GRAZING PROPERTY CARBON BUDGET IN CENTRAL QUEENSLAND

- Avocet -

Property Carbon Budgeting in Central Queensland Report No. 2

Central Queensland University, Emerald
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AUSTRALIAN Greenhouse Office
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AVOCET CARBON BUDGET

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Central Queensland University

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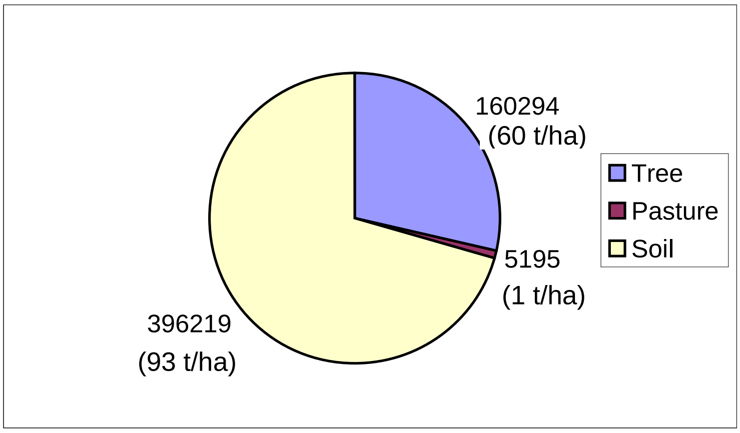
Introduction

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 "Avocet", a cattle property near Emerald in Central Queensland. It was estimated that approximately 561708 tonnes of carbon are stored on the property in the soil (70.5%), trees (28.5%) and pasture grasses (0.9%) – see Figure 1.

Figure 1. Main Sources of Carbon Stored on "Avocet" (tonnes)



SECTION 1. GENERAL INFORMATION

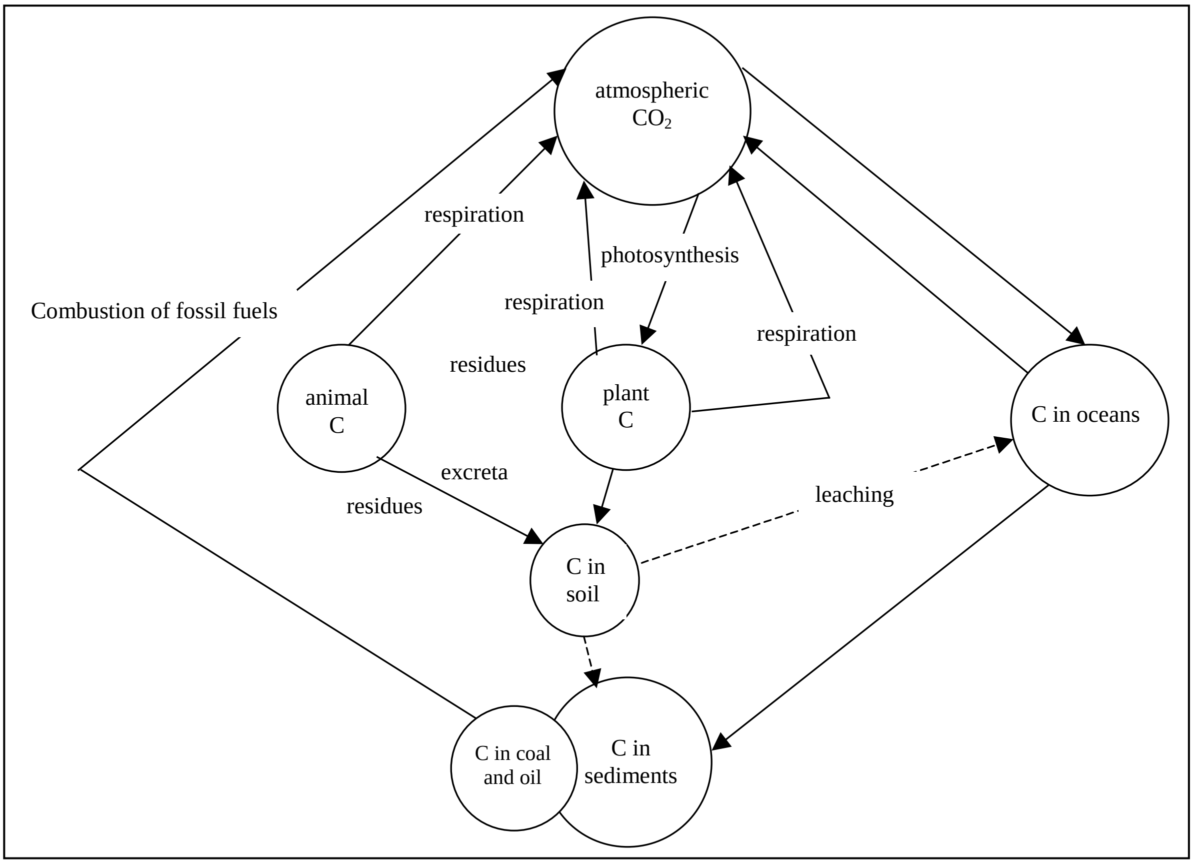
Greenhouse gas emissions

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 2). 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 2. 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 your farm

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 vegetation 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, estimates of the carbon in each of these pools has been made.

An example from the Emerald area in Central Queensland

The carbon estimates outlined below were taken from "Avocet", a grazing property, located approximately 32 km south of Emerald in Central Queensland. The property has a total area of 4274 ha, of which about 1533 ha (36%) has been cleared for grazing, and the remainder is uncleared natural bushland. Cattle are grazed in both cleared and uncleared areas.

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.

Each Regional Ecosystem is given a three digit number. The first digit refers to a biogeographical region. The second digit number refers to the land zone which is a simplified geology/substrate-landform classification for Queensland. Twelve different land zones are recognised. The third digit is the unique regional ecosystem number.

"Avocet" is located within the Brigalow Belt Bioregion, and includes vegetation categorised in 18 Regional Ecosystems. See Table 1 for details.

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

RE code	Brief description	Area (ha)	%
11.3.1	Brigalow and/or Belah on alluvial plains	36.1	0.8
11.3.2	Poplar Box woodland on alluvial plains. Texture contrast and deep clay soil	69.4	1.6
11.3.3	River Coolibah woodland on alluvial plains	4.1	0.1
11.3.6	**Silver Leaf Ironbark woodland on alluvial plains**	**39.5**	**0.9**
11.3.25	Blue Gum or River Red Gum, River She Oak fringing woodland on alluvial plains	8.9	0.2

RE code	Brief description	Area (ha)	%
11.4.2	Eucalyptus-Bloodwood grassy or shrubby woodland on Cainozoic clay plains	19.1	0.4
11.4.8	Dawson Gum open forest with Brigalow or Blackwood on Cainzoic clay plains	8.5	0.2
11.4.9	**Brigalow shrubby open forest on Cainozoic clay plains**	**131.0**	**3.1**
11.5.3	Poplar Box and/or Silver Leaf Ironbark and/or Clarkson's Bloodwood on Cainzoic sand plains/remnant surfaces	10.6	0.2
11.7.2	**Acacia woodland on Cainozoic lateritic duricrust. Scarp retreat zone**	**21.1**	**0.5**
11.8.5	**Mountain Coolibah open woodland on Cainozoic igneous rocks**	**212.3**	**5.0**
11.8.11	Queensland Bluegrass grassland on Cainozoic igneous rocks. Lowlands	31.4	0.7
11.9.1	**Brigalow – Dawson Gum open forest on Cainozoic fine-grained sedimentary rocks**	**214.5**	**5.0**
11.10.3	**Bendee or Lancewood open forest on Cainozoic coarse-grained sedimentary rocks. Crests and scarps**	**586.5**	**13.7**
11.10.11	**Silver Leaf Ironbark, Cypress Pine woodland on Cainozoic coarse grained sedimentary rocks**	**980.6**	**4.2**
11.10.12	**Poplar Box woodland on Cainozoic medium to coarse grained sedimentary rocks**	**177.4**	**22.9**
11.10.13	Mixed Eucalyptus-Bloodwood open forest on scraps and sandstone tableland	48.8	1.1
11.11.2	Lancewood or Bendee low open forest on old sedimentary rocks with varying degrees of metamorphism and folding	82.0	1.9
	Total uncleared	2681.8	62.8
	Total cleared	1532.7	35.9
	Other	59	1.4
	Total property size	**4273.5**	100.0

1. Estimating the carbon stored in the trees and bushes

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

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.

In some REs one site was not sufficient to represent the variation in vegetation that occurred and in such cases more that one site was sampled. Table 2 provides details of the number of sites, transects and trees (major tree type) measured in each RE. Sites where high numbers of trees were counted in indicate the presence of large numbers of scrubby trees.

Table 2. Number of Main Tree Types Measured for Each RE

RE	Main tree type	Property area (%)	No of sites	No of transects	No of main tree type measured
11.3.6	Silver Leaf Ironbark	0.9	1	30	37
11.4.9	Brigalow	3.1	1	30	353
11.7.2	Early-flowering Black Wattle	0.5	1	30	163
11.8.5	Mountain Coolibah	5.0	3	90	116
11.9.1	Brigalow	5.0	2	60	247
11.10.3	Lancewood	13.7	2	60	126
11.10.11	Silver Leaf Ironbark	4.2	2	60	177
11.10.12	Poplar Box	22.9	3	90	119

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 (se 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 160,294 tonnes of carbon were stored in the trees and bushes on the property, or approximately 60 tonnes carbon per hectare (in the uncleared area). 118695 tonnes (74%) of this carbon was stored in the above-ground tree biomass and 41599 tonnes (26%) in the tree roots or below-ground tree biomass.

A summary of the carbon in the different tree types is presented in Table 3 – full details are provided in Appendix 2. Photographs of the main tree types on the property are present in Appendix 3.

Table 3. Carbon Stores in Trees and Bushes on "Avocet"

		Total tree C (t) /ha		Total Tree C(t)/ha	RE Area (ha.)	Total Tree Carbon (t)/RE
		Above-ground	Below-ground			
11.3.1.	Brigalow	42.04	16.96	59.00	36.07	2128.20
11.3.2	Poplar Box	52.17	15.59	67.76	69.38	4702.01
11.3.3	River Coolibah	37.05	12.94	49.99	4.10	205.12
11.3.6	Silver Leaf Ironbark	24.07	6.34	30.41	39.54	1203.03
11.3.25	Blue/Red River Gum	37.05	12.94	49.99	8.93	446.63
11.4.2	Bloodwood	29.91	9.73	39.64	19.12	757.81
11.4.8	Brigalow	32.21	13.76	45.97	8.46	389.03
11.4.9	Brigalow	32.21	13.76	45.97	130.95	6019.85
11.5.3	Poplar Box	52.17	15.59	67.76	10.64	721.44
11.7.2	Early-flowering Black Wattle	32.41	11.37	43.78	21.09	923.34
11.8.5	Mountain Coolibah	24.55	7.07	31.62	212.29	6715.68
11.9.1	Brigalow	23.48	9.65	33.13	214.49	7105.90
11.10.3	Lancewood	65.84	28.11	93.95	586.52	55108.30
11.10.11	Silver Leaf Ironbark	41.64	11.59	53.23	980.59	52206.16
11.10.12	Poplar Box	52.17	15.59	67.76	177.39	12022.87
11.10.13	Bloodwood	29.91	9.73	39.64	48.84	1936.11
11.11.2	Lancewood	65.84	28.11	93.95	81.98	7702.72
		Total			**2650.38**	**160294.20**

Carbon stored in individual Regional Ecosystems

11.3.1 Brigalow

The amount of carbon per hectare for this Brigalow ecosystem was not directly measured. The amount of carbon per hectare estimated for Brigalow in the same RE at "Berrigurra" (another property in the same area) was used, presuming that all components of one RE are the same at both properties. Full details are presented in Appendix 2.

Total above-ground carbon was estimated to be 42.04 tonnes/ha, with below-ground estimated at 16.96 tonnes/ha. This gave an average amount of carbon in the trees and bushes of 59 tonnes/ha, for the 36 hectares of RE 11.3.1 of this Brigalow country at "Avocet".

11.3.2 and 11.5.3 Poplar Box

The amount of carbon per hectare for these Poplar Box ecosystems was not directly measured. The amount of carbon per hectare estimated for all trees in RE 11.10.12 (another Poplar Box ecosystem) was used to represent these two ecosystems. If tree density or the shape of trees in RE 11.10.12 is significantly different to these two REs, this approach of transferring values may not be fully accurate. This potential has to be balanced against the cost of calculating data, and the small proportion of these REs on the property (1.8%).

Total above-ground carbon was estimated to be 52.17 tonnes/ha, with below-ground estimated at 15.59 tonnes/ha. This gave an average amount of carbon in vegetation of 67.76 tonnes/ha, for the 69 hectares and 11 hectares of REs 11.3.2 and 11.5.3 respectively, of this Poplar Box country at “Avocet”.

11.3.3 River Coolibah

The amount of carbon per hectare for this Coolibah ecosystem was not directly measured. Instead, the average value of carbon in all sampled REs on the property was used to represent this RE. This estimate may be lower or higher than the true value for this RE type.

Total above-ground carbon was estimated to be 37.05 tonnes/ha, with below-ground estimated at 12.94 tonnes/ha. This gave an average amount of carbon in vegetation of 49.99 tonnes/ha, for the 4 hectares of Coolibah country at “Avocet”.

11.3.6 Silver Leaf Ironbark

This ecosystem was measured in detail and the amount of carbon per hectare estimated includes other trees as well as Silver Leaf Ironbark (see Table 4). It was estimated that there were 385 trees/ha for Silver Leaf Ironbark, 37 trees/ha for False Sandalwood, 157 trees/ha for Acacias, 35 trees/ha for Bloodwoods, and 32 trees/ha for Others

Table 4. Measurements for Silver Leaf Ironbark RE 11.3.6 at “Avocet”

Tree Types	Silver Leaf Ironbark	False Sandalwood	Acacia	Blood wood	Other
Biomass (tonnes/tree)	0.12	0.01	0.001	0.01	0.02
Carbon/tree (tonnes)	0.06	0.003	0.001	0.004	0.01
Average number of trees/ha	385	37	157	35	32
Aboveground tree biomass (t/ha)	46.98	0.24	0.19	0.25	0.51
Belowground tree biomass (t/ha)	12.21	0.10	0.08	0.07	0.22
Belowground tree C (t/ha)	6.11	0.05	0.04	0.03	0.11
Aboveground tree C (t/ha)	23.49	0.12	0.09	0.12	0.25

The equations used to estimate the biomass for each tree type are summarised in Appendix 1. The average biomass for each tree was calculated by averaging the estimates from all the trees of that type measured in the transects.

Total above-ground carbon for Silver Leaf Ironbark was estimated at 24.07 tonnes/ha, while below-ground carbon was estimated to be 6.34 tonnes/ha. This gave a total of 30.41 tonnes/ha for trees and bushes in this Regional Ecosystem (40 hectares at “Avocet”).

11.3.25 Blue/Red River Gum

The amount of carbon per hectare for this Coolibah ecosystem was not directly measured. Instead, the average value of carbon in all sampled REs on the property was used to represent this RE. This estimate may be lower or higher than the true value for this RE type.

Total above-ground carbon was estimated to be 37.05 tonnes/ha, with below ground estimated at 12.94 tonnes/ha. This gave an average amount of carbon in vegetation of 49.99 tonnes/ha, for the 9 hectares of River Gum country at "Avocet".

11.4.2 and 11.10.13 Bloodwood

The amount of carbon per hectare for these Bloodwood ecosystems was not directly measured and values for both of these REs were transferred from the trees sampled in RE 11.4.2 at "Berrigurra" (another property in the same area). Full details are presented in Appendix 2.

Biomass for all the Bloodwoods was estimated with the equations for different tree types developed by Burrows, Scanlan and Harrington (Appendix 1).

Total above-ground carbon was estimated to be 29.91 tonnes/ha, with below-ground estimated at 9.73 tonnes/ha. This gave an average amount of carbon in vegetation of 39.64 tonnes/ha, for the 19 and 49 hectares of Bloodwood REs 11.4.2 and 11.10.13 at "Avocet".

11.4.8 Brigalow

This ecosystem was not sampled, but on the basis of land zone type and the dominant vegetation it was considered similar to RE 11.4.9, which was sampled intensively. Thus the value of carbon/ha for RE 11.4.9 - 45.97 tonnes/ha, was used for this RE also.

11.4.9 Brigalow

This ecosystem was measured in detail and was measured separately from the other Brigalow ecosystem (RE 11.9.1) to reflect the two types of Brigalow – this, the scrubby type and the older tree type or open Brigalow (see Appendix 3 for a photographic comparison) at the other Regional Ecosystems on the property.

The amount of carbon per hectare estimated includes other trees as well as Brigalow (see Table 5). It was estimated that there were 4842 trees/ha for Brigalow, 40 trees/ha for False Sandalwood, 7 trees/ha for Poplar Box, and 40 trees/ha for Others. Brigalow trees dominated this site and the other trees were counted, but not measured. Values for these False Sandalwood, Poplar Box and Others were transferred from the other Brigalow site (RE 11.9.1).

The equations used to estimate the biomass for each tree type are summarised in Appendix 1. The average biomass for each tree was calculated by averaging the estimates from all the trees of that type measured in the transects.

Table 5. Measurements for Scrubby Brigalow RE 11.4.9 at "Avocet"

Tree Types	Brigalow	False Sandalwood	Poplar Box	Other
Biomass (tonnes/tree)	0.01	0.01	0.11	*
Carbon/tree (tonnes)	0.01	0.003	0.06	*
Average number of trees/ha	4842	40	7	40
Aboveground tree biomass (t/ha)	63.44	0.23	0.74	*
Belowground tree biomass (t/ha)	27.22	0.10	0.21	*
Belowground tree C (t/ha)	13.61	0.05	0.10	*
Aboveground tree C (t/ha)	31.72	0.12	0.37	*

* measurements too small to record

Total above-ground carbon for Scrubby Brigalow was estimated at 32.21 tonnes/ha, while below-ground carbon was estimated to be 13.76 tonnes/ha. This gave a total of 45.97 tonnes/ha for trees and bushes in this Brigalow Regional Ecosystem (131 hectares at "Avocet").

11.7.2 Early-flowering Black Wattle

This ecosystem was measured in detail and the amount of carbon per hectare estimated includes other trees as well as Early-flowering Black Wattle (see Table 6). It was estimated that there were 1158 trees/ha for Early-flowering Black Wattle, 61 trees/ha for Bloodwoods, 258 trees/ha for False Sandalwood, 19 trees/ha for Silver Leaf Ironbark and 31 trees/ha for Others. Silver Leaf Ironbark trees were counted but not measured and values were averaged from the measurements taken at the two Silver Leaf Ironbark sites (REs 11.3.6 and 11.10.11).

The equations used to estimate the biomass for each tree type are summarised in Appendix 1. The average biomass for each tree was calculated by averaging the estimates from all the trees of that type measured in the transects.

Table 6. Measurements for Black Wattle Regional Ecosystem 11.7.2 at "Avocet"

Tree Types	Black Wattle	Blood wood	False Sandalwood	Silver Leaf Ironbark	Others
Biomass (tonnes/tree)	0.02	0.51	0.01	0.14	0.003
Carbon/tree (tonnes)	0.01	0.25	0.01	0.07	0.001
Average number of trees/ha	1158	61	258	19	31
Aboveground tree biomass (t/ha)	27.60	31.04	3.42	2.69	0.08
Belowground tree biomass (t/ha)	11.84	8.69	1.47	0.70	0.03
Belowground tree C (t/ha)	5.92	4.35	0.73	0.35	0.02
Aboveground tree C (t/ha)	13.80	15.52	1.71	1.35	0.04

Total above-ground carbon for Black Wattle was estimated at 32.41 tonnes/ha, while below-ground carbon was estimated to be 11.37 tonnes/ha. This gave a total of 43.78 tonnes/ha for trees and bushes in this Black Wattle Regional Ecosystem (21 hectares at "Avocet").

11.8.5 Mountain Coolibah

This ecosystem was measured in detail and the amount of carbon per hectare estimated includes other trees as well as Mountain Coolibah (see Table 7). It was estimated that there were 77 trees/ha for Mountain Coolibah, 46 trees/ha for Bloodwoods, 18 trees/ha for False Sandalwood, 32 trees/ha for Acacia, 8 trees/ha for Silver Leaf Ironbark and 100 trees/ha for Others.

The equations used to estimate the biomass for each tree type are summarised in Appendix 1. The average biomass for each tree was calculated by averaging the estimates from all the trees of that type measured in the transects.

Table 7. Measurements for Mountain Coolibah RE 11.8.5 at "Avocet"

Tree Types	Mountain Coolibah	Blood wood	False Sandalwood	Acacia	Silver Leaf Ironbark	Others
Biomass (tonnes/tree)	0.48	0.17	0.02	0.02	0.12	0.02
Carbon/tree (tonnes)	0.24	0.09	0.01	0.01	0.06	0.01
Average number of trees/ha	77	46	18	32	8	100
Aboveground tree biomass (t/ha)	37.14	8.02	0.28	0.52	1.02	2.12
Belowground tree biomass (t/ha)	10.40	2.25	0.12	0.22	0.27	0.91
Belowground tree C (t/ha)	5.20	1.12	0.06	0.11	0.13	0.45
Aboveground tree C (t/ha)	18.57	4.01	0.14	0.26	0.51	1.06

Total above-ground carbon for Mountain Coolibah was estimated at 24.55 tonnes/ha, while below-ground carbon was estimated to be 7.07 tonnes/ha. This gave a total of 31.62 tonnes/ha for trees and bushes in this Mountain Coolibah Regional Ecosystem (212 hectares at "Avocet").

11.9.1 Brigalow

This ecosystem was measured in detail and the amount of carbon per hectare estimated includes other trees as well as Brigalow (see Table 8). It was estimated that there were 928 trees/ha for Brigalow, 359 trees/ha for False Sandalwood 51 trees/ha for Poplar Box, and 29 trees/ha for Others

Table 8 Measurements for Brigalow Regional Ecosystem 11.9.1 at "Avocet"

Tree Types	Brigalow	False Sandalwood	Poplar Box	Others
Biomass (tonnes/tree)	0.04	0.01	0.11	*
Carbon/tree (tonnes)	0.02	0.003	0.06	*
Average number of trees/ha	928	359	51	29
Aboveground tree biomass (t/ha)	39.21	2.10	5.65	*
Belowground tree biomass (t/ha)	16.82	0.90	1.58	*
Belowground tree C (t/ha)	8.41	0.45	0.79	*
Aboveground tree C (t/ha)	19.60	1.05	2.83	*

* measurements too small to record

The equations used to estimate the biomass for each tree type are summarised in Appendix 1. The average biomass for each tree was calculated by averaging the estimates from all the trees of that type measured in the transects.

Total above-ground carbon for Brigalow was estimated at 23.48 tonnes/ha, while below-ground carbon was estimated to be 9.65 tonnes/ha. This gave a total of 33.13 tonnes/ha for trees and bushes in this Brigalow Regional Ecosystem (215 hectares at "Avocet").

11.10.3 Lancewood

This ecosystem was measured in detail and the amount of carbon per hectare estimated includes other trees as well as Lancewood (see Table 9). It was estimated that there were 561 trees/ha for Lancewood, 279 trees/ha for Turkey Bush, 9 trees/ha for Bloodwood, 10 trees/ha for Narrow Leaf Ironbark and 65 trees/ha for Others.

The equations used to estimate the biomass for each tree type are summarised in Appendix 1. The average biomass for each tree was calculated by averaging the estimates from all the trees of that type measured in the transects.

Table 9. Measurements for Lancewood Regional Ecosystem 11.10.3 at "Avocet"

Tree Types	Lancewood	Turkey Bush	Bloodwood	Narrow Leaf Ironbark	Others
Biomass (tonnes/tree)	0.23	0.01	0.09	0.06	0.04
Carbon/tree (tonnes)	0.11	0.003	0.04	0.03	0.02
Average number of trees/ha	561	279	9	10	65
Aboveground tree biomass (t/ha)	126.26	1.59	0.81	0.65	2.36
Belowground tree biomass (t/ha)	54.17	0.68	0.23	0.15	1.01
Belowground tree C (t/ha)	27.08	0.34	0.11	0.07	0.51
Aboveground tree C (t/ha)	63.13	0.80	0.41	0.32	1.18

Total above-ground carbon for Lancewood was estimated at 65.84 tonnes/ha, while below-ground carbon was estimated to be 28.11 tonnes/ha. This gave a total of 93.95 tonnes/ha for trees and bushes in this Lancewood Regional Ecosystem (587 hectares at "Avocet").

11.10.11 Silver Leaf Ironbark

This ecosystem was measured in detail and the amount of carbon per hectare estimated includes other trees as well as Silver Leaf Ironbark (see Table 10). It was estimated that there were 446 trees/ha for Silver Leaf Ironbark, 73 trees/ha for False Sandalwood, 88 trees/ha for Acacia, 62 trees/ha for Bloodwoods, 2 trees/ha for Poplar Box and 66 trees/ha for Others.

Table 10. Measurements for Silver Leaf Ironbark RE 11.10.11 at "Avocet"

Tree Types	Silver Leaf Ironbark	False Sandalwood	Acacia	Blood wood	Poplar Box	Others
Biomass (tonnes/tree)	0.15	0.01	0.03	0.13	0.37	0.08
Carbon/tree (tonnes)	0.07	0.003	0.01	0.07	0.19	0.04
Average number of trees/ha	446	73	88	62	2	66
Aboveground tree biomass (t/ha)	66.63	0.59	2.30	8.15	0.62	5.02
Belowground tree biomass (t/ha)	17.32	0.25	0.99	2.28	0.17	2.15
Belowground tree C (t/ha)	8.66	0.13	0.49	1.14	0.09	1.08
Aboveground tree C (t/ha)	33.31	0.29	1.15	4.07	0.31	2.51

The equations used to estimate the biomass for each tree type are summarised in Appendix 1. The average biomass for each tree was calculated by averaging the estimates from all the trees of that type measured in the transects.

Total above-ground carbon for Silver Leaf Ironbark was estimated at 41.64 tonnes/ha, while below-ground carbon was estimated to be 11.59 tonnes/ha. This gave a total of 53.23 tonnes/ha for trees and bushes in this Silver Leaf Ironbark Regional Ecosystem (981 hectares at "Avocet").

11.10.12 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 11). It was estimated that there were 239 trees/ha for Poplar Box, 194 trees/ha for Acacia, 568 trees/ha for False Sandalwood, 19 trees/ha for Bloodwood and Eucalypts and 43 trees/ha for Others.

The equations used to estimate the biomass for each tree type are summarised in Appendix 1. The average biomass for each tree was calculated by averaging the estimates from all the trees of that type measured in the transects.

Table 11. Measurements for Poplar Box Regional Ecosystem 11.10.12 at "Avocet"

Tree Types	Poplar Box	Acacia	False Sandalwood	Bloodwood/ Eucalyptus	Others
Biomass (tonnes/tree)	0.37	0.02	0.02	0.11	0.02
Carbon/tree (tonnes)	0.19	0.01	0.01	0.06	0.01
Average number of trees/ha	239	194	568	19	43
Aboveground tree biomass (t/ha)	88.94	3.74	8.87	2.15	0.66
Belowground tree biomass (t/ha)	24.90	1.60	3.81	0.60	0.28
Belowground tree C (t/ha)	12.45	0.80	1.90	0.30	0.14
Aboveground tree C (t/ha)	44.47	1.87	4.43	1.07	0.33

Total above-ground carbon for Poplar Box was estimated at 52.17 tonnes/ha, while below-ground carbon was estimated to be 15.59 tonnes/ha. This gave a total of 67.76 tonnes/ha for trees and bushes in this Poplar Box Regional Ecosystem (177 hectares at "Avocet").

11.11.2 Lancewood

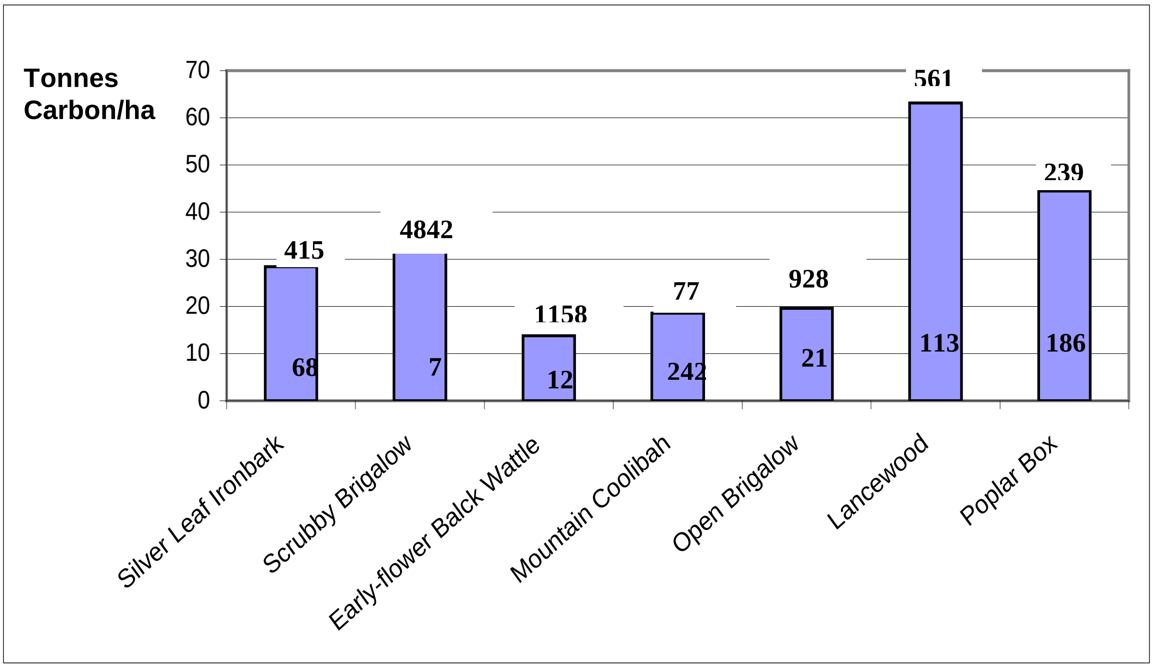
The amount of carbon per hectare for this Lancewood ecosystem was not directly measured. The per hectare measurements of the other Lancewood ecosystem on the property (RE 11.10.3) were used for this ecosystem.

Total above-ground carbon for Lancewood was estimated at 65.84 tonnes/ha, while below-ground carbon was estimated to be 28.11 tonnes/ha. This gave a total of 93.95 tonnes/ha for trees and bushes in this Lancewood Regional Ecosystem (82 hectares at "Avocet").

Summary of above-ground carbon stored in the trees and bushes at "Avocet"

Although Mountain Coolibah has the highest carbon content per tree (242 kgs), more carbon is stored in Lancewood per hectare (63 tonnes/ha) because there is a greater density of trees (Figure 3). It also appears that scrubby Brigalow (RE 11.4.9) stores larger amounts of carbon (32 tonnes/ha) than the larger trees (20 tonnes/ha) of RE 11.9.1, because of the higher density of trees.

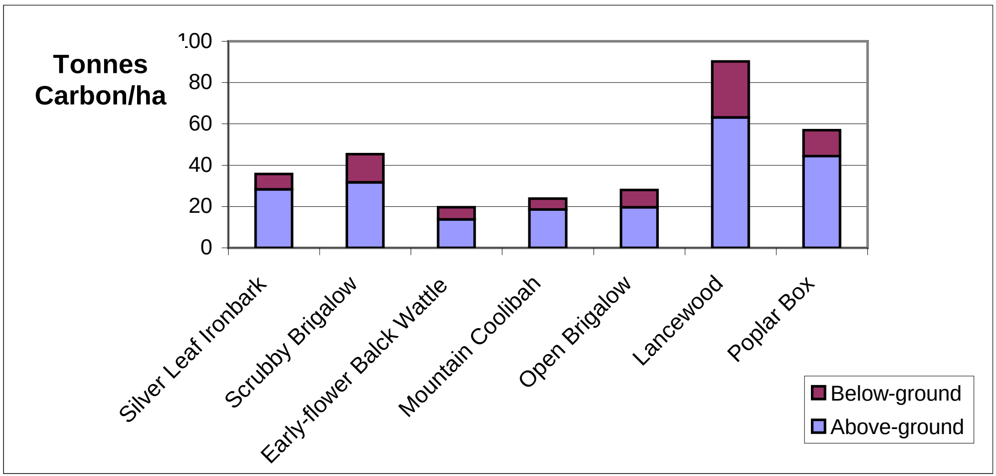
Figure 3. Above -ground Tree Carbon Stores



Figures within each column indicate the amount of carbon per tree (kgs)
Figures above each column indicate the number of trees per hectare

Carbon stored in tree roots makes a significant contribution to the total carbon stocks on Avocet. It was estimated that approximately 41,600 tonnes of carbon were stored in the below-ground tree biomass on Avocet or 35% of that stored above the ground. Figure 4 shows the comparison of carbon stored below the ground versus that stored above ground.

Figure 4. Above and Below-ground Tree Carbon

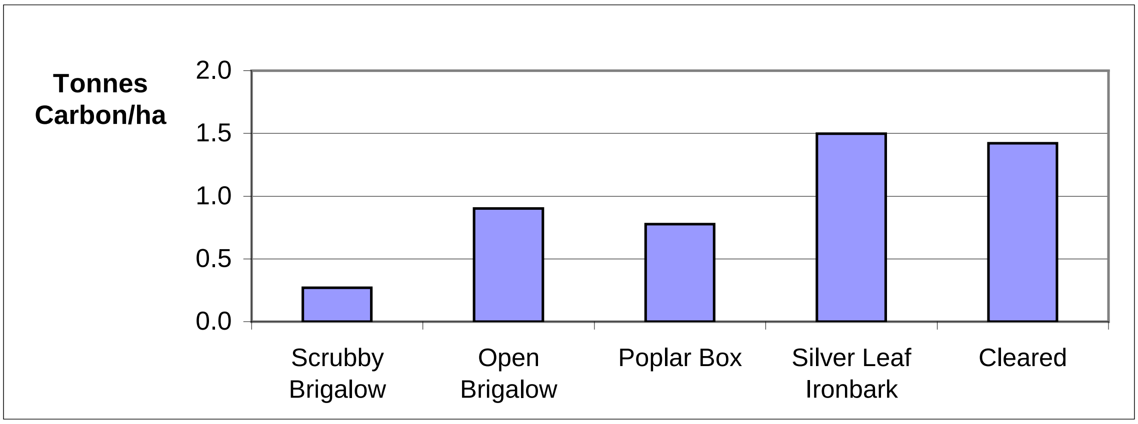


2. Estimating the carbon in pasture grasses

Approximately 50% of the dry matter weight of pasture is carbon. This means that pasture stocks can add to the amount of carbon held on a property. The biomass of pasture (as dry matter) can range from a couple of hundred kilograms per hectare in very bare conditions up to about eight tonnes per hectare for very dense introduced grass species (eg buffel grass).

Samples of pasture grasses were taken from four of the main vegetation types at three month intervals for one year. Samples were taken in uncleared areas and also from adjacent cleared areas. The biomass of these grasses varied from Silver Leaf Ironbark (3 tonnes/ha), Open Brigalow (1.8 t/ha), Poplar Box (1.6 t/ha), Scrubby Brigalow (0.5 t/ha) to 3 tonnes/ha in the cleared areas, which included areas of uncleared blue grass. Figure 5 illustrates the relative amounts of carbon stored in these grasses.

Figure 5. Carbon Stored in the Pasture Grasses at the Main Vegetation Types



The pasture biomass measurements were averaged for the two main groups, being native pasture in road areas, and pasture (native and improved) in cleared areas and open bluegrass plains. These average measurements could then be multiplied by the area of the relative groups. It was estimated that a total of 5195 tonnes of carbon were stored in the pasture grasses on the property, with a density of 1.42 tonnes/ha in the bluegrass and cleared areas, compared with 1.12 tonne/ha in the uncleared areas.

3. Estimating the carbon in soils

Carbon exists in soils in two main forms – organic and inorganic carbon. Organic carbon is associated with the humus or organic matter in the soil, which determines the quality of the soil and the amount of biomass it can support. Levels of organic carbon vary widely between different soil types and also between the different depths within the same soil. Generally, the highest levels of carbon are found in the first few centimetres of soil.

The carbon stored in the soils at “Avocet” is the most significant pool of carbon on the property, with approximately twice as much carbon stored in the soil itself as in the plants that grow on the soil. 70% of the estimated carbon came from the soil (396,219 tonnes), compared with the trees and bushes, which comprised 28%.

There are primarily two major soil types on the property, texture contrast soils and shallow rocky soils. The texture contrast soils can either be deep with a thin layer of sandy or loamy surface soils, or deep with a thick layer of sandy surface soils. Soils were sampled at 34 sites including the major tree types as well as at other parts of the property. Sampling was performed with a hydraulic ram that took a 50mm core of the soil. The intention was to take one meter deep samples, but the depth of the cores varied from site to site. Over all the average soil depth at Avocet was found to be approximately 72 cm.

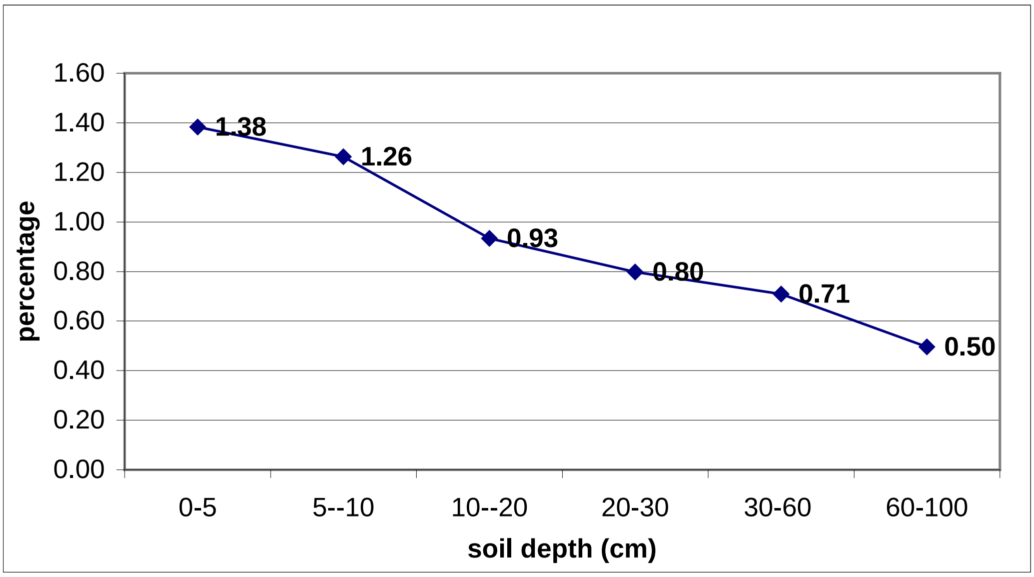
At each site selected for sampling, eight soil cores were taken and combined to get one sample (soil cores were combined to minimise the costs of analysis). Each sample was then dried and analysed for its carbon content using specialist equipment. The total amount of carbon in the soils associated with the different vegetation types is presented in Table 12. Soils were not sampled for Bloodwood and River Gum REs and estimates for these REs were based on the average for all Poplar Box, Silver Leaf Ironbark and Mountain Coolibah soils.

Table 12. Carbon Stores in the Soils of the Main Tree Types at "Avocet"

RE	Major Tree	Total Carbon (tonnes/ha)	RE Area (ha.)	Total Soil Carbon (tonnes /RE)
11.3.1.	Brigalow	96.73	36.07	3489.31
11.3.2	Poplar Box	59.47	69.38	4125.63
11.3.3	River Coolibah	141.72	4.10	581.50
11.3.6	Silver Leaf Ironbark	76.14	39.54	3010.47
11.3.25	Blue/Red River Gum	101.40	8.93	905.96
11.4.2	Bloodwood	101.40	19.12	1938.37
11.4.8	Brigalow	96.73	8.46	818.59
11.4.9	Brigalow	140.37	130.95	18381.46
11.5.3	Poplar Box	59.47	10.64	633.01
11.7.2	Early-flowering Black Wattle	52.77	21.09	1113.08
11.8.5	Mountain Coolibah	141.72	212.29	30086.03
11.8.11	Queensland Bluegrass	141.20	31.40	4433.79
11.9.1	Brigalow	96.73	214.49	20745.08
11.10.3	Lancewood	71.19	586.52	41754.57
11.10.11	Silver Leaf Ironbark	59.47	980.59	10549.08
11.10.12	Poplar Box	76.14	177.39	74659.34
11.10.13	Bloodwood	101.40	48.84	4952.32
11.11.2	Lancewood	71.19	81.98	5836.21
	Cleared	109.75	1532.67	168205.14
	Total		**4214.44**	**396218.93**

Table 12 provides information on the total carbon content of the soils to a depth of one metre. In order to establish the extent to which the carbon content varied throughout the soil profile, carbon was measured at intervals within the profile. As the carbon content is highest in organic matter associated with the top-soil, it would be expected that the proportion of carbon in the soil would decline with depth. When measurements from all the soil types are combined a clear trend emerges with the proportion of carbon in the soil declining with depth (see Figure 6). The percentage of carbon in the soil drops from 1.38% in the first five centimetres to 0.5% at the deepest part of the profile.

Figure 6. Carbon Proportions in Soil Profile



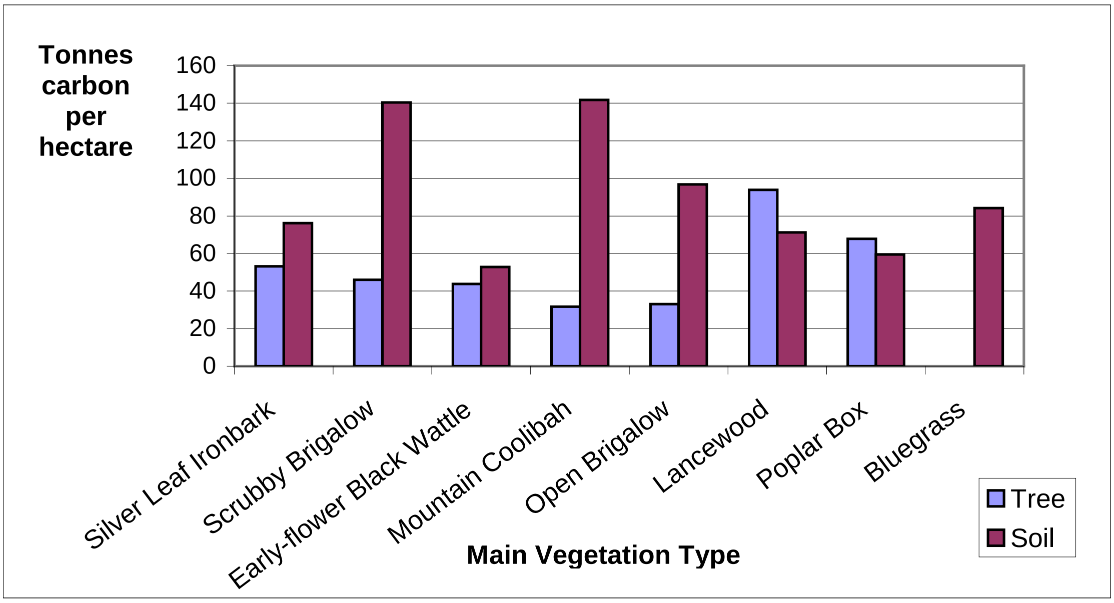
When the measurements for the soils of the main vegetation types are examined separately, it can be seen that this downward trend is generally true across the different types (see Table 13). But, soils at Mountain Coolibah and Bluegrass sites do not follow this trend. This highlights the fact that the soil samples were taken at one point in time, whereas the carbon content in soils changes over time. For example, a storm event may wash organic matter through the soil profile of particularly porous soils or perhaps a cracking clay soil.

Table 13. Carbon Content (%) in Soil Profiles under Different Vegetation Types

Soil Depth (cm)	Poplar Box	Silver Leaf Ironbark	Brigalow	Mountain Coolibah	Lancewood	Black Wattle	Bluegrass
No of sites	6	6	6	5	2	1	3
0-5	1.12	1.31	1.44	1.44	1.45	1.78	1.14
5-10	0.98	1.03	1.19	1.54	1.26	1.11	1.75
10-20	0.63	0.78	0.97	1.33	1.03	0.77	1.03
20-30	0.52	0.63	0.82	1.13	0.86	0.68	0.96
30-60	0.42	0.42	0.63	1.45	0.63	0.42	0.99
60-100	0.27	0.41	0.35	1.23	0.37	0.35	-

The comparison between carbon stores in trees and soils for major vegetation types is shown in Figure 7. The figure illustrates that carbon is higher than the tree component of the five ecosystems dominated by Shrubby Brigalow, Early-flowering Black Wattle, Mountain Coolibah, Open Brigalow and Silver Leaf Ironbark, but in Lancewood and Poplar Box the trend is reverse. The possible explanation for the reverse trend maybe due to the shallow and low fertility soils associated with these ecosystems.

Figure 7. Carbon Stored in Vegetation Compared with Soils at the Main Ecosystems



Conclusions

This report provides an example of how carbon stocks may be estimated on a grazing property, and provides a break-up of different carbon pools. Estimates of the carbon stored in trees, has been gained by measuring trees in different vegetation types. Pastures were sampled at three month intervals over a one year period to derive an average estimate for the amount of carbon in pastures. Soils have been sampled with 50 mm cores to a one metre depth, and analysis performed for different sections of the cores.

The results demonstrate that soils account for 70.5% of soils stocks on the property, trees (including roots) account for 28.5%, and pastures for 1%. However, there are substantial variations in carbon stocks across the different ecosystem types. The amount of carbon in trees and bushes varied from an average of 30 tonnes/ha in Silver Leaf Ironbark country to 94 tonnes/ha in Lancewood country. The amounts of carbon stored in soils varied from an average of 53 tonnes/ha in Black Wattle country to 143 tonnes/ha in Mountain Coolibah 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, Red River Gum, Ghost Gum, Queensland Yellow Jacket, Rough-leaved Bloodwood, Peppermint (Queensland peppermint), Bloodwood	*E. orgadophila, E. camaldulensis, E. papuana, E. similis, E. setosa, E. exserta, Corymbia spp.*	$B = e^{(-4.92+2.39 \times \ln \mathbf{C})}$	Burrows et al. (2000)
Wattles	Brigalow, Lancewood, Early-flowering Black Wattle, Iron wood, Gidgee, other Acacias	*Acacia harpophylla, A. shirleyi, A. leiocalyx, A. excelsa, A. cambagei, 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*	$B = e\left(^{(-4.453 + 2.257 \times \ln (Dx1.15))}\right) + e\left(^{(-3.890 + 2.623 \times \ln (Dx1.15))}\right)$	Harington (1979)
Others	Cattle Bush (Whitewood), Bitter Bark, Beefwood, Soap Bush (Soapy Box), Wallaby Apple (Orange Thorn), Emu Apple, Monkey Vine, Canthium (Supple Jack), Bauhinia, Bulloak, Black Cyprus Pine, Red Bottlebrush, Hopbush, Prickly Pine, Tea-tree	*Atalaya hemiglauca, Alistonia constricta, Grevilea striata, Alphitonia excelsa, Citriobatus spinescens, Owenia acidula, Parsonsia eucalyptophylla, Canthium coprosmoides, Lysiphylum spp., Hakea lorea, Callitris endlicheri, Callistemon viminalis, Dodonea spp., Bursaria incana, Melaluca 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 Avocet Property*

RE	Tree type	Estimate source	Ave basal area# (M^2)	Carbon/ Tree (tonnes)	Trees/ ha	Carbon/ ha (tonnes) Above ground	Below ground	Total Tree Carbon	RE area (ha)	Total tree Carbon (tonnes)
11.3.1.	Brigalow	"Berrigurra"	1.014	0.020	1198	24.19	10.38	59.00	36.07	2128.20
	False Sandalwood		0.011	0.011	35	0.40	0.17			
	Eucalypts		0.088	0.228	32	7.22	2.02			
	Others		0.011	0.093	110	10.23	4.39			
11.3.2	Poplar Box	11.10.12				52.17	15.59	67.76	69.38	4702.01
11.3.3	River Coolibah	Average all REs				37.05	12.94	49.99	4.10	205.12
11.3.6	**Silver Leaf Ironbark**		0.028	0.061	385	23.49	6.11	30.41	39.54	1203.03
	False Sandalwood		0.005	0.003	37	0.12	0.05			
	Acacia		0.068	0.001	157	0.09	0.04			
	Bloodwood		0.003	0.004	35	0.12	0.03			
	Others		0.006	0.008	32	0.25	0.11			
11.3.25	Blue/Red River Gum	Average all REs				37.05	12.94	49.99	8.93	446.63
11.4.2	Bloodwood	"Berrigurra"	0.047	0.085	39	3.29	0.92	39.64	19.12	757.81
	Other Bloodwood		0.045	0.130	57	7.382	2.067			
	Poplar Box		0.010	0.197	22	4.338	1.214			
	Narrow Leaf Ironbark		0.069	0.013	8	0.108	0.025			
	Acacia		0.021	0.047	167	7.913	3.395			
	False Sandalwood		0.006	0.007	65	0.456	0.196			
	Moreton Bay Ash		0.015	0.032	18	0.567	0.159			
	Other Trees		0.003	0.005	157	0.786	0.337			
11.4.8	Brigalow	11.4.9				32.21	13.76	45.97	8.46	389.03
11.4.9	**Brigalow**		0.004	0.007	4842	31.72	13.61	45.97	130.95	6019.85
	False Sandalwood	11.9.1	0.002	0.003	40.	0.12	0.05			
	Poplar Box	11.9.1	0.020	0.056	6.7	0.37	0.10			
11.5.3	Poplar Box	11.10.12				52.17	15.59	67.76	10.64	721.44
11.7.2	**Early-flow' Black Wattle**		0.007	0.012	1158.3	13.80	5.92	43.78	21.09	923.34
	Bloodwood		0.089	0.254	61.1	15.52	4.35			
	False Sandalwood		0.006	0.007	258.3	1.71	0.73			

	Silver Leaf Ironbark	Ave 11.3.6 + 11.10.11	0.028	0.069	19.4	1.34	0.35			
	Others		0.002	0.001	30.6	0.04	0.02			
11.8.5	**Mountain Coolibah**		0.078	0.242	76.7	18.57	5.20	31.62	212.29	6715.68
	Bloodwood		0.035	0.087	46.1	4.01	1.12			
	False Sandalwood		0.009	0.008	17.8	0.14	0.06			
	Acacia		0.007	0.008	31.7	0.26	0.11			
	Silver Leaf Ironbark		0.029	0.061	8.3	0.51	0.13			
	Others		0.008	0.011	100.0	1.06	0.45			
11.9.1	**Brigalow**		0.010	0.021	928.3	19.60	8.41	33.13	214.49	7105.90
	False Sandalwood		0.002	0.003	359.2	1.05	0.45			
	Poplar Box		0.020	0.056	50.8	2.82	0.79			
11.10.3	**Lancewood**		0.044	0.113	560.8	63.13	27.08	93.95	586.52	55108.30
	Turkey Bush		0.003	0.003	279.2	0.80	0.34			
	Bloodwood		0.047	0.044	9.2	0.40	0.11			
	Narrow Leaf Ironbark		0.030	0.032	10.0	0.33	0.07			
	Others		0.010	0.018	65.0	1.18	0.51			
11.10.11	**Silver Leaf Ironbark**		0.027	0.075	445.8	33.31	8.66	53.23	980.59	52206.16
	False Sandalwood		0.007	0.004	73.3	0.29	0.13			
	Acacia		0.013	0.013	88.3	1.15	0.49			
	Bloodwood		0.023	0.066	61.7	4.07	1.14			
	Poplar Box	11.10.12	0.080	0.186	1.7	0.31	0.09			
	Others		0.004	0.038	65.8	2.51	1.08			
11.10.12	**Poplar Box**		0.080	0.186	239.4	44.47	12.45	67.76	177.39	12022.87
	Acacia		0.006	0.010	193.7	1.87	0.80			
	False Sandalwood		0.004	0.008	568.1	4.43	1.90			
	Bloodwood/Eucalyptus		0.028	0.056	19.1	1.07	0.30			
	Others		0.004	0.008	43.2	0.33	0.14			
11.10.13	Bloodwood	"Berrigurra" as 11.4.2				29.91	9.73	39.64	48.84	1936.11
11.11.2	Lancewood	11.10.3	0.044	0.113	560.8	63.13	27.08	93.95	81.98	7702.72
								Total	**2650.38**	**160294.20**

* Tree types that are highlighted were actually measured. Those not highlighted were estimated, or transferred from another site. Estimates were also used in cases where a tree type may have been present and counted, but not measured, ie it occurred after the 30 main tree types had already been measured.

The basal area is the cross-sectional area of the tree trunk – in this case measured at a height of 30 cms above the ground.