

GRAZING PROPERTY CARBON BUDGET IN CENTRAL QUEENSLAND



- *Wololla* -

Property Carbon Budgeting in Central Queensland Report No. 4

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WOLOLLA CARBON BUDGET

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Introduction

The information in this report is presented in two sections. The first section provides a general overview of carbon credits and carbon trading. Information has been gathered from two government publications, *Growing trees as greenhouse sinks. An overview for landholders* (The Australian Greenhouse Office) and *Carbon credits from forestry: questions and answers for rural landholders* (Queensland Government). The second section outlines details of the carbon budget estimated for “Wololla”, a cattle property near Jericho in the Desert Uplands region of Central Queensland.

It was estimated that approximately 369,409 tonnes of carbon were stored in the trees and bushes on the property. This represents an average of 29.56 tonnes/ha of carbon in vegetation (excluding cleared and naturally open areas). In the predominant vegetation types, the values range from an average 24.5 tonnes/ha of carbon in ironbark country to 74.8 tons/ha of carbon in bloodwood country. Approximately 72.9% of the carbon is in the above-ground part of the trees and scrubs, while 27.1% is below-ground in the roots.

SECTION 1. GENERAL INFORMATION

Greenhouse gas emissions

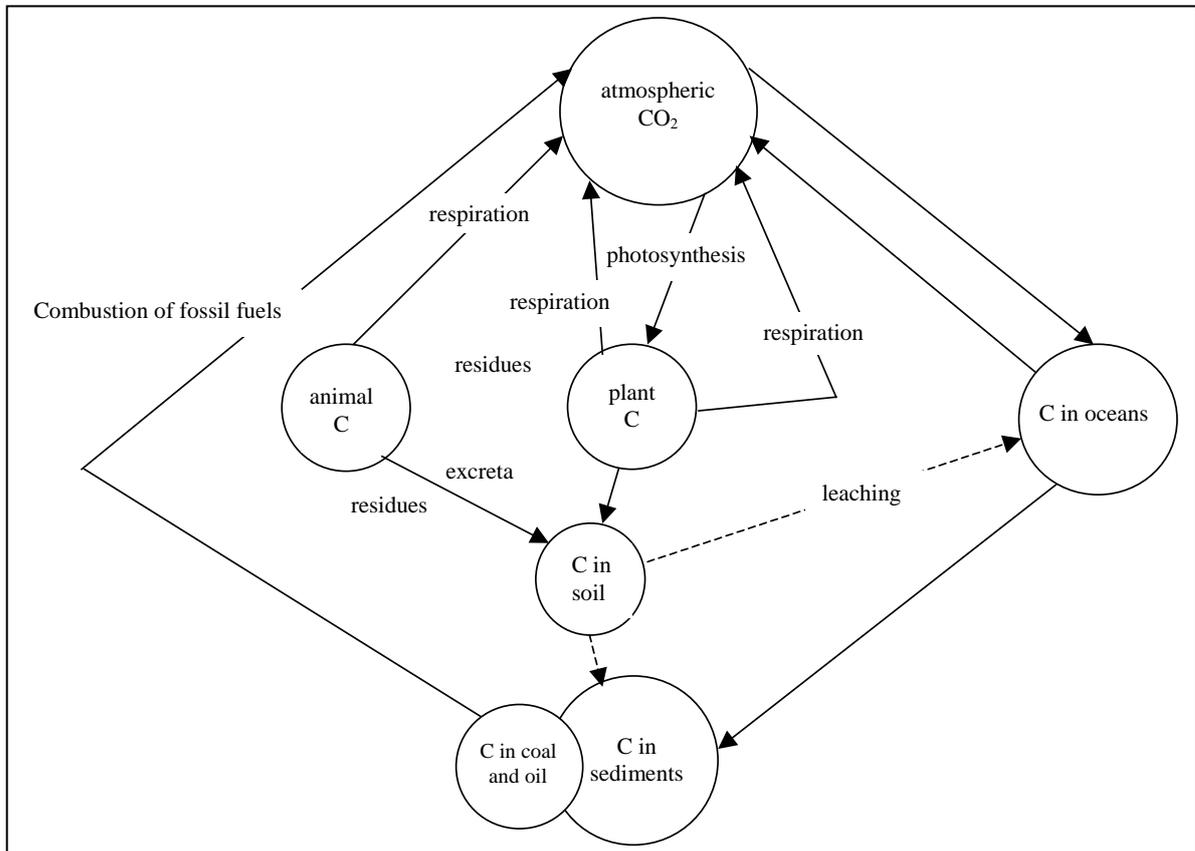
An increased level of certain gases in the atmosphere, known as the greenhouse effect, is believed by scientists to cause global warming and climate change. In 1998 Australia recorded its hottest year since quality records began, in line with a general increase in global temperatures. The increase in greenhouse gas emissions since the industrial revolution could be causing the increase in global temperatures. Carbon dioxide is the main greenhouse gas emitted by human activity, and is responsible for over half the increases in the greenhouse effect. The main source of carbon dioxide emissions comes from the burning of fossil fuels, principally from power generation and transport. Agriculture is also responsible for large emissions of carbon dioxide from vegetation and soils.

Trees and plants act as a carbon sink

Trees and plants use carbon dioxide from the atmosphere and store it as carbon in the leaves, branches, stem, bark and roots (Figure 1). The rate at which trees absorb carbon depends on the site where they are growing, and to a lesser extent on the species planted. It also varies during the different growth stages. While the plants are growing and carbon is absorbed and stored, they act as a carbon sink. When trees are harvested and some

material is burnt or rots, carbon will be released back into the atmosphere. Mature forests act mostly as a store of carbon, because the amount of carbon taken up each year in new growth is balanced by losses from decay and fire. Forest products, such as timber and paper, also act as carbon stores until they are allowed to decay.

Figure 1. The Carbon Cycle



Carbon sinks and carbon trading.

The global community has viewed the prospect of the greenhouse effect to be serious enough to draft a planned commitment to cap greenhouse gas emissions. This planned commitment, known as the 1997 Kyoto Protocol, is an international treaty, agreed in principle but not yet ratified by all countries. The United States of America and Australia have not ratified the agreement. The Protocol assigns each developed country a greenhouse gas target – Australia has a target of 108% of 1990 emissions, to be achieved, on average, during the period 2008 - 2012 (the first commitment period). While much emphasis is placed on the reduction of emissions, consideration is also given to practices that remove carbon dioxide from the atmosphere and lock up carbon in **carbon sinks**. This leads to the potential for **carbon trading**. Trading would work by people selling **carbon credits** (the amount of carbon locked up or stored) to a buyer who needed credits to offset their excessive level of emissions.

The Kyoto Protocol provides basic rules for using greenhouse sinks to reduce or offset emissions, and only internationally approved carbon sinks will be eligible to generate credits used for Kyoto purposes. However, formal decisions about the detailed rules, definitions and methodologies relating to sinks and the eligibility of additional sinks

activities have yet to be agreed. It is also possible that some countries may establish their own internal carbon trading system that may differ from an international system. The Australian government has not yet decided on the introduction of a national emissions trading system for greenhouse gases.

Australia has made general commitments to controlling greenhouse gas emissions, even though it has not ratified the Kyoto Protocol. It is possible that the Australian Government will encourage some forms of carbon offsets even if it does not join any international trading programs.

Carbon sink activities

A major way of offsetting carbon dioxide emissions is to soak up carbon in growing forests. Forestry is likely to be the major source of carbon credits because large amounts of carbon are sequestered as the trees grow over a period of time. However, forestry will not be the only activity that may be recognised. A range of other land management practices, such as revegetation involving shrubs and other non-woody vegetation, minimum till cropping, crop rotation, and stock management, could become recognised sink activities.

Under carbon trading, major emitters (eg industry) may pay land managers to soak up carbon by growing forests or other activities. If a carbon trading system is established, there will need to be clear definitions of what constitutes a carbon sink. Most emphasis has been on growing forests. As yet, there are no exact definitions, but the forest plantings that meet the following definitions may be eligible as afforestation or reforestation sinks:

- a forest of trees with a potential height of at least two metres and crown cover of at least 20 per cent;
- in patches greater than one hectare in area;
- established since 1 January 1990;
- on land that was clear of forest at 1 January 1990 - not land that has been cleared since 1990, or land covered in woody weeds; and
- established by direct human induced methods, i.e. planting or direct seeding, or human induced promotion of regeneration from natural seed sources.

The following requirements may be proposed to meet eligibility criteria as revegetation activities:

- establishment of vegetation that is too small or sparse to qualify as afforestation or reforestation;
- a minimum area yet to be determined;
- established since 1 January 1990; and
- established by direct human induced methods only, i.e. planting or direct seeding.

Carbon trading examples

No national system of standards in relation to carbon sinks and carbon trading has yet been established in Australia, but some states are taking a proactive approach. In 1998

NSW enacted legislation that enabled the rights to carbon sequestered in planted forest to be separated as a legal entity from the land on which the planted forest grows and the timber rights attached to the planted trees themselves.

Tokyo Electric Power Company (TEPCO) signed a contract with State Forests of NSW to establish a planted forest for carbon sequestration and timber products over a ten-year period. TEPCO had been seeking an opportunity to invest in carbon sinks for greenhouse gas offsets, as part of its overall package of measures to deliver internal greenhouse gas emissions reduction targets. This type of investment can achieve a positive return from the commercial forestry aspect even assuming no value for carbon. The contract is for the planting of 1,000 hectares initially, with a target area of between 10,000 and 40,000 hectares. State Forests expects to lease the land from private landowners to establish the plantations, for which the landowner will receive an annual payment.

In June 2001, Australian Plantation Timber Ltd (APT) signed a deal with Cosmo Oil, one of Japan's biggest oil companies to supply carbon credits from 5,000 hectares of its Western Australian blue gum plantations. This deal is the first to come out of an agreement between APT and Japan's biggest bank, the Industrial Bank of Japan, to provide a suitable carbon trading vehicle for emitters. Investors in the blue gum plantations own the timber while APT owns the land and carbon rights.

What are the risks?

There are substantial risks and uncertainties associated with early carbon trading as there are no formally agreed rules. Recent estimates indicate that farming trees for carbon alone is not profitable, and assessing the potential for carbon credits should be considered as only one of a variety of benefits associated with tree planting on farms. The costs of developing a carbon sink activity need to be recognised, such as tree establishment, registration, insurance etc, and until an emissions trading system is introduced, it is hard to estimate the market price of carbon.

How does this relate to land managers in Central Queensland?

Many properties in Central Queensland are both sources and sinks for carbon. Emissions come from clearing vegetation (when it is burnt or rots), from cattle and sheep emitting methane, and from farming activities. Sinks come from growing trees, protecting trees from clearing or fire, and from improving soils. However, most sinks are not currently recognised as potential offsets because of issues about definition and measurement.

It is possible that land managers in the future will be asked to consider their sources and sinks of greenhouse gases. Better information is needed about the impacts of land management on greenhouse sources and sinks, at the property level.

SECTION 2. ON-FARM CARBON ASSESSMENT

Carbon stores on a property

There are three important pools of carbon to consider in a grazing property. The first is the carbon that is locked up in trees and bushes. This includes carbon in the trees and bushes above the ground, and carbon below the ground in the form of roots. The second pool to consider is carbon in grass, while the third is carbon in the soil. Carbon makes up about 50% of the dry matter weight of trees, bushes and grasses, and a smaller proportion of the soils.

Most of the discussion about carbon sinks has focused on trees. However, a full carbon budget for a grazing property should also include information on grasses and soils. In the example below, only estimates of the carbon in the trees and bushes have been made. It is estimated that approximately 369,409 tonnes of carbon are stored in these sources on the property.

An example from the Desert Uplands region in Central Queensland

The carbon estimates outlined below were taken from “Wololla” a cattle property in the Desert Uplands region. The property is located approximately 20 kilometres south-west of Jericho. The property has a total area of 15,997 hectares, of which about 3,499 hectares (22%) has been cleared for grazing and established with improved pasture. The remainder 12,498 hectares (78% of the property) is uncleared and classified as remnant vegetation by the Department of Natural Resources and Mines.

Different Types of Vegetation or Regional Ecosystems at “Wololla”

Queensland is divided into 13 bioregions based on broad landscape patterns that reflect the major underlying geology, climate patterns and broad groupings of plants and animals. Regional Ecosystems describe the vegetation communities within a bioregion. These Regional Ecosystems have been mapped by the Queensland Department of Natural Resources and Mines and the Queensland Herbarium. This is the mapping used for managing vegetation and the tree clearing permits.

The classification of the Regional Ecosystems (RE) follows a set pattern where there are three numbers that make up a classification. The first number refers to a biogeographical region. For the Desert Uplands, all Regional Ecosystem numbers start with 10. The second number refers to the land zone which is a simplified geology/substrate-landform classification for Queensland. Twelve different land zones are recognised. The third number relates to the vegetation.

“Wololla” is located within the Desert Uplands Bioregion, and includes vegetation categorised in 17 Regional Ecosystems. See Table 1 below for details.

Table 1: Regional Ecosystems (RE) and Area Represented on “Wololla”

RE	Major Tree Type	Scientific Name	RE Area (ha)	%
10.3.3	Ghost Gum	<i>Eucalyptus papuana</i>	510.81	4.09
10.3.4	Gidgee	<i>Acacia cambegei</i>	49.02	0.39
10.3.8	Wire Grass	<i>Aristida sp.</i>	2.12	0.02
10.3.12	Moreton Bay Ash	<i>Corymbia tessellaris</i>	83.38	0.67
10.3.14	River Coolibah	<i>Eucalyptus coolibah</i>	25.47	0.20
10.3.25	False Sandalwood	<i>Eremophila mitchelii</i>	4.25	0.03
10.3.26	Bauhinia	<i>Lysiphyllum caronii</i>	0.43	0.00
10.3.27	Poplar Box	<i>Eucalyptus populnea</i>	2,213.72	17.72
10.3.28	Silver Leaf Ironbark	<i>Eucalyptus melanophloia</i>	155.18	1.24
10.5.1	Yellow Jacket	<i>Eucalyptus similis</i>	1,210.56	9.69
10.5.2	Bloodwood	<i>Corymbia brachycarpa</i>	7.34	0.06
10.5.5	White's Ironbark	<i>Eucalyptus whitei</i>	4,756.04	38.06
10.5.10	Bloodwood	<i>Corymbia leichhardtii</i>	317.62	2.54
10.5.12	Poplar Box	<i>Eucalyptus populnea</i>	2,352.48	18.83
10.7.3	Lancewood	<i>Acacia shirleyi</i>	690.18	5.52
10.7.5	Napunyah	<i>Eucalyptus thoziana</i>	67.06	0.54
10.7.12	Narrow Leaf Ironbark	<i>Eucalyptus crebra</i>	52.30	0.42
Total area of uncleared vegetation			12498	100

Estimating the carbon in trees and bushes

As the property included such a wide range of Regional Ecosystems (REs) it was decided to sample only three of the REs, (marked in bold in Table 1) and to apply the information from these and other sites on similar properties, to the other REs.

At each RE one general area (site) was selected to be representative of the vegetation. Trees were measured in 200m² rectangular plots called transects. 30 transects were laid out at each site. Each transect was 50 metres long and 4 metres wide, and all were laid in a north-south direction. All trees were measured in the first three transects. Dead trees, if encountered were included in the measurements. In the remaining transects, trees were measured until thirty trees of each major tree type had been measured and then, only the number of trees was counted in each transect. All trees and bushes over 1.8 metres were measured. It was assumed that trees and bushes lower than this height would be susceptible to fire and may have perished in the landscape.

How the carbon budget was calculated

There are two components of the carbon stored in trees and bushes that need to be considered. The obvious component is the part of the tree that can be seen, ie tree trunk, bark, branches and leaves. This is known as the **above-ground tree biomass**. Carbon is also stored in the plant roots, known as the **below-ground tree biomass**, and this too needs to be considered.

The stem circumference of each tree selected was measured at a height of 30 cm above the ground. From this measurement, the tree biomass was calculated using previously developed equations, which relate stem circumference, or in some cases, stem diameter,

to total above-ground biomass. A list of the available equations that were used is provided in Appendix 1. Although the carbon content varies between tree types, it is generally assumed that carbon constitutes 50% of the tree biomass. Consequently, once the tree biomass was calculated, an estimate of the carbon stored in the trees and bushes was readily assembled.

Estimating the carbon stored in the tree roots or below-ground biomass.

Estimates of carbon stored in the tree roots have to be calculated separately. Tree root biomass can be estimated by determining the root-shoot ratio or the proportion of the tree roots in relation to the above-ground tree biomass. It is known from the work of Burrows and others (see reference section), that below-ground biomass is 23%, 26% and 28% of the above-ground biomass of Narrow Leaf Ironbark, Silver Leaf Ironbark and Poplar Box respectively. The proportion for Poplar Box was applied to the other Eucalypt and Bloodwood trees on the property. A proportion of 43% was used for all other species, based on the assertion in Eamus, McGuinness and Burrows (see reference section) that approximately 30 - 50% of the total biomass in tropical Australian vegetation is located below ground. If 30% of the biomass is below ground, then the root/shoot ratio must be 30/70 which equals 0.43.

It was estimated that approximately 369,409 tonnes of carbon were stored in the trees and scrubs on the property, or approximately 30 tonnes carbon per hectare. There is estimated to be 269,385 tonnes (72.9%) of carbon was stored in the above-ground vegetation, and 100,024 tonnes (27.1%) of carbon was stored in the below-ground stocks. A summary of the carbon in the different vegetation types is presented in Table 2 below; full details are presented in Appendix 2.

Table 2. Tonnes (t) of Carbon (C) Stores in Trees and Bushes on Wololla

RE	Main tree	Total below ground tree C (t) /ha	Total above ground tree C (t)/ha	Total Tree C (t)/ha	RE Area (ha.)	Total Tree Carbon (t)/RE
10.3.3	Ghost Gum	6.18	21.87	28.04	510.81	14324.62
10.3.4	Gidgee	14.09	33.39	47.48	49.02	2327.39
10.3.8	Wire Grass	Not sampled			2.12	
10.3.12	Moreton Bay Ash	16.42	58.37	74.79	83.38	6235.79
10.3.14	River Coolibah	9.44	33.41	42.85	25.47	1091.49
10.3.25	False Sandalwood	0.07	0.17	0.24	4.25	1.01
10.3.26	Bauhinia	9.44	33.41	42.85	0.43	18.21
10.3.27	Poplar Box	5.73	20.00	25.73	2213.72	56956.76
10.3.28	Silver Leaf Ironbark	5.24	19.26	24.50	155.18	3802.50
10.5.1	Yellow Jacket	9.25	30.89	40.14	1210.56	48588.01
10.5.2	Bloodwood	16.42	58.37	74.79	7.34	548.95
10.5.5	White's Ironbark	5.24	19.26	24.50	4756.04	116541.13
10.5.10	Bloodwood	16.42	58.37	74.79	317.62	23754.24
10.5.12	Poplar Box	5.73	20.00	25.73	2352.48	60526.91
10.7.3	Lancewood	9.44	33.41	42.85	690.18	29576.83
10.7.5	Napunyah	9.44	33.41	42.85	67.06	2873.78
10.7.12	Narrow Leaf Ironbark	9.44	33.41	42.85	52.30	2241.42
				Total	12497.95	369409.21

Carbon in individual Regional Ecosystems

10.3.3 Ghost Gum

This ecosystem was measured in detail and the amount of carbon per hectare estimated includes other trees as well as Ghost Gum (see Table 3). It was estimated that there were 167 tree/ha for Ghost Gum, 10 trees/ha for Ironbark, 62 trees/ha for Chinee Tree and Quinine Bush, 15 trees/ha for Bloodwoods, 50 trees/ha for Acacias and Desert Oak, and 30 trees/ha for Others (Hakea, Prickly Pine, and Karajong).

Table 3. Measurements for Ghost Gum Regional Ecosystem 10.3.3 at “Wololla”

	Ghost Gum	Iron bark	Chinee T, Quinine B	Blood wood	Acacia, D. Oak	Others
Biomass (tonnes/tree)	0.244	0.082	0.001	0.096	0.006	0.015
Carbon/tree (tonnes)	0.122	0.041	0.001	0.048	0.003	0.007
Average number of trees/ha	167	10	62	15	50	30
Aboveground tree biomass (t/ha)	40.667	0.818	0.065	1.443	0.300	0.443
Belowground tree biomass (t/ha)	11.387	0.213	0.028	0.404	0.129	0.190
Belowground tree C (t/ha)	5.693	0.106	0.014	0.202	0.064	0.095
Aboveground tree C (t/ha)	20.333	0.409	0.032	0.721	0.150	0.221

The total above-ground carbon for this Ghost Gum ecosystem was estimated at 21.87 tonnes/ha, while the below-ground carbon was estimated to be 6.18 tonnes/ha. This gave a total of 28.04 tonnes/ha in the trees and bushes for this Regional Ecosystem, with 511 hectares at “Wololla”.

10.3.4 Gidgee

The amount of carbon per hectare for the Gidgee ecosystem was not directly measured and values were transferred from measurements taken for the same RE 10.3.4 at a nearby property “The Lake”.

Total above-ground carbon was estimated to be 33.39 tonnes/ha, with below-ground carbon estimated at 14.09 tonnes/ha. This gave a total amount of carbon in the trees and bushes of 47.48 tonnes/ha, for the 49 hectares of Gidgee country at “Wololla”.

10.3.12 Moreton Bay Ash

The amount of carbon per hectare for this Moreton Bay Ash ecosystem was not directly measured and values were transferred from another Bloodwood ecosystem on the property (RE 10.5.2) which was measured in detail.

Total above-ground carbon was estimated to be 58.37 tonnes/ha, with below-ground carbon estimated at 16.42 tonnes/ha. This gave a total amount of carbon in the trees and bushes of 74.79 tonnes/ha, for the 83 hectares of Moreton Bay Ash country at “Wololla”.

10.3.14 River Coolibah

The amount of carbon per hectare for this River Coolibah ecosystem was not directly measured and values were estimated by averaging the measurements of the total carbon/ha measurements of all trees in all sampled REs on the property. This gave a total amount of carbon in the trees and bushes of 42.85 tonnes/ha, for the 25 hectares of Coolibah country in the RE 10.3.14, at “Wololla”.

10.3.25 False Sandalwood

The amount of carbon per hectare for this False Sandalwood ecosystem was not directly measured. Values were used from estimates taken for False Sandalwood in Poplar Box RE 10.3.27 which was measured in detail on the property. This gave a total amount of carbon of 0.24 tonnes/ha, for the 4 hectares of False Sandalwood country at “Wololla”.

10.3.26 Bauhinia

The amount of carbon per hectare for this Bauhinia ecosystem was not directly measured and values were estimated by averaging the measurements of the total carbon/ha measurements of all trees in all sampled REs on the property. This gave a total amount of carbon in the trees and bushes of 42.85 tonnes/ha, for this small area (0.4 ha) of Bauhinia country at “Wololla”.

10.3.27 Poplar Box

This ecosystem was measured in detail and the amount of carbon per hectare estimated includes other trees as well as Poplar Box (see Table 4). It was estimated that there were 287 tree/ha for Poplar Box, 57 trees/ha for False Sandalwood, 20 trees/ha for Silver Leaf Ironbark, 2 trees/ha for Acacia, and 180 trees/ha for Others (Prickly Pine, Cypress Pine, Whitewood, Grevillea, and Beefwood).

Table 4. Measurements for Poplar Box Regional Ecosystem 10.3.27 at “Wololla”

	Poplar Box	F'Sandalwood	Silver Leaf Ironbark	Acacia	Others
Biomass (tonnes/tree)	0.127	0.006	0.082	0.006	0.009
Carbon/tree (tonnes)	0.063	0.003	0.041	0.003	0.004
Average number of trees/ha	287	57	20	2	180
Aboveground tree biomass (t/ha)	36.422	0.334	1.637	0.012	1.596
Belowground tree biomass (t/ha)	10.198	0.143	0.426	0.005	0.684
Belowground tree C (t/ha)	5.099	0.072	0.213	0.003	0.342
Aboveground tree C (t/ha)	18.211	0.167	0.818	0.006	0.798

The total above-ground carbon for the Poplar Box ecosystem was estimated at 20.00 tonnes/ha, while the below-ground carbon was estimated to be 5.73 tonnes/ha. This gave a total of 25.73 tonnes/ha in the trees and bushes in this Regional Ecosystem, with 2214 hectares at “Wololla”.

10.3.28 Silver Leaf Ironbark and 10.5.5 White's Ironbark

The amount of carbon per hectare for these two Ironbark ecosystems was not directly measured at “Wololla”. Whites Ironbark (RE 10.5.5) had been measured in detail at “Swanlea” and “The Lake” (two nearby properties) and the average of those measurements was used to represent this ecosystem.

Total above-ground carbon was estimated to be 19.26 tonnes/ha, with below-ground estimated at 5.24 tonnes/ha. This gave a total amount of 24.50 tonnes of carbon/ha in the trees and bushes of the 155 hectares of Silver Leaf Ironbark country and 4756 hectares of White’s Ironbark country at “Wololla”.

10.5.1 Yellow Jacket

The amount of carbon per hectare for this Yellow Jacket ecosystem was not directly measured at “Wololla”. Yellow Jacket (RE 10.5.1) had been measured in detail at “Swanlea” and “The Lake”, two nearby properties, and the average of those measurements was used to represent this ecosystem.

Total above-ground carbon for Yellow Jacket was estimated at 30.89 tonnes/ha, while below-ground carbon was estimated to be 9.25 tonnes/ha. This gave a total of 40.14 tonnes/ha for trees and bushes in this Regional Ecosystem (1211 hectares at “Wololla”).

10.5.2 Bloodwood

This ecosystem was measured in detail and the amount of carbon per hectare estimated includes other trees as well as Bloodwood (see Table 5). It was estimated that there were 122 trees/ha for Bloodwoods, 8 trees/ha for Ghost Gum, 41 trees/ha for Chinee Tree and Quinine Bush, 3 trees/ha for Silver Leaf Ironbark, 3 trees/ha for Desert Oak, 10 trees/ha for Acacias and 55 trees/ha for Others (Prickly Pear, Whitewood, Hakea).

Table 5. Measurements for Bloodwood Regional Ecosystem 10.5.2 at “Wololla”

	Blood wood	Ghost Gum	Chinee, Quinine	Ironbark	Desert Oak	Acacia	Others
Biomass (tonnes/tree)	0.912	0.530	0.000	0.082	0.097	0.006	0.013
Carbon/tree (tonnes)	0.456	0.265	0.000	0.041	0.048	0.003	0.006
Average number of trees/ha	122	8	41	3	3	10	55
Aboveground tree biomass (t/ha)	110.987	4.414	0.014	0.273	0.290	0.060	0.700
Belowground tree biomass (t/ha)	31.076	1.236	0.006	0.071	0.124	0.026	0.300
Belowground tree C (t/ha)	15.538	0.618	0.003	0.035	0.062	0.013	0.150
Aboveground tree C (t/ha)	55.493	2.207	0.007	0.136	0.145	0.030	0.350

Total above-ground carbon for this Bloodwood ecosystem was estimated at 58.37 tonnes/ha, while below-ground carbon was estimated to be 16.42 tonnes/ha. This gave a total of 74.79 tonnes/ha in the trees and bushes of this Regional Ecosystem (7 hectares at “Wololla”).

10.5.10 Bloodwood

The amount of carbon per hectare for this ecosystem was not directly measured and measurements were transferred from another Bloodwood ecosystem (RE 10.5.2), measured in detail on the property.

Total above-ground carbon was estimated to be 58.37 tonnes/ha, with below-ground carbon estimated at 16.42 tonnes/ha. This gave a total amount of carbon of 74.79 tonnes/ha in the trees and bushes of the 318 hectares of this Bloodwood country at “Wololla”.

10.5.12 Poplar Box

The amount of carbon per hectare for this ecosystem was not directly measured and measurements were transferred from another Poplar Box ecosystem (RE 10.3.27), measured in detail on the property.

Total above-ground carbon was estimated to be 20.00 tonnes/ha, with below-ground carbon estimated at 5.73 tonnes/ha. This gave a total carbon amount of 25.73 tonnes/ha in the trees and bushes of the 2353 hectares of this Poplar Box country at “Wololla”.

10.7.3 Lancewood

The amount of carbon per hectare for this Lancewood ecosystem was not directly measured and values were estimated by averaging the measurements of the total carbon/ha measurements of all trees in all sampled REs on the property. This gave a total amount of carbon in the trees and bushes of 42.85 tonnes/ha, for the 690 hectares of this Lancewood country at “Wololla”.

10.7.5 Napunyah

The amount of carbon per hectare for this Napunyah ecosystem was not directly measured and values were estimated by averaging the measurements of the total carbon/ha measurements of all trees in all sampled REs on the property. This gave a total amount of carbon in the trees and bushes of 42.85 tonnes/ha, for the 67 hectares of Napunyah country at “Wololla”.

10.7.12 Narrow Leaf Ironbark

The amount of carbon per hectare for this Narrow Leaf Ironbark ecosystem was not directly measured and values were estimated by averaging the measurements of the total carbon/ha measurements of all trees in all sampled REs on the property. This gave an average amount of carbon in the trees and bushes of 42.85 tonnes/ha, for the 52 hectares of Narrow Leaf Ironbark country at “Wololla”.

Summary of the carbon stored in trees and bushes at “Wololla”

Three main ecosystems were measured in detail on the property - Poplar Box, Ghost Gum and Bloodwood. Poplar Box ecosystems covered 37% of the uncleared area on the property, and carbon stored in the vegetation, accounted for the 32% of the overall carbon budget for the property (Figure 2). Ironbark also made an important contribution both in terms of the total area and the total carbon stores. However, measurements were not taken directly on the property and instead, estimates were averaged from detailed measurements on two nearby properties, “The Lake” and “Swanlea”. The same method was used to estimate values for Yellow Jacket. The “Others” category in Figure 2 included all the ecosystems where the average value was applied, from all ecosystems measured on the property.

Figure 2. Contribution of the Main Tree REs to Total Area and Total Carbon Stores

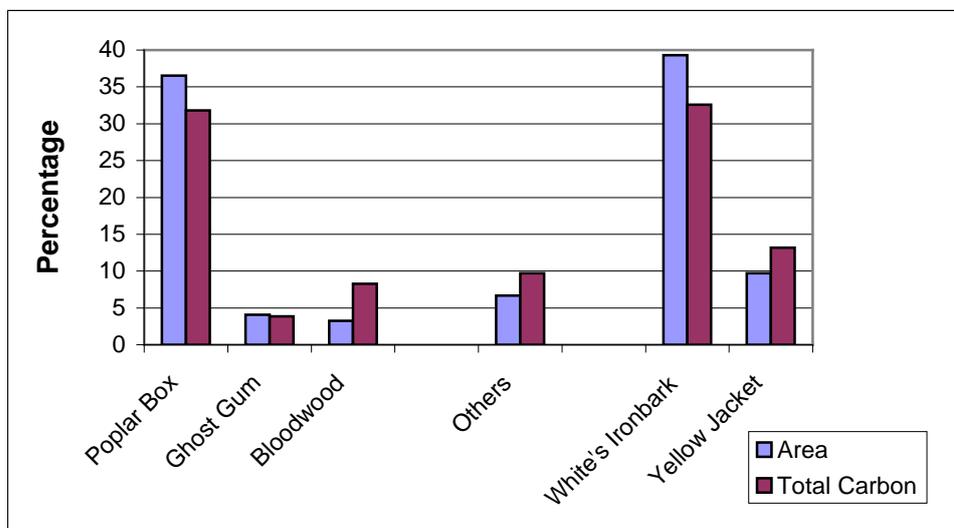
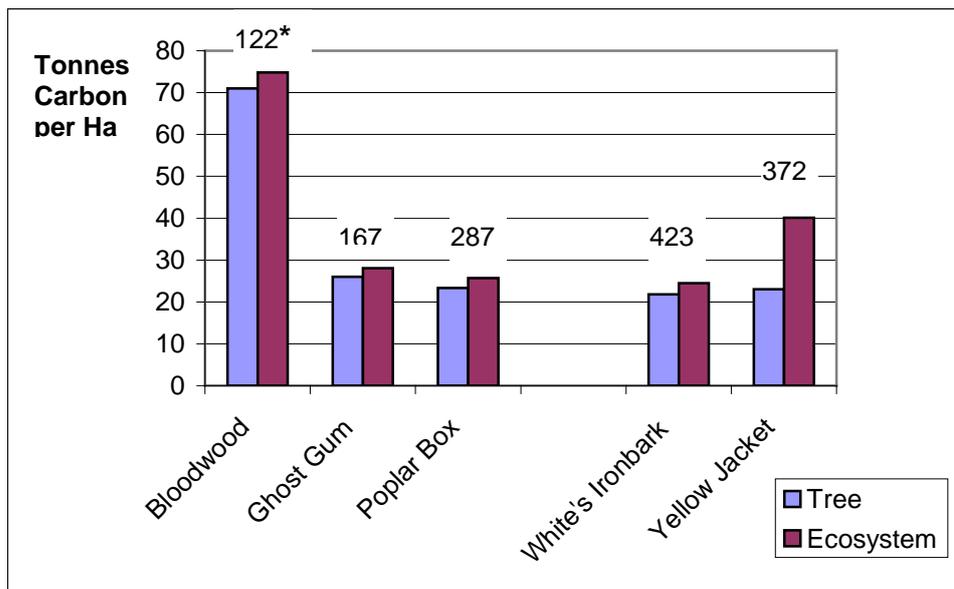


Figure 2 illustrates the differences in the overall contribution of different ecosystems to the main carbon pool on the property, but influence is based on size. Poplar Box and Ironbark are important because they cover large areas of the property. A different picture emerges when the contribution to total carbon stores is examined on a per hectare basis (See Figure 3).

In Figure 3 it can be seen that Poplar Box and Ironbark lose their dominance and Bloodwood is the most influential, both in terms of the contribution of the individual trees (71 tonnes carbon/ha), and in terms of the ecosystem (75 tonnes carbon/ha). The influence of Poplar Box, Ghost Gum and Ironbark were similar both in terms of the tree and ecosystem.

Figure 3. Tree and Ecosystem Carbon stores for Measured REs at “Wololla”



* The Figures above the columns are the number of trees per hectare

The difference between the carbon content of the tree versus the ecosystem in Yellow Jacket is an indication that the carbon content of other tree types is influencing the total figure. In this case Yellow Jacket contributed over half of the carbon (57%) for the ecosystem, but Bloodwoods contributed 28% and Acacias 13%.

One factor that may influence the total carbon budget is the proportion used to calculate the below-ground tree biomass. However, there was little variation in the proportions used for the main tree types at “Wololla”. A figure of 28% was used to calculate the below-ground biomass for Bloodwood, Ghost Gum, Poplar Box and Yellow Jacket. A slightly lower proportion (26%) was used with Ironbark.

The two main factors that affect the total carbon stores are the amount of carbon stored in a particular tree type, and the number of trees or tree density. A lot of trees, each with low amounts of carbon, may make the same contribution to the total carbon pool as a few trees each with a high carbon content. Figure 3 illustrates that even though Bloodwood had the lowest tree density (122 trees/ha) the carbon content of each tree was far greater than any of the other trees, and obviously, there were some very big Bloodwood trees on the property.

Conclusion

This report provides an example of how the amount of carbon stored in the trees and bushes may be estimated on a cattle property. Estimates have been made by measuring trees in different vegetation or Regional Ecosystem types.

The results demonstrate that there are substantial variations in carbon stocks across the different ecosystem types. The amount of carbon in trees and bushes varied from a total of 25 tonnes/ha in Ironbark country to 75 tonnes/ha in Bloodwood country.

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Appendix 1: Common and Scientific Tree Names and Equations Used to Estimate Above-ground Tree Biomass

Category	Common Name	Scientific Name	Function	Reference
Silver Leaf Ironbark	Silver Leaf Ironbark, White's Ironbark	<i>Eucalyptus melanophloia</i> , <i>E. whitei</i>	$B = e^{(-6.553 + 2.726 \times \ln C)}$	Burrows et al. (2000)
Narrow Leaf Ironbark	Narrow Leaf Ironbark	<i>Eucalyptus crebra</i>	$B = e^{(-6.505 + 2.756 \times \ln C)}$	Burrows et al. (2000)
Box	Poplar Box, Reid River Box,	<i>Eucalyptus populnea</i> , <i>E. brownii</i> ,	$B = e^{(-2.809 + 1.922 \times \ln C)}$	Burrows et al. (2000)
Other Eucalypts and Bloodwoods	Mountain Coolibah, River Coolibah, Red River Gum, Dawson River Gum, Ghost Gum, Queensland Yellow Jacket, Rough Leaf Bloodwood, Qld Peppermint, Napunyah, Moreton Bay Ash, Gum-topped Bloodwood, Bloodwood	<i>E. orgadophila</i> , <i>E. coolibah</i> , <i>E. camaldulensis</i> , <i>E. cambageana</i> , <i>E. papuana</i> , <i>E. similis</i> , <i>E. setosa</i> , <i>E. exserta</i> , <i>E. thozetiana</i> , <i>Corymbia tessellaris</i> , <i>C. brachycarpa</i> , <i>Corymbia spp.</i>	$B = e^{(-4.92 + 2.39 \times \ln C)}$	Burrows et al. (2000)
Acacias	Brigalow, Lancewood, Black Wattle, Sally Wattle, Ironwood, Gidgee, Black Gidyea, Desert Oak, other Acacias	<i>Acacia harpophylla</i> , <i>A. shirleyi</i> , <i>A. leiocalyx</i> , <i>A. salicina</i> , <i>A. excelsa</i> , <i>A. cambagei</i> , <i>A. argyrodendron</i> , <i>A. coriacea</i> , <i>Acacia spp.</i>	$b = e^{(-3.568 + 2.384 \times \ln c)} \times e^{0.031}$	Scanlan (1991)
Bushes	False Sandalwood, Turkey Bush, Quinine Bush	<i>Eremophila mitchellii</i> , <i>Erythroxylum australe</i> , <i>Petalostigma pubescens</i>	$B = e^{(-4.453 + 2.257 \times \ln (D \times 1.15))} + e^{(-3.890 + 2.623 \times \ln (D \times 1.15))}$	Harington (1979)
Others	Cattle Bush (Whitewood), Bitter Bark, Beefwood, Wilga, Soap Bush (Soapy Box), Wallaby Apple (Orange Thorn), Emu Apple, Monkey Vine, Canthium (Supple Jack), Bauhinia, Bulloak, Hakea, Black Cyprus Pine, Red Bottlebrush, Hop Bush, Prickly Pine, Paperbark, Tea-tree, Saltbush, Karajong, Maoli Orange	<i>Atalaya hemiglauca</i> , <i>Alistonia constricta</i> , <i>Grevillea striata</i> , <i>Geijera parviflora</i> , <i>Alphitonia excelsa</i> , <i>Citriobatus spinescens</i> , <i>Owenia acidula</i> , <i>Parsonsia eucalyptophylla</i> , <i>Canthium coprosmoides</i> , <i>Lysiphylum spp.</i> , <i>Hakea lorea</i> , <i>Hakea sp.</i> , <i>Callitris endlicheri</i> , <i>Callistemon viminalis</i> , <i>Dodonea spp.</i> , <i>Bursaria incana</i> , <i>Melaleuca leucodendro</i> , <i>Melaleuca spp.</i> , <i>Holosarcia spp.</i> , <i>Brachychiton spp.</i> , <i>Capperacea spp.</i>	$B = e^{(-2.156 + 1.614 \times \ln D)} + e^{(-2.028 + 2.119 \times \ln D)}$ B = above ground biomass (kg.) C = circumference at 0.3 mH (cm.) b = above ground biomass (g) c = circumference at 0.3mH (mm) D = diameter at 0.3mH (cm.)	Harington (1979)

Appendix 2: Above and Below Ground Tree Carbon for “Wololla

RE	Main tree type	Estimate source	Carbon/ Tree (tonnes)	Trees/ha	Carbon/ ha (tonnes)			RE area (ha)	Total tree Carbon (tonnes/RE)
					Above ground	Below ground	Total Tree Carbon		
10.3.3	Ghost Gum	Measured	0.122	167	20.333	5.693	28.04	510.81	14324.62
	Silver Leaf Ironbark		0.041	10	0.409	0.106			
	Chinee Tree, Quinine Bush		0.001	62	0.032	0.014			
	Bloodwood		0.048	15	0.721	0.202			
	Acacia, Desert Oak		0.003	50	0.150	0.064			
	Others		0.007	30	0.221	0.095			
10.3.4	Gidgee	“The Lake”	0.072	442	31.645	13.576	47.48	49.02	2327.39
	Acacia	RE 10.3.4	0.001	97	0.048	0.020			
	False Sandalwood		0.003	25	0.085	0.037			
	Eucalypts		0.039	42	1.616	0.452			
10.3.8	Wire Grass	Not sampled					2.12		
10.3.12	Moreton Bay Ash	RE 10.5.2			58.369	16.420	74.79	83.38	6235.79
10.3.14	River Coolibah	Average all measured REs			33.41	9.44	42.85	25.47	1091.49
10.3.25	False Sandalwood	F Sandalwood in RE 10.3.27			0.17	0.07	0.24	4.25	1.01
10.3.26	Bauhinia	Average all measured REs			33.41	9.44	42.85	0.43	18.21
10.3.27	Poplar Box	Measured	0.063	287	18.211	5.099	25.73	2213.72	56956.76
	False Sandalwood		0.003	57	0.167	0.072			
	Silver Leaf Ironbark		0.041	20	0.818	0.213			
	Acacia		0.003	2	0.006	0.003			
	Others		0.004	180	0.798	0.342			
10.3.28	Whites Ironbark	Average	0.041	423	17.307	4.500	24.50	155.18	3802.50
	Acacia	“The Lake”+	0.004	146	0.636	0.273			
	Quinine B, F.Swood Turkey B	“Swanlea”	0.003	40	0.104	0.045			

RE	Main tree type	Estimate source	Carbon/ Tree (tonnes)	Trees/ha	Carbon/ ha (tonnes)			RE area (ha)	Total tree Carbon (tonnes/RE)
					Above ground	Below ground	Total Tree Carbon		
	Eucalyptus	REs 10.5.5	0.007	6	0.039	0.011			
	Box		0.105	3	0.290	0.081			
	Bloodwood		0.074	4	0.310	0.087			
	Others		0.009	65	0.574	0.246			
10.5.1	Yellow Jacket	Average	0.048	373	18.008	5.042	40.14	1210.56	48588.01
	Acacia	“The Lake”+	0.004	807	3.516	1.509			
	Soap bush and others	“Swanlea”	0.002	131	0.294	0.126			
	Quinine Bush, Chinee Tree	REs 10.5.1	0.005	48	0.225	0.097			
	Bloodwood		0.284	31	8.724	2.443			
	Ironbark		0.015	8	0.123	0.032			
10.5.2	Bloodwood	Measured	0.456	122	55.493	15.538	74.79	7.34	548.95
	Ghost Gum		0.265	8	2.207	0.618			
	Chinee Tree, Quinine Bush		0.000	41	0.007	0.003			
	Silver Leaf Ironbark		0.041	3	0.136	0.035			
	Desert Oak		0.048	3	0.145	0.062			
	Acacia		0.003	10	0.030	0.013			
	Others		0.006	55	0.350	0.150			
10.5.5	Whites Ironbark	Same as RE 10.3.28 above			19.26	5.24	24.50	4756.04	116541.30
10.5.10	Bloodwood	Same as RE 10.5.2 above			58.37	16.42	74.79	317.62	23754.24
10.5.12	Poplar Box	Same as RE 10.3.27 above			20.00	5.73	25.73	2352.48	60526.91
10.7.3	Lancewood	Average all measured REs			33.41	9.44	42.85	690.18	29576.83
10.7.5	Napunyah	Average all measured REs			33.41	9.44	42.85	67.06	2873.78
10.7.12	Narrow Leaf Ironbark	Average all measured REs			33.41	9.44	42.85	52.30	2241.42
							Total	12497.96	369409.21