Forest Research

Measuring and managing woodland carbon balances

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Forest Research,

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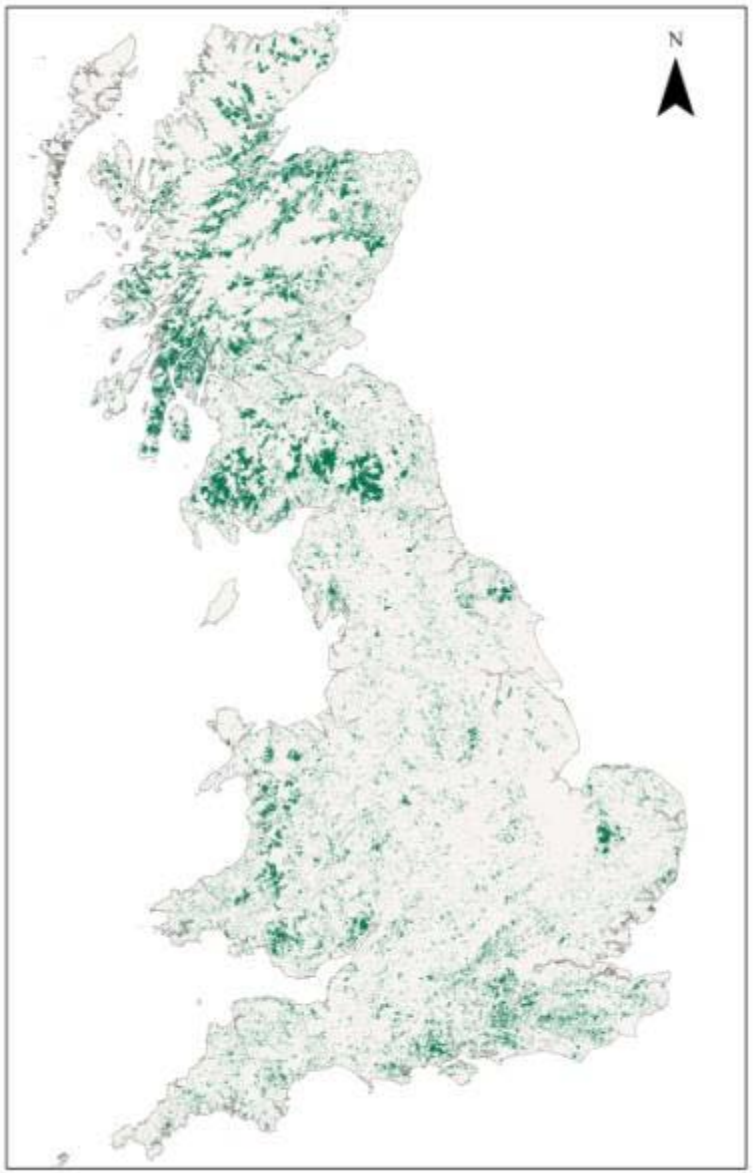
Talk for ECN 20 year symposium

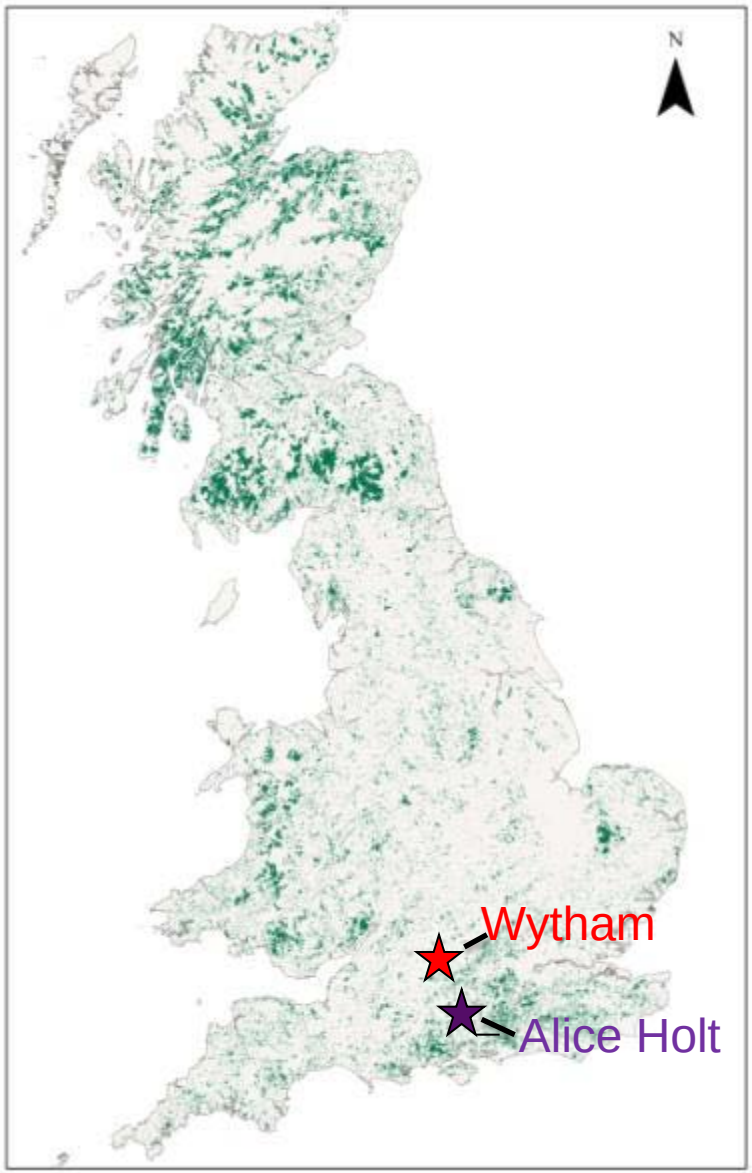
GB forests & woodlands



- 3.1 million hectares (13% of land)
- 1.6 Mha conifer
- 1.5 Mha broadleaves

- Important ecosystem services
- Soil & water protection
- Biodiversity
- Cultural & recreational
- 8.4 Mt softwood, 0.4 Mt hardwood per year
- C stock and C sequestration

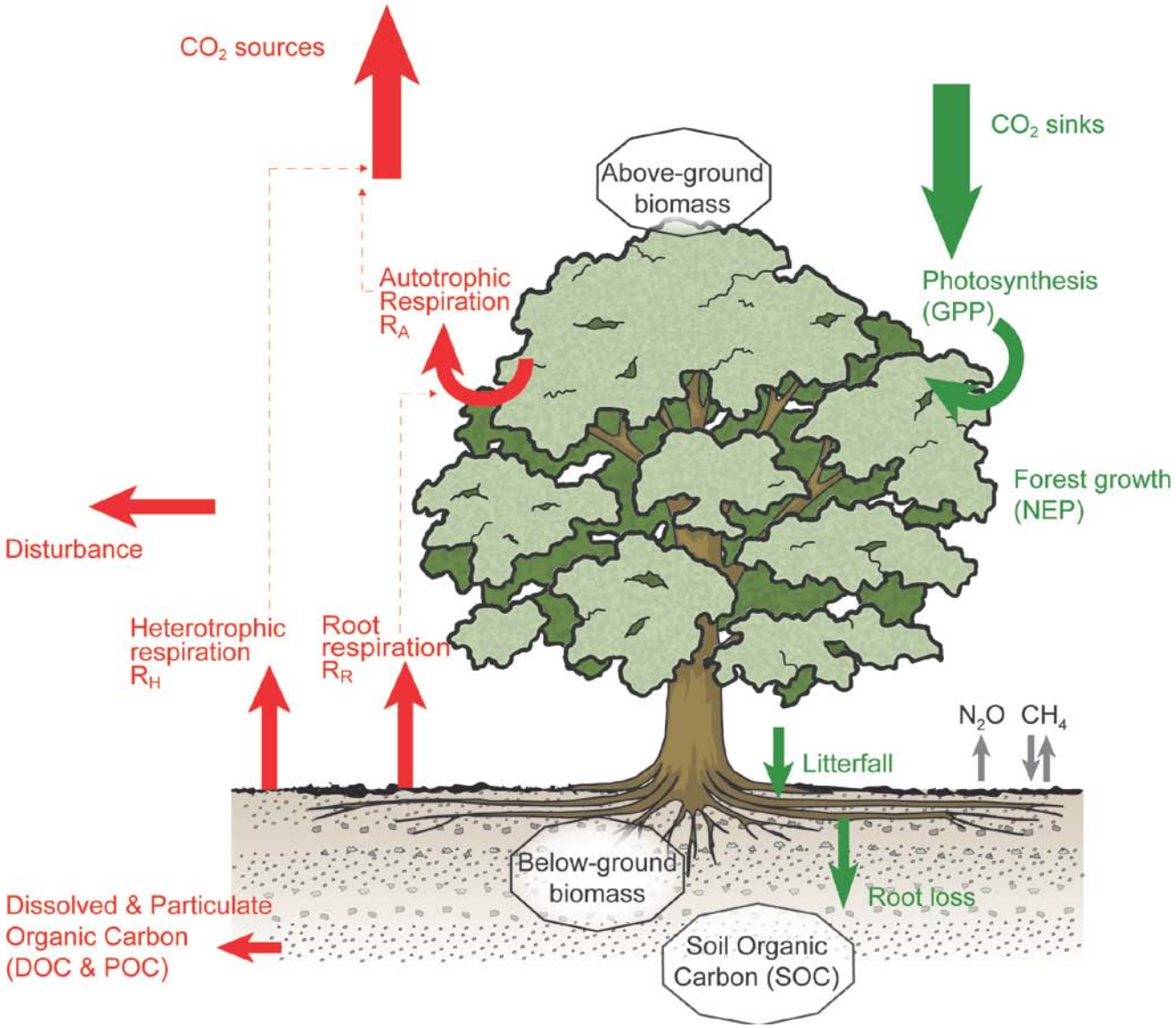
GB forests & woodlands



Outline

- describe the C balance of one woodland, Alice Holt, particularly the Straits Inclosure managed oak plantation
- Compare with figures from ‘unmanaged’ Wytham Wood
- Look at effect of ‘local’ management on CO_2 fluxes
- Example of wider regional land use change issues

Woodland C balance

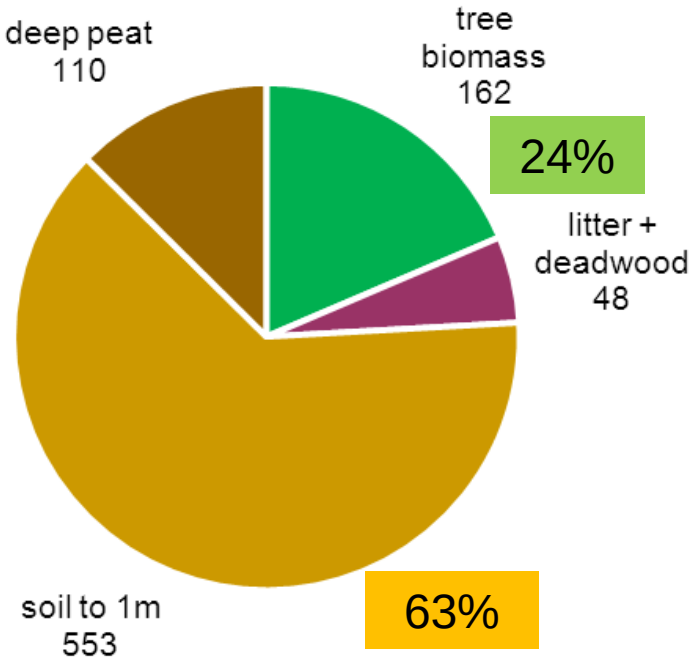


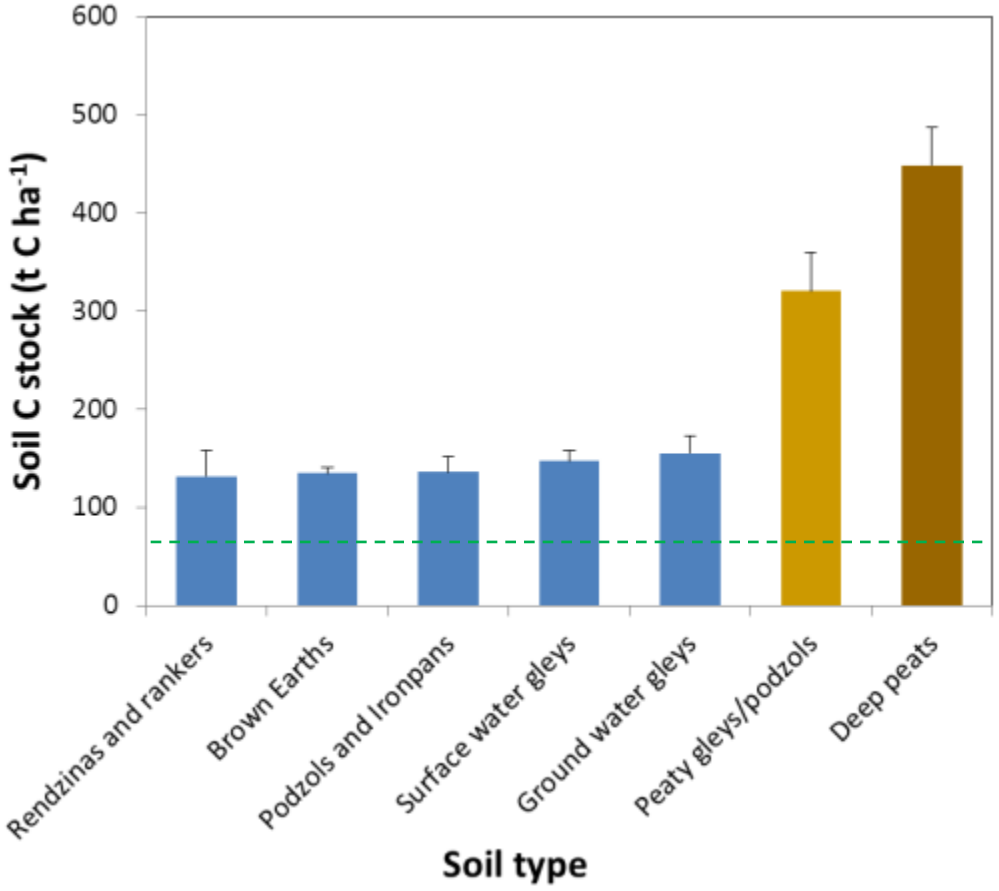
Carbon stocks

- Above-ground biomass
  - stemwood
  - branchwood
  - bark
  - foliage
  - seeds
- Below-ground biomass
  - coarse roots
  - fine roots
  - stumps
- Litter
- Coarse woody debris
- Soil organic carbon

Woodland C stocks - national

Estimates from the National Inventory of Trees & Woodlands (late 1990's) & BioSoil survey (2003-6)

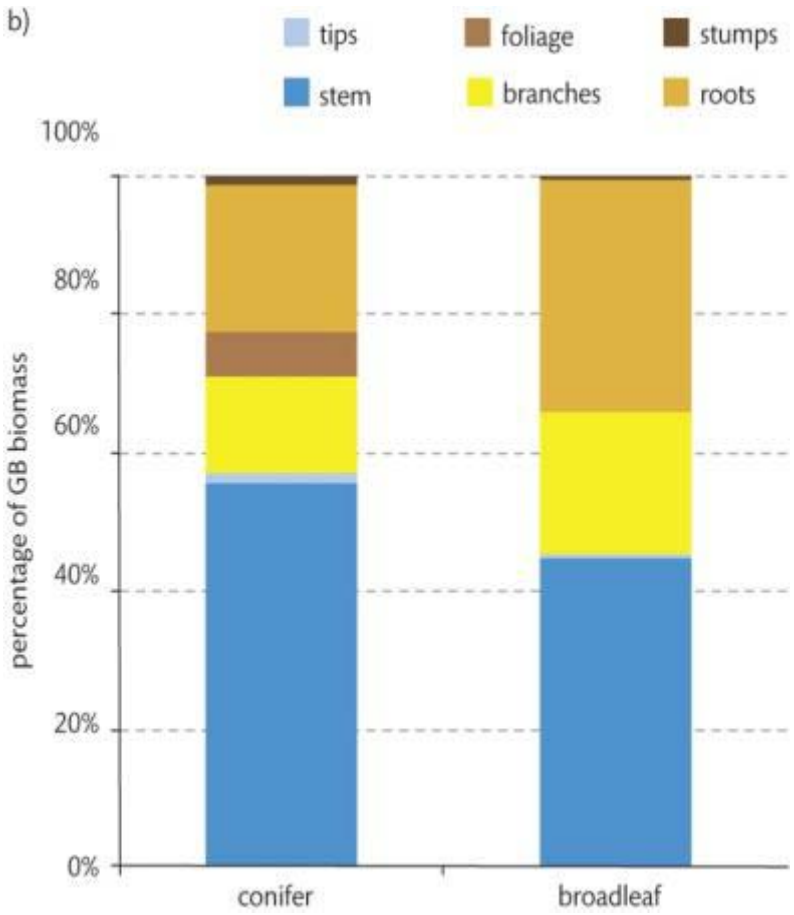




total UK C stock 'in forest' = 878 Mt C

(Vanguelova et al., Soil Use & Man., 2013)

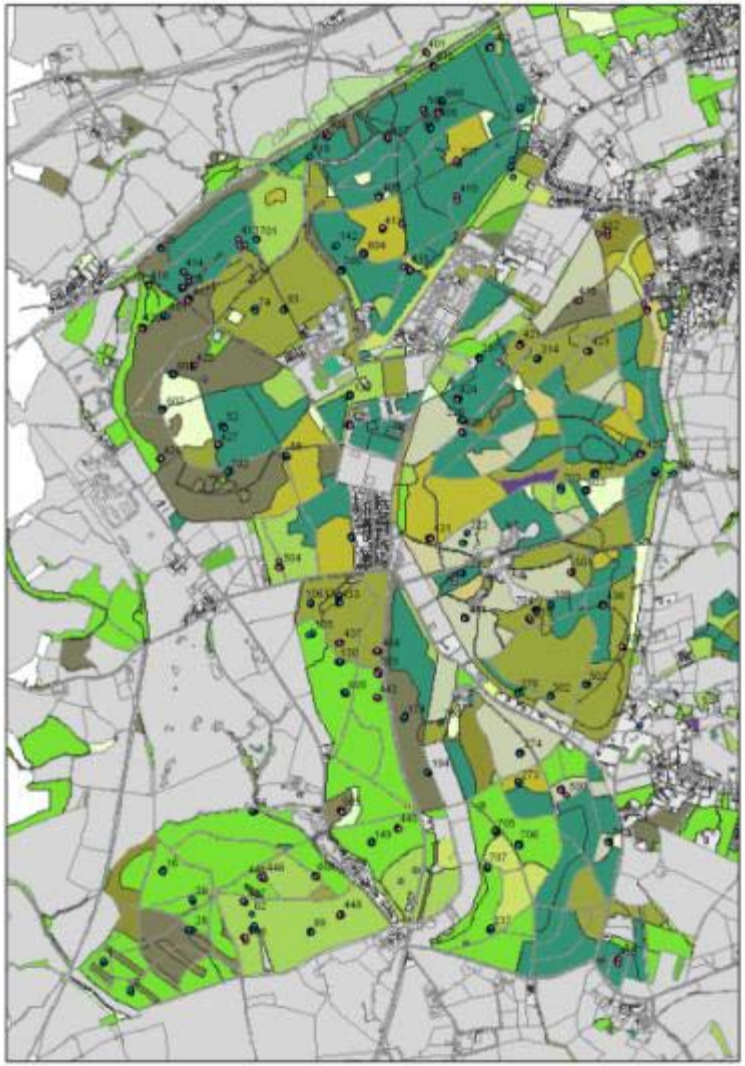
Woodland tree C stocks



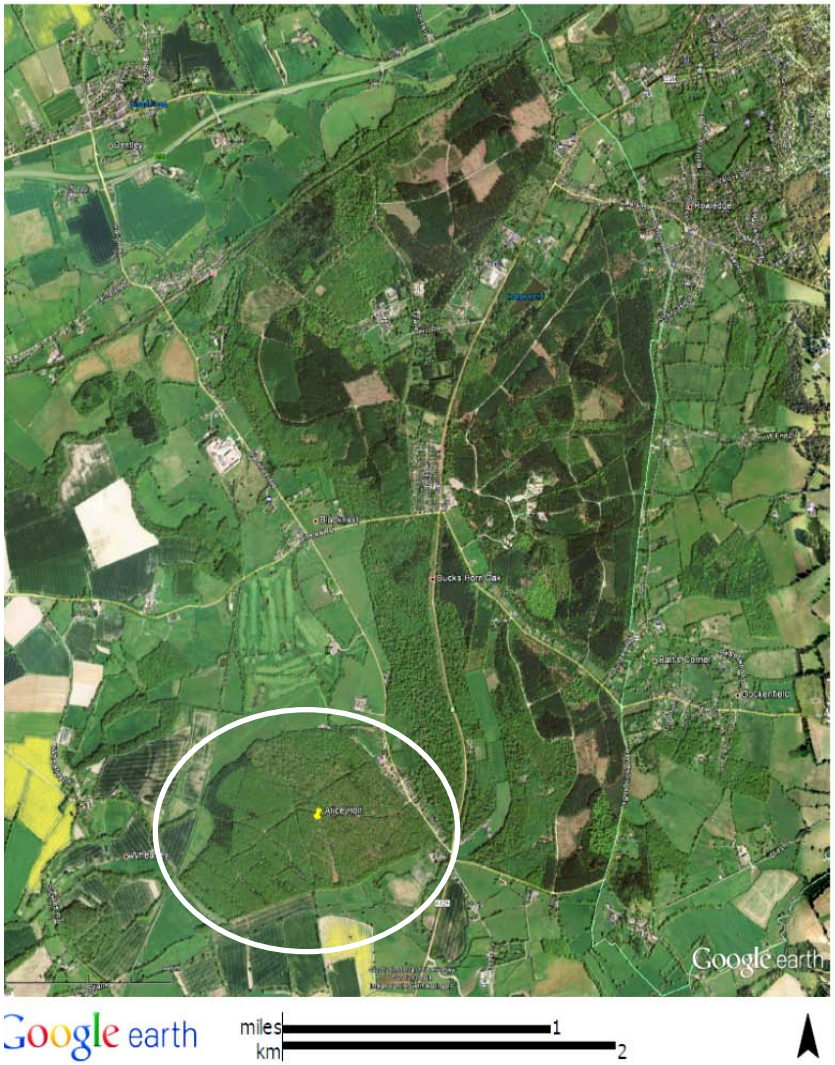
GB averages

(Morison et al. 2012, *Understanding the C and GHG balance of forests in Britain*, Forestry Commission, 150 pp.)

Alice Holt, ECN site

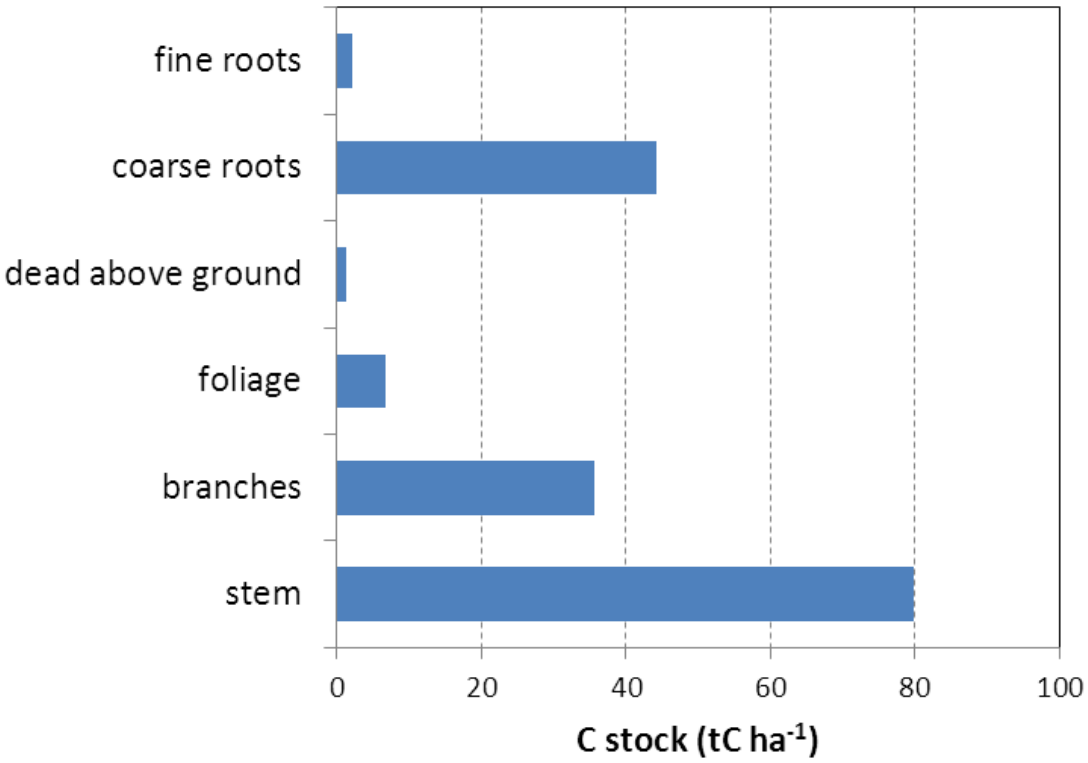


Points show ECN veg plots



Oval show location of TSS & Straits site

AH Straits Inclosure



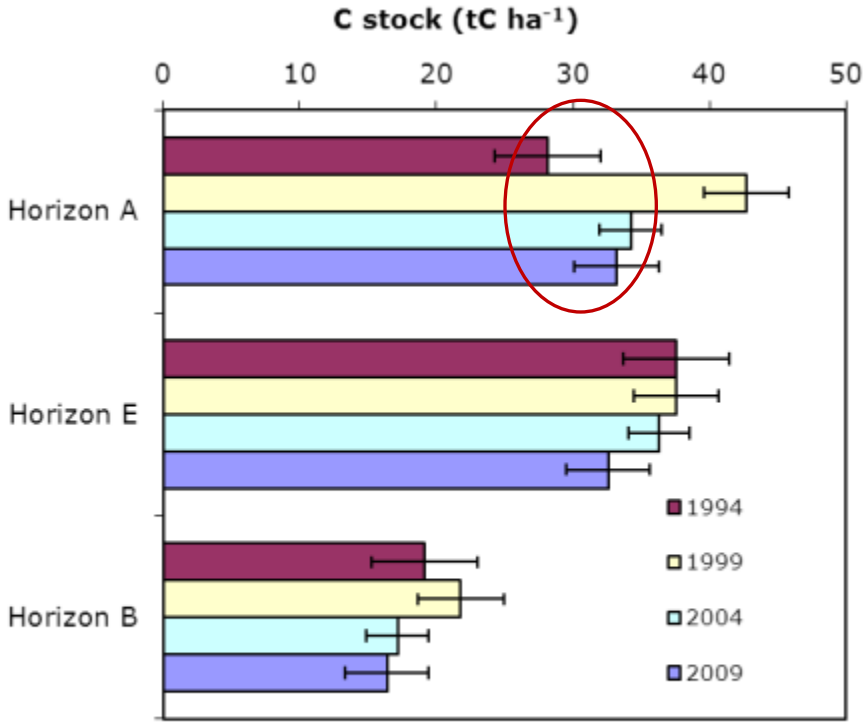
80 y old oak plantation

	tC ha^{-1}
Biomass =	170
Soil =	157
Litter =	17

But the rate of change is more interesting – 'fluxes'

AH, soil C stock changes

Repeat sampling ECN TSS

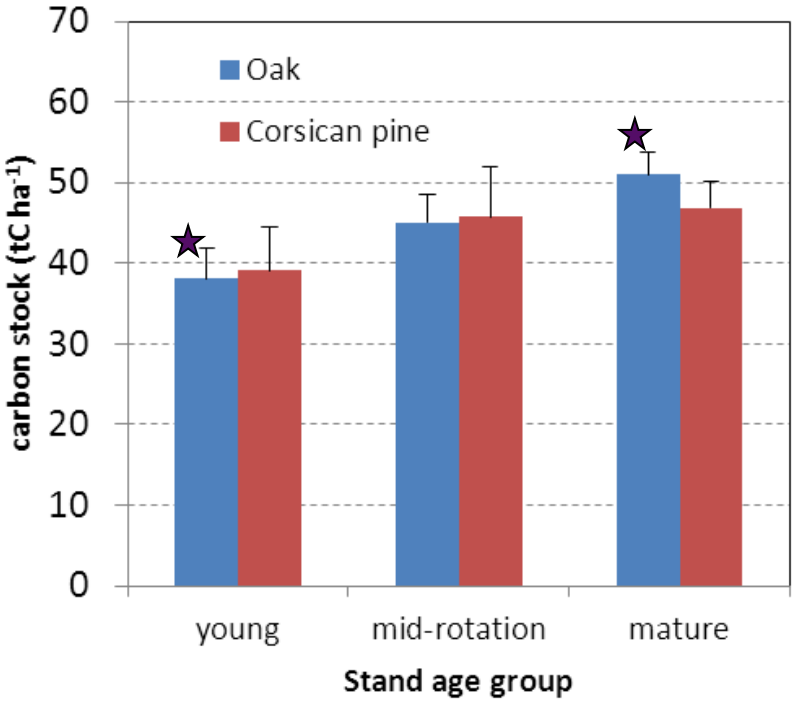


Increase after 1994,
~ 0.34 tC ha^{-1} y^{-1}

(Benham et al., Sci Tot Env 2012)

Chronosequence ECN plots

(0-15 cm)



~60% in stable fraction

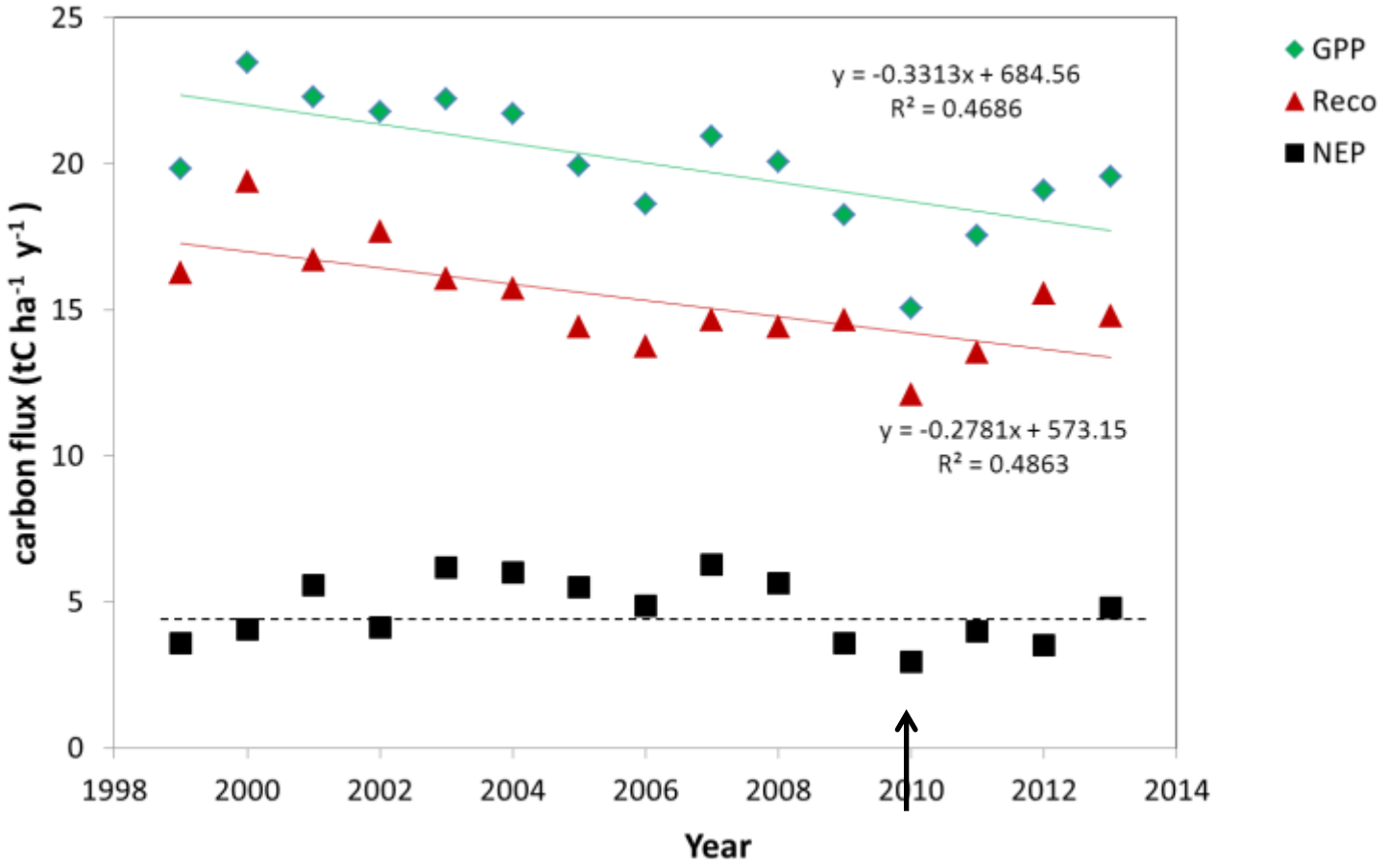
Increase with age,
~ 0.1-0.2 tC ha^{-1} y^{-1}

(Pitman et al., Forestry 2013)

Alice Holt, Straits Inclosure

Eddy covariance flux tower

AH Straits CO_2 balance

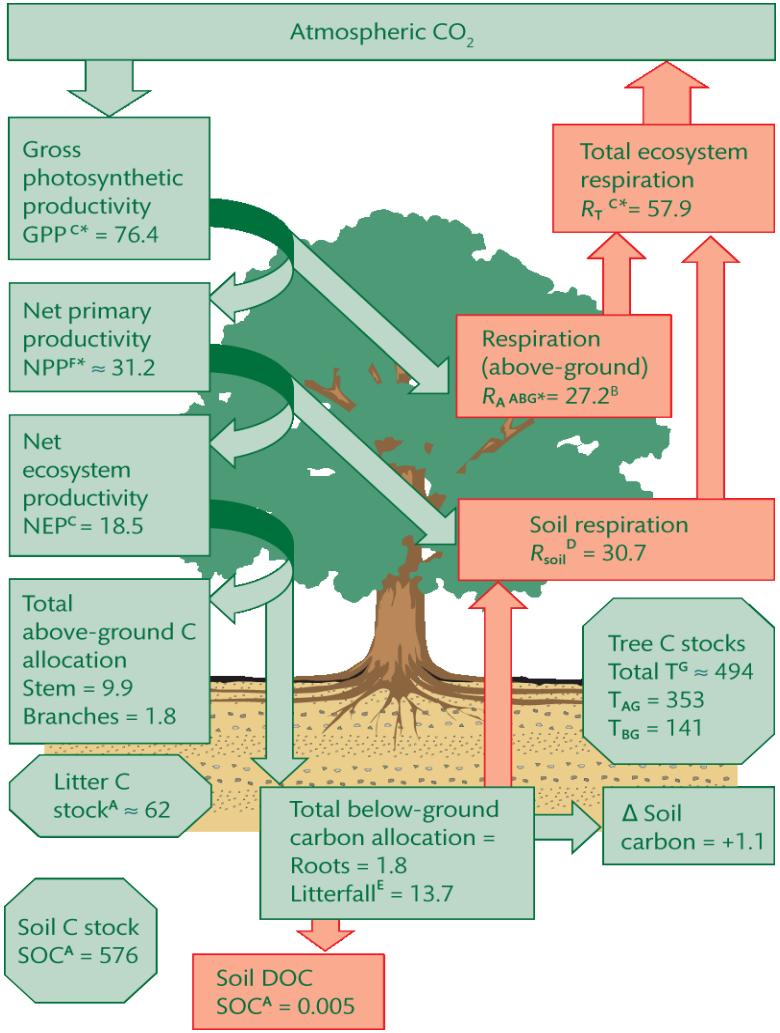


NEP shows interannual variation but no trend, downward trend in GPP and R_{eco}
Age, Environmental change, Insects, Management ….?

(updated from Wilkinson et al., 2012, Biogeosciences)

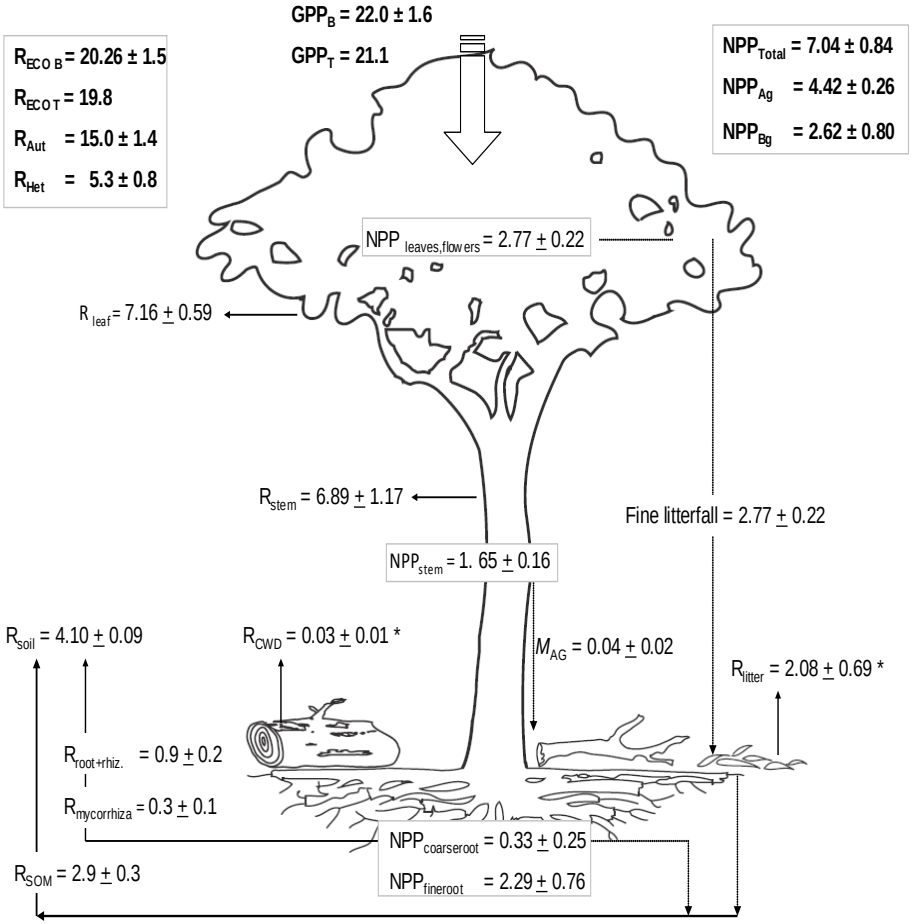
Stand scale woodland C balance

Alice Holt Straits



(Morison et al. *Understanding the C and GHG balance of forests in Britain*, FC, 2012)

Wytham Woods



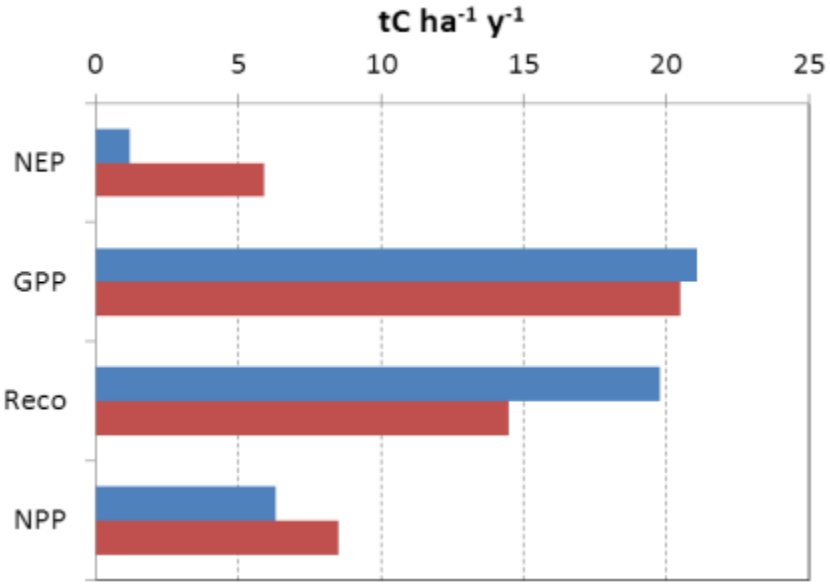
(Fenn, Malhi, Morecroft et al., Ecosystems, in review)

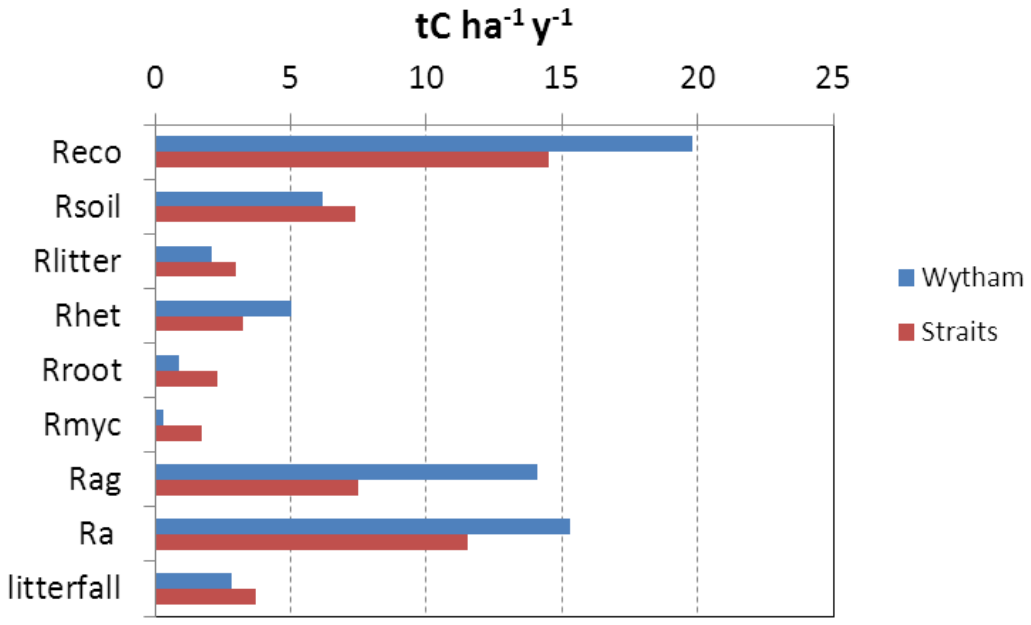
Comparison of AH Straits & Wytham

- Deciduous woodland, similar climate

	AH, Straits	Wytham
Type	Managed plantation	Unmanaged semi-natural
Tree age	Mostly 75-80 y	Wide range (>150y?)
Species	Oak >85%	Syc 70%, Ash 17%, Oak 5%
Understorey	extensive coppice	few shrubs (?)
Basal area	29.7 m^2 ha^{-1}	32.9 m^2 ha^{-1}
Tree density	427 ha^{-1}	450 ha^{-1}
Peak LAI	7.8	6.3
Soil type	Pelo-stagno gley	Stagni-vertic cambisol
Precip & Tair	780 mm, 9.6°C	730 mm, 10.1°C

Comparison AH Straits & Wytham





NEP much smaller at Wytham, larger respiration – mainly autotrophic

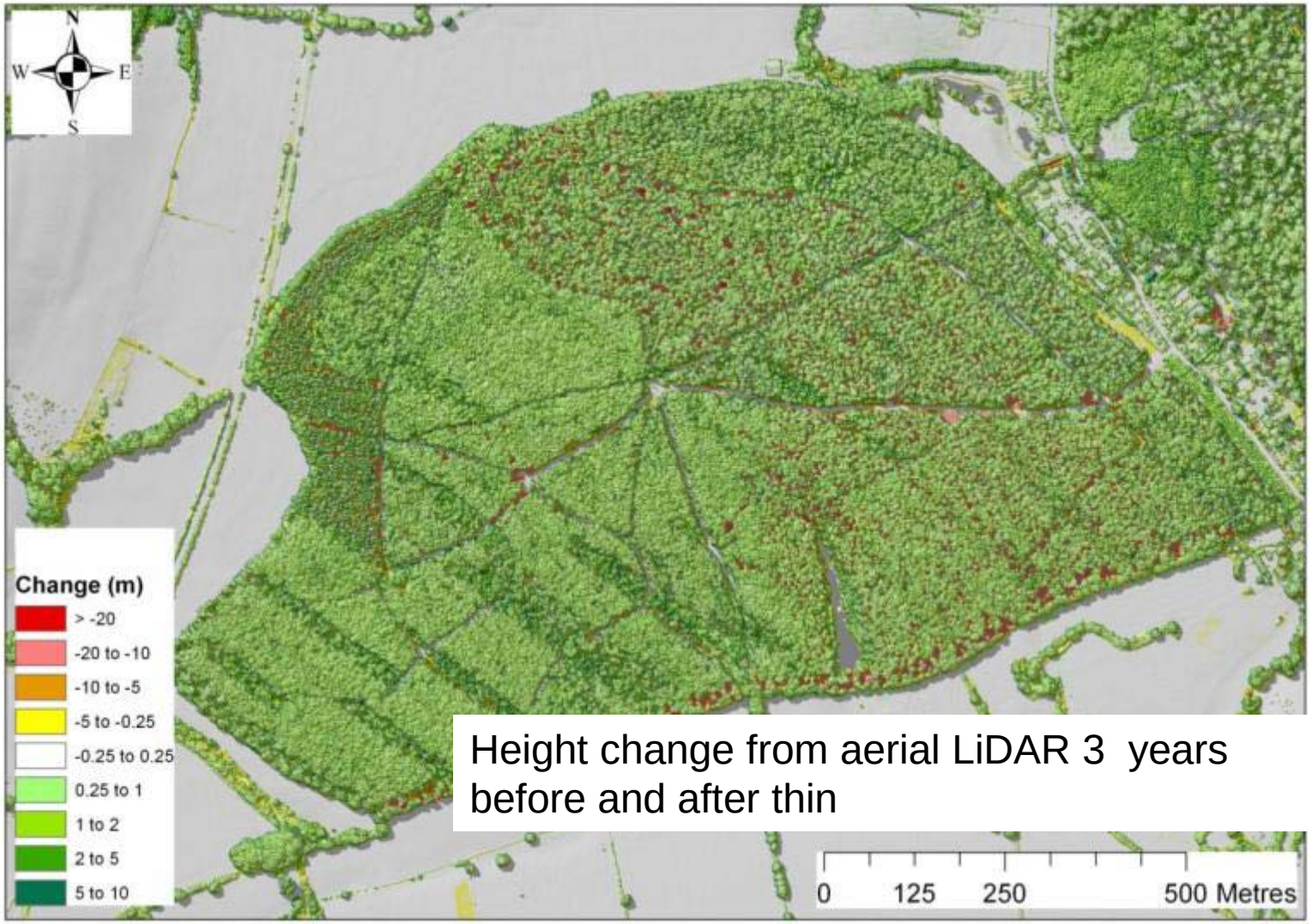
AH Straits: thinning effects

Stand thinning is a normal part of woodland management – removal of some trees

Might expect:

- reduction in GPP due to loss of canopy
- increase Reco due to decomposition
- unknown effects on soil due to disturbance
- unknown time scale of changes?

AH Straits: thinning effects



(analysis by Peter Crow, FR, data from Cambridge University ULM)

AH Straits: thinning effects

- Using fluxes measured at central point from East vs West directions – Thinned and Unthinned
- CO_2 balance not straightforward to interpret as weather conditions also vary
- E & W woodland areas not identical
- Also more gaps in data – more difficult to 'fill'
- Analysis still under way, but looks as though GPP not much affected initially; compensation by other vegetation components ?
- Reco increased after a lag – decomposition ?

(analysis in progress by Matt Wilkinson, FR)

Regional management: LUC

Woodland creation increases C sequestration

- other environmental effects e.g. water and energy balance
- vegetation radiation balance needs to be considered in calculating climate effect of LUC

Data from ECN sites:

Generalised values:

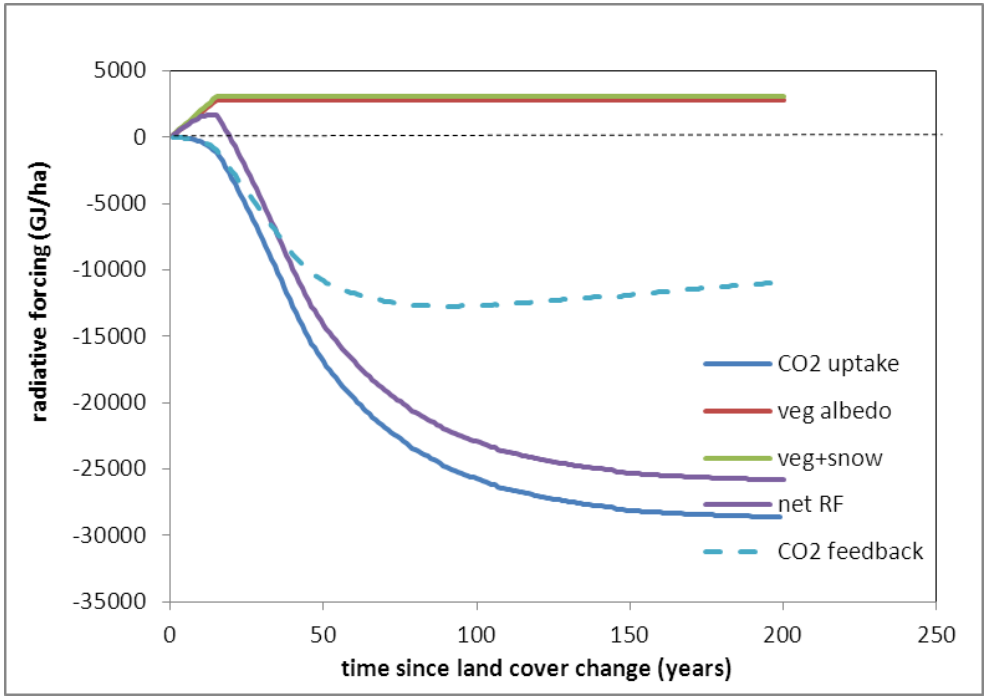
Albedo %	
Conifers:	8-12
Broadleaves:	15-18
Grassland:	15-25
Moorland:	15 (?)

(analysis in progress by Ed Eaton, FR)

LUC & radiative forcing

- If changing vegetation results in increased net CO_2 uptake, this has a cooling effect (-ve radiative forcing)
- But if decrease in reflected solar energy this has a warming effect (+ve radiative forcing)
- Need to consider net effect

Assumptions:
10% change in albedo
Sitka spruce moderate productivity
25 days snow lying
Average daily radiation 9 MJ m^{-2} d^{-1}



Need also to consider other GHG and water balance etc

(Calculations adapted from Kirschbaum et al., Biogeosciences 2011)

Summary

- Outlined C balance and components for contrasting woodlands
- Example of changes due to management at local scale (e.g. woodland age, thinning)
- Using understanding from ‘local’ measurements to assess impact of changes at larger scales
- Examples of use of detailed monitoring as in the ECN supplemented with other measurements to understand differences between sites and changes over time.
- *ECN is a key part of research infrastructure*

Thank you !

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