SWANLEA 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 "Swanlea", a cattle property near Aramac in the Desert Uplands region of Central Queensland.

It was estimated that approximately 147,374 tonnes of carbon were stored in the trees and bushes on the property. . This represents an average of 21.16 tonnes/ha of carbon in vegetation (excluding cleared and naturally open areas). In the predominant vegetation types, the values range from an average 20.6 tons/ha of carbon in yellowjacket country to 56.2 tonnes/ha of carbon in box country. Approximately 76.2% of the carbon is in the above-ground part of the trees and scrubs, while 23.8% is below-ground in the roots.

SECTION 1. GENERAL INFORMATION

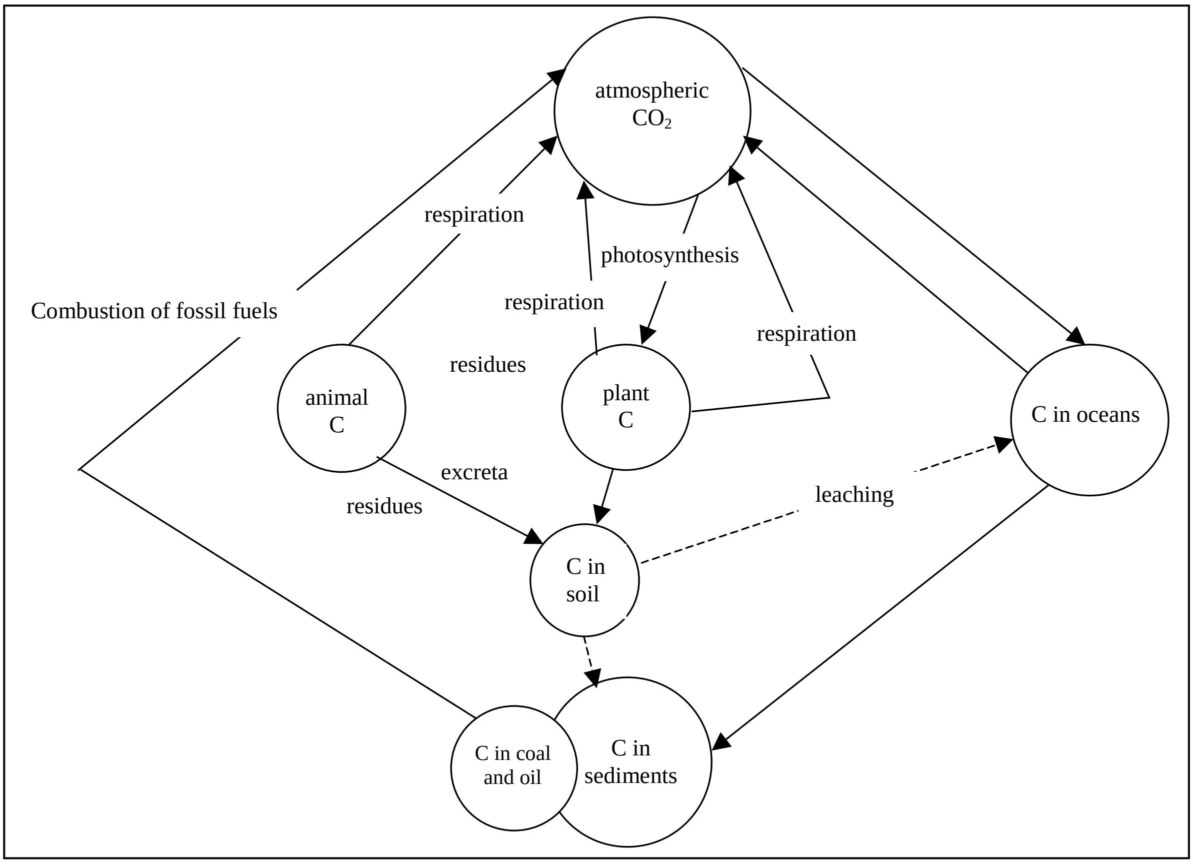
Greenhouse gas emissions

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 to 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 147,374 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 “Swanlea”, a cattle property located at the southern point of Lake Gallilee, east of Aramac. The property has a total area of 8143 hectares, of which about 1178 hectares (14%) has been cleared for grazing and established with improved pasture. The remaining 6,965 hectares (86%) is uncleared and classified as remnant vegetation by the Department of Natural Resources and Mines.

Different Types of Vegetation or Regional Ecosystems at “Swanlea”

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. All Regional Ecosystem numbers starting with 10 are classified as part of the Desert Uplands. 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.

“Swanlea” is located within the Desert Uplands Bioregion and includes vegetation categorised in 14 Regional Ecosystems. See Table 1 below for details.

Table 1: Regional Ecosystems (RE) and Area Represented on "Swanlea"

RE	Major Tree	Scientific Name	RE Area (ha.)	RE Area %
10.3.4	Gidgee	Acacia cambagei	48.0	0.69
10.3.6	**Reid River Box**	**Eucalyptus brownii**	**60.8**	**0.87**
10.3.14	Coolibah	Eucalyptus coolibah	58.0	0.83
10.3.17	Sally Wattle	Acacia salicina	3.1	0.04
10.3.19	Gidgee	Acacia cambagei	55.8	0.80
10.3.23	Saltbush	Holosarcia sp	321.4	4.61
10.5.1	**Queensland Yellow Jacket**	**Eucalyptus similis**	**5349.7**	**76.81**
10.5.2	Gum-topped Bloodwood	Corymbia brachycarpa	331.3	4.76
10.5.5	**White's Ironbark**	**Eucalyptus whitei**	**296.83**	**4.26**
10.5.8	Rough Leaf Bloodwood	Corymbia sp	239.5	3.44
10.5.11	White's Ironbark	Eucalyptus whitei	137.2	1.97
10.7.3	Lancewood	Acacia shirleyi	25.8	0.37
10.7.5	Napunyah	Eucalyptus thozetiana	6.5	0.09
10.7.7	Desert Tea Tree.	Melaleuca sp	31.1	0.45
		Total area of uncleared vegetation	**6965**	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 measurements from these sites to the other REs. In addition, estimates were used from ecosystems sampled at "The Lake", a nearby property in the Desert Uplands.

At each RE one general area (site) was selected to be representative of the vegetation. Trees were measured in 200m^2 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 Popular 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 147,374 tonnes of carbon were stored in the trees and bushes on the property, or approximately 21.16 tonnes carbon per hectare. Approximately 112,365 tonnes (76.2%) of carbon were stored in the aboveground vegetation, and 35,009 tonnes (23.8%) of carbon were stored in the belowground 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 "Swanlea"

RE	Main Tree	Total belowground tree C (t) /ha	Total aboveground tree C (t)/ha	Total Tree C(t)/ha	RE Area (ha.)	Total Tree Carbon (t)/RE
10.3.4	Gidgee	14.09	33.39	47.48	48.00	2279.10
10.3.6	Reid River Box	12.43	43.80	56.23	60.84	3421.11
10.3.14	River Coolibah	10.46	24.40	34.86	57.97	2021.04
10.3.17	Sally Wattle	10.46	24.40	34.86	3.10	108.06
10.3.19	Gidgee	14.09	33.39	47.48	55.79	2648.99
10.3.23	Saltbush	Carbon not estimated			321.37	
10.5.1	Qld Yellow Jacket	4.84	15.75	20.59	5349.66	110126.80
10.5.2	Gum-topped Bloodwd	5.36	16.55	21.91	331.31	7258.58
10.5.5	White's Ironbark	5.86	21.91	27.78	296.83	8244.68
10.5.8	Rough-Leaf Bloodwd	5.36	16.55	21.91	239.48	5246.67
10.5.11	White's Ironbark	5.86	21.91	27.78	137.16	3809.68
10.7.3	Lancewood	10.46	24.40	34.86	25.79	899.01
10.7.5	Napunyah	10.46	24.40	34.86	6.45	224.75
10.7.7	Desert Tea Tree,	10.46	24.40	34.86	31.13	1085.42
	Total				**6964.88**	**147,373.90**

Carbon in individual Regional Ecosystems

10.3.4 and 10.3.19 Gidgee

These two Gidgee ecosystems were not measured directly and values were transferred from a Gidgee ecosystem (RE 10.3.4) measured in detail 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 48 hectares of RE 10.3.4 and the 56 hectares of RE 10.3.19 at "Swanlea".

10.3.6 Reid River Box

This ecosystem was measured in detail at "Swanlea". While the dominant tree type in the sampled area was Reid River Box, other tree types were also found (see Table 3 below). It was estimated that there were 364 trees/ha for Reid River Box, 53 trees/ha for False Sandalwood, 48 trees/ha for Acacia species, 20 trees/ha for Ironbarks, and 29 trees/ha for Whitewoods.

Table 3. Measurements for Reid River Box Regional Ecosystem 10.3.6 at "Swanlea"

Tree Types	Reid Box	False Sandalwood	Acacia	Ironbark	Whitewood
Biomass (tonnes/tree)	0.230	0.007	0.027	0.076	0.027
Carbon/tree (tonnes)	0.115	0.004	0.014	0.038	0.013
Average number of trees/ha	364	53	48	20	29
Aboveground tree biomass (t/ha)	83.643	0.379	1.312	1.482	0.774
Belowground tree biomass (t/ha)	23.420	0.163	0.563	0.385	0.193
Belowground tree C (t/ha)	11.710	0.081	0.282	0.193	0.166
Aboveground tree C (t/ha)	41.821	0.190	0.656	0.741	0.387

Total above-ground carbon for Reid River Box was estimated at 43.80 tonnes/ha, while below-ground carbon was estimated to be 12.43 tonnes/ha. This gave a total amount of carbon in the trees and bushes of 56.23 tonnes/ha in this Regional Ecosystem (61 hectares at "Swanlea").

10.3.14 River Coolibah

The amount of carbon per hectare for this ecosystem was not directly measured and values were estimated by averaging the measurements of all trees in all sampled REs on the property. This gave a total amount of carbon in the trees and bushes of 34.86 tonnes/ha, for the 58 hectares of River Coolibah country at "Swanlea".

10.3.17 Sally Wattle

The amount of carbon per hectare for this ecosystem was not directly measured and values were estimated by averaging the measurements of all trees in all sampled REs on the property. This gave a total amount of carbon in the trees and bushes of 34.86 tonnes/ha, for the 3 hectares of Sally Wattle country at "Swanlea".

10.3.23 Saltbush

These are salt-tolerant plants that grow in the shallow reaches of Lake Galillee when the water level is low. Because the plants are not permanent, no carbon has been estimated as a part of the vegetation budget. There are 321 hectares of this country at "Swanlea".

10.5.1 Queensland Yellow Jacket

This is the major vegetation type at "Swanlea", covering an area of 5350 hectares or 77% of the uncleared area on the property. This vegetation type was sampled at several locations on the property. While the dominant tree type in the sampled area was Yellow Jacket, other tree types were also found (see Table 4 below). For example, it was estimated that there were 458 trees/ha for Yellow Jacket, 1288 trees/ha for Acacias, 23 trees/ha for Quinine Bush, 3 trees/ha for Bloodwoods, and 112 trees/ha for Others (Soap Bush, Karajong and Grevillea).

Table 4. Measurements for Queensland Yellow Jacket RE 10.5.1 at "Swanlea"

Tree Types	Yellow Jacket	Acacia	Quinine B	Bloodwood	Others
Biomass (tonnes/tree)	0.052	0.004	0.002	0.525	0.013
Carbon/tree (tonnes)	0.026	0.002	0.006	0.262	0.001
Average number of trees/ha	458	1288	23	3	112
Aboveground tree biomass (t/ha)	23.693	5.672	0.307	1.575	0.089
Belowground tree biomass (t/ha)	6.634	2.433	0.132	0.441	0.038
Belowground tree C (t/ha)	3.317	1.217	0.066	0.220	0.019
Aboveground tree C (t/ha)	11.846	2.836	0.144	0.787	0.133

Total above-ground carbon for Yellow Jacket was estimated at 15.75 tonnes/ha, while below-ground carbon was estimated to be 4.84 tonnes/ha. This gave a total amount of carbon of 20.59 tonnes/ha for trees and bushes in this Regional Ecosystem (5350 hectares at "Swanlea").

10.5.2 Gum-topped Bloodwood and 10.5.8 Rough Leaf Bloodwood

The amount of carbon per hectare for these Bloodwood ecosystems was not directly measured at "Swanlea" and values were substituted from the Bloodwood RE 10.5.2 , measured in detail at a nearby property, "The Lake".

Total above-ground carbon was estimated to be 16.55 tonnes/ha, with below-ground carbon estimated at 5.36 tonnes/ha. This gave a total amount of carbon in the trees and bushes of 21.91 tonnes/ha, for the 331 hectares and 239 hectares of Bloodwood REs 10.5.2 and 10.5.8 respectively, at "Swanlea".

10.5.5 White's Ironbark

This White's Ironbark ecosystem was measured in detail at "Swanlea". While the dominant tree type in the sampled area was White's Ironbark, other tree types were also found (see Table 5). For example, it was estimated that there were 396 trees/ha for Ironbark, 106 trees/ha for Acacia species, 6 trees/ha for Whitewoods, and 3 trees/ha for Reid River Box.

Total above-ground carbon for Ironbark was estimated at 21.91 tonnes/ha, while below-ground carbon was estimated to be 5.86 tonnes/ha. This gave a total of 27.78 tonnes/ha for vegetation in this Regional Ecosystem (297 hectares at "Swanlea").

Table 5. Measurements for White's Ironbark.

Tree Types	White's Ironbark	Acacia	Whitewood	Reid Box
Biomass (tonnes/tree)	0.104	0.016	0.027	0.230
Carbon/tree (tonnes)	0.052	0.008	0.013	0.115
Average number of trees/ha	396	106	6	3
Aboveground tree biomass (t/ha)	41.340	1.701	0.149	0.639
Belowground tree biomass (t/ha)	10.748	0.730	0.064	0.179
Belowground tree C (t/ha)	5.374	0.365	0.032	0.089
Aboveground tree C (t/ha)	20.670	0.851	0.075	0.319

10.5.11 White's Ironbark

It was assumed that the measurements for this Regional Ecosystem would be the same as for the other White's Ironbark ecosystem RE 10.5.5 and those values were used to represent this ecosystem.

Total above-ground carbon was estimated at 21.91 tonnes/ha, while below-ground carbon was estimated to be 5.86 tonnes/ha. This gave a total amount of carbon of 27.78 tonnes/ha for the trees and bushes in this Ironbark Regional Ecosystem (137 hectares at "Swanlea").

10.7.3 Lancewood.

The amount of carbon per hectare for this ecosystem was not directly measured and values were estimated by averaging the measurements of all trees in all sampled REs on the property. This gave a total amount of carbon in the trees and bushes of 34.86 tonnes/ha, for the 26 hectares of Lancewood country at "Swanlea".

10.7.5 Napunyah

The amount of carbon per hectare for this ecosystem was not directly measured and values were estimated by averaging the measurements of all trees in all sampled REs on the property. This gave a total amount of carbon in the trees and bushes of 34.86 tonnes/ha, for the 6 hectares of Napunyah country at "Swanlea".

10.7.7 Desert Tea Tree

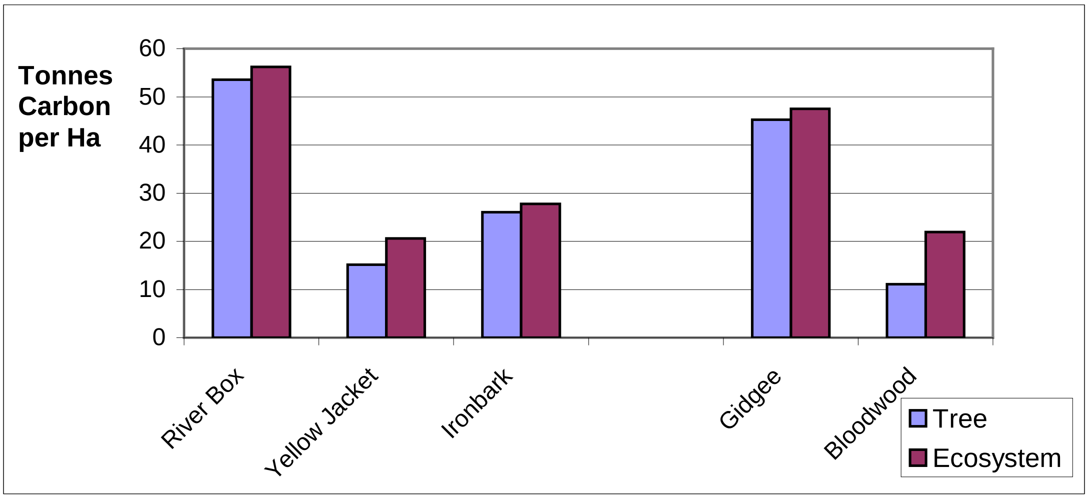
The amount of carbon per hectare for this ecosystem was not directly measured and values were estimated by averaging the measurements of all trees in all sampled REs on the property. This gave a total amount of carbon in the trees and bushes of 34.86 tonnes/ha, for the 31 hectares of Desert Tea Tree country at “Swanlea”.

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

The vegetation at “Swanlea” is dominated by Queensland Yellow Jacket. As an ecosystem, it covers 77% of the uncleared area and accounts for 74% of the total carbon budget for the property. However, Yellow Jacket was not the only tree in the ecosystem and while it contributed 74% to the ecosystem carbon pool, Acacias contributed 20%, with another 5% from Bloodwoods. In the other two ecosystems that were measured in detail, the main tree types completely dominated the carbon pool. Reid River Box comprised 95% and White’s Ironbark comprised 90% of the carbon pool in their respective ecosystems.

In terms of the carbon contribution of the different ecosystem types and individual tree types, Reid River Box was the tree type and the ecosystem with the highest carbon content per hectare (Figure 2). Both Gidgee and Bloodwood, were measured in detail, but at a nearby property. In contrast to Bloodwood, Gidgee had a high carbon content both in the tree and the ecosystem.

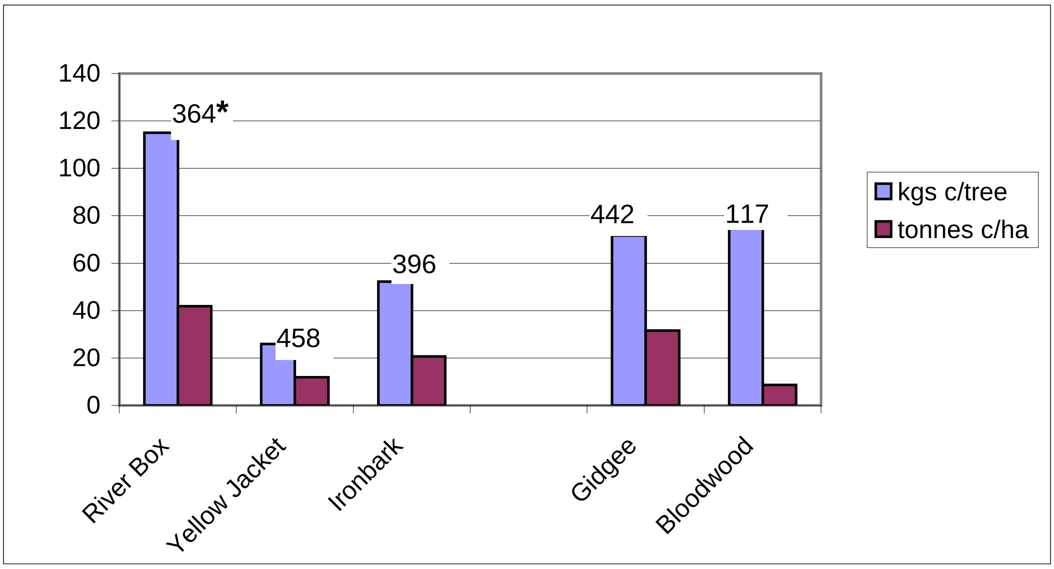
Figure 2. Tree and Ecosystem Carbon stores for Measured REs at “Swanlea”



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 pool as a few trees each with a high carbon content. Another factor that influences the total carbon budget is the proportion used to calculate the below-ground tree biomass. In this case, a figure of 28% was used to calculate the below-ground biomass for Reid’s Box, Yellow Jacket and Bloodwood trees and 26% was used for Ironbark. However, a much higher proportion (43%) was used to calculated below-ground tree biomass for Gidgee. Figure 3 illustrates the differences in above-ground carbon stores on the property, and while the relative carbon contribution from Gidgee, is reduced, it remains an important source.

Reid River Box had the highest above-ground carbon content per tree (115 kg) and with a relatively high density of trees (364 trees per hectare), the highest carbon content per hectare (42 tonnes). The average above-ground carbon content of White's Ironbark (52 kg/tree) was much higher than Queensland Yellow Jacket (26 kg/tree) and although the tree density was lower (396 trees/ha for Ironbark compared with 458 trees/ha for Yellow Jacket), Ironbark, as an ecosystem had a higher carbon content compared with Yellow Jacket (Figure 3). Bloodwood had a relatively high above-ground carbon content (75 kg/tree), but with lower tree density (117 trees/ha), the carbon content of the ecosystem was the lowest.

Figure 3. Above-ground Tree Carbon Stores and Tree Density at "Swanlea"



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

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 21 tonnes/ha in Yellow Jacket country to 56 tonnes/ha in Reid River Box 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	*Eucalyptus melanophloia, E. whitei*	$B = e^{(-6.553 + 2.726 \times \ln \mathbf{C})}$	Burrows et al. (2000)
Narrow Leaf Ironbark	Narrow Leaf Ironbark	*Eucalyptus crebra*	$B = e^{(-6.505 + 2.756 \times \ln \mathbf{C})}$	Burrows et al. (2000)
Box	Poplar Box, Reid River Box,	*Eucalyptus populnea, E. brownii,*	$B = e^{(-2.809 + 1.922 \times \ln \mathbf{C})}$	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	*E. orgadophila, E. coolibah, E. camaldulensis, E. cambageana, E. papuana, E. similis, E. setosa, E. exserta, E. thozetiana, Corymbia tessellaris, C. brachycarpa, Corymbia spp.*	$B = e^{(-4.92+2.39 \times \ln \mathbf{C})}$	Burrows et al. (2000)
Acacias	Brigalow, Lancewood, Black Wattle, Sally Wattle, Ironwood, Gidgee, Black Gidyea, Desert Oak, other Acacias	*Acacia harpophylla, A. shirleyi, A. leiocalyx, A. salicina, A. excelsa, A. cambagei, A. argyrodendron, A. coriacea, Acacia spp.*	$b = e^{(-3.568 + 2.384 \times \ln \mathbf{c})} \times e^{0.031}$	Scanlan (1991)
Bushes	False Sandalwood, Turkey Bush, Quinine Bush	*Eremophila mitchellii, Erythroxylum australe, Petalostigma pubescens*	$B = e^{(-4.453 + 2.257 \times \ln (D \times 1.15))} + e^{(-3.890 + 2.623 \times \ln (D \times 1.15))}$	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	*Atalaya hemiglauca, Alistonia constricta, Grevillea striata, Geijera parviflora, Alphitonia excelsa, Citriobatus spinescens, Owenia acidula, Parsonsia eucalyptophylla, Canthium coprosmoides, Lysiphylum spp., Hakea lorea, Hakea sp, Callitris endlicheri, Callistemon viminalis, Dodonea spp., Bursaria incana, Melaleuca leucodendro, Melaluca spp, Holosarcia spp, Brachychiton spp, Capperacea spp*	$B = e^{(-2.156 + 1.614 \times \ln D)} + e^{(-2.028 + 2.119 \times \ln D)}$ 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 the Swanlea Property

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		
10.3.4	Gidgee	"The Lake"	0.072	442	31.645	13.576	47.48	48.00	2279.10
	Acacia	RE 10.3.4	0.001	97	0.048	0.020			
	False Sandalwood		0.003	25	0.085	0.037			
	Eucalyptus		0.039	42	1.616	0.452			
10.3.6	Reid River Box	Measured	0.115	364	41.821	11.710	56.23	60.84	3421.11
	False Sandalwood		0.004	53	0.190	0.081			
	Acacia		0.014	48	0.656	0.282			
	Ironbark		0.038	20	0.741	0.193			
	Whitewood		0.013	29	0.387	0.166			
10.3.14	River Coolibah	Average all measured REs			24.40	10.46	34.86	57.97	2021.04
10.3.17	Sally Wattle.	Average all measured REs			24.40	10.46	34.86	3.10	108.06
10.3.19	Gidgee	"The Lake" RE 10.3.4 (see above)			33.39	14.09	47.48	55.79	2648.99
10.5.1	Queensland Yellow Jacket	Measured	0.026	458	11.846	3.317	20.59	5349.66	110126.80
	Acacia		0.002	1288	2.836	1.217			
	Quinine Bush,		0.006	23	0.144	0.066			
	Bloodwood		0.262	3	0.787	0.220			
	Others		0.001	112	0.133	0.019			
10.5.2	Gum-topped Bloodwood	"The Lake"	0.074	117	8.691	2.434	21.91	331.31	7258.575
	F. Sandalwood, Quinine Bush	RE 10.5.2	0.006	188	1.100	0.472			
	Acacia		0.007	248	1.799	0.772			
	Ironbark		0.062	19	1.170	0.304			
	Yellow Jacket		0.069	13	0.868	0.243			
	Eucalyptus		0.022	19	0.408	0.114			
	Box		0.094	4	0.392	0.110			
	Others		0.005	425	2.122	0.910			

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		
10.5.5	White's Ironbark	Measured	0.052	396	20.670	5.374	27.78	296.83	8244.68
	Acacia		0.008	106	0.851	0.365			
	Whitewood		0.013	6	0.075	0.032			
	Reid Box		0.115	3	0.319	0.089			
10.5.8	Rough leaved Bloodwood	"The Lake" RE 10.5.2 as above			16.55	5.36	21.91	239.48	5246.67
10.5.11	White's Ironbark	RE 10.5.5			21.91	5.86	27.78	137.16	3809.68
10.7.3	Lancewood	Average all measured REs			24.40	10.46	34.86	25.79	899.01
10.7.5	Napunyah	Average all measured REs			24.40	10.46	34.86	6.45	224.75
10.7.7	Desert Tea Tree,	Average all measured REs			24.40	10.46	34.86	31.13	1085.42
							Total	**6964.88**	**147,373.90**