Solving the climate change problem facing Australia and the world requires that emissions of greenhouse gases be reduced and that the storage of carbon in vegetation be increased, so as to enable atmospheric concentrations of greenhouse gasses to be stabilized at a level that avoids the most dangerous climate changes.

The need for reducing emissions from deforestation and forest degradation is now recognized by the international community as an essential part of solution to addressing carbon emissions. Since the 2007 United Nations Climate Change Conference in Bali international negotiations have focused on the role of natural forests in storing carbon.

Native forests play a significant role in the storage of carbon and the sequestration of carbon dioxide from the atmosphere. Old growth forests are the most significant carbon storehouses, with most carbon stored in the oldest and biggest trees (Roxburgh et.al. 2006, Mackey et. al. 2008, Stephenson et. al 2014). Old-growth forests also remove carbon dioxide from the atmosphere and sequester it in live woody tissues and slowly decomposing organic matter in litter and soil. (Zhou et. al. 2006, Luysaert et. al. 2008)

Mackey et. al. (2008) found;

Our analyses showed that the stock of carbon for intact natural forests in south-eastern Australia was about 640 t C ha-1 of total carbon (biomass plus soil, with a standard deviation of 383), with 360 t C ha-1 of biomass carbon (living plus dead biomass, with a standard deviation of 277). The average net primary productivity (NPP) of these natural forests was 12 t C ha-1 yr-1 (with a standard deviation of 1.8).
Average Carbon Carrying Capacity of the Eucalypt Forests of South-eastern Australia. (from Mackey et. al. 2008)

<table>
<thead>
<tr>
<th>Carbon component</th>
<th>Soil (t C ha⁻¹)</th>
<th>Living biomass (t C ha⁻¹)</th>
<th>Total biomass (t C ha⁻¹)</th>
<th>Total carbon (t C ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon stock ha⁻¹</td>
<td>280(161)</td>
<td>289(226)</td>
<td>360(277)</td>
<td>640(383)</td>
</tr>
</tbody>
</table>

Carbon stock per hectare is represented as a mean and standard deviation (in parentheses), which represents the variation in modelled estimates across the region.

Logging significantly reduces the volume of carbon stored in forests. In regards to logging Mackey et. al. (2008) note:

The carbon stock of forests subject to commercial logging, and of monoculture plantations in particular, will always be significantly less on average (~40 to 60 per cent depending on the intensity of land use and forest type) than the carbon stock of natural, undisturbed forests.

The majority of biomass carbon in natural forests resides in the woody biomass of large old trees. Commercial logging changes the age structure of forests so that the average age of trees is much younger. The result is a significant (more than 40 per cent) reduction in the long-term average standing stock of biomass carbon compared with an unlogged forest.

It is important to recognise the outstanding contribution of big old trees to storage of carbon in forests. For example Roxburgh et.al. (2006) found:

In mature forests, large diameter trees greater than 100 cm d.b.h. comprised 18% of all trees greater than 20 cm d.b.h. and contained 54% of the total above-ground carbon in living vegetation. ... The influence of large trees on carbon stock therefore increases with their increasing size and abundance.

In Australian forests Roxburgh et.al. (2006) found that following logging:

Model simulations predicted the recovery of an average site to take 53 years to reach 75% carrying capacity, and 152 years to reach 90% carrying capacity.

This is compatible with the findings of Harmon et. al. (1990) in America, who found that during simulated harvesting carbon storage is reduced by 49-62% and does not approach old growth storage capacity for at least 200 years (even when storage in wooden buildings is accounted for).

Sillett *et al.* (2010) found that traditional ground-based measurements are inadequate to quantify whole tree wood production of tall tree species, finding that “*larger trees produce more wood annually than smaller trees*”, and that “*annual aboveground wood production increased with size and age up to and including the largest and oldest trees*” they measured. Stephenson *et al.* (2014) concluded:

*Forests are major components of the global carbon cycle, providing substantial feedback to atmospheric greenhouse gas concentrations. Our ability to understand and predict changes in the forest carbon cycle—particularly net primary productivity and carbon storage—increasingly relies on models that represent biological processes across several scales of biological organization, from tree leaves to forest stands. Yet, despite advances in our understanding of productivity at the scales of leaves and stands, no consensus exists about the nature of productivity at the scale of the individual tree, in part because we lack a broad empirical assessment of whether rates of absolute treemass growth (and thus carbon accumulation) decrease, remain constant, or increase as trees increase in size and age. Here we present a global analysis of 403 tropical and temperate tree species, showing that for most species mass growth rate increases continuously with tree size. Thus, large, old trees do not act simply as senescent carbon reservoirs but actively fix large amounts of carbon compared to smaller trees; at the extreme, a single big tree can add the same amount of carbon to the forest within a year as is contained in an entire mid-sized tree.*

Mackey *et al.* (2008) state:

*Conventional approaches to estimating biomass carbon stocks are based on stand-level commercial forestry inventory techniques. These data are not, however, suitable for calculating the carbon carrying capacity of natural forests.*

Roxburgh *et al.* (2006) and Mackey *et al.* (2008) advocate an approach to assessing the carbon stocks of native forests based on the Carbon Carrying Capacity of oldgrowth forest. Mackey *et al.* (2008) consider that for reliable carbon accounts two kinds of baseline are needed;

1) *the current stock of carbon stored in forests*; and 2) *the natural carbon carrying*
capacity of a forest (the amount of carbon that can be stored in a forest in the absence of human land-use activity). The difference between the two is called the carbon sequestration potential—

the maximum amount of carbon that can be stored if a forest is allowed to grow given prevailing climatic conditions and natural disturbance regimes.

With the urgent need to sequester carbon from the atmosphere we should be managing our forests as carbon sinks. As Mackey et. al. (2008) conclude;

The remaining intact natural forests constitute a significant standing stock of carbon that should be protected from carbon-emitting land-use activities. There is substantial potential for carbon sequestration in forest areas that have been logged commercially, if allowed to regrow undisturbed by further intensive human land-use activities.

For the Great Eastern Ranges corridor Mackey et. al. (2010) note:

One necessary action to help solve the climate change problem is to prevent emissions from deforestation and forest degradation (reduced emissions from deforestation and degradation: REDD) (IPCC 2007a). Emissions from deforestation represent about 18% of annual global emissions – a share greater than that of the global transport sector (Nakicenovic 2000; IPCC 2006). Emissions from degradation of forests and other ecosystems have yet to be fully accounted for, but they are likely to be in the order of 10–15%. This would mean that emissions from land clearing and ecosystem degradation may account for more than 20% of the root cause of the climate change problem. Various mechanisms are now being considered for directing investments for funding activities that will result in REDD. Different rules and policies may be promulgated for REDD in developing versus developed countries. In any case, we should plan for ‘wall-to-wall’ carbon accounting in anticipation that the green carbon in natural forests and woodlands will very soon have a market value.

More specifically, appropriate conservation management could lead to the GER corridor making a significant contribution to Australia’s national carbon accounts by (Keith et al 2009, 2010):

● protecting the stocks of carbon in forests and avoiding depletion of these stocks through emissions associated with forest logging, soil disturbance and regeneration burning
● allowing forests to reach towards their carbon-carrying capacity by cessation of the logging and other land use activities that remove, in particular, large, old trees that store most of the aboveground carbon and cause emissions of soil carbon stocks, thus restoring the forest’s current carbon stocks
● further increasing the stock of carbon stored in the GER corridor ecosystems by promoting permanent native revegetation and restoration.

Perkins and Mackintosh (2013) undertook an economic analysis to compare the net financial benefits from harvesting NSW’s Southern Forest Region’s native forests with those produced by conserving the forests and generating carbon credits, finding that “using the forests to generate carbon credits will generate greater aggregate net benefits than harvesting”. They note:

The analysis in this paper suggests that, in the absence of a rebound in relevant wood product prices (especially the export woodchip price), continued harvesting in the SFR is likely to generate substantial aggregate net losses over the next 20 years. In the core harvest scenario (H1), the combined net financial benefits
generated by the Forestry Corporation of NSW and the SFR’s private hardwood processors over the period 2014-2033 were estimated at between -$40 million and -$77 million. These losses would be borne by the Forestry Corporation of NSW and SEFE; the sawmills are projected to produce a small positive net financial benefit over the projection period. This is mainly because the Forestry Corporation of NSW and SEFE’s operations subsidise SFR hardwood sawmilling.

Stopping harvesting and using the native forests of the SFR to generate carbon credits offers a viable alternative to commercial forestry. In the core no-harvest scenario (CC1, method 1), it was estimated that the New South Wales government could earn 33.8 million ACCUs over the period 2014-2033 (an average of 1.7 million per year). The net financial benefits that could be generated through the sale of these credits (accounting for transaction and management costs) were estimated at $222 million. The Australian government would also receive the benefit of 12.8 million residual FM credits from the cessation of harvesting in the SFR over the period 2014-2033. However, if the New South Wales government receives ACCUs, the financial benefits to the Australian government are likely to be relatively small as lost company tax revenues associated with ceasing harvesting would largely cancel out the financial benefits received from the residual FM credits.

Overall, the analysis supports two general conclusions:

- under current and likely future market conditions, the harvesting and processing of native logs in the SFR is likely to generate substantial losses; and
- the aggregate net financial benefits are likely to be significantly higher if commercial harvesting is stopped and the native forests of the SFR are used to generate carbon credits.

Using the forests to generate carbon credits will generate greater aggregate net benefits to the community than harvesting. The avoidance of emissions by retaining trees, and their ongoing carbon sequestration, provides a higher benefit to the people of NSW than logging them. Protecting forests is an essential part of the solution to climate change.

Global Warming
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Perkins, F. and Mackintosh, A. (2013) Logging or carbon credits, Comparing the financial returns from forest-based activities in NSW’s Southern Forestry Region. Australia Institute, Tech Brief 23. ISSN 1836-9014

