Old trees, flammable forests and global climate change

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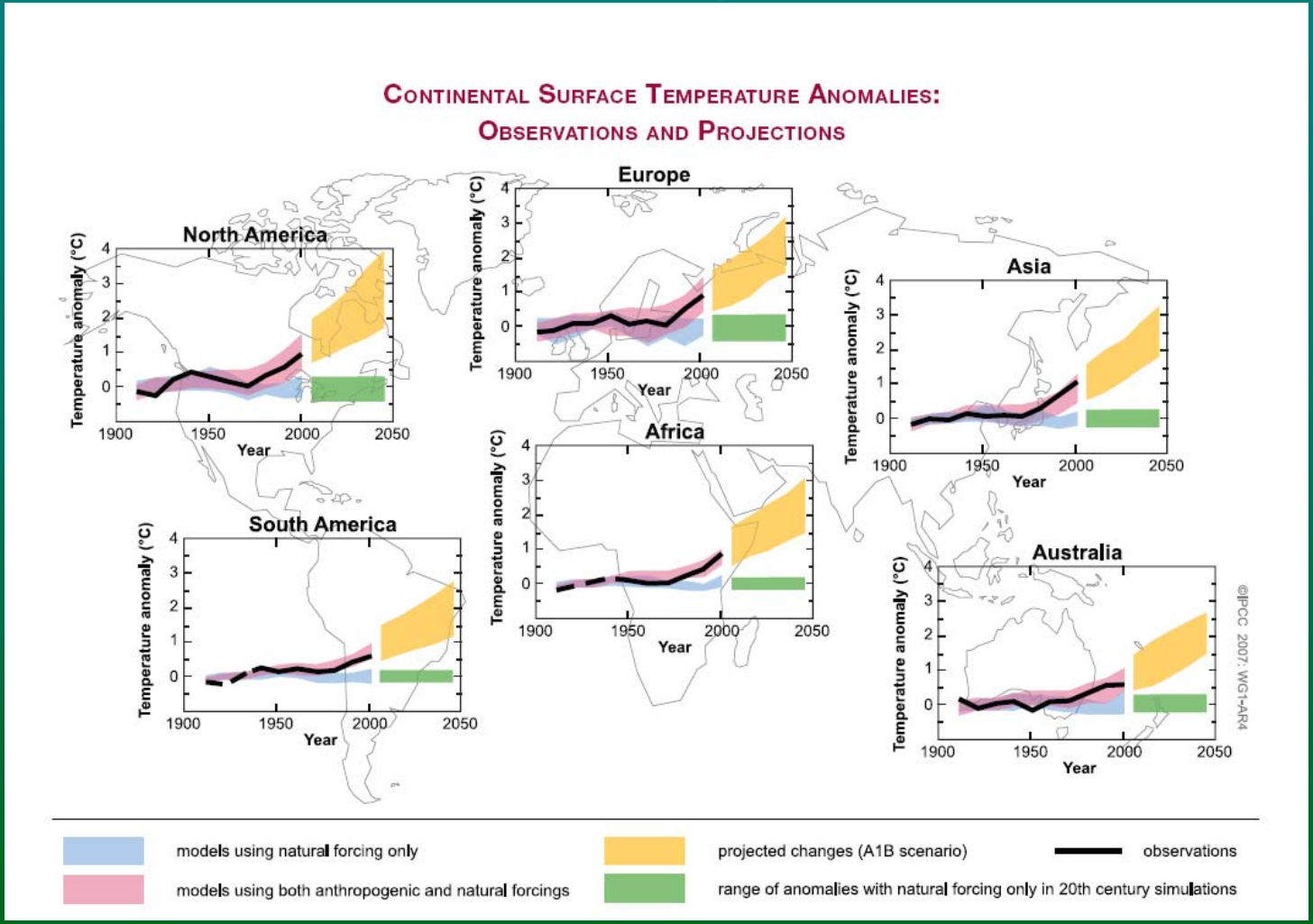
The inconvenient truth: Global Climate Change



A1B is a moderate emissions scenario – warming could be much worse

Intergovernmental Panel on Climate Change (IPCC) *Climate Change (2007) Synthesis Report – Summary for Policy Makers*

Duncan Poore's (1989) uncertain future

"The exact contribution of deforestation to the **increase of carbon dioxide** in the atmosphere is not yet certain, but is perhaps of the order of one-quarter of that provided by the burning of fossil fuels. The effectiveness of forest in locking up carbon depends upon the standing woody biomass, not upon the rate of growth. The highest biomass is generally contained in heavily stocked stands of **old-growth trees** – stands which have been the principal target of loggers. Anything that can be done to increase the number of standing trees will make some contribution to reducing the **danger of global warming**, even though there is uncertainty about the exact quantity of that contribution. A new element now needs to enter land-use and forest policies: to maximise, other things being equal, the standing volume of wood on the land. This would suggest some **changes of the direction of forest policies**: greater emphasis on protection; less stress on harvesting stands before they become "over-mature"; strong emphasis on **developing new plantations on land previously devoid of tree cover**; and, wherever possible, the encourage of tree crops in any agricultural land or waste land."

The catch: eucalypts, fire and carbon

- Poore(1989) *No Timber without trees: sustainability in the tropical forests* (Earthscan Publications, London)
- Old growth eucalypts forests aren't equivalent to tropical rainforests because of their (inter)dependence on landscape fire

Succession and landscape change

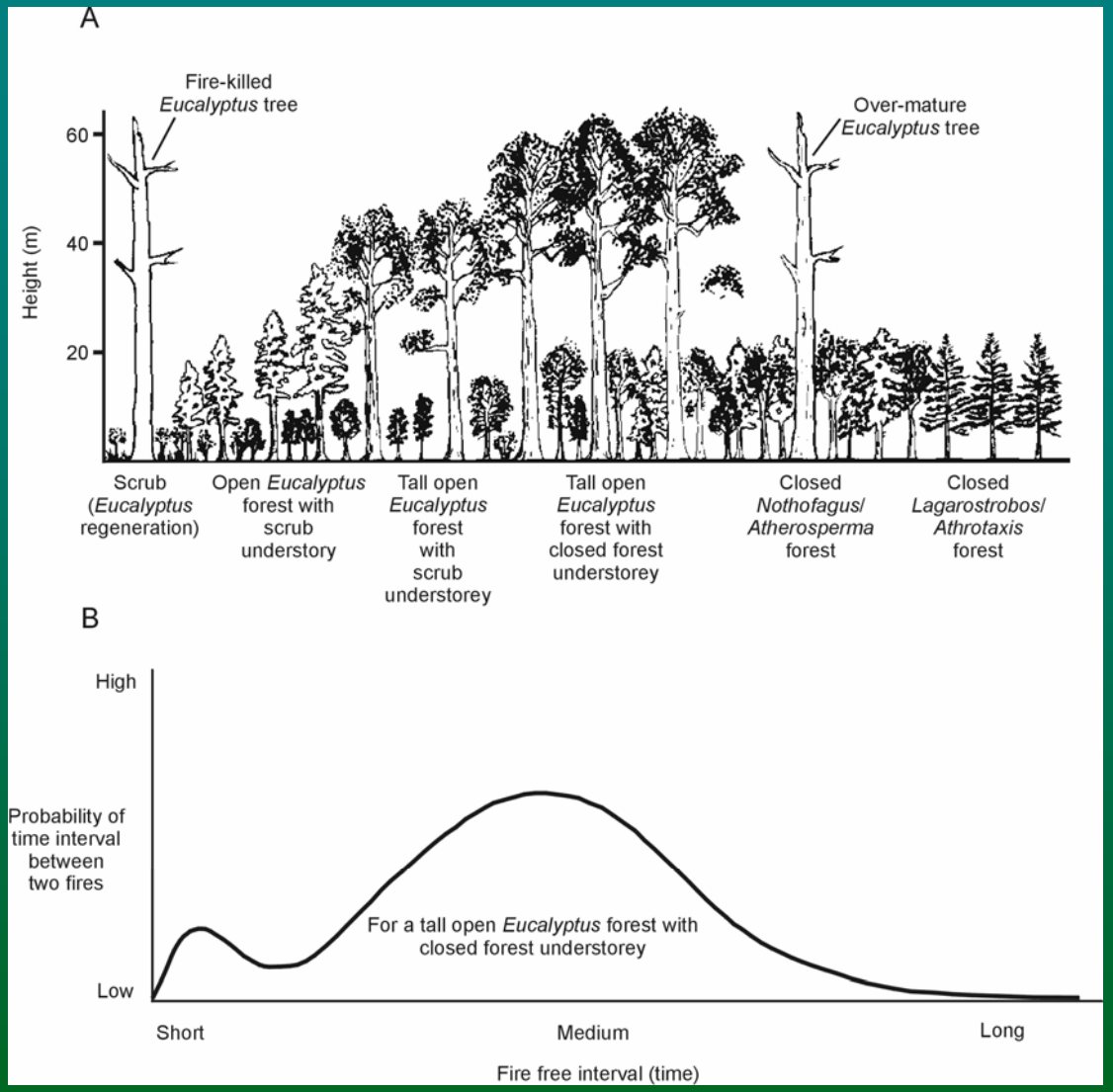
In the long run we are all dead

and

from little things big things grow

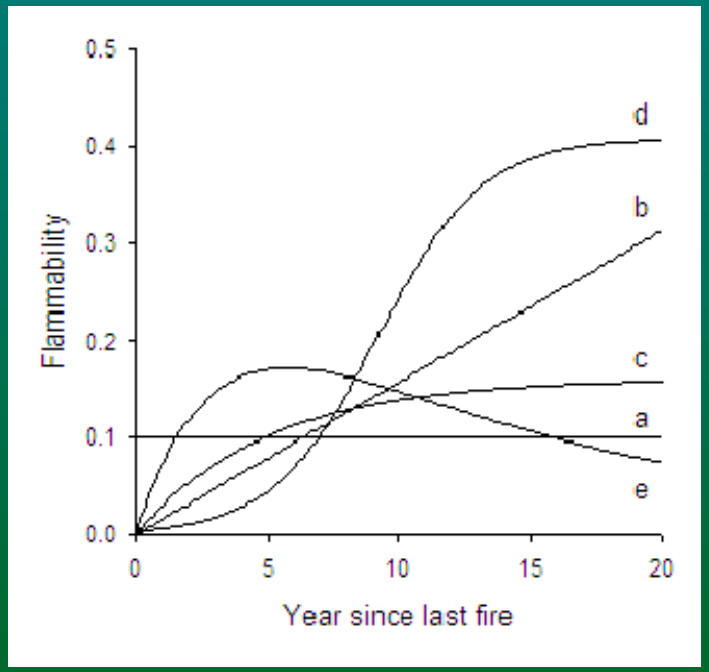
Fire risk and succession

- Old growth eucalypts part of a fire-cycle
- Regrowth assumed to carry additional risk of fire
- Long period without fire result in succession to self sustaining temperate rainforest



Bowman (1986) *Vegetatio* 65,105-113.

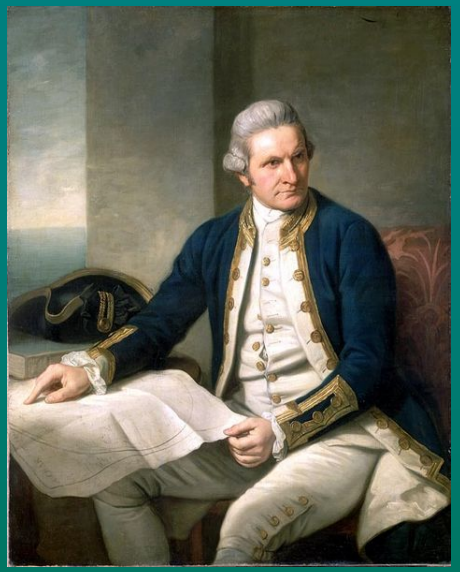
What is the actual fire risk of regrowth vs. old growth?



- Theoretical argument about how flammability changes with stand age and limited hard data to discriminate between alternatives
- Requires historical reconstructions
- Dendrochronological potential of eucalypts have little studied
- Non-trivial issue given changes in the extent (and spatial arrangement) of regrowth may change inherent fire risk in landscape

McCarthy *et al.* (2001) *International Journal of Wildland Fire* **10**, 73-77.

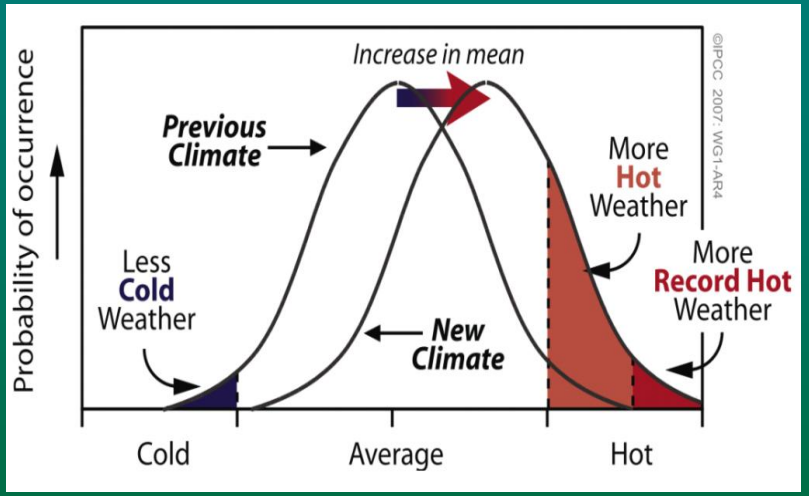
A methodological problem: understanding succession and old growth eucalypts



- Old growth eucalypts demand a historical context
  - Germinating before Cook discovered eastern Australia!
- Mortals (including scientists) are limited in their ability travel in time
- Broad sweeps of time favour focusing on the **here and now**

A new confounder for bushfire risk in SE Australia - climate change

- Warmer
- Drier
- More climatic extremes – e.g. heatwaves
- *Very high confidence* declining forest productivity and more bushfires in SE Australia
- Upshot - future (and present?) non-equilibrium/analogue relative to past conditions



Intergovernmental Panel on Climate Change (IPCC) *Climate Change (2007) Impacts, Adaptation And Vulnerability – Summary for Policy Makers*

Forests and carbon storage

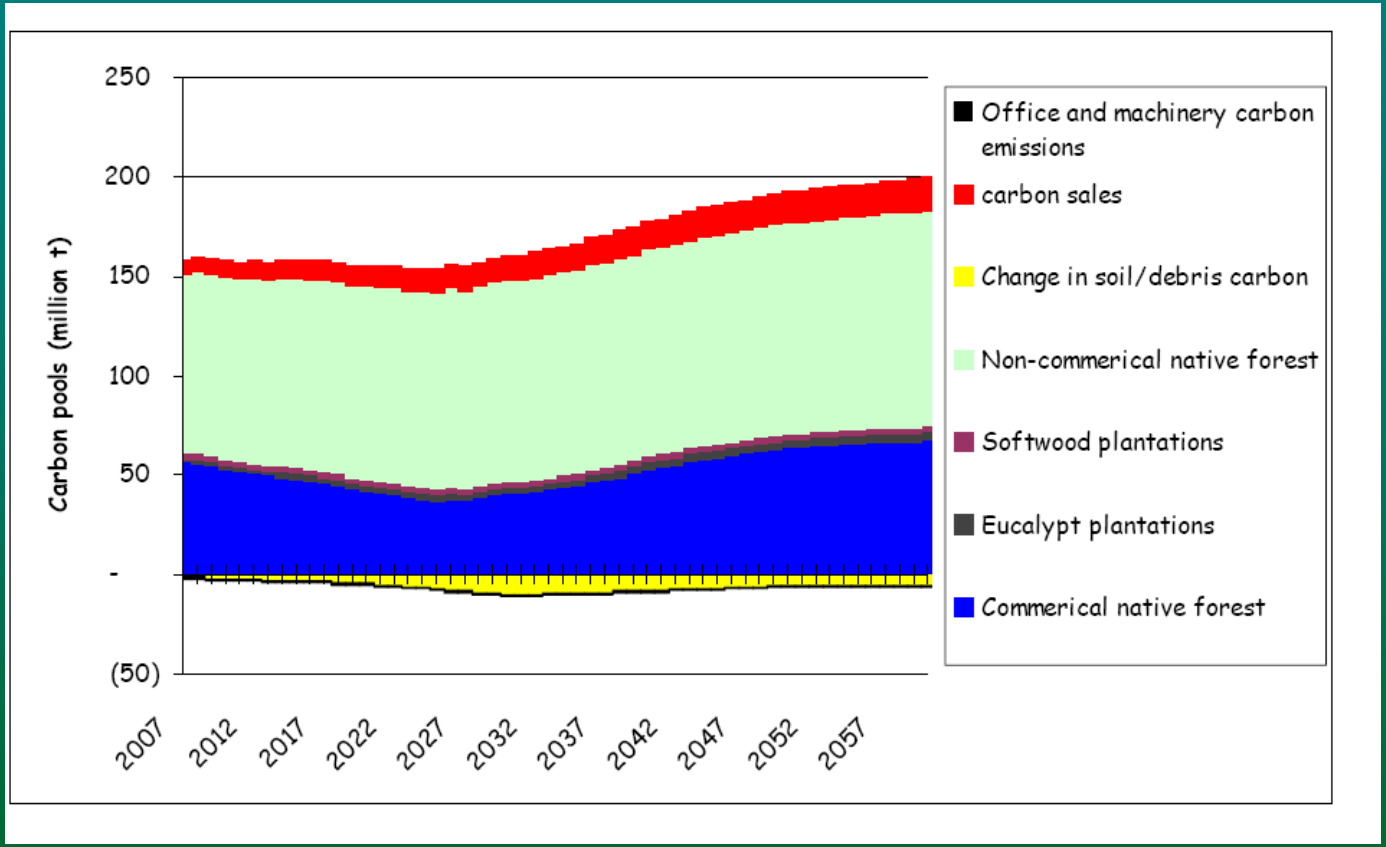
- Poorly developed methodology for carbon ‘accounting’
- Must include carbon in
  - Living plants
  - Dead stems
  - Litter and coarse woody debris
  - Soils
  - Could include *type* of land cover
- Large statistical variation hence sampling issues
- Concerns risk management
- Influenced by the politics and economics of trading of ‘carbon sequestration benefits’
- Debate about the relative carbon storage of regrowth and old growth

‘*Increased carbon storage will presumably occur if there are economic incentives and carbon sequestration can compete with the market value of other land services.’* Huston and Marland (2003) *J. Environ. Management* 67, 77-86.

Examples of the challenges of carbon, fire and climate change

1. Projections of *Forestry Tasmania's* carbon stores
2. Modelling stand age in response to deterministic or stochastic fire
3. The trade-off between regowth and old growth for carbon sequestration
4. Sensitivity of forest management to carbon price

1. Forestry Tasmania's carbon sequestration position

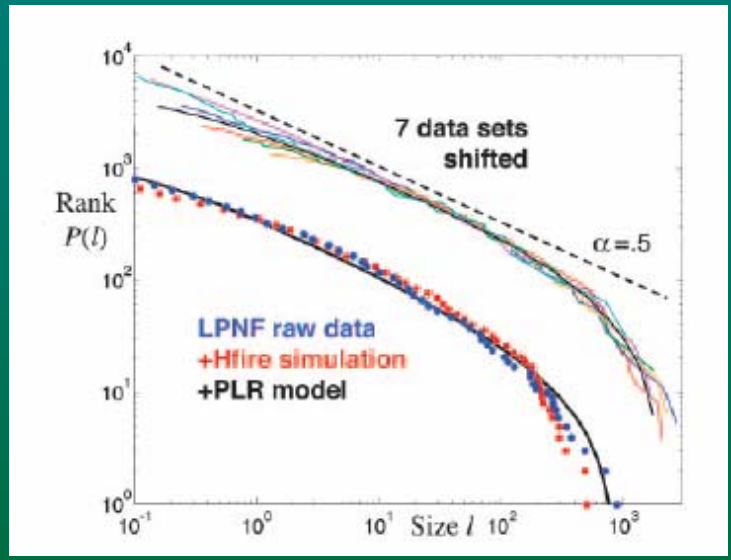


- 'Ignores the impact of wildfire'
- Ignores climate change
  - fire X climate change
  - IPCC predicts reduced forest productivity by 2030 due to drought and fire in SE Australia

MBAC Consulting Group – 2 December 2007

2. Modelling stand age in response to deterministic or stochastic fire

- Modeling showed that the age distribution of *E. regnans* was very sensitive to the variance around mean fire return times.
- For example, if the average fire disturbance was once every 200 years
  - a deterministic disturbance regime will yield a landscape with 25% of the stands older than 151 years
  - a stochastic regime would have approximately 50% the stands older than 151 years
- How should fire be incorporated into modelling scenarios?
  - Incomplete knowledge of fire frequency, flammability risk, and effect of climate change
  - But cumulative number of fires vs. fire size follow a specific power-law

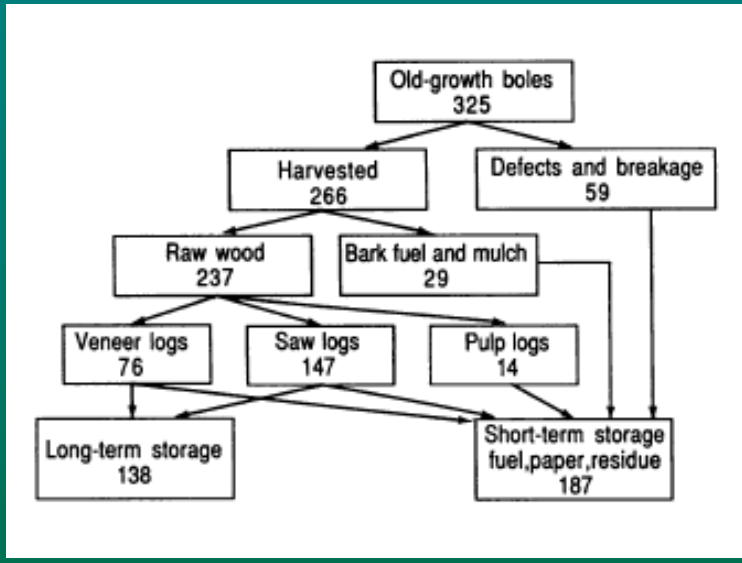


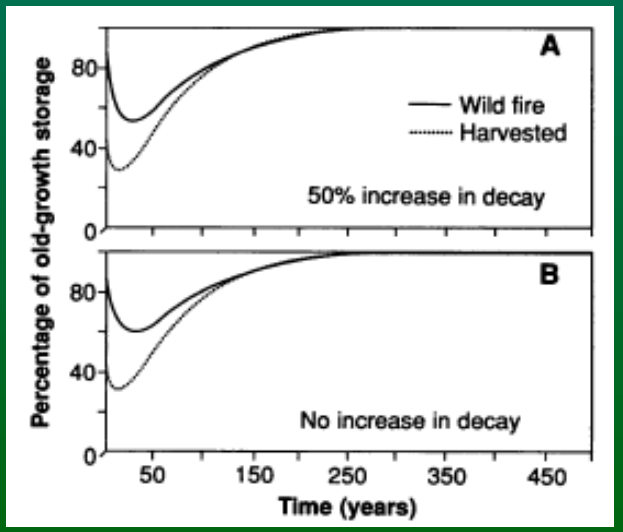
Moritz, Morais, Summerell, Carlson & Doyle (2005) *PNAS* 102, 17912 -17197

McCarthy MA & Burgman MA (1995) *Forest Ecology and Management* **74**, 23-36.

3. #1 The trade-off between regrowth and old growth for carbon sequestration

- A trade-off between C storage vs. C uptake
- In Pacific Northwest forests modelling suggests conversion of old growth to regrowth releases CO_2 for up to 200 years
  - 42% off-take in storage > 5 yrs
  - To reduce this carbon in harvested products needs to be sequestered more effectively
- Recovery following logging slower that from natural disturbance
  - Uncertainty in effects of climate change on growth and fire risk





Harmon, Ferrell & Franklin (1990) *Science* 247, 699-702

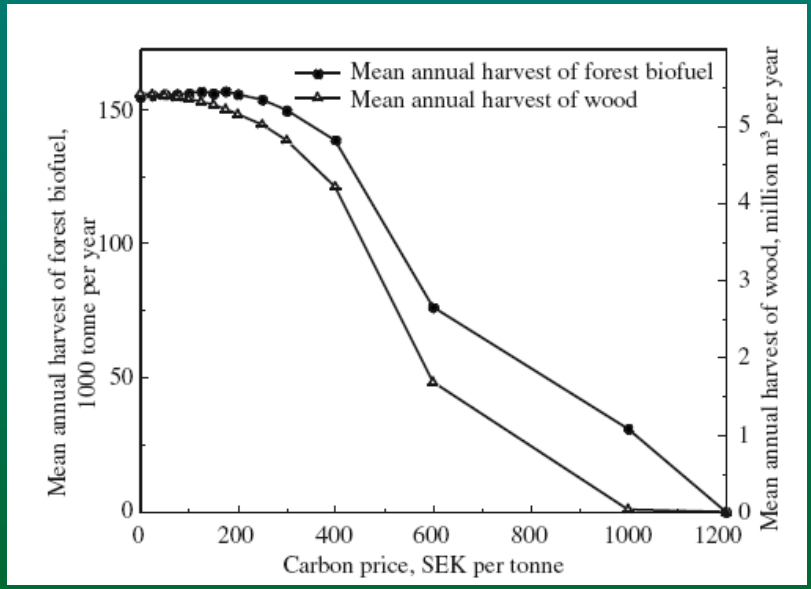
3. #2 The trade-off between regrowth and old growth for carbon sequestration

- Regrowth forests have a substantial carbon sequestration potential
- Logged eucalypt forests on SE Aust. Eucalypt coast have 60% of their estimated carbon carry capacity (CCC) in above ground biomass
- Modelling suggests that CCC recovery from logging is 75% complete at 53 years and 90% complete at 152 years
- '*native forest management should be considered when developing terrestrial carbon management options, and for terrestrial carbon accounting more generally*'

Roxburgh, Wood, Mackey, Woldendorp & Gibbons (2006) *J. Applied Ecology* 43, 1149-1159

4. Sensitivity of forest management to carbon price

- Sweden: Regional economic analysis showed a decline of biofuel, pulp and timber off-take with increasing carbon price over a 100 year projection
  - Least productive forests used for C storage first
  - Timber superior to pulp because of C storage
- Analysis unrealistic
  - pulp, timber and biofuel prices were held constant over 100 years
  - assumed no interaction between C and other prices locally or globally
  - No soil C
  - No disturbance



Half the Swedish price of Carbon in 2002!

Backéus, Wikström, & Lämås (2006) *Silva Fennica* 40, 615-629.

The current forest debate

Biodiversity

Production

Aesthetics

The emerging forest debate

Biodiversity

Fire

Production

Aesthetics

Carbon

Conclusion

- The longevity of eucalypts and their interdependence with fire renders them particularly susceptible to climate change
  - Basic knowledge gaps limits predictions
- Concern for carbon sequestration *may* see a change in the social value and management of forests
  - longer rotations for *carbon*
  - But *'it's the [carbon] economy, stupid'*
- **Fire management** will be of paramount importance
  - Demands landscape planning, including fire breaks and access
  - Greater understanding of fire risk and significance for forest and carbon dynamics
  - Significant investment of human resources