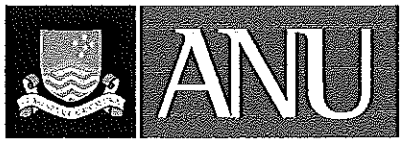
Estimating Carbon in Direct Seeded Environmental Plantings

by

Charles Lowson

Submitted in partial fulfilment of the requirements for the degree of
Bachelor of Science (Forestry) with Honours
in the Fenner School of Environment and Society,
Australian National University
November 2008



THE AUSTRALIAN NATIONAL UNIVERSITY

Abstract

The future of Australia's ecosystems is increasingly uncertain due to the major global environmental impacts of anthropogenic climate change. Reafforestation is one technique which, by reducing the amount of carbon dioxide present in the atmosphere, is capable of mitigating the effects of climate change. Direct seeded environmental plantings are an increasingly popular form of reafforestation for agricultural land within Australia, as they provide a range of environmental and production benefits. At present, however, there is a lack of knowledge regarding the carbon sequestration potential of these plantings. Further, although a range of methods are available to measure the carbon within these plantings, the most appropriate method differs between projects. This thesis aims to identify the best available measurement methods within the project's constraints, and also to estimate the mass of carbon within direct seeded environmental plantings. In addition, this thesis aims to quantify the effects of site factors – such as age, thinning, grazing history and edge effects – on carbon sequestration in environmental plantings.

Measurements of tree diameter, height and other characteristics were collected from healthy vegetation, between the ages of 12 and 18 years, on 38 plots located within the Southern Tablelands The carbon mass for each plot was estimated using: (i) volume based allometrics estimated from DBH and height, then expanded to mass; (ii) generic allometric relationships based on DBH; and (iii) the National Carbon Accounting System's FullCAM model.

These methods – which were used to determine tree carbon mass – produced a variety of estimates based on the embedded assumptions in their model framework. The estimates showed that: models based on similar assumptions correlate well with each other; and FullCAM generally underestimates site carbon mass for plots that contain greater than 20tC/ha in the live above-ground carbon pool. There is some suggestion that FullCAM's conservative prediction in one pool is compensated for by its prediction in other pools. This, however, was not able to be properly established.

Tree height and, therefore, carbon mass, was found to be different for sites with different grazing and thinning histories. The location of a tree on an inner or outer row was also found to be significant ($P<0.05$) in determining tree shape. This will, therefore, influence those tree mass estimation techniques that use DBH and height as input variables. Surprisingly, the age of a site was not found to significantly affect its carbon mass, with 18 year old sites not carrying significantly more carbon than 12 year old sites. The interaction causing this anomalous finding was unable to be established within this thesis.

The "best" method to measure the carbon mass in direct seeded environmental plantings was not obvious, as it required a trade-off between the available information, the data which

was able to be collected, and the "type" of answer required. This study concludes that the model which assumes a "conservative" tree shape – the BHFF 1/3 allometric – is a good compromise between these tradeoffs, as long as DBH and height information is available. This model is known to give conservative estimates and, thus, could be very useful as a carbon mass baseline. This method predicted the total above-ground carbon pool of healthy plantings between the ages of 12 and 18 within the Southern Tablelands to be: 24.9(±5.4)t/ha (P=0.05).

If DBH and height information is not available, then estimates produced by FullCAM for these direct seeded sites can be used. However, caution is needed when using the default parameter estimates due to FullCAM under-predicting the carbon mass of sites containing greater than 20tC/ha in their live above-ground carbon pool. There is a likelihood that important parameters within FullCAM – such as the age at which maximum mean growth occurs – are not well estimated for these direct seeded environmental plantings. Adjusting these parameters may significantly reduce the bias observed in this thesis.

Further research is required to measure the true value of these plantings and accurately quantify the effect of a range of site factors on the mass of carbon sequestered. The conservative estimate of 24.9(±5.4)t/ha for the live above-ground carbon pool can, however, be used as a starting point from which the carbon credits applicable to this revegetation method may be ascertained. This result may, therefore, have implications for the land-use change strategies employed by Australia in its climate change mitigation efforts.