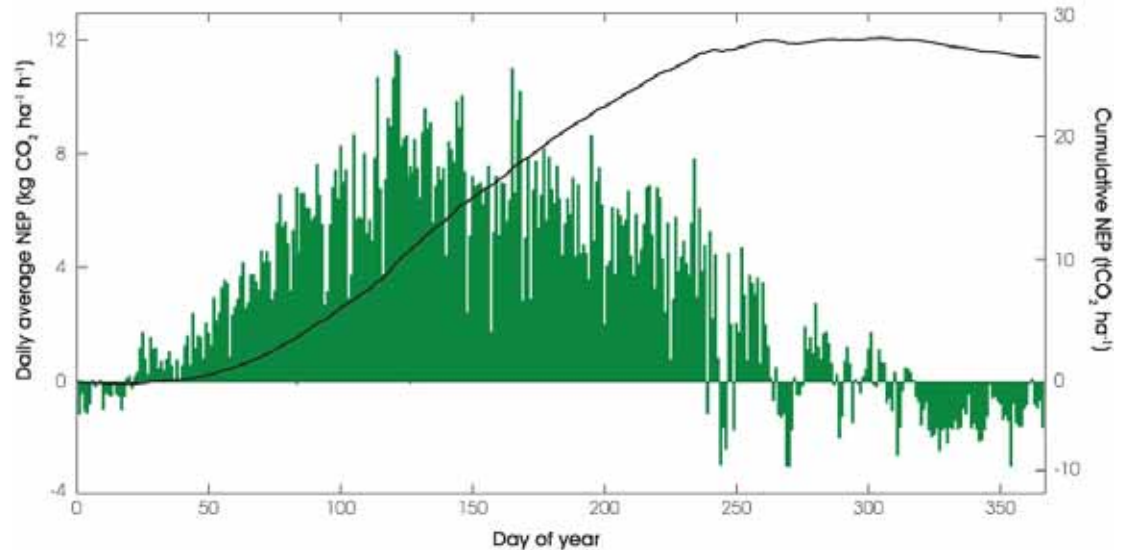


Carbon in UK Forests:  
Trees 150 Mt C  
Soils & litter 640 Mt C  
Timber & wood products 80 Mt C

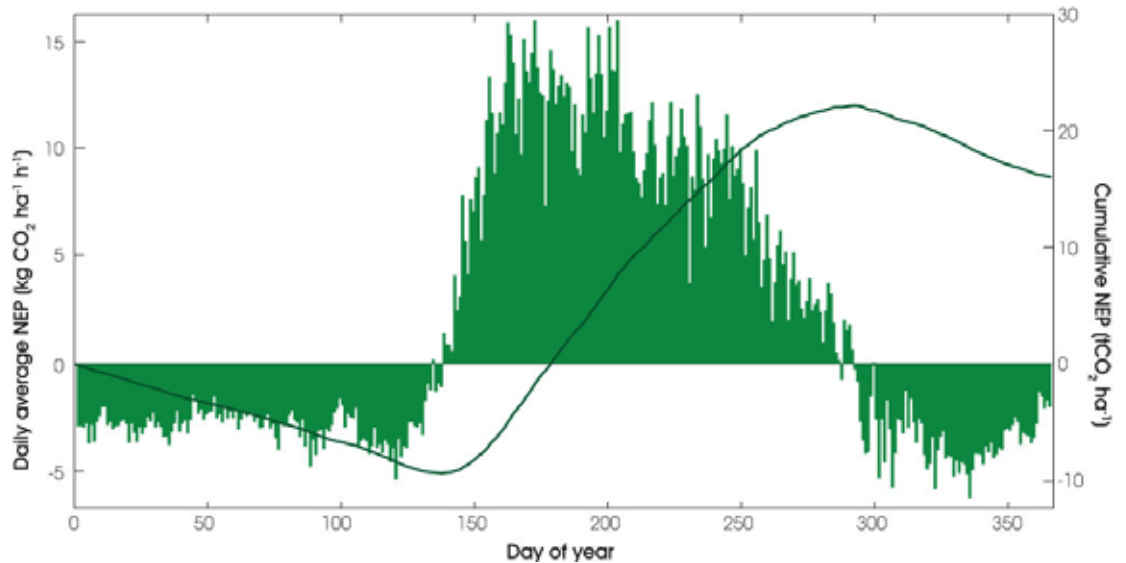
1 t C is roughly equivalent to 3.67 t  $\text{CO}_2 \text{ e}$   
1 Mt = 1 000 000 tonnes  
1Gt = 1 000 000 000 tonnes

# Average daily removal or release of CO<sub>2</sub> during year

17–21 year old  
Sitka spruce  
evergreen.  
Annual total  
removal of CO<sub>2</sub>  
24 tonnes per  
hectare per year.

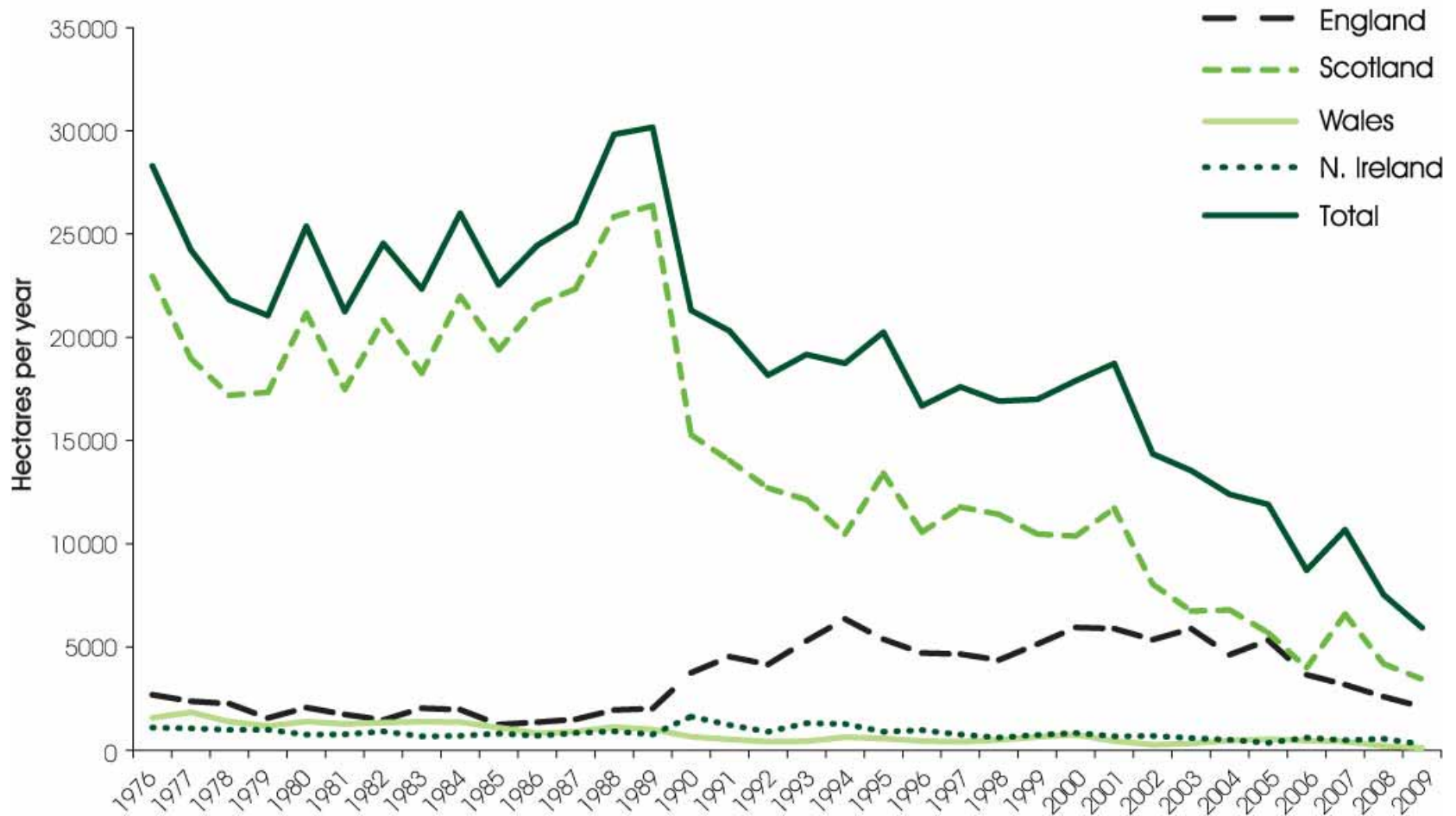


72–80 year old  
oak & mixed  
deciduous.  
Annual total  
removal of CO<sub>2</sub>  
15 tonnes per  
hectare per year.



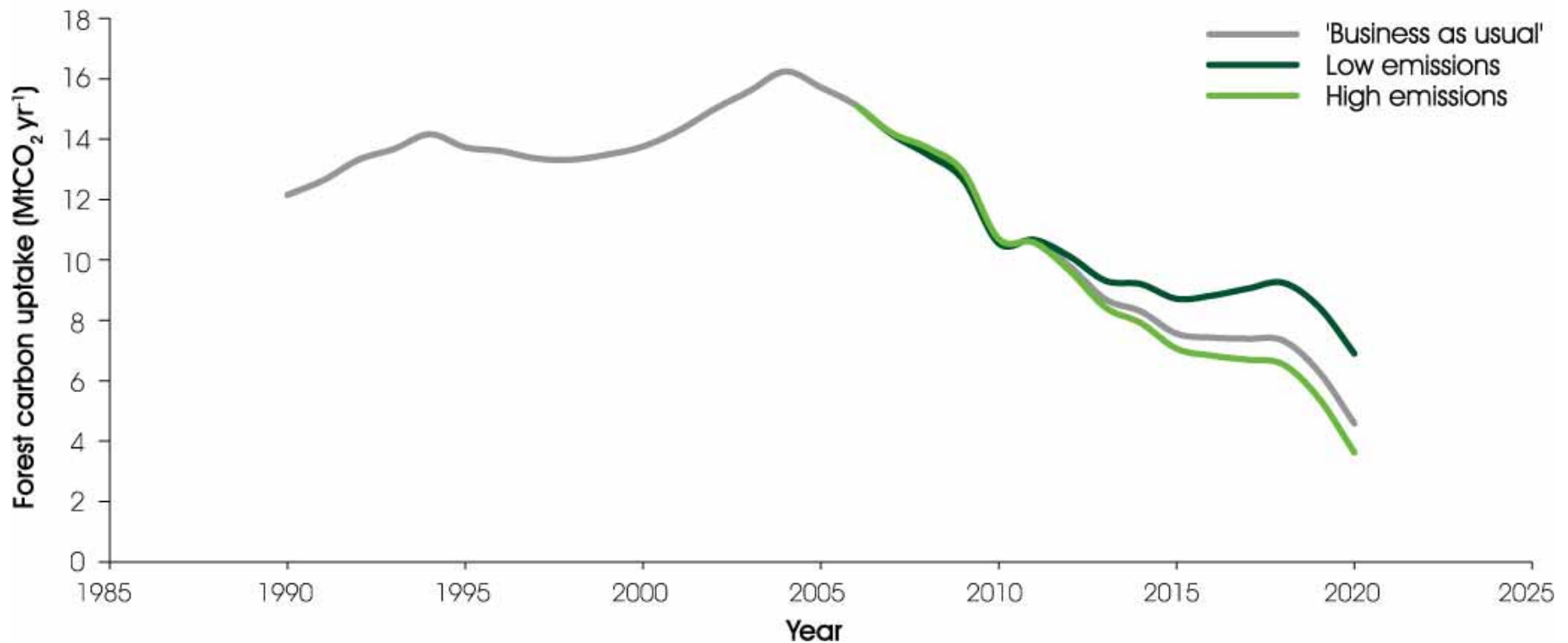
# But we've been creating fewer new woodlands

Areas of new forest planting in the UK between 1975 and 2009. The progressive decline in total UK planting in recent years is striking.



# So uptake of greenhouse gases is projected to fall

The estimated net greenhouse gas (GHG) uptake by UK forests projected to 2020. Values are presented as net CO<sub>2</sub> equivalent uptake from the atmosphere, under three different assumed scenarios, viz: afforestation continues at its present (i.e. declining) rate - referred to as 'business as usual' (grey line), increased rates of afforestation, i.e. 25 000 ha per year - referred to as 'low emissions' (dark green line), and uptake assuming no further afforestation - referred to as 'high emissions' (light green line). These estimates comprise the forestry component of the UK Land Use, Land Use Change and Forestry (LULUCF) GHG inventory.

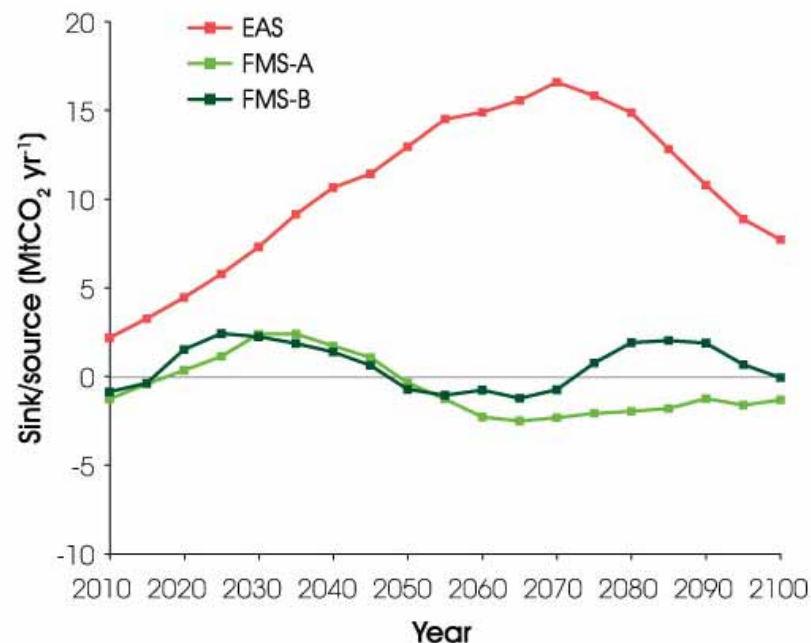


# Can we harness this C-fixing capability to provide mitigation of emissions?

The projected impacts, from the present to 2100 of alternative forest management scenarios on uptake (i.e. abatement = net sink) or release (= net source) of CO<sub>2</sub> (Mt per year). The three scenarios are:

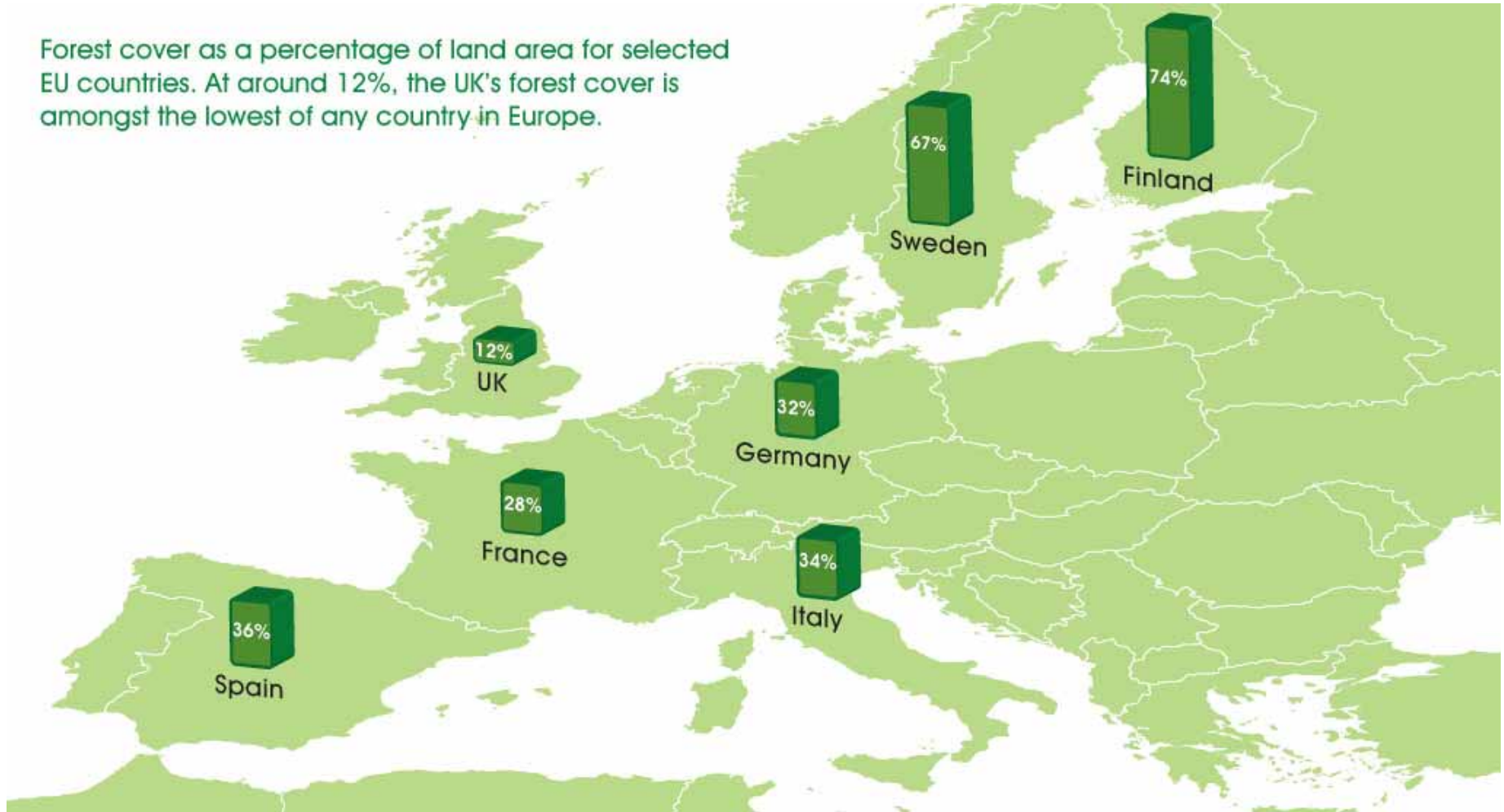
Enhanced afforestation (EAS): the planting of a total of 23 200 ha per year of new woodland between 2010 and 2050. This total is made up of 14 840 ha per year of new planting over and above the current (and assumed ongoing) planting of 8360 ha per year (red line). FMS-A: management of existing forests to maximise retention of carbon stocks (light green line). FMS-B: management involving an increased intervention combined with optimisation of rotation length to maximise timber production (dark green line).

The lines indicate the total CO<sub>2</sub> abatement achieved in trees, litter, soil harvested wood products and fossil fuel substitution.



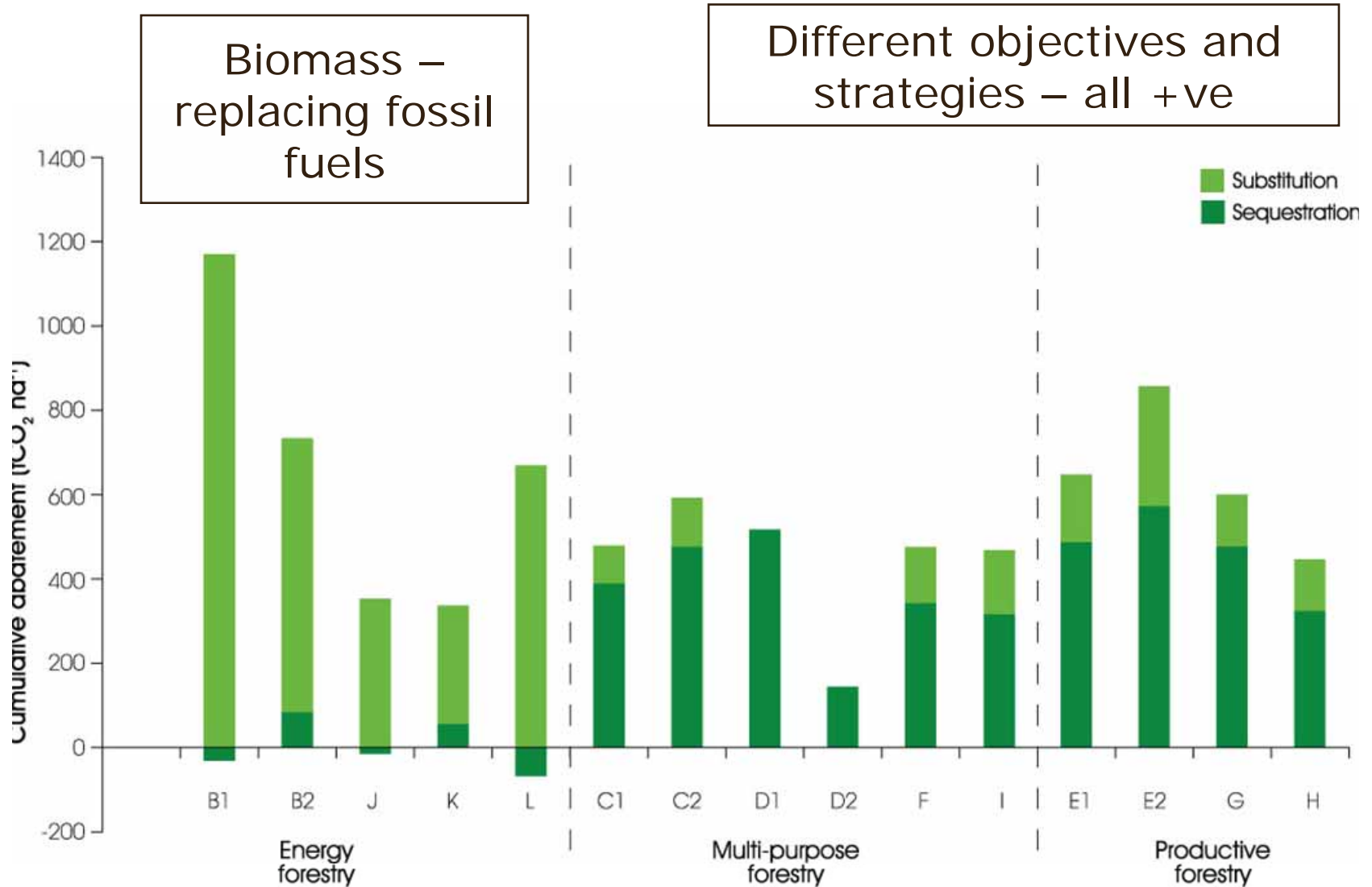
# Forest land cover in parts of Europe

Forest cover as a percentage of land area for selected EU countries. At around 12%, the UK's forest cover is amongst the lowest of any country in Europe.



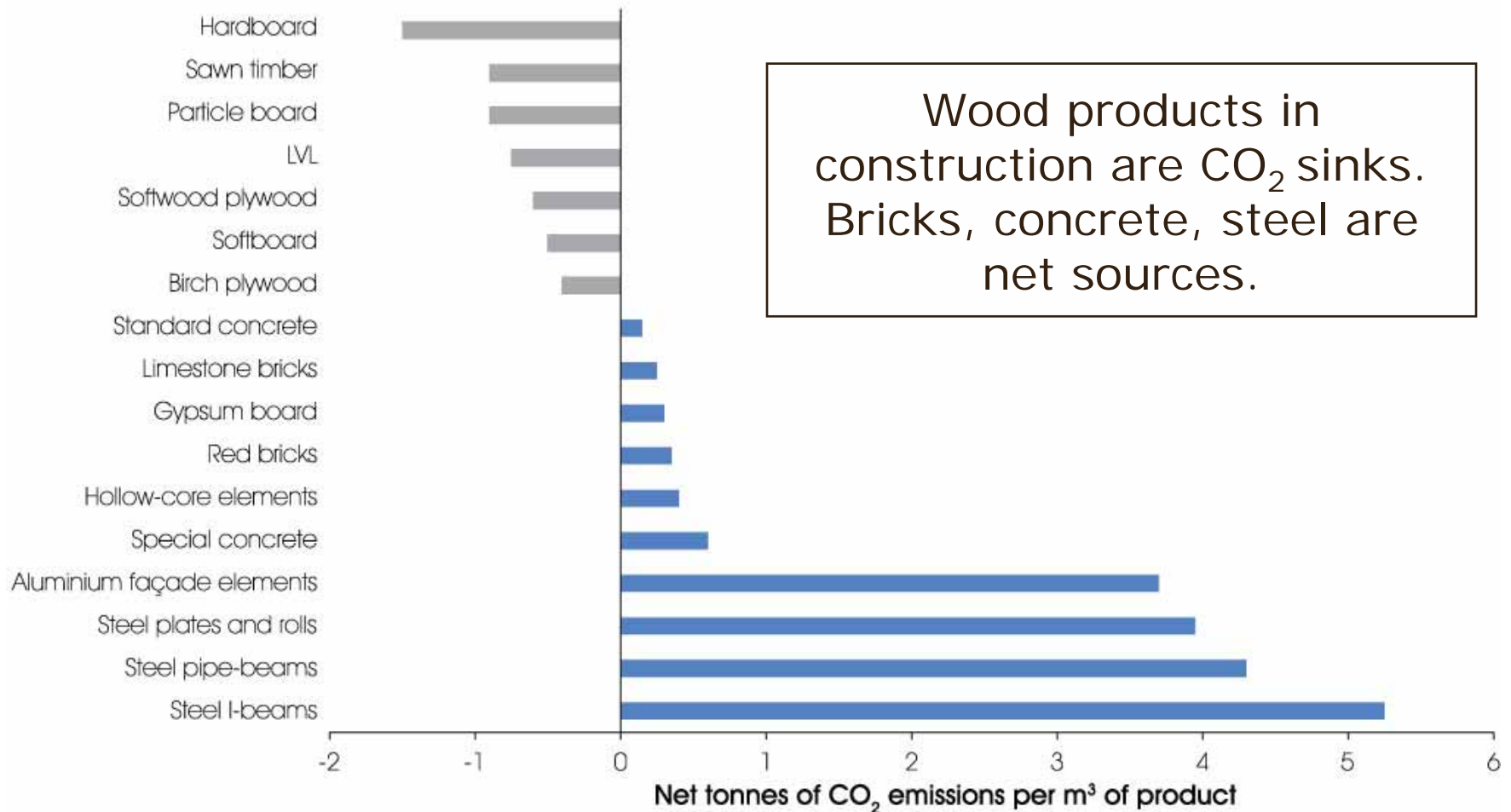
+4% change in land cover proposed would still be one of lowest in Europe

# Substitution – carbon lock up after felling



# Wood products extend carbon lock up

The net CO<sub>2</sub> emissions of the major products used in the construction industry. All non-woody components are seen to constitute net sources of CO<sub>2</sub> while all wood-based components are net sinks. LVL = laminated veneer lumber.

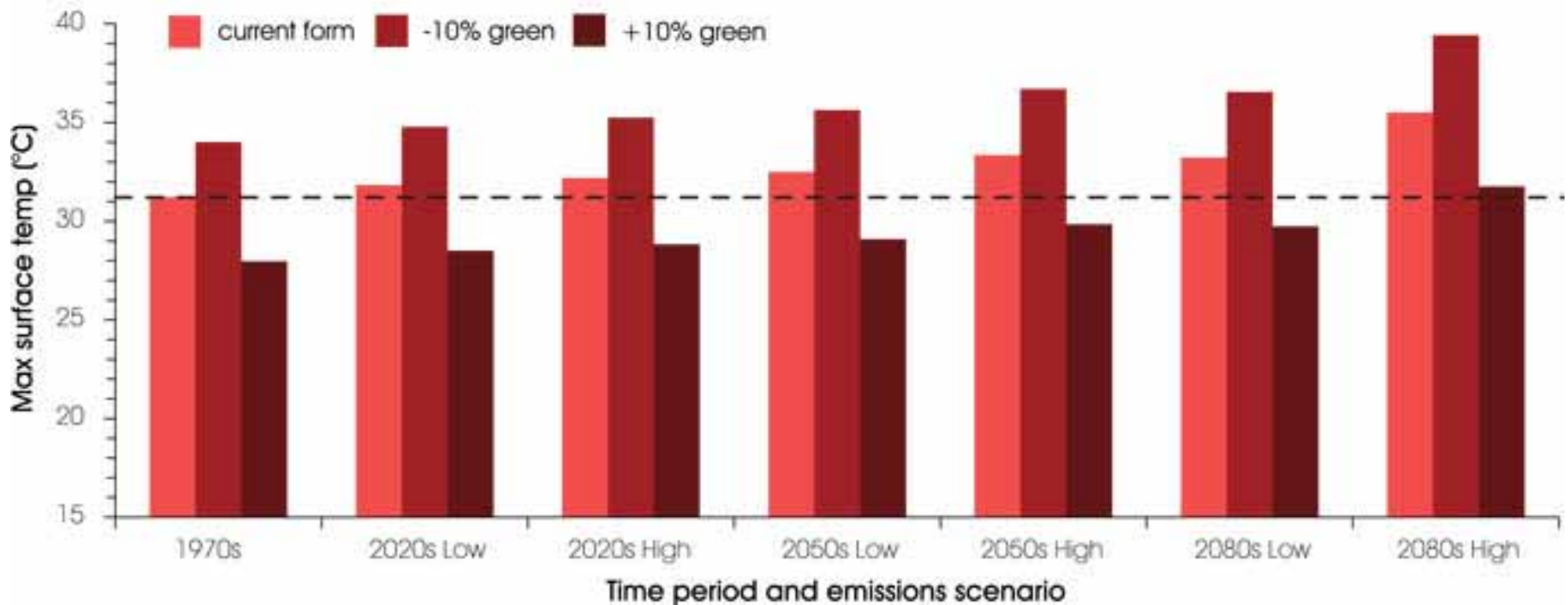


Woodlands need to be planned so that ecosystem services are provided together with emissions abatement.



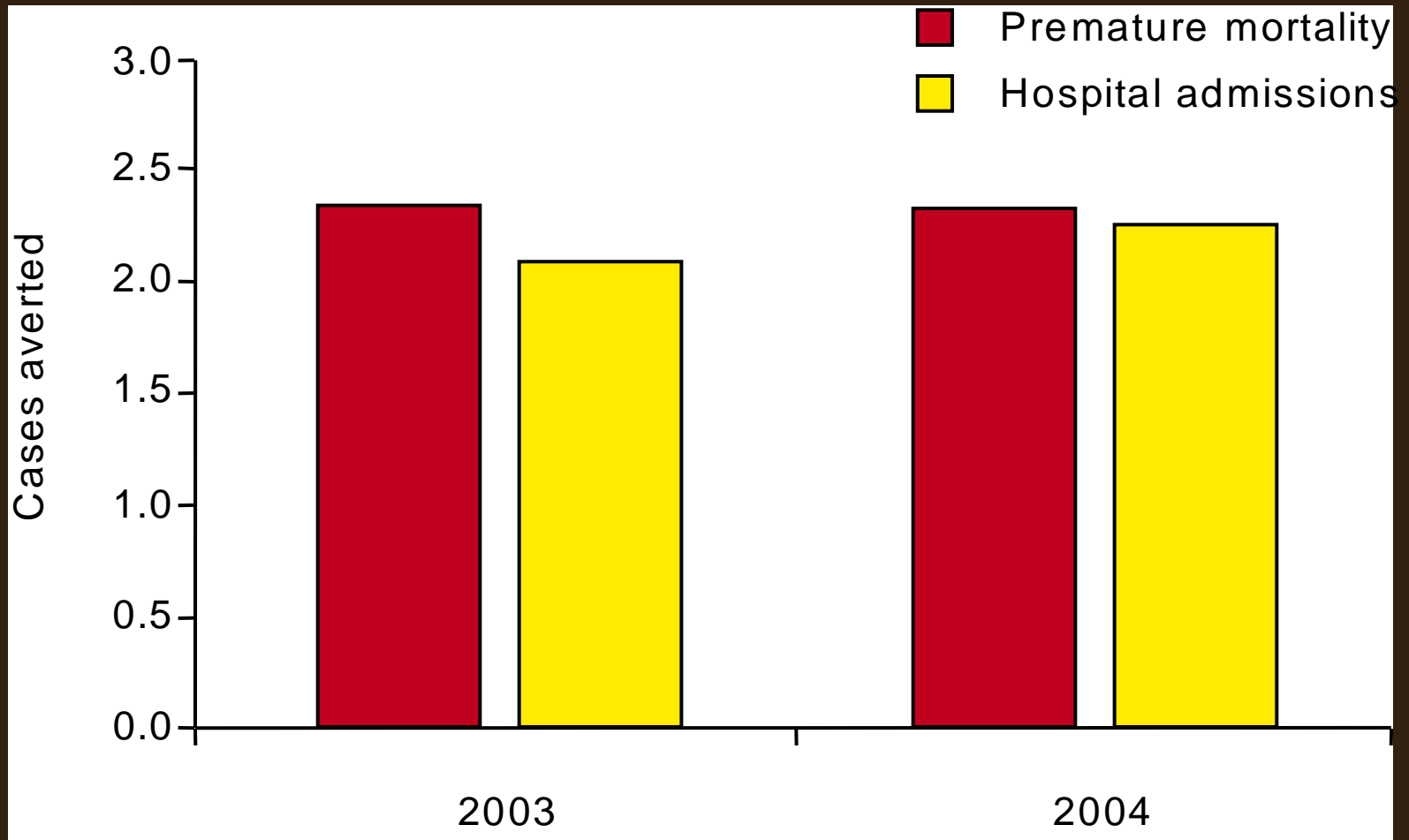
# Trees help people adapt: Maximum surface temperature in Manchester

Maximum surface temperature in the town centre UMT with current form and plus or minus 10% green cover (black dashed line shows 1961–1990 current form temperature) (Gill, 2006).



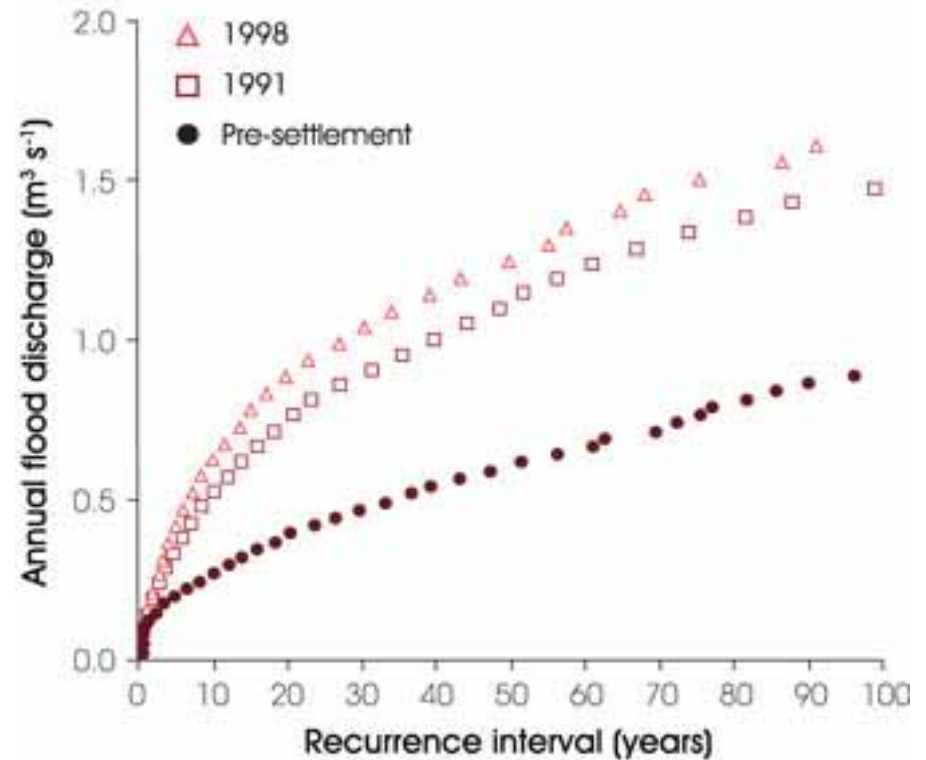
+10% green cover would help cooling  
esp where people live or gather

Nos of premature deaths and hospital admissions averted per year by 5.5% urban greenspace (25 % trees) per million people in ELGG area.

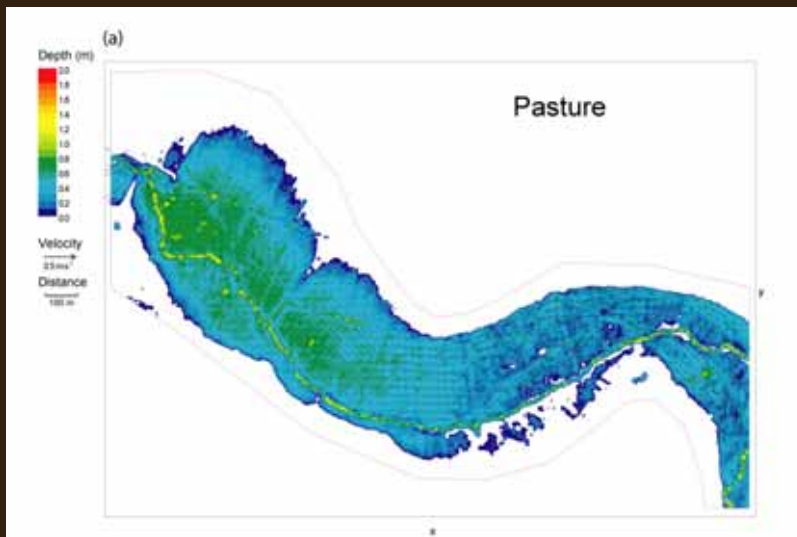


The interaction of forests with water is complex but targeted woodland creation has potential to alleviate flooding

Simulated flood-frequency curves ( $\text{m}^3 \text{s}^{-1}$ ) for Maplewood Creek. Flood-frequency curves indicate that annual flood discharge rates for 1991 and 1998 exceed pre-settlement discharge rates. Symbols: open triangles, the flood-frequency curve for 1998; open squares, the 1991 flood-frequency curve; solid circles, the flood-frequency curve for pre-settlement conditions. Pre-settlement conditions represent fully forested cover and no impervious surfaces.



# Forestry and flooding



Thomas & Nisbet 2007

# Key findings

# A clear need for more woodlands

Enhanced planting of 23,000 ha per year over next 40 years could by 2050 abate 10% of GHG emissions

- Technically feasible – if challenging
- All options cost-effective
- Rapid growing conifers and energy crops best
- But mixed woodlands still only £25 per tonne CO<sub>2</sub>

# An asset to be managed wisely

UK forests store 790 MtC and remove 15 MtCO<sub>2</sub> per year

- Climate change impacts are already being seen
- Pests and diseases causing increasing concern
- Regulatory framework important including for urban trees to ensure continued delivery of range of ecosystem services

# The status quo is not an option

Long timescales mean need for action now

- Changes to selection of species and origin needed now
- In future need to consider new species e.g. from continental Europe
- Difficult questions for conservation of biodiversity in woodland communities

# Harvesting and use of wood increases forestry's mitigation potential

Wood products act as a C store and Biomass can replace fossil fuels

- Wood can substitute for materials with high GHG emissions in their production
- Evidence of technical properties of wood needs to be better known
- Carbon in wood products in UK housing = 10 Mt  
– could grow by 10 Mt in next 10 years
- Wood fuel has the potential to save between 2 and 4 MtC per year by substituting for fossil fuel in the UK

Plant now  
Use sustainably

# Availability

Combating Climate Change; A role for UK Forests.

An assessment of the potential of the UK's trees and woodlands to mitigate and adapt to climate change.

ISBN 978-0-11497-351-3 £30.00

or

The Synthesis Report – ISBN 978-0-11497-352-0 free

Online [www.tsoshop.co.uk](http://www.tsoshop.co.uk) and [customer.service@tso.co.uk](mailto:customer.service@tso.co.uk)



# COMBATING CLIMATE CHANGE

## A ROLE FOR UK FORESTS

An assessment of the potential of the UK's trees and woodlands to mitigate and adapt to climate change

Species and mixture selection for the site  
– ESC and Duncan Ray

FC Forests and Climate Change Guidelines  
- due for publication this year.

FC Code of Good Practice for Forest Carbon Projects  
- also for launch & publication this year and will have QA, validation & accreditation by UKAS .