Appendix 1: Introduction to basic measurements and conventions

A1.1 Units used in Forestry

Linear measurements		
cm	Centimetre	0.01 metre
m	Metre	
km	Kilometre	1 000 metres
Area measurements		
m^2	Square metre	
ha	Hectare	10 000 m^2
Volume measurement		
m^3	Cubic metre	1 000 litres
Weight measurement		
Tonne		1 000 000 grams

Constants: π = 3.1415927. As a convention 1 m^3 of water is taken to weigh 1 tonne.

A1.2 Measuring diameter

All diameters should be measured in centimetres. Diameters of individual trees are conventionally rounded down to the nearest whole centimetre. Mean diameters may be recorded to the nearest whole centimetre

Diameters may be measured with a special tape marked in cm diameter, known as a girthing tape, which is placed round the circumference of the tree or log. Girthing tapes which are marked in rounded down 1 cm diameter classes are available from specialist suppliers (see Figure A1.1). In cases where the zero point is found to fall on the dividing line between two diameter classes, the higher diameter class should be used.

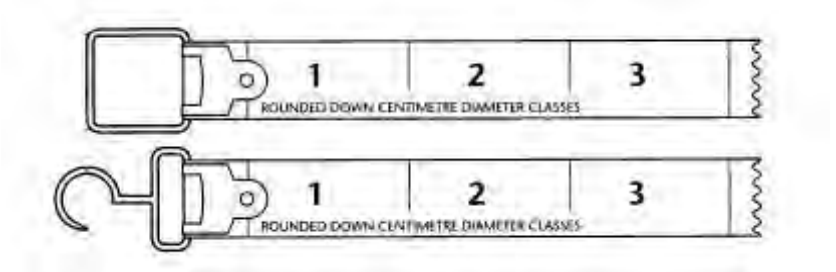


Figure A1.1: Examples of girthing tapes – the dotted line shows the zero point.

Diameters can also be measured with manual or electronic callipers, while the diameters of stumps and of the ends of logs are usually measured with a timber or log rule.

A1.2.1 Measuring diameter at breast height

The dbh is the diameter of the trunk at 1.3 m above ground level (breast height). In forestry in the UK trees with a dbh of less than 7 cm are assumed to have no timber volume and are conventionally classified as 'unmeasurable', however for the purposes of carbon assessment this minimum dbh will ultimately be reduced to 4 cm.

There are conventions for determining the point on the stem where the beast height should be measured. On sloping ground, this is the ground level on the upper side of the tree, while on leaning trees on level ground, this is the ground level on the underside of the tree. More details are given in Forest Mensuration: a handbook for practitioners pages 36-37.

A1.2.2 Calculating mean dbh

The mean diameter of a stand or group of trees is the diameter of the tree of mean basal area, which is the same as the quadratic mean of the dbh's of all the trees. Unmeasurable trees (*i.e.* with a dbh of less than 7 cm) are normally excluded from this calculation, but if they are included this should be clearly stated. The mean diameter can be calculated using one of two methods:

- Using a calculator or computer
- Using a table of basal areas.

Using a scientific calculator or computer

a. Square each dbh.
b. Add all the squared values together.
c. Divide by the number of trees, to give the mean squared dbh.
d. Calculate the square root of this value, to give the quadratic mean dbh.

That is:

$$\text{Quadratic mean dbh} = \sqrt{\left(\frac{dbh_1^2 + dbh_2^2 + dbh_3^2 + K + dbh_n^2}{n}\right)}$$

Where dbh_i = breast height diameter, in cm, of the i^{th} sample tree
n = total number of sample trees.

Using Table A1.1 below

a. Convert each dbh into the equivalent basal area.
b. Add all the basal areas together.
c. Divide by the number of trees, to give the mean basal area.
d. Convert this to the quadratic mean dbh (using Table A1.1 in reverse), rounding down to the nearest centimetre dbh class when necessary.

Table A1.1 Basal areas

Dbh or diameter (cm)	Basal area or cross-sectional area (m^2)	Dbh or diameter(cm)	Basal area or cross-sectional area (m^2)
7	0.0038	34	0.091
8	0.0050	35	0.096
9	0.0064	36	0.102
10	0.0079	37	0.108
11	0.0095	38	0.113
12	0.0113	39	0.119
13	0.0133	40	0.126
14	0.0154	41	0.132
15	0.018	42	0.139
16	0.020	43	0.145
17	0.023	44	0.152
18	0.025	45	0.159
19	0.028	46	0.166
20	0.031	47	0.173
21	0.035	48	0.181
22	0.038	49	0.189
23	0.042	50	0.196
24	0.045	51	0.204
25	0.049	52	0.212
26	0.053	53	0.221
27	0.057	54	0.229
28	0.062	55	0.238
29	0.066	56	0.246
30	0.071	57	0.255
31	0.075	58	0.264
32	0.080	59	0.273
33	0.086	60	0.283

A1.2.3 Mid diameter

The mid-sectional diameter is measured at the mid-point of the rounded down length section. If the mid diameter falls on a whorl or swelling the diameter should be measured immediately above it (towards the small end). If the mid diameter of a timber length falls below the breast height point on the standing tree, the dbh should be regarded as the mid diameter. Mid diameter should be measured consistently either overbark or underbark.

A1.3 Measuring height

Lengths and heights should be measured in metres. They are conventionally rounded down to the nearest 0.1 m for lengths up to 10 m, and to the nearest whole metre for lengths greater than 10 m.

A1.3.1 Measuring length

The length of a piece of felled timber should be measured with a tape in a direct line from end to end (Figure 2). This is a revision to a previous convention that involved measurement along the curve of the log.

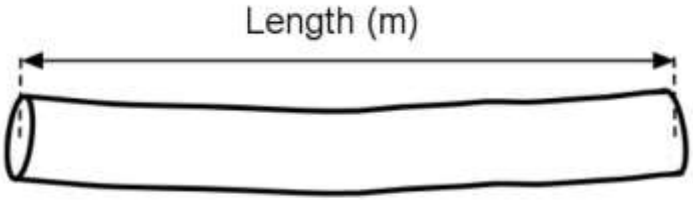


Figure A1.2 – The method of assessment of length on curved logs

A1.3.2 Total height

The total height of a standing tree is the vertical distance from the base of the tree to the uppermost point (tip). The total length of a felled tree is the straight line distance from the base to the tip. The total height of young standing trees can be measured with graduated poles. The total height of felled trees should be measured with a tape. The total height of other trees should be measured with a manual or electronic hypsometer or clinometer, and the instructions supplied with the instrument should be followed. Each tree should ideally be measured from opposite sides perpendicular to any lean, and the two measurements averaged. The distance of the observation points from the tree should be in the region of 1 to 1.5 times the height of the tree. When measuring the heights of trees it is important to remember that accurate use of hypsometers or clinometers requires training, checking, and, most of all, practice.

A1.3.3 Timber height

The timber height of a tree (or the timber length) is the distance from the base of the tree to the lowest point on the main stem where the diameter is 7 cm overbark. In hardwoods and occasionally in conifers this point may alternatively be the 'spring of the crown'; *i.e.* the lowest point at which no main stem is distinguishable. It should be measured in exactly the same way as total height.

A1.4 Classifying trees as live or dead

If the cambium is either active or dormant, the tree is classed as alive. Otherwise it is classes as dead.

A1.5 Classifying maturity.

Maturity is defined as one of three classes for the purposes of this assessment:

- Seedling: Any tree less than 50 cm tall
- Sapling: Any tree that is more than 50 cm tall and less than 7 cm dbh.
- Tree: Any tree with dbh equal to or greater than 7 cm.

A1.6 Species.

Standard species abbreviations are given in Appendix 2 (on page 75).

Appendix 2: Standard species abbreviations

The following standard abbreviations for species are used throughout this document.

Species abbreviation	Common name	Latin name
AH	ash	*Fraxinus* spp.
AR	alder	*Alnus* spp.
BE	beech	*Fagus sylvatica*
BI	birch	*Betula* spp.
BIP	Bishop pine	*Pinus muricata*
CP	Corsican pine	*Pinus nigra* var *maritima*
DF	Douglas fir	*Pseudotsuga menziesii*
EL	European larch	*Larix decidua*
EM	elm	*Ulmus* spp.
GF	grand fir	*Abies grandis*
HBM	hornbeam	*Carpinus betulus*
HL	hybrid larch	*Larix* x *eurolepis*
JCR	Japanese cedar/Sugi	*Cryptomeria japonica*
JL	Japanese larch	*Larix kaempferi*
LC	Lawson cypress	*Chamaecyparis lawsoniana*
LEC	Leyland cypress	*Cupressocyparis leylandii*
LI	lime	*Tilia* spp.
LP	lodgepole pine	*Pinus contorta* var *latifolia*
MAP	maritime pine	*Pinus pinaster*
MET	dawn redwood (Metasequoia)	*Metasequoia glyptostroboides*
MX	mixed species	
NF	noble fir	*Abies procera*
NOM	Norway maple	*Acer platinoides*
NS	Norway spruce	*Picea abies*
OBN	southern beech/roble	*Nothofagus obliqua*
OK	oak	*Quercus* spp.
OMS	Omorika spruce (Serbian spruce)	*Picea omorika*
PDP	ponderosa pine	*Pinus ponderosa*
PO	poplar	*Populus* spp.
PRN	southern beech/rauli	*Nothofagus procera*
RAP	radiata pine (Monterey pine)	*Pinus radiata*
RC	western red cedar	*Thuja plicata*
ROK	red oak	*Quercus rubra*
RSQ	coast redwood	*Sequoia sempervirens*
SC	sweet/Spanish chestnut	*Castanea sativa*
SP	Scots pine	*Pinus sylvestris*
SS	Sitka spruce	*Picea sitchensis*
SY	sycamore	*Acer pseudoplatanus*

Standard species abbreviations (continued)

Species abbreviation	**Common name**	***Latin name***
TOK	Turkey oak	*Quercus cerris*
WEP	Weymouth pine	*Pinus strobus*
WH	western hemlock	*Tsuga heterophylla*
WSQ	Wellingtonia (giant redwood)	*Sequoiadendron giganteum*
XB	miscellaneous broadleaf	
XC	miscellaneous coniferous	
XF	miscellaneous fir	*Abies* spp.
XP	miscellaneous pine	*Pinus* spp.
XS	miscellaneous spruce	*Picea* spp.

Appendix 3: Estimating the tariff number of minor tree species.

This table lists the available relationships for estimating the tariff number of major tree species in Britain. For those species where no relationship has been characterised the table suggests an alternative. It must be stressed that many of these equivalencies for minor species are provisional and the tariff number derived in this way should be regarded as the currently best available estimate.

Common name	Abbreviation	Single tree tariff	Stand tariff from top height
beech	BE	•	OK
English elm	-	•	OK
hornbeam	-	BE	BE
pedunculate oak	OK	•	•
raoul	-	BE	BE
roble	-	BE	BE
red oak	-	BE	OK
sessile oak	OK	•	•
sweet chestnut/Spanish chestnut	-	BE	OK
wych elm	-	•	OK
Corsican pine	CP	•	•
Monterey pine	-	CP	CP
western red pine	-	CP	CP
Bishop pine	-	LP	LP
Douglas fir	DF	•	•
European larch	EL	•	•
hybrid larch	HL	•	•
Japanese larch	JL	•	•
coast redwood	-	GF	GF
grand fir	GF	•	•
Wellingtonia/giant sequoia	-	GF	GF
lodgepole pine	LP	•	•
maritime pine	-	LP	LP

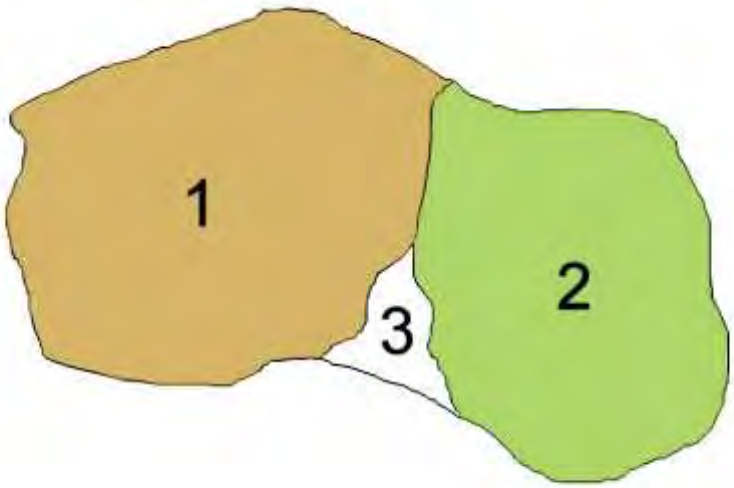
Estimating the tariff number of minor tree species (continued)

Common name	Abbreviation	Single tree tariff	Stand tariff
European silver fir	-	NF	NF
noble fir	NF	•	•
Nordmann fir	-	NF	NF
Siberian fir	-	NF	NF
blue spruce	-	NS	NS
Englemann spruce	-	NS	NS
Norway spruce	NS	•	•
Omorika spruce	OMS	NS	NS
oriental spruce	-	NS	NS
white spruce	-	NS	NS
Sitka spruce	SS	•	•
Lawson cypress	LC	RC	RC
Leyland cypress	-	RC	RC
Monterey cypress	-	RC	RC
Nootka cypress	-	RC	RC
western red cedar	RC	•	•
ash	AH	•	OK
bird cherry	-	BI	BI
black poplar	-	•	BI
common alder	-	BI	OK
downy birch	BI	•	•
field maple	-	SY	BI
grey alder	-	BI	OK
hazel	-	BI	BI
horse chestnut	-	SY	OK
hybrid black poplar	-	•	BI
Italian alder	-	BI	OK
London plane	-	SY	-
Norway maple	-	SY	BI
silver birch	BI	•	•
sycamore	SY	•	BI
wild cherry	-	BI	BI
Scots pine	SP	•	•
Ponderosa pine	-	SP	SP
Weymouth pine/(eastern) white pine	-	SP	SP
western hemlock	WH	•	•

Appendix 4: Worked example for a 10.2ha conifer project

Description:

A 10.2 ha conifer woodland - *"Greenwood"*, composed of a 6 ha compartment/stand of variable Scots pine (1), a 3.8 ha compartment/stand of uniform Corsican pine (2) and a 0.4 ha compartment of open space with no trees present (3). The trees in each compartment were planted at the same time and there are no differences large enough to require further stratification of compartments/strata.



Using the decision tree in Figure 4.1 (page 26) Method C was chosen to estimate the above ground "tree" carbon in the project.

Field work

Number of sample plots required:

Compartment 1 = Variable stand between 2-10 ha (see Table 4.1.4) = 12 plots

Compartment 2 = uniform stand between 2-10 ha = 8 plots

Compartment 3 = no trees = no plots.

Size of plots:

Compartment 1 = Older, well spaced stand = 0.02 ha plots, radius = 8.0 metres.

Compartment 2 = closely-spaced young stand = 0.01 ha plots, radius = 5.6 metres.

The appropriate data collection form (see Appendix 7) was used to collect plot, dbh and height data for the two compartments/strata within the project containing trees. The completed forms are shown in Figures A4.1 to A4.4. Note that the height sample trees selected and recorded in Section 3 of the form are also recorded in Section 2. This is a useful check – if any of the diameters of the trees recorded in Section 3 of the form are not recorded in Section 2 the method has not been followed correctly.

Office work and calculations

Compartment 1:

Number of trees in stratum:

Total number of trees in all (12) plots = 146

Area of all plots = 12 × 0.02 ha = 0.24 ha

Average number of trees per hectare = 146/0.24 = 608.33

Number of trees in compartment = 608.33 × 5.6 ha (net area) = 3406

Mean (quadratic) dbh:

The number of trees in each centimetre dbh class in the stratum (based on adding together the values in each row) is shown in the right-most column of Section 2 of the data collection form (Figure A4.1). To calculate the mean (quadratic) dbh, multiply the number of trees in each class by the square of the dbh for each class. Next, add the results together for each class and divide by the number of trees measured. For the current example, this calculation gives a mean "squared" dbh of 629.27. The square root of this value gives the mean (quadratic) dbh:

$$\sqrt{629.27} = 25.1 \text{ cm}$$

To calculate mean tree volume at a later stage the mean (quadratic) dbh was converted into the mean basal area using the equation in Section 4.1.5.

Mean basal area = $\frac{\pi \times 25.1^2}{40000}$ = 0.049 m^2 (shown to 3 decimal points)

Stand/stratum tariff number:

The stand tariff number is the rounded down mean of the single tree tariff numbers of each height sample tree recorded in Section 3 of the data collection form. The tariff number for each tree is calculated by entering the dbh and height measurements of each tree into Equation 3, described in Section 4.1.5. The parameters a1-a3 in the equation differ for each species. In this case, the parameters for Scots pine were selected. The results of each calculation should be rounded to the nearest whole tariff number and were entered in to the right-most column of Section 3 of the data collection form. The next step was to add all of the individual tariff numbers for the stratum together, which gave a total of 582

582 ÷ 24 = 24.2 rounded down to a stand tariff number of 24.

Mean merchantable tree volume:

The mean tree volume is calculated using Equation 5 in Section 4.1.5 using the stand tariff number and the mean basal area (from mean quadratic dbh).

Mean merchantable tree volume = $a_1 + (a_2 \times 0.049)$ = 0.344 m^3

where:

$a_1 = (0.0360541 \times 24) - (a_2 \times 0.118288)$

$a_2 = 0.315049301 \times (24 - 0.138763302)$.

Mean total stem volume:

To calculate the mean total stem volume, including volume above 7 cm top diameter, the mean merchantable volume is multiplied by the factor given in Table 4.1.9 (page 40) for the appropriate mean (quadratic) dbh:

Mean total stem volume = 0.344 × 1.01 = 0.34744 m^3 (unrounded).

Total stem volume of the stratum:

The total stem volume of the stratum is estimated by multiplying the mean total stem volume (per tree) by the estimated number of trees in the stratum:

Total stem volume in stratum = 0.34744 × 3406 = 1183.4 m^3.

Total Biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the nominal specific gravity of the species (see Table 5.2.1):

1183.4 × 0.42 = 497.0 oven dry tonnes.

Crown biomass per tree:

The quadratic mean dbh already calculated for the Scots pine in stratum 1 is 25.1 cm. The crown biomass (branches and foliage) is therefore estimated using Equation 6 (page 52) and the species-specific parameters for Scots pine from Table 5.2.2 (page 52).

Crown biomass = $0.0000161411 \times 25.1^{2.4767}$ = 0.047261 oven dry tonnes

Total crown biomass of the stratum:

The total crown biomass of the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total crown biomass = 0.047261 × 3406 = 161.0 oven dry tonnes.

Root biomass per tree:

Because the quadratic mean dbh is less than 30 cm, root biomass is estimated using Equation 8 (page 54) with the species-specific parameters for Scots pine from Table 5.2.4 (page 54).

Root biomass = $0.000015404 \times 25.1^{2.5}$ = 0.04862 oven dry tonnes

Total root biomass of the stratum:

The total root biomass of the stratum is estimated by multiplying the root biomass (per tree) by the estimated number of trees in the stratum:

Total root biomass = 0.04862 × 3406 = 165.6 oven dry tonnes.

Total above ground tree carbon in stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass from the stem and crown components in the stratum and multiplying by 0.5:

(497 + 161.0 + 165.6) × 0.5 = 411.8 tonnes C (carbon).

Compartment 2:

Number of trees in stratum:

Total number of trees in all (8) plots = 107

Area of all plots = 8 × 0.01 ha = 0.08 ha

Average number of trees per hectare = 107/0.08 = 1337.5

Number of trees in compartment = 1337.5 × 3.6 ha (net area) = 4815

Mean (quadratic) dbh:

The number of trees in each centimetre dbh class in the stratum (based on adding together the values in each row) is shown in the right-most column of Section 2 of the data collection form (Figure A4.1). Multiplying the trees in each class by the square of the dbh for each class and then adding these results together for each class and dividing by the number of trees measured gives a mean "squared" dbh of 338.11. The square root of this value gives the mean (quadratic) dbh:

$\sqrt{338.11}$ = 18.4 cm

To calculate mean tree volume at a later stage the mean (quadratic) dbh was converted into the mean basal area using the equation in Section 4.1.5.

mean basal area = $\frac{\pi \times 18.4^2}{40000}$ = 0.027 m^2 (shown to 3 decimal points)

Stand/stratum tariff number:

The stand tariff number is the rounded down mean of the single tree tariff numbers of each height sample tree recorded in Section 3 of the data collection form. The tariff number for each tree is calculated by entering the dbh and height measurements of each tree into Equation 3, as described in Section 4.1.5. The parameters a1-a3 in the equation differ for each species. In this case, the parameters for Corsican pine were selected. The results of each calculation should be rounded to the nearest whole tariff number and were entered in to the right-most column of Section 3 of the data collection form. The next step was to add all of the individual tariff numbers for the stratum together, which gave a total of 337

337 ÷ 16 = 21.06 rounded down to a stand tariff number of 21.

Mean merchantable tree volume:

The mean tree volume is calculated using Equation 5 in Section 4.1.5 based on the stand tariff number and the mean basal area (from the quadratic mean dbh).

Mean merchantable tree volume = $a_1 + (a_2 \times 0.027)$ = 0.157 m^3

where:

$a_1 = (0.0360541 \times 21) - (a_2 \times 0.118288)$

$a_2 = 0.315049301 \times (21 - 0.138763302)$.

Mean total stem volume:

To calculate the mean total stem volume, including volume above 7 cm top diameter, the mean merchantable volume is multiplied by the factor given in Table 4.1.9 (page 40) for the appropriate mean (quadratic) dbh:

Mean total stem volume = 0.157 × 1.02 = 0.16014 m^3 (unrounded).

Total stem volume of the stratum:

The total stem volume of the stratum is estimated by multiplying the mean total stem volume (per tree) by the estimated number of trees in the stratum:

Total stem volume in stratum = 0.16014 × 4815 = 771.1 m^3.

Total Biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the nominal specific gravity of the species (see Table 5.2.1):

771.1 × 0.40 = 308.4 oven dry tonnes.

Crown biomass per tree:

The quadratic mean dbh already calculated for the Corsican pine in stratum 2 is 18.4 cm. The crown biomass (branches and foliage) is therefore estimated using Equation 6 (page 52) and the species-specific parameters for Corsican pine from Table 5.2.2 (page 52).

Crown biomass = $0.0000122645 \times 18.4^{2.4767}$ = 0.016643 oven dry tonnes

Total crown biomass of the stratum:

The total crown biomass of the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total crown biomass = 0.016643 × 4815 = 80.1 oven dry tonnes.

Root biomass per tree:

Because the quadratic mean dbh is less than 30 cm, root biomass is estimated using Equation 8 (page 54) with the species-specific parameter for Corsican pine from Table 5.2.4 (page 54).

Root biomass = $0.000010722 \times 18.4^{2.5}$ = 0.015571 oven dry tonnes

Total root biomass of the stratum:

The total root biomass of the stratum is estimated by multiplying the root biomass (per tree) by the estimated number of trees in the stratum:

Total root biomass = 0.0115571 × 4815 = 74.98 oven dry tonnes.

Total tree carbon in stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass from the stem and crown components in the stratum and multiplying by 0.5:

(308.4 + 101.1 + 74.98) × 0.5 = 242.24 tonnes C (carbon).

For the project:

Total above ground tree carbon for the project:

This is the sum of the carbon estimates for all of the strata in the project (compartment 3 does not contain trees so there is no (tree) carbon associated with it):

Total carbon = 411.8 + 242.24 = 654 tonnes C (carbon).

The estimated total carbon dioxide sequestered in the project is calculated as:

654 tonnes C × 44 ÷ 12 = **2 398 tCO_2e**

It is this final figure (2 398 tCO_2e) which should be reported under the Woodland Carbon Code.

CARBON ASSESSMENT DATA COLLECTION SHEET METHOD C

Section 1 - Basic stand information

Woodland: GREENWOOD
Stand/Stratum: 1
Species: SCOTS PINE (SP)
Age: 43
Gross Area: 6
Net area: 5.6

Total area of plots: 0.24 **(ha)**
Mean basal area: _____ **m²**
Mean dbh: _____ **cm**
(estimated from mean basal area)
Date measured: 01/02/2011
Measured by: J. SMITH

Section 2 - Details of number of trees and dbhs in plots

Dbh (cm)	Count of trees (use gate style, i.e. 𝍸) Plot number												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	
7													
8													
9													
10													
1													
2													
3													
4													
5													
6	II	I	I		I			I		III			9
7	I	I			I	I		I					5
8	I		I			I	I			II		II	8
9	II	I			I	II		II		I			9
20	I		I				IIII				I	I	7
1	II	I								I	I		5
2	III	I	I	I	I				II				9
3		I	I			I	I		III			I	8
4	I	II		I					II		I		7
5			I	I	I			I		I	II		7
6			I		III	I			I	I			7
7	II					II	II	II	I		III	I	13
8			I	I	II	I		II	I	III	I	I	13
9		I	II	I	II	II	I	II		I	II	II	16
30					I		II				I		4
1	I	I	I			I	I	I	II		I	I	10
2			I	I	II	I		I		II	I		9
3													
4													
5													
6													
7													
8													
9													
TOTAL	16	10	12	6	15	13	11	13	12	15	14	9	146

1 of 2

Figure A4.1: Page 1 of completed data collection form for compartment 1.

CARBON ASSESSMENT DATA COLLECTION SHEET METHOD C

Section 3 - Details of height and diameter sample trees

No.	Species (code)	Dbh (cm)	Height (m)	Tariff no. (round to nearest)
1	SP	22	13.5	23
2	"	27	16.1	26
3	"	29	14.1	23
4	"	21	13.7	24
5	"	20	13.7	24
6	"	25	15.4	25
7	"	22	12.7	22
8	"	24	14.7	24
9	"	30	14.6	24
10	"	28	14.7	24
11	"	26	15.6	25
12	"	23	14.1	24
13	"	20	15	25
14	"	30	14.2	23
15	"	27	15.8	25
16	"	28	14.2	23
17	"	23	15.4	25
18	"	26	14.2	24
19	"	21	14.9	25
20	"	29	15.7	25
21	"	27	15.1	25
22	"	25	14.6	24
23	"	27	14.8	24
24	"	29	16.4	26
			Total:	582
			Mean tariff number: (Rounded down)	24

2 of 2

Figure A4.2: Page 2 of completed data collection form for compartment 1.

CARBON ASSESSMENT DATA COLLECTION SHEET METHOD C

Section 1 - Basic stand information

Woodland: GREENWOOD
Stand/Stratum: 2
Species: CORSICAN PINE (CP)
Age: 25
Gross Area: 3·8
Net area: 3·6

Total area of plots: 0·08 **(ha)**
Mean basal area: _____ **m^2**
Mean dbh: _____ **cm**
(estimated from mean basal area)
Date measured: 02/02/2011
Measured by: J. SMITH

Section 2 - Details of number of trees and dbhs in plots

Dbh (cm)	Count of trees (use gate style, i.e. 𝍸) Plot number												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	
7													
8													
9													
10													
1													
2	I					I	IIII						6
3	II		I	IIII	𝍸								12
4	I	II		II	I	I							7
5	I	I	IIII										6
6	I	III					III						7
7	III			II	II	III	III	II					15
8	II				III	III		I					9
9	I	I	II	I	I		I						7
20		I			I	II	I						5
1		I		I		I	I						4
2	I	I	II	III	IIII	I	I	II					15
3				II									2
4	II	I	III		I	II	I	II					12
5													
6													
7													
8													
9													
30													
1													
2													
3													
4													
5													
6													
7													
8													
9													
TOTAL	15	11	12	15	18	14	15	7					107

1 of 2

Figure A4.3: Page 1 of completed data collection form for compartment 2.

CARBON ASSESSMENT DATA COLLECTION SHEET METHOD C

Section 3 - Details of height and diameter sample trees

No.	Species (code)	Dbh (cm)	Height (m)	Tariff no. (round to nearest)
1	CP	13	11·7	23
2	"	17	12·3	23
3	"	16	11	21
4	"	16	11·3	22
5	"	24	10·2	18
6	"	24	11·7	21
7	"	14	11·3	22
8	"	23	12·1	22
9	"	19	10·2	19
10	"	13	10·1	20
11	"	22	11·3	21
12	"	17	11·7	22
13	"	24	11·6	21
14	"	17	11·5	22
15	"	24	11·7	21
16	"	17	9·6	19
17				
18				
19				
20				
21				
22				
23				
24				
			Total:	337
			Mean tariff number: (Rounded down)	21

2 of 2

Figure A4.4: Page 2 of completed data collection form for compartment 2.

Appendix 5: Worked example for a small-scale broadleaf project

Carbon assessment protocol: Broadleaf project example

Description:

A 1.12 ha broadleaved woodland – *"Coed Glas"*, containing an intimate mixture of approximately 1400 stems of oak, ash and birch approximately 30 years old. Oak and ash are the major tree species, with birch making up less than 10% of the total number of tree stems. Ash and birch were therefore treated as one species group and oak as another.

Using the decision tree in Figure 4.1 (page 26) Method E was chosen to estimate the above ground "tree" carbon in the project.

Field work

Sampling fraction:

Oak = approximately 700 stems
Looking at Table 3.2.2 the recommended dbh sampling fraction is 1:6 and 1:10 of the dbh sample trees will be assessed as height sample trees. The diameter of every 6th tree was therefore measured and every 60th tree had timber height assessed.

Ash and birch = approximately 700 stems
Looking at Table 3.2.2 the recommended dbh sampling fraction is 1:6 and 1:10 of the dbh sample trees will be assessed as height sample trees. The diameter of every 6th tree was therefore measured and every 60th tree had timber height assessed.

The data collection form (see Appendix 7) was used to collect plot, dbh and height data for the two compartments/strata within the project containing trees. The completed forms are shown in Figures A5.1 to A5.3.

Office work and calculations

The following section follows the procedure set-out in Section 4.2.3, starting on page 44.

Seedlings:

There were no seedlings recorded. No further office work is therefore required for seedlings.

Saplings:

There were no saplings recorded. No further office work is therefore required for saplings.

Trees:

Total stem volume

See page 45.

a. Tariff numbers were estimated for each sample tree with a dbh of 10 cm or greater using Equation 2 on page 45 and the species-specific constants listed in Table 4.2.3 on the same page.

   For the oak component, the equation used is:

   $T = 5.88300 + (2.01230 \times h) + (-0.0054780 \times dbh) + (-0.0057397 \times dbh \times h)$

   Where T is the species-specific single tree Tariff number being calculated.

   Taking tree number 1 from Figure A5.1 on page 80 as an example:

   dbh = 17 cm
   timber height = 10.6 m

   $T = 5.88300 + (2.01230 \times 10.6) + (-0.0054780 \times 17) + (-0.0057397 \times 17 \times 10.6)$

   $T = 26.09$

   Single tree tariff numbers are always rounded to the nearest whole number. In this instance a Tariff number of 26 is recorded.

   The above calculation is repeated for each oak sample tree with a dbh of 10 cm or greater.

For the ash component, the corresponding single tree Tariff equation used is:

T = 9.16050 + (2.02560 × h) + (-0.0668420 × dbh) + (-0.0044172 × dbh × h)

Taking tree number 26 from Figure A5.1 on page 80 as an example:

dbh = 25 cm
timber height = 8.8 m

T = 9.16050 + (2.02560 × 8.8) + (-0.0668420 × 25) + (-0.0044172 × 25 × 8.8)

T = 24.34

Single tree tariff numbers are always rounded to the nearest whole number. In this instance a Tariff number 24 is recorded.

The above calculation is repeated for each ash sample tree with a dbh of 10 cm or greater.

b. The average tariff number is calculated for each species.

For the oak component of the stand, the average tariff number is:

235 ÷ 9 = 26.11

The average Tariff number is always rounded down and an average of 26 is therefore recorded for the oak.

For the ash component of the stand, the average tariff number is:

221 ÷ 9 = 24.56

The average Tariff number is always rounded down and an average of 24 is therefore recorded for the ash.

c. Calculation of the (quadratic) mean dbh for each species.

The number of trees in each centimetre dbh class for each species (based on adding together the values in each row) is shown in column (3) of Section 4 of the

data collection form (Figure A5.3). Multiplying the trees in each class (column 3) by the square of the dbh for each class (column 4) and then adding these results together for each class (total, column 5) and dividing by the number of trees measured gives a mean "squared" dbh of 217.5 for oak and 285.4 for ash. The square root of this value gives the mean (quadratic) dbh:

For the oak $\sqrt{217.5}$ = 14.7 cm

For the ash $\sqrt{285.4}$ = 16.9 cm

d. Calculate the mean merchantable volume for each species.

Firstly, the (quadratic) mean dbh is converted into the mean basal area for each species using the equation in Section 4.2.3.

Mean basal area (oak) = $\frac{\pi \times 14.7}{40000}$ = 0.017 m^2 (shown to 3 decimal points)

Mean basal area (ash) = $\frac{\pi \times 16.9}{40000}$ = 0.022 m^2 (shown to 3 decimal points)

The mean tree basal areas are used in Equation 5 in Section 4.2.3 in conjunction with the average tariff numbers estimated in step b in order to estimate the mean merchantable volume for each species.

Mean merchantable tree volume (oak) = $a_1 + (a_2 \times 0.017) = 0.104$ m^3

Mean merchantable tree volume (ash) = $a_1 + (a_2 \times 0.022) = 0.141$ m^3

where:

$a_1 = (0.0360541 \times 24) - (a_2 \times 0.118288)$
$a_2 = 0.315049301 \times (24 - 0.138763302)$

e. Estimate the mean total stem volume for each species. The mean total stem volume includes volume above 7 cm top diameter and is calculated by multiplying the appropriate factor given in Table 4.2.5 (page 44) by the mean merchantable volume calculated above.

Mean total stem volume (oak) = 0.104 × 1.05 = 0.1092 m^3 (unrounded).

Mean total stem volume (ash) = 0.141 × 1.03 = 0.14523 m^3 (unrounded).

f. Find the total estimated volume for each species by multiplying the unrounded mean total stem by the estimated total number of trees of that species.

Total estimated volume (oak) = 0.1092 m^3 × 678 trees = 74.0 m^3

Total estimated volume (ash) = 0.14523 m^3 × 630 trees = 91.5 m^3

Total biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the nominal specific gravity of the species (see Section 5.2.1):

For the oak, 74.0 m^3 × 0.56 = 41.44 oven dry tonnes.

For the ash, 91.5 m^3 × 0.53 = 48.50 oven dry tonnes.

Crown biomass per tree:

The quadratic mean dbh already calculated for the oak is 14.7 cm. The crown biomass (branches and foliage) is therefore estimated using Equation 6 (page 52) and the species-specific parameters for oak from Table 5.2.2 (page 52).

Crown biomass = $0.0000168513 \times 14.7^{2.4767}$ = 0.013114 oven dry tonnes

There is no crown biomass equation specifically calibrated for ash. The species mapping table for broadleaves (Table 5.2.6 on page 57) indicates that, for estimating crown biomass for ash, it is appropriate to use the species-specific parameters for oak. Substituting the quadratic mean diameter already estimated for ash component (16.9 cm) into Equation 6 (page 52) and mapping to the species-specific parameters for oak from Table 5.2.2 (page 52) therefore gives:

Crown biomass = $0.0000168513 \times 16.9^{2.4767}$ = 0.018524 oven dry tonnes

Total crown biomass in the stratum:

The total crown biomass in the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total oak crown biomass = 0.013114 ODT × 678 trees = 8.89 oven dry tonnes

Total ash crown biomass = 0.018524 ODT × 630 = 11.67 oven dry tonnes

Root biomass per tree:

There is currently only one set of species specific parameters applicable for use for the estimation of root biomass in broadleaved tree species (see Table 5.2.6 on page 57). However the calculation using Equation 8 (page 54) will need to be done separately for each species as the quadratic mean diameter differs (14.7 cm for the oak component, 16.9 cm for the ash component).

Root biomass per tree (oak) = $0.0000227 \times 14.7^{2.5}$ = 0.018807 oven dry tonnes

Root biomass per tree (ash) = $0.0000227 \times 16.9^{2.5}$ = 0.026653 oven dry tonnes

Total root biomass in the stratum:

The total root biomass in the stratum is estimated by multiplying the root biomass per tree by the estimated number of trees of the requisite species present in the stratum:

Total root biomass (oak) = 0.018807 × 678 = 12.75 oven dry tonnes.

Total root biomass (ash) = 0.026653 × 630 = 16.79 oven dry tonnes.

Total tree carbon in the stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass for the stem, crown and root components in the stratum and multiplying by 0.5:

Carbon in oak = (41.44 + 8.89 + 12.75) × 0.5 = 31.54 tonnes C (carbon).

Carbon in ash = (48.50 + 11.67 + 16.79) × 0.5 = 38.48 tonnes C (carbon).

For the project:

Total above ground tree carbon for the project:

This is the sum of the carbon estimates for all of the species in the project:

Total carbon = 31.54 + 38.48 = 70.02 tonnes C (carbon).

The estimated total carbon dioxide sequestered in the project is calculated as:

70.02 tonnes C × 44 ÷ 12 = **257 tCO_2e**

It is this final figure (257 tCO_2e) which should be reported under the Woodland Carbon Code.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD E

Section 1 – Basic Assessment Information

Woodland: COED GLAS **Compartment(s):** —
Species: OAK (OK), ASH (AH), BIRCH (BI) **Gross area (ha):** 1.2
Diameter sampling fraction: 1: 6 **Net area (ha):** 1.2
Height sampling fraction: 1: 10

Date measured: 15 SEPTEMBER 2010 **Measured by:** HOW NELSON

Section 2 – Details of height and diameter sample trees

N.B. For conifer species record total height; for broadleaved species record timber height and total height. Tariff number should be rounded to the nearest whole number, except where stated otherwise.

No.	Spp code	Dbh (cm)	H_{timb} (m)	H_{total} (m)	Tariff no.
1	OK	17	10.6	16.4	26
2	OK	8	1.4	12.4	—
3	OK	25	14.6	17.8	33
4	OK	19	12.5	16.5	30
5	OK	11	7.6	13.1	21
6	OK	15	9.7	14.2	24
7	OK	18	13.1	17.1	31
8	OK	12	10.0	15.2	25
9	OK	8	2.4	11.7	—
10	OK	15	6.7	10.2	19
11	OK	17	10.6	14.7	26
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
Total (by species group):					235
Mean tariff number: (Rounded down)					26

No.	Spp code	Dbh (cm)	H_{timb} (m)	H_{total} (m)	Tariff no.
26	AH	25	8.8	13.2	24
27	AH	23	11.5	17.4	30
28	AH	9	6.0	15.0	—
29	AH	17	10.0	13.9	28
30	BI	19	9.4	13.1	22
31	AH	25	8.8	17.6	24
32	BI	10	5.2	15.9	16
33	AH	18	8.2	13.0	24
34	AH	19	11.1	14.8	29
35	AH	18	8.2	13.9	24
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
Total (by species group):					221
Mean tariff number: (Rounded down)					24

Sheet 1 of 3

Figure A5.1: Page 1 of completed data collection form for Method E.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD E

Section 3 – Full tree tally

Species: OAK (OK)	**Species:** ASH (AH) (+ BIRCH)
Total number: 678	**Total number:** 630

Sheet 2 of 3

Figure A5.2: Page 2 of completed data collection form for Method E.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD E

Section 4 – Diameter distribution & calculation of mean basal area.

	Species: OAK (OK)				Species: ASH (AH)(+ BI)			
(1) Dbh	(2) tally	(3) n	(4) dbh²	(5) n×dbh²	(2) tally	(3) N	(4) dbh²	(5) n×dbh²
7	𝍸 II	7	49	343	II	2	49	98
8	𝍸 𝍸 𝍸	15	64	960	III	4	64	256
9	𝍸 I	6	81	486	IIII	4	81	324
10	IIII	4	100	400	𝍸 I	6	100	600
1	𝍸 I	6	121	726	II	2	121	242
2	𝍸 𝍸	10	144	1440	𝍸	5	144	720
3	𝍸 I	6	169	1014	𝍸 I	6	169	1014
4	II	3	196	588	𝍸 I	6	196	1176
5	𝍸 𝍸 I	11	225	2475	𝍸 II	7	225	1575
6	𝍸	5	256	1280	𝍸 III	8	256	2048
7	𝍸 𝍸 𝍸 III	18	289	5202	𝍸 𝍸 II	12	289	3468
8	III	4	324	1296	𝍸 III	9	324	2916
9	𝍸 I	6	361	2166	𝍸 𝍸 III	13	361	4693
0	IIII	4	400	1600	I	1	400	400
1	I	1	441	441	𝍸 I	6	441	2646
2	III	3	484	1452	II	2	484	968
3					III	4	529	2116
4								
5	I	1	625	625	𝍸 I	6	625	3750
6	II	2	676	1352	I	1	676	676
7	I	1	729	729				
8								
9								
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
0								
Col. totals (Σ)		113		24575		104		29686
Mean dbh² = Σ(5)÷ Σ(3)				217.5				285.4
Mean ba = n × mean dbh² ÷ 40000				0.01708 m²				0.02242 m²
Mean dbh = sqrt(mean dbh²)				14.7 cm				16.9 cm

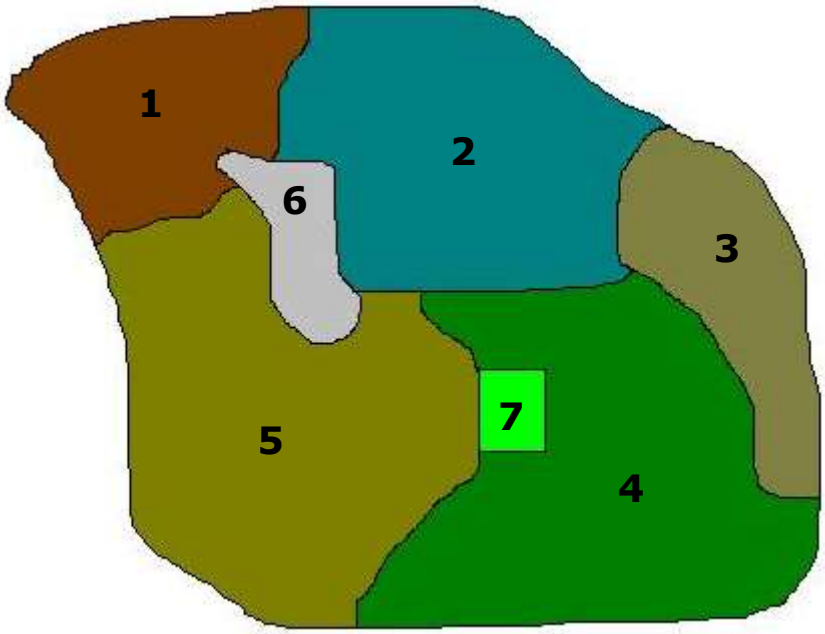
Sheet 3 of 3

Figure A5.3: Page 3 of completed data collection form for Method E.

Appendix 6: Worked example based on a large-scale project

Description:

A 300 ha woodland - *"Rob's Wood"*, is composed of seven compartments as detailed in the table below.



Stratification

The forest area was stratified using the methodology outlined in Section 3 (page 21). None of the 7 compartments were similar enough to any other compartment to allow them to be combined into a single stratum. The trees in compartments 1, 2, 3, and 6 are described as uniform and exhibit no differences large enough to require further stratification of these compartments. In compartment 4 there are three identified strata based on tree size. Compartments 5 and 7 each contain two strata based on species.

Table A6.1: Tree species composition – Rob's wood

Compartment	Species	YC	Planting year	Area (ha)	Stratum
1	BI	N/A	2003	25	I
2	SP	8	1970	50	II
3	WH	N/A	2010	40	III
4	OK	8	1878	31	IV
4	OK	6	1922	37	V
4	OK	8	1960	12	VI
5	SS	16	1984	37.5	VII
5	LP	6	1984	37.5	VIII
6	MB	12	2000	20	IX
7	AH	10	1986	5	X
7	NS	14	1958	5	XI

Using the decision tree in Figure 4.1 (page 26) the following methods were chosen for each stratum to estimate the above ground "tree" carbon in the project. Compartment 1 is comprised of saplings. Compartment 2 contains two distinct areas of pine. Compartment 3 is made up of seedlings. Compartment 4 is multi-storey. Compartment 5 is a line mixture. Compartment 6 is scrub. Compartment 7 is a closely monitored under-planting experiment of a potential future commercial planting mixture and therefore needs an accurate measurement.

Stratum	Method
I	Sapling
II	D
III	Seedling
IV	B
V	B
VI	B
VII	C
VIII	C
IX	B
X	A
XI	A

Pre-field work

Plot size required:

Stratum I: Saplings are treated differently to trees and require a circular plot of radius 5.6m (0.01 ha).

Stratum II: The row structure of the 1.8m initial planting space are still clearly visible. Using Table 4.1.3 (page 29) a rectangular plot of 3 rows at 1.8m spacing was selected to give a plot area of 0.01 ha and to contain between 7 and 20 trees.

Stratum III: Seedlings are treated differently to trees and require a circular plot of radius 5.6m (0.01 ha).

Stratum IV: The rows can no longer be seen as the stand is now mature and well thinned. A 17.6m radius circular plot (0.1 ha) was selected from Table 4.1.2.

Stratum V: Although not as old or tall as stratum IV the spacing between trees is approximately the same. A 17.6m radius circular plot (0.1 ha) ha will be used.

Stratum VI: Although not as old or tall as stratum V the spacing between trees is approximately the same. A 17.6m radius circular plot (0.1 ha) ha will be used.

Stratum VII: This is a line mix with stratum VIII at a 1.8m planting spacing. The rows are still clearly visible so using a rectangular plot of 4 rows at 1.8m spacing will give a plot area of 0.02 ha and contain between 7 and 20 trees.

Stratum VIII: This is a line mix with stratum VII at a 1.8m planting spacing. The rows are still clearly visible so a rectangular plot of 4 rows at 1.8m spacing will give a plot area of 0.01 ha and contain between 7 and 20 trees.

Stratum IX: This scrubby compartment contains a few scattered trees. A circular plot of 0.1 ha will be used.

Stratum X: The rows are still clearly visible for the original planting spacing of 1.5m. Using table 4.1.3 a rectangular plot of 3 rows at 1.5m spacing will give a plot area of 0.02 ha and contain between 7 and 20 trees.

Stratum XI: : This well maintained plot of NS initially planted at 2 m spacing has been well thinned to approximately 10 m spacing. A 0.1 ha square plot should contain between 7 and 20 trees.

Number of sample plots required:

Table 4.1.4 is used to estimate the number of sample plots required.

Stratum I = Uniform stand over 10 ha = 10 plots.
Stratum II = Uniform stand over 10 ha = 10 plots.
Stratum III = Uniform stand over 10 ha = 10 plots.
Stratum IV = Uniform stand over 10 ha = 10 plots.
Stratum V = Uniform stand over 10 ha = 10 plots.
Stratum VI = Uniform stand over 10 ha = 10 plots.
Stratum VII = Uniform stand over 10 ha = 10 plots**.**
Stratum VIII **=** Uniform stand over 10 ha = 10 plots.
Stratum IX = Uniform stand over 10 ha = 10 plots.
Stratum X = Uniform stand 2 - 10 ha = 8 plots.
Stratum XI = Uniform stand 2 - 10 ha = 8 plots.

Field work

Appropriate data collection forms (see Appendix 7) were used to collect plot, dbh and height data for the strata within the project containing trees. The completed forms are shown in Figures A6.1 to A6.21. Note that in methods B and C the height sample trees selected and record in Section 3 of the form are also recorded in Section 2. This is a useful check - if any of the diameters of the trees recorded in Section 3 of the form are not recorded in Section 2 the method has not been followed correctly.

Office work and calculations

Stratum I (containing only saplings):

Average height of saplings:

The total heights are shown in section 2 of the sapling data collection form (see Figure A6.1). There are 10 heights in total which add up to a total of 50.8 m. The arithmetic mean height is 5 m.

Number of saplings in stratum:

Total number of saplings in all (10) plots = 289

Area of all plots = 10 × 0.01 ha = 0.1 ha

Average number of saplings per hectare = 289/0.1 = 2890

Number of saplings in compartment = 2890 × 24 ha (net area) = 69360

Total above ground sapling carbon in stratum:

The mean sapling height of 5m is calculated in section 2 of the data form.

The mean carbon content per sapling derived from Table 6.1.3 (page 64) is 0.0015756 tonnes C (carbon)

The total carbon in the stratum is calculated by multiplying the mean carbon content of one sapling by the total number of saplings in the stratum:

0.0015756 x 69360 = 109.28 tonnes C (carbon).

Stratum II (using Method D):

Number of trees in stratum:

Total number of trees in all (10) plots = 169

Area of all plots = 10 × 0.01 ha = 0.1 ha

Average number of trees per hectare = 169/0.1 = 1690

Number of trees in compartment = 1690 × 45 ha (net area) = 76050

Mean (quadratic) dbh:

The number of trees in each dbh class in the stratum (based on adding together the values in each row) is shown in the right-most column of Section 2 of the data collection form (Figure A6.3). Multiplying the trees in each class by the square of the dbh for each class and then adding these results together for each class and dividing by the number of trees measured gives a mean "squared" dbh of 143.97. The square root of this value gives the mean (quadratic) dbh:

$\sqrt{143.97}$ = 11.9 cm

To calculate mean tree volume at a later stage the mean (quadratic) dbh was converted into the mean basal area using the equation in Section 4.1.5.

Mean basal area = $\frac{\pi \times 11.9^2}{40000}$ = 0.011 m^2 (shown to 3 decimal points)

Stand/stratum tariff number:

The sum of the total heights is 101m.

The arithmetic mean is the sum of the heights divided by the number of trees:

101/10 = 10.1 m. This is the top height.

The stand tariff number is calculated by entering the top height into Equation 4, described in Section 4.1.5. The parameters a1-a3 in the equation differ for each species. In this case, the parameters for Scots pine were selected.

The tariff number is 19.

Mean merchantable tree volume:

The mean tree volume is calculated using Equation 5 in Section 4.1.5 using the stand tariff number and the mean basal area (from mean quadratic dbh).

Mean merchantable tree volume = $a_1 + (a_2 \times 0.011) = 0.632\ m^3$

where:

$a_1 = (0.0360541 \times 19) - (a_2 \times 0.118288)$

$a_2 = 0.315049301 \times (19 - 0.138763302)$.

Mean total stem volume:

To calculate the mean total stem volume, including volume above 7 cm top diameter, the mean merchantable volume is multiplied by the factor given in Table 4.1.9 (page 40) for the appropriate mean (quadratic) dbh:

Mean total stem volume = 0.632 × 1.09 = 0.68888 m^3 (unrounded).

Total stem volume of the stratum:

The total stem volume of the stratum is estimated by multiplying the mean total stem volume (per tree) by the estimated number of trees in the stratum:

Total stem volume in stratum = 0.68888 × 76050 = 52389.3 m^3.

Total Biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the nominal specific gravity of the species (see Table 5.2.1):

52389.3 × 0.42 = 22003.51 oven dry tonnes.

Crown biomass per tree:

The crown biomass (branches and foliage) for trees between 7 cm and 50 cm dbh is estimated using Equation 6 (page52) with the appropriate species-specific parameters from Table 5.2.2 (page 52). So, for Scots pine with quadratic mean dbh 11.9 cm, the estimated crown biomass per tree is:

Crown biomass = $0.0000161411 \times 11.9^{2.4767}$ = 0.007443 oven dry tonnes

Total crown biomass of the stratum:

The total crown biomass of the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total crown biomass = 0.007443 × 76050 = 566.04 oven dry tonnes.

Root biomass per tree:

The root biomass for trees up to and including 30 cm dbh is estimated using Equation 8 (page 54) with the appropriate species-specific parameter from Table 5.2.4 (page 54). So, for Scots pine with quadratic mean dbh 11.9 cm, estimated root biomass per tree is:

Root biomass = $0.000015404 \times 11.9^{2.5}$ = 0.007525 oven dry tonnes.

Total root biomass of the stratum:

The total root biomass of the stratum is estimated by multiplying the root biomass (per tree) by the estimated number of trees in the stratum:

Total root biomass = 0.007525 × 76050 = 572.28 oven dry tonnes.

Total tree carbon in stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass from the stem, crown and root components in the stratum and multiplying by 0.5:

(22003.51 + 566.04 + 572.28) × 0.5 = 11570.92 tonnes C (carbon).

Stratum III (containing only seedlings):

Average height of seedlings:

The total heights are shown in section 2 of the seedling data collection form (Figure A6.4). There are 10 heights in total which add up to a total of 288 cm. The arithmetic mean height is 28.8 cm.

Number of seedlings in stratum:

Total number of seedlings in all (10) plots = 305

Area of all plots = 10 × 0.01 ha = 0.1 ha

Average number of seedlings per hectare = 305/0.1 = 3050

Number of trees in compartment = 3050 × 34 ha (net area) = 103700

Total above ground seedling carbon in stratum:

The mean carbon content of 1000 seedlings derived from Table 6.1.2 (page 63) is 0.0046951 tonnes C (carbon)

The total seedling carbon in the stratum is calculated by multiplying the mean carbon content of 1000 seedlings by the total number of seedlings in the stratum divided by 1000:

0.0046951 × (103700/1000) = 0.487 tonnes C (carbon).

Stratum IV (using Method B):

Number of trees in stratum:

Total number of trees in all (10) plots = 75

Area of all plots = 10 × 0.1 ha = 1 ha

Average number of trees per hectare = 75/1 = 75

Number of trees in compartment = 75 × 26 ha (net area) = 1950

Mean (quadratic) dbh:

The number of trees in each dbh class in the stratum (based on adding together the values in each row) is shown in the right-most column of Section 2 of the data collection form (Figure A6.6). Multiplying the trees in each class by the square of the dbh for each class and then adding these results together for each class and dividing by the number of trees measured gives a mean "squared" dbh of 4371.56. The square root of this value gives the mean (quadratic) dbh:

$\sqrt{4371.56}$ = 66.1 cm

To calculate mean tree volume at a later stage the mean (quadratic) dbh was converted into the mean basal area using the equation in Section 4.1.5.

mean basal area = $\frac{\pi \times 66.1^2}{40000}$ = 0.343 m^2 (shown to 3 decimal points)

Stand/stratum tariff number:

The stand tariff number is the rounded down mean of the single tree tariff numbers of each height sample tree recorded in Section 3 of the data collection form. The tariff number for each tree is calculated by entering the dbh and height measurements of each tree into Equation 3, described in Section 4.1.5. The parameters a1-a3 in the equation differ for each species. In this case, the parameters for oak were selected. The results of each calculation should be rounded to the nearest whole tariff number and were entered in to the right-most column of Section 3 of the data collection form. The next step was to add all of the individual tariff numbers for the stratum together, which gave a total of 1166

1166 ÷ 20 = 58.3 rounded down to a stand tariff number of 58.

Mean merchantable tree volume:

The mean tree volume is calculated using Equation 5 in Section 4.1.5 using the stand tariff number and the mean basal area (from mean quadratic dbh).

Mean merchantable tree volume = $a_1 + (a_2 \times 0.343) = 8.255$ m^3

where:

$a_1 = (0.0360541 \times 58) - (a_2 \times 0.118288)$

$a_2 = 0.315049301 \times (58 - 0.138763302)$.

Mean total stem volume:

To calculate the mean total stem volume, including volume above 7 cm top diameter, the mean merchantable volume is multiplied by the factor given in Table 4.1.9 (page 40) for the appropriate mean (quadratic) dbh:

Mean total stem volume = 8.255 × 1.00 = 8.255 m^3 (unrounded).

Total stem volume of the stratum:

The total stem volume of the stratum is estimated by multiplying the mean total stem volume (per tree) by the estimated number of trees in the stratum:

Total stem volume in stratum = 8.255 × 1950 = 16097.25 m^3.

Total Biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the nominal specific gravity of the species (see Table 5.2.1):

16097.25 × 0.56 = 9014.46 oven dry tonnes.

Crown biomass per tree:

The crown biomass (branches and foliage) for trees greater than 50 cm dbh is estimated using Equation 7 (page 53) with the appropriate species-specific parameters from Table 5.2.3 (page 53). So, for oak with quadratic mean dbh 66.1 cm, the estimated crown biomass per tree is:

Crown biomass = -0.411550464 + 0.013669801 × 66.1 = 0.492023 oven dry tonnes

Total crown biomass of the stratum:

The total crown biomass of the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total crown biomass = 0.492023 × 1950 = 959.44 oven dry tonnes.

Root biomass per tree:

There is currently only one set of species specific parameters applicable for use for the estimation of root biomass in broadleaved tree species (see Table 5.2.6 on page 57). The root biomass for broadleaved trees greater than 30 cm dbh is estimated using Equation 9 (page 55) with the species-specific parameter for red alder from Table 5.2.5 (page 55). So, for oak with quadratic mean dbh 66.1 cm, estimated root biomass per tree is:

Root biomass = -0.174882004 + 0.009559391 x 66.1 = 0.456994 oven dry tonnes.

Total root biomass of the stratum:

The total root biomass of the stratum is estimated by multiplying the root biomass (per tree) by the estimated number of trees in the stratum:

Total root biomass = 0.456994 × 1950 = 891.14 oven dry tonnes.

Total tree carbon in stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass from the stem, crown and root components in the stratum and multiplying by 0.5:

(9014.46 + 959.44 + 891.14) × 0.5 = 5432.52 tonnes C (carbon).

Stratum V (using Method B):

Number of trees in stratum:

Total number of trees in all (10) plots = 194

Area of all plots = 10 × 0.1 ha = 1 ha

Average number of trees per hectare = 194/1 = 194

Number of trees in compartment = 194 × 32 ha (net area) = 6208

Mean (quadratic) dbh:

The number of trees in each dbh class in the stratum (based on adding together the values in each row) is shown in the right-most column of Section 2 of the data collection form (Figure A6.8). Multiplying the trees in each class by the square of the dbh for each class and then adding these results together for each class and dividing by the number of trees measured gives a mean "squared" dbh of 1530. The square root of this value gives the mean (quadratic) dbh:

$\sqrt{1530}$ = 39.12 cm

To calculate mean tree volume at a later stage the mean (quadratic) dbh was converted into the mean basal area using the equation in Section 4.1.5.

$$\text{mean basal area} = \frac{\pi \times 39.12^2}{40000} = 0.120 \text{ m}^2 \text{ (shown to 3 decimal points)}$$

Stand/stratum tariff number:

The stand tariff number is the rounded down mean of the single tree tariff numbers of each height sample tree recorded in Section 3 of the data collection form. The tariff number for each tree is calculated by entering the dbh and height measurements of each tree into Equation 3, described in Section 4.1.5. The parameters a1-a3 in the equation differ for each species. In this case, the parameters for oak were selected. The results of each calculation should be rounded to the nearest whole tariff number and were entered in to the right-most column of Section 3 of the data collection form. The next step was to add all of the individual tariff numbers for the stratum together, which gave a total of 984.

984 ÷ 20 = 49.2 rounded down to a stand tariff number of 49.

Mean merchantable tree volume:

The mean tree volume is calculated using Equation 5 in Section 4.1.5. Based on the stand tariff number and the mean basal area (from mean quadratic dbh).

Mean merchantable tree volume = $a_1 + (a_2 \times 0.120) = 1.793$ m^3

where:

$a_1 = (0.0360541 \times 49) - (a_2 \times 0.118288)$

$a_2 = 0.315049301 \times (49 - 0.138763302)$.

Mean total stem volume:

To calculate the mean total stem volume, including volume above 7 cm top diameter, the mean merchantable volume is multiplied by the factor given in Table 4.1.9 (page 40) for the appropriate mean (quadratic) dbh:

Mean total stem volume = $1.793 \times 1.00 = 1.793$ m^3 (unrounded).

Total stem volume of the stratum:

The total stem volume of the stratum is estimated by multiplying the mean total stem volume (per tree) by the estimated number of trees in the stratum:

Total stem volume in stratum = $1.793 \times 6208 = 11130.94$ m^3.

Total Biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the nominal specific gravity of the species (see Table 5.2.1):

$11130.94 \times 0.56 = 6233.33$ oven dry tonnes.

Crown biomass per tree:

The crown biomass (branches and foliage) for trees between 7 cm and 50 cm dbh is estimated using Equation 6 (page52) with the appropriate species-specific parameters from Table 5.2.2 (page 52). So, for oak with quadratic mean dbh 39.12 cm, the estimated crown biomass per tree is:

Crown biomass = $0.0000168513 \times 39.12^{2.4767} = 0.148091$ oven dry tonnes

Total crown biomass of the stratum:

The total crown biomass of the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total crown biomass = 0.148091 × 6208 = 919.35 oven dry tonnes.

Root biomass per tree:

There is currently only one set of species specific parameters applicable for use for the estimation of root biomass in broadleaved tree species (see Table 5.2.6 on page 57). The root biomass for broadleaved trees greater than 30 cm dbh is estimated using Equation 9 (page 55) with the species-specific parameter for red alder from Table 5.2.5 (page 55). So, for oak with quadratic mean dbh 39.12 cm, estimated root biomass per tree is:

Root biomass = -0.174882004 + 0.009559391 x 39.12 = 0.199081 oven dry tonnes.

Total root biomass of the stratum:

The total root biomass of the stratum is estimated by multiplying the root biomass (per tree) by the estimated number of trees in the stratum:

Total root biomass = 0.199081 × 6208 = 1235.89 oven dry tonnes.

Total tree carbon in stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass from the stem, crown and root components in the stratum and multiplying by 0.5:

(6233.33 + 919.35 + 1235.89) × 0.5 = 4194.285 tonnes C (carbon).

Stratum VI:

Number of trees in stratum:

Total number of trees in all (10) plots = 160

Area of all plots = 10 × 0.1 ha = 1 ha

Average number of trees per hectare = 160/1 = 160

Number of trees in compartment = 160 × 10.2 ha (net area) = 1632

Mean (quadratic) dbh:

The number of trees in each dbh class in the stratum (based on adding together the values in each row) is shown in the right-most column of Section 2 of the data collection form (Figure A6.10). Multiplying the trees in each class by the square of the dbh for each class and then adding these results together for each class and dividing by the number of trees measured gives a mean "squared" dbh of 628.6. The square root of this value gives the mean (quadratic) dbh:

$\sqrt{628.6}$ = 25.07 cm

To calculate mean tree volume at a later stage the mean (quadratic) dbh was converted into the mean basal area using the equation in Section 4.1.5

$$\text{mean basal area} = \frac{\pi \times 25.07^2}{40000} = 0.049 \text{ m}^2 \text{ (shown to 3 decimal points)}$$

Stand/stratum tariff number:

The stand tariff number is the rounded down mean of the single tree tariff numbers of each height sample tree recorded in Section 3 of the data collection form. The tariff number for each tree is calculated by entering the dbh and height measurements of each tree into the equation described in Section 4.1.5. The parameters a1-a3 in the equation differ for each species. In this case, the parameters for oak were selected. The results of each calculation should be rounded to the nearest whole tariff number and were entered in to the right-most column of Section 3 of the data collection form. The next step was to add all of the individual tariff numbers for the stratum together, which gave a total of 909.

909 ÷ 20 = 45.45 rounded down to a stand tariff number of 45.

Mean merchantable tree volume:

The mean tree volume is calculated using Equation 5 in Section 4.1.5 using the stand tariff number and the mean basal area (from mean quadratic dbh).

Mean merchantable tree volume = $a_1 + (a_2 \times 0.049) = 0.643$ m^3

where:

$a_1 = (0.0360541 \times 45) - (a_2 \times 0.118288)$

$a_2 = 0.315049301 \times (45 - 0.138763302)$.

Mean total stem volume:

To calculate the mean total stem volume, including volume above 7 cm top diameter, the mean merchantable volume is multiplied by the factor given in Table 4.1.9 (page 40) for the appropriate mean (quadratic) dbh:

Mean total stem volume = 0.643 × 1.01 = 0.649 m^3 (unrounded).

Total stem volume of the stratum:

The total stem volume of the stratum is estimated by multiplying the mean total stem volume (per tree) by the estimated number of trees in the stratum:

Total stem volume in stratum = 0.649 × 1632 = 1059.87 m^3.

Total Biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the nominal specific gravity of the species (see Table 5.2.1):

1059.87 × 0.56 = 593.53 oven dry tonnes.

Crown biomass per tree:

The crown biomass (branches and foliage) for trees between 7 cm and 50 cm dbh is estimated using Equation 6 (page52) with the appropriate species-specific parameters from Table 5.2.2 (page 52). So, for oak with quadratic mean dbh 25.07 cm, the estimated crown biomass per tree is:

Crown biomass = $0.0000168513 \times 25.07^{2.4767} = 0.049195$ oven dry tonnes

Total crown biomass of the stratum:

The total crown biomass of the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total crown biomass = 0.049195 × 1632 = 80.29 oven dry tonnes.

Root biomass per tree:

There is currently only one set of species specific parameters applicable for use for the estimation of root biomass in broadleaved tree species (see Table 5.2.6 on page 57). The root biomass for broadleaved trees up to and including 30 cm dbh is estimated using Equation 8 (page 54) with the species-specific parameter for red alder from Table 5.2.4 (page 54). So, for oak with quadratic mean dbh 25.07 cm, estimated root biomass per tree is:

Root biomass = $0.0000227 \times 25.07^{2.5}$ = 0.071435 oven dry tonnes.

Total root biomass of the stratum:

The total root biomass of the stratum is estimated by multiplying the root biomass (per tree) by the estimated number of trees in the stratum:

Total root biomass = 0.071435 × 1632 = 116.58 oven dry tonnes.

Total tree carbon in stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass from the stem, crown and root components in the stratum and multiplying by 0.5:

(593.53 + 80.29 + 116.58) × 0.5 = 395.2 tonnes C (carbon).

Stratum VII (using Method C):

Number of trees in stratum:

Total number of trees in all (10) plots = 95

Area of all plots = 10 × 0.02 ha = 0.2 ha

Average number of trees per hectare = 95/0.2 = 475

Number of trees in compartment = 475 × 32 ha (net area) = 15200

Mean (quadratic) dbh:

The number of trees in each dbh class in the stratum (based on adding together the values in each row) is shown in the right-most column of Section 2 of the data collection form (Figure A6.12). Multiplying the trees in each class by the square of the dbh for each class and then adding these results together for each class and dividing by the number of trees measured gives a mean "squared" dbh of 375.5. The square root of this value gives the mean (quadratic) dbh:

$\sqrt{375.5}$ = 19.38 cm

To calculate mean tree volume at a later stage the mean (quadratic) dbh was converted into the mean basal area using the equation in Section 4.1.5

$$\text{mean basal area} = \frac{\pi \times 19.38^2}{40000} = 0.029 \text{ m}^2 \text{ (shown to 3 decimal points)}$$

Stand/stratum tariff number:

The stand tariff number is the rounded down mean of the single tree tariff numbers of each height sample tree recorded in Section 3 of the data collection form. The tariff number for each tree is calculated by entering the dbh and height measurements of each tree into the equation described in Section 4.1.5. The parameters a1-a3 in the equation differ for each species. In this case, the parameters for Sitka spruce were selected. The results of each calculation should be rounded to the nearest whole tariff number and were entered in to the right-most column of Section 3 of the data collection form. The next step was to add all of the individual tariff numbers for the stratum together, which gave a total of 495.

495 ÷ 20 = 24.75 rounded down to a stand tariff number of 24.

Mean merchantable tree volume:

The mean tree volume is calculated using Equation 5 in Section 4.1.5 using the stand tariff number and the mean basal area (from mean quadratic dbh).

Mean merchantable tree volume = $a_1 + (a_2 \times 0.029) = 0.194$ m^3

where:

$a_1 = (0.0360541 \times 24) - (a_2 \times 0.118288)$

$a_2 = 0.315049301 \times (24 - 0.138763302)$.

Mean total stem volume:

To calculate the mean total stem volume, including volume above 7 cm top diameter, the mean merchantable volume is multiplied by the factor given in Table 4.1.9 (page 40) for the appropriate mean (quadratic) dbh:

Mean total stem volume = $0.194 \times 1.01 = 0.196$ m^3 (unrounded).

Total stem volume of the stratum:

The total stem volume of the stratum is estimated by multiplying the mean total stem volume (per tree) by the estimated number of trees in the stratum:

Total stem volume in stratum = $0.196 \times 15200 = 2978.29$ m^3.

Total Biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the nominal specific gravity of the species (see Table 5.2.1):

$2978.29 \times 0.33 = 982.84$ oven dry tonnes.

Crown biomass per tree:

The crown biomass (branches and foliage) for trees between 7 cm and 50 cm dbh is estimated using Equation 6 (page52) with the appropriate species-specific parameters from Table 5.2.2 (page 52). So, for Sitka spruce with quadratic mean dbh 19.38 cm, the estimated crown biomass per tree is

Crown biomass = $0.0000144620 \times 19.38^{2.4767} = 0.022316$ oven dry tonnes

Total crown biomass of the stratum:

The total crown biomass of the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total crown biomass = 0.022316 × 15200 = 339.20 oven dry tonnes.

Root biomass per tree:

The root biomass for trees up to and including 30 cm dbh is estimated using Equation 8 (page 54) with the appropriate species-specific parameter from Table 5.2.4 (page 54). So, for Sitka spruce with quadratic mean dbh 19.38 cm, estimated root biomass per tree is:

Root biomass = $0.000020454 \times 11.9^{2.5}$ = 0.033819 oven dry tonnes.

Total root biomass of the stratum:

The total root biomass of the stratum is estimated by multiplying the root biomass (per tree) by the estimated number of trees in the stratum:

Total root biomass = 0.033819 × 15200 = 514.05 oven dry tonnes.

Total tree carbon in stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass from the stem, crown and root components in the stratum and multiplying by 0.5:

(982.84 + 339.20 + 514.05) × 0.5 = 918.045 tonnes C (carbon).

Stratum VIII (using Method C):

Number of trees in stratum:

Total number of trees in all (10) plots = 138

Area of all plots = 10 × 0.01 ha = 0.1 ha

Average number of trees per hectare = 138/0.1 = 1380

Number of trees in compartment = 1380 × 32 ha (net area) = 44160

Mean (quadratic) dbh:

The number of trees in each dbh class in the stratum (based on adding together the values in each row) is shown in the right-most column of Section 2 of the data collection form (Figure A6.14). Multiplying the trees in each class by the square of the dbh for each class and then adding these results together for each class and dividing by the number of trees measured gives a mean "squared" dbh of 124.5. The square root of this value gives the mean (quadratic) dbh:

$\sqrt{124.5}$ = 11.16 cm

To calculate mean tree volume at a later stage the mean (quadratic) dbh was converted into the mean basal area using the equation in Section 4.1.5

$$\text{mean basal area} = \frac{\pi \times 11.16^2}{40000} = 0.010 \text{ m}^2 \text{ (shown to 3 decimal points)}$$

Stand/stratum tariff number:

The stand tariff number is the rounded down mean of the single tree tariff numbers of each height sample tree recorded in Section 3 of the data collection form. The tariff number for each tree is calculated by entering the dbh and height measurements of each tree into the equation described in Section 4.1.5. The parameters a1-a3 in the equation differ for each species. In this case, the parameters for lodgepole pine were selected. The results of each calculation should be rounded to the nearest whole tariff number and were entered in to the right-most column of Section 3 of the data collection form. The next step was to add all of the individual tariff numbers for the stratum together, which gave a total of 323.

323 ÷ 20 = 16.15 rounded down to a stand tariff number of 16.

Mean merchantable tree volume:

The mean tree volume is calculated using Equation 5 in Section 4.1.5 using the stand tariff number and the mean basal area (from mean quadratic dbh).

Mean merchantable tree volume = $a_1 + (a_2 \times 0.01) = 0.036$ m^3

where:

$a_1 = (0.0360541 \times 16) - (a_2 \times 0.118288)$

$a_2 = 0.315049301 \times (16 - 0.138763302)$.

Mean total stem volume:

To calculate the mean total stem volume, including volume above 7 cm top diameter, the mean merchantable volume is multiplied by the factor given in Table 4.1.9 (page 40) for the appropriate mean (quadratic) dbh:

Mean total stem volume = $0.036 \times 1.09 = 0.039$ m^3 (unrounded).

Total stem volume of the stratum:

The total stem volume of the stratum is estimated by multiplying the mean total stem volume (per tree) by the estimated number of trees in the stratum:

Total stem volume in stratum = $0.039 \times 44160 = 1732.83$ m^3.

Total Biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the nominal specific gravity of the species (see Table 5.2.1):

$1732.83 \times 0.39 = 675.81$ oven dry tonnes.

Crown biomass per tree:

The crown biomass (branches and foliage) for trees between 7 cm and 50 cm dbh is estimated using Equation 6 (page52) with the appropriate species-specific parameters from Table 5.2.2 (page 52). So, for lodgepole pine with quadratic mean dbh 11.16 cm, the estimated crown biomass per tree is

Crown biomass = $0.0000176287 \times 11.16^{2.4767} = 0.006934$ oven dry tonnes

Total crown biomass of the stratum:

The total crown biomass of the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total crown biomass = 0.006934 × 44160 = 306.21 oven dry tonnes.

Root biomass per tree:

The root biomass for trees up to and including 30 cm dbh is estimated using Equation 8 (page 54) with the appropriate species-specific parameter from Table 5.2.4 (page 54). So, for lodgepole pine with quadratic mean dbh 11.16 cm, estimated root biomass per tree is:

Root biomass = $0.000017326 \times 11.16^{2.5} = 0.007209$ oven dry tonnes.

Total root biomass of the stratum:

The total root biomass of the stratum is estimated by multiplying the root biomass (per tree) by the estimated number of trees in the stratum:

Total root biomass = 0.007209 × 44160 = 318.35 oven dry tonnes.

Total tree carbon in stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass from the stem, crown and root components in the stratum and multiplying by 0.5:

(1732.83 + 306.21 + 318.35) × 0.5 = 1178.695 tonnes C (carbon).

Stratum IX (using Method B):

Number of trees in stratum:

Total number of trees in all (10) plots = 89

Area of all plots = 10 × 0.1 ha = 1 ha

Average number of trees per hectare = 89/1 = 89

Number of trees in compartment = 89 × 17 ha (net area) = 1513

Mean (quadratic) dbh:

The number of trees in each dbh class in the stratum (based on adding together the values in each row) is shown in the right-most column of Section 2 of the data collection form (Figure A6.16). Multiplying the trees in each class by the square of the dbh for each class and then adding these results together for each class and dividing by the number of trees measured gives a mean "squared" dbh of 65. The square root of this value gives the mean (quadratic) dbh:

$\sqrt{65}$ = 8.06 cm

To calculate mean tree volume at a later stage the mean (quadratic) dbh was converted into the mean basal area using the equation in Section 4.1.5

mean basal area = $\frac{\pi \times 8.06^2}{40000}$ = 0.005 m^2 (shown to 3 decimal points)

Stand/stratum tariff number:

The stand tariff number is the rounded down mean of the single tree tariff numbers of each height sample tree recorded in Section 3 of the data collection form. The tariff number for each tree is calculated by entering the dbh and height measurements of each tree into the equation described in Section 4.1.5. The parameters a1-a3 in the equation differ for each species. In this case, the parameters for mixed broadleaves were selected. The results of each calculation should be rounded to the nearest whole tariff number and were entered in to the right-most column of Section 3 of the data collection form. The next step was to add all of the individual tariff numbers for the stratum together, which gave a total of 511.

511 ÷ 20 = 25.55 rounded down to a stand tariff number of 25.

Mean merchantable tree volume:

The mean tree volume is calculated using Equation 5 in Section 4.1.5 using the stand tariff number and the mean basal area (from mean quadratic dbh).

Mean merchantable tree volume = $a_1 + (a_2 \times 0.005) = 0.014$ m^3

where:

$a_1 = (0.0360541 \times 25) - (a_2 \times 0.118288)$

$a_2 = 0.315049301 \times (25 - 0.138763302)$.

Mean total stem volume:

To calculate the mean total stem volume, including volume above 7 cm top diameter, the mean merchantable volume is multiplied by the factor given in Table 4.1.9 (page 40) for the appropriate mean (quadratic) dbh:

Mean total stem volume = $0.014 \times 1.19 = 0.017$ m^3 (rounded).

Total stem volume of the stratum:

The total stem volume of the stratum is estimated by multiplying the mean total stem volume (per tree) by the estimated number of trees in the stratum:

Total stem volume in stratum = $0.017 \times 1513 = 25.72$ m^3.

Total Biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the average nominal specific gravity of the species (see Table 5.2.1):

$25.72 \times 0.52 = 13.37$ oven dry tonnes.

Crown biomass per tree:

The crown biomass (branches and foliage) for trees between 7 cm and 50 cm dbh is estimated using Equation 6 (page52) with the appropriate species-specific parameters from Table 5.2.2 (page 52). So, for mixed broadleaves (mapped to oak) with quadratic mean dbh 8.06 cm, the estimated crown biomass per tree is:

Crown biomass = $0.0000168513 \times 8.06^{2.4767} = 0.002960$ oven dry tonnes

Total crown biomass of the stratum:

The total crown biomass of the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total crown biomass = 0.002960 × 1513 = 4.48 oven dry tonnes.

Root biomass per tree:

There is currently only one set of species specific parameters applicable for use for the estimation of root biomass in broadleaved tree species (see Table 5.2.6 on page 57). The root biomass for broadleaved trees up to and including 30 cm dbh is estimated using Equation 8 (page 54) with the species-specific parameter for red alder from Table 5.2.4 (page 54). So, for mixed broadleaves with quadratic mean dbh 8.06 cm, estimated root biomass per tree is:

Root biomass = $0.000022700 \times 8.06^{2.5} = 0.004187$ oven dry tonnes.

Total root biomass of the stratum:

The total root biomass of the stratum is estimated by multiplying the root biomass (per tree) by the estimated number of trees in the stratum:

Total root biomass = 0.004187 × 1513 = 6.33 oven dry tonnes.

Total tree carbon in stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass from the stem, crown and root components in the stratum and multiplying by 0.5:

(25.72 + 4.48 + 6.33) × 0.5 = 18.265 tonnes C (carbon).

Stratum X (using Method A):

Number of trees in stratum:

Total number of trees in all (8) plots = 80

Area of all plots = 8 × 0.02 ha = 0.16 ha

Average number of trees per hectare = 80/0.16 = 500

Number of trees in compartment = 500 × 4.5 ha (net area) = 2250

Mean (quadratic) dbh:

The number of trees in each dbh class in the stratum (based on adding together the values in each row) is shown in the right-most column of Section 2 of the data collection form (Figure A6.18). Multiplying the trees in each class by the square of the dbh for each class and then adding these results together for each class and dividing by the number of trees measured gives a mean "squared" dbh of 444.8. The square root of this value gives the mean (quadratic) dbh:

$\sqrt{444.8}$ = 21.09 cm

To calculate mean tree volume at a later stage the mean (quadratic) dbh was converted into the mean basal area using the equation in Section 4.1.5

$$\text{mean basal area} = \frac{\pi \times 21.09^2}{40000} = 0.035 \text{ m}^2 \text{ (shown to 3 decimal points)}$$

Stand/stratum tariff number:

The stand tariff number is the rounded down mean of the single tree tariff numbers of each height sample tree recorded in Section 3 of the data collection form. The tariff number for each tree is calculated by entering the dbh and height measurements of each tree into the equation described in Section 4.1.5. The results of each calculation should be rounded to the nearest whole tariff number and were entered in to the right-most column of Section 3 of the data collection form. The next step was to add all of the individual tariff numbers for the stratum together, which gave a total of 372.

372 ÷ 16 = 23.25 rounded down to a stand tariff number of 23.

Mean merchantable tree volume:

The mean tree volume is calculated using Equation 5 in Section 4.1.5 using the stand tariff number and the mean basal area (from mean quadratic dbh).

Mean merchantable tree volume = $a_1 + (a_2 \times 0.035) = 0.229$ m^3

where:

$a_1 = (0.0360541 \times 23) - (a_2 \times 0.118288)$

$a_2 = 0.315049301 \times (23 - 0.138763302)$.

Mean total stem volume:

To calculate the mean total stem volume, including volume above 7 cm top diameter, the mean merchantable volume is multiplied by the factor given in Table 4.1.9 (page 40) for the appropriate mean (quadratic) dbh:

Mean total stem volume = $0.229 \times 1.02 = 0.234$ m^3 (rounded).

Total stem volume of the stratum:

The total stem volume of the stratum is estimated by multiplying the mean total stem volume (per tree) by the estimated number of trees in the stratum:

Total stem volume in stratum = $0.234 \times 2250 = 526.5$ m^3.

Total Biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the average nominal specific gravity of the species (see Table 5.2.1):

$526.5 \times 0.53 = 279.05$ oven dry tonnes.

Crown biomass per tree:

The crown biomass (branches and foliage) for trees between 7 cm and 50 cm dbh is estimated using Equation 6 (page52) with the appropriate species-specific parameters from Table 5.2.2 (page 52). So, for ash (mapped to oak, see Table 5.2.6 on page 57) with quadratic mean dbh 21.09 cm, the estimated crown biomass per tree is:

Crown biomass = $0.0000168513 \times 21.09^{2.4767} = 0.032061$ oven dry tonnes

Total crown biomass of the stratum:

The total crown biomass of the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total crown biomass = 0.041 × 2250 = 72.14 oven dry tonnes.

Root biomass per tree:

There is currently only one set of species specific parameters applicable for use for the estimation of root biomass in broadleaved tree species (see Table 5.2.6 on page 57). The root biomass for broadleaved trees up to and including 30 cm dbh is estimated using Equation 8 (page 54) with the species-specific parameter for red alder from Table 5.2.4 (page 54). So, for ash with quadratic mean dbh 21.09 cm, estimated root biomass per tree is:

Root biomass = $0.000022700 \times 21.09^{2.5} = 0.046368$ oven dry tonnes.

Total root biomass of the stratum:

The total root biomass of the stratum is estimated by multiplying the root biomass (per tree) by the estimated number of trees in the stratum:

Total root biomass = 0.046368 × 2250 = 104.33 oven dry tonnes.

Total tree carbon in stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass from the stem, crown and root components in the stratum and multiplying by 0.5:

(279.05 + 72.14 + 104.33) × 0.5 = 227.76 tonnes C (carbon).

Stratum XI (using Method A):

Number of trees in stratum:

Total number of trees in all (8) plots = 78

Area of all plots = 8 × 0.1 ha = 0.8 ha

Average number of trees per hectare = 78/0.8 = 97.5

Number of trees in compartment = 97.5 × 4.5 ha (net area) = 438.75

Mean (quadratic) dbh:

The number of trees in each dbh class in the stratum (based on adding together the values in each row) is shown in the right-most column of Section 2 of the data collection form (Figure A6.20). Multiplying the trees in each class by the square of the dbh for each class and then adding these results together for each class and dividing by the number of trees measured gives a mean "squared" dbh of 1229.56. The square root of this value gives the mean (quadratic) dbh:

$\sqrt{1229.56}$ = 35.07 cm

To calculate mean tree volume at a later stage the mean (quadratic) dbh was converted into the mean basal area using the equation in Section 4.1.5

$$\text{mean basal area} = \frac{\pi \times 35.07^2}{40000} = 0.097 \text{ m}^2 \text{ (shown to 3 decimal points)}$$

Stand/stratum tariff number:

The stand tariff number is the rounded down mean of the single tree tariff numbers of each height sample tree recorded in Section 3 of the data collection form. The tariff number for each tree is calculated by entering the dbh and height measurements of each tree into the equation described in Section 4.1.5. The results of each calculation should be rounded to the nearest whole tariff number and were entered in to the right-most column of Section 3 of the data collection form. The next step was to add all of the individual tariff numbers for the stratum together, which gave a total of 529.

529 ÷ 16 = 33.06 rounded down to a stand tariff number of 33.

Mean merchantable tree volume:

The mean tree volume is calculated using Equation 5 in Section 4.1.5 using the stand tariff number and the mean basal area (from mean quadratic dbh).

Mean merchantable tree volume = $a_1 + (a_2 \times 0.097) = 0.969$ m^3

where:

$a_1 = (0.0360541 \times 33) - (a_2 \times 0.118288)$

$a_2 = 0.315049301 \times (33 - 0.138763302)$.

Mean total stem volume:

To calculate the mean total stem volume, including volume above 7 cm top diameter, the mean merchantable volume is multiplied by the factor given in Table 4.1.9 (page 40) for the appropriate mean (quadratic) dbh:

Mean total stem volume = $0.969 \times 1.00 = 0.969$ m^3 (rounded).

Total stem volume of the stratum:

The total stem volume of the stratum is estimated by multiplying the mean total stem volume (per tree) by the estimated number of trees in the stratum:

Total stem volume in stratum = $0.969 \times 438.75 = 425.15$ m^3.

Total Biomass of stems:

The total stem biomass is estimated by multiplying the total stem volume of the stratum by the average nominal specific gravity of the species (see Table 5.2.1):

$425.15 \times 0.33 = 140.29$ oven dry tonnes.

Crown biomass per tree:

The crown biomass (branches and foliage) for trees between 7 cm and 50 cm dbh is estimated using Equation 6 (page52) with the appropriate species-specific parameters from Table 5.2.2 (page 52). So, for Norway spruce with quadratic mean dbh 35.07 cm, the estimated crown biomass per tree is

Crown biomass = $0.0000144620 \times 35.07^{2.4767} = 0.096955$ oven dry tonnes

Total crown biomass of the stratum:

The total crown biomass of the stratum is estimated by multiplying the crown biomass (per tree) by the estimated number of trees in the stratum:

Total crown biomass = 0.096955 × 438.75 = 46.90 oven dry tonnes.

Root biomass per tree:

The root biomass for trees greater than 30 cm dbh is estimated using Equation 9 (page 55) with the appropriate species-specific parameter from Table 5.2.5 (page 55). So, for Norway spruce with quadratic mean dbh 39.12 cm, estimated root biomass per tree is:

Root biomass = -0.091547262 + 0.005004152 x 35.07 = 0.083948 oven dry tonnes.

Total root biomass of the stratum:

The total root biomass of the stratum is estimated by multiplying the root biomass (per tree) by the estimated number of trees in the stratum:

Total root biomass = 0.083948 × 438.75 = 40.61 oven dry tonnes.

Total tree carbon in stratum:

The total tree carbon in the stratum is calculated by adding together the total biomass from the stem, crown and root components in the stratum and multiplying by 0.5:

(140.29 + 46.90 + 40.61) × 0.5 = 113.9 tonnes C (carbon).

For the project:

Total above ground tree carbon for the project:

This is the sum of the carbon estimates for all of the strata in the project:

Total carbon = 109.28 + 11570.92 + 0.48 + 5432.52 + 4194.28 + 395.20 + 918.04 + 1178.69 + 18.26 + 227.76 + 113.90 = 24 159.33 tonnes C (carbon).

The estimated total carbon dioxide sequestered in the project is calculated as:

24 159.33 tonnes C × 44 ÷ 12 = **88 584 tCO_2e**

It is this final figure (88 584 tCO_2e) which should be reported under the Woodland Carbon Code.

CARBON ASSESSMENT DATA COLLECTION FORM SAPLINGS

Section 1 - Basic stand information

Woodland: ROB'S WOOD Gross Area: 25 ha

Stand/Stratum: I Net area: 24 ha

Date measured: 03/02/2011 Plot area: 0.01 ha

Measured by: S. JONES Total area of plots: 0.1 (ha)

Section 2 - Details of number of trees

Count of trees (use gate style, *i.e.* 𝍸)

Species: BI Plot no: 1	Species: BI Plot no: 2	Species: BI Plot no: 3
𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸
𝍸 III	𝍸 IIII	𝍸 IIII

Species: BI Plot no: 4	Species: BI Plot no: 5	Species: BI Plot no: 6
𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸
𝍸 𝍸 III	𝍸 𝍸 II	𝍸 𝍸 𝍸 𝍸

Total heights (m)

1	2	3	4	5	6	7	8
4.3	3.5	6.4	2.8	6.7	6.3	5.9	4.9
9	10	11	12	13	14	15	16
3.1	6.9						
17	18	19	20	21	22	23	24

Number of heights measured 10

Sum of heights measured 50.8

Average height (total of heights ÷ number measured): 5 m.

Sheet 1 of 1

Figure A6.1: Page 1 of the completed "Saplings" data collection form for Stratum I.

CARBON ASSESSMENT DATA COLLECTION FORM SAPLINGS

Section 1 - Basic stand information

Woodland: ROB'S WOOD **Gross Area:** 25 ha
Stand/Stratum: I **Net area:** 24 ha
Date measured: 03/02/2011 **Plot area:** 0.01 ha
Measured by: S. JONES **Total area of plots:** 0.1 **(ha)**

Section 2 - Details of number of trees

Count of trees (use gate style, *i.e.* 𝍸)

Species: B1 Plot no: 7	Species: B1 Plot no: 8	Species: B1 Plot no: 9
𝍸 𝍸 𝍸 𝍸 1	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸 𝍸
Species: B1 Plot no: 10	**Species: Plot no:**	**Species: Plot no:**
𝍸 𝍸 𝍸 𝍸 𝍸 𝍸		

Total heights (m)

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24

Number of heights measured _____

Sum of heights measured _____

Average height (total of heights ÷ number measured): _____ m.

Sheet 1 of 1

Figure A6.2: Page 2 of the completed "Saplings" data collection form for Stratum I.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD D

Woodland: 208'S WOOD
Stand/Stratum: II
Species: SP
Age: 31
Gross Area: 50 ha
Net area: 45 ha
Total area of plots: 0·1 ha

Tariff number: 19
(based on top height)
Mean basal area: 0·01 m²
Mean dbh: 12 cm
(estimated from mean basal area)
Date measured: 03/02/2011
Measured by: S. JONES

Dbh (cm)	Count of trees (use gate style, *i.e.* 𝍸) Plot number												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	
7		𝍸	𝍸		𝍸	𝍸	𝍸	𝍸		𝍸			8
8	𝍸	𝍸	𝍸		𝍸				𝍸	𝍸			6
9	𝍸𝍸	𝍸𝍸	𝍸𝍸	𝍸	𝍸𝍸	𝍸	𝍸𝍸	𝍸	𝍸	𝍸𝍸			18
10	𝍸𝍸	𝍸	𝍸𝍸	𝍸	𝍸𝍸	𝍸𝍸	𝍸𝍸	𝍸𝍸	𝍸𝍸	𝍸𝍸			25
11	𝍸	𝍸			𝍸	𝍸𝍸𝍸	𝍸	𝍸𝍸	𝍸	𝍸			13
12	𝍸𝍸	𝍸𝍸	𝍸𝍸	𝍸𝍸	𝍸𝍸	𝍸𝍸	𝍸𝍸	𝍸	𝍸𝍸	𝍸			45
13	𝍸𝍸	𝍸𝍸	𝍸		𝍸𝍸	𝍸𝍸	𝍸𝍸	𝍸	𝍸𝍸	𝍸𝍸			20
14	𝍸	𝍸𝍸	𝍸𝍸		𝍸𝍸	𝍸𝍸	𝍸𝍸	𝍸𝍸		𝍸			16
15	𝍸	𝍸	𝍸𝍸	𝍸	𝍸			𝍸	𝍸𝍸	𝍸𝍸𝍸			13
16					𝍸		𝍸			𝍸			4
17								𝍸					1
18													
19													
20													
TOTAL	18	16	18	11	16	18	19	15	18	20			

Total heights (m)									
1	2	3	4	5	6	7	8	9	10
10·5	9·4	9·8	11·2	8·3	10·3	10·5	11·2	9·2	10·6
11	12	13	14	15	16	17	18	19	20

Top height (mean of total heights): 10·1 m

Sheet 1 of 1

Figure A6.3: Completed "Method D" data collection form for Stratum II.

CARBON ASSESSMENT DATA COLLECTION FORM SEEDLINGS

Section 1 - Basic stand information

Woodland: ROB'S WOOD
Gross Area: 40 ha
Stand/Stratum: III
Net area: 34 ha
Date measured: 04/02/2011
Plot area: 0·01 ha
Measured by: S. JONES
Total area of plots: 0·1 (ha)

Section 2 - Details of number of trees

Count of trees (use gate style, *i.e.* 𝍸)

Species: WH Plot no: 1	Species: WH Plot no: 2	Species: WH Plot no: 3
𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸
𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸
𝍸 𝍸	𝍸 𝍸 𝍸	𝍸 𝍸
Species: WH Plot no: 4	Species: WH Plot no: 5	Species: WH Plot no: 6
𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸
𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸	𝍸 𝍸 𝍸 𝍸
𝍸 𝍸 𝍸 |	𝍸 𝍸	|

Total heights (cm)

1	2	3	4	5	6	7	8
24	49	12	36	48	21	36	45
9	10	11	12	13	14	15	16
16	12						
17	18	19	20	21	22	23	24

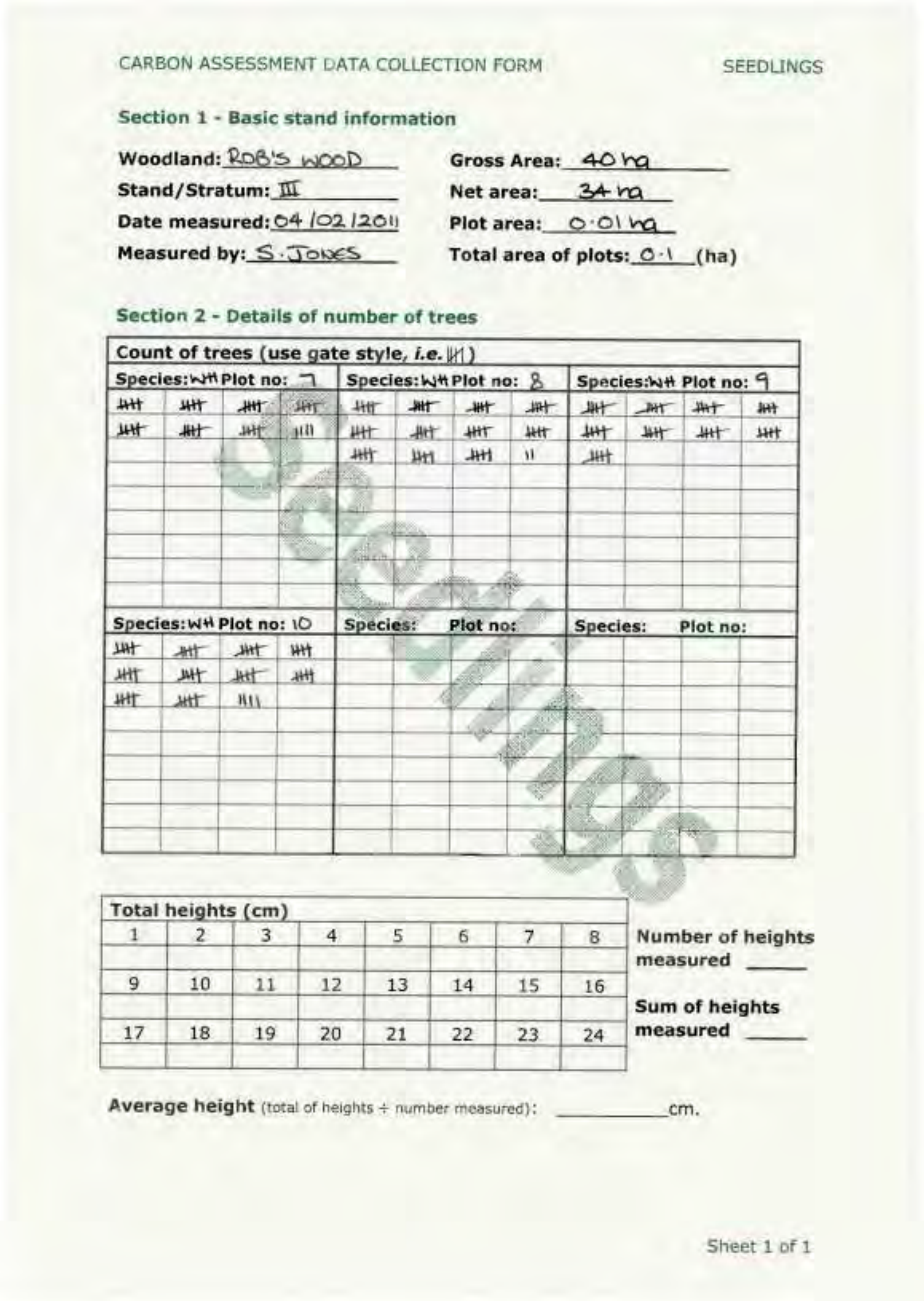
Number of heights measured 10

Sum of heights measured 288

Average height (total of heights ÷ number measured): 28·8 cm.

Sheet 1 of 1

Figure A6.4: Page 1 of completed "Seedlings" data collection form for Stratum III.



CARBON ASSESSMENT DATA COLLECTION FORM SEEDLINGS

Section 1 - Basic stand information

Woodland: ROB'S WOOD	**Gross Area:** 40 ha
Stand/Stratum: III	**Net area:** 34 ha
Date measured: 04/02/2011	**Plot area:** 0·01 ha
Measured by: S. JONES	**Total area of plots:** 0·1 (ha)

Section 2 - Details of number of trees

Count of trees (use gate style, *i.e.* 卌)

Species: WH Plot no: 7				Species: WH Plot no: 8				Species: WH Plot no: 9			
卌	卌	卌	卌	卌	卌	卌	卌	卌	卌	卌	卌
卌	卌	卌	|||	卌	卌	卌	卌	卌	卌	卌	卌
				卌	卌	卌	||	卌			

Species: WH Plot no: 10				Species: Plot no:				Species: Plot no:			
卌	卌	卌	卌								
卌	卌	卌	卌								
卌	卌	|||									

Total heights (cm)

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24

Number of heights measured ______

Sum of heights measured ______

Average height (total of heights ÷ number measured): __________ cm.

Sheet 1 of 1

Figure A6.5: Page 2 of completed "Seedlings" data collection form for Stratum III.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD B

Section 1 - Basic stand information

Woodland: ROB'S WOOD
Stand/Stratum: IV
Species: OK
Age: 133
Gross Area: 31
Net area: 26

Total area of plots: 1 (ha)
Mean basal area: 0·3 m^2
Mean dbh: 66 cm
(estimated from mean basal area)
Date measured: 04/02/2011
Measured by: S. JONES

Section 2 - Details of number of trees and dbh's in plots

Dbh (cm)	Count of trees (use gate style, *i.e.* 𝍸) Plot number												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	
51													
52						1							1
53													
54													
55	1				1								2
56			1						1				2
57									1				1
58		II		1			1						4
59				1				1					2
60			1	1	1		1						4
61	1		1					1					3
62								II	1				3
63										1			1
64	II	1	1	1	II	II	II	1	1				13
65	1		1	1	1	1	1			1			7
66		1								II			3
67										1			1
68		1	1		1	1	1	1	II				8
69													
70	1		1		1		1			1			5
71										1			1
72		1		1		1		1	1				5
73													
74													
75							1						1
76	1					1							2
77													
78			1					1	1				3
79													
80		1											1
81													
82				1	1								2
83													
TOTAL	7	7	8	7	8	7	8	8	8	7			

Sheet 1 of 2

Figure A6.6: Page 1 of completed "Method B" data collection form for Stratum IV.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD B

Section 3 - Details of height and diameter sample trees

No.	Species (code)	Dbh (cm)	Timber height (m)	Tariff number (round to nearest)
1	OK	64	31·5	57
2	OK	64	33·0	60
3	OK	58	34·7	64
4	OK	68	33·2	59
5	OK	65	32·8	59
6	OK	68	30·6	55
7	OK	58	31·4	58
8	OK	65	33·5	60
9	OK	64	30·5	56
10	OK	60	32·2	59
11	OK	76	34·2	60
12	OK	65	32·9	59
13	OK	75	31·4	55
14	OK	64	30·5	56
15	OK	62	31·9	58
16	OK	72	33·0	58
17	OK	68	33·4	60
18	OK	62	30·6	56
19	OK	78	33·8	58
20	OK	63	32·2	59
21				
22				
23				
24				
			Total:	1166
			Mean tariff number: (Rounded down)	58

Sheet 2 of 2

Figure A6.7: Page 2 of completed "Method B" data collection form for Stratum IV.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD B

Section 1 - Basic stand information

Woodland: ROB'S WOOD
Stand/Stratum: V
Species: OK
Age: 89
Gross Area: 37
Net area: 32

Total area of plots: 1 (ha)
Mean basal area: 0·1 m^2
Mean dbh: 39 cm
(estimated from mean basal area)
Date measured: 04/02/2011
Measured by: S. JONES

Section 2 - Details of number of trees and dbh's in plots

Dbh (cm)	Count of trees (use gate style, *i.e.* 𝍸) Plot number												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	
7													
8													
9													
30													
31													
32			1										1
33			1										1
34	1	1	1		𝍸		1	1					7
35	𝍸	𝍸	𝍸	𝍸	𝍸	1	1	1	𝍸	1			19
36	𝍸			1	1		𝍸	𝍸					8
37	𝍸	1	1	𝍸	𝍸	𝍸	1	𝍸	𝍸	𝍸			26
38	𝍸	1	𝍸	𝍸	𝍸	1	1	1	𝍸	1			20
39	𝍸	𝍸	1	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸 1	𝍸 1			36
40	𝍸	1	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	1			23
41		1	1		1	1	𝍸	𝍸	𝍸	𝍸			15
42	1	𝍸	1		1	𝍸	𝍸	𝍸	1	𝍸			16
43	𝍸	1	1		1	1			1				7
44	1		1				1	1					4
45	1		1	1	𝍸								5
46	𝍸		1	𝍸	1								6
47													
48													
49													
50													
1													
2													
3													
4													
5													
6													
7													
8													
9													
TOTAL	24	14	18	20	23	15	18	22	24	16			

Sheet 1 of 2

Figure A6.8: Page 1 of completed "Method B" data collection form for Stratum V.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD B

Section 3 - Details of height and diameter sample trees

No.	Species (code)	Dbh (cm)	Timber height (m)	Tariff number (round to nearest)
1	OK	38	22·5	46
2	OK	37	26·3	53
3	OK	40	22·9	46
4	OK	35	23·6	48
5	OK	38	24·9	50
6	OK	35	24·5	50
7	OK	36	25·2	51
8	OK	37	24·8	50
9	OK	39	24·1	49
10	OK	39	23·9	48
11	OK	46	23·5	47
12	OK	37	24·6	50
13	OK	37	23·9	49
14	OK	45	24·0	48
15	OK	40	23·9	48
16	OK	38	25·1	51
17	OK	38	24·9	50
18	OK	46	25·0	49
19	OK	39	25·6	51
20	OK	40	24·8	50
21				
22				
23				
24				
			Total:	984
			Mean tariff number: (Rounded down)	49

Sheet 2 of 2

Figure A6.9: Page 2 of completed "Method B" data collection form for Stratum V.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD B

Section 1 - Basic stand information

Woodland: ROB'S WOOD
Stand/Stratum: VI
Species: OK
Age: 51
Gross Area: 12
Net area: 10·2

Total area of plots: 1 (ha)
Mean basal area: 0·05 m^2
Mean dbh: 25 cm
(estimated from mean basal area)
Date measured: 03/02/2011
Measured by: A. McDUFF

Section 2 - Details of number of trees and dbh's in plots

Dbh (cm)	Count of trees (use gate style, *i.e.* 𝍸) Plot number												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	
7													
8													
9													
20				1				1					2
21													
22	11	11	111	1	1	11	1	1	1	1			15
23	11	1			1	1	11		11				9
24	11	11	1	1	1	11	111	1	111	1111			20
25	𝍸 1	𝍸 1	111	1111	1111	𝍸	𝍸 11	111	𝍸 1	𝍸 111			52
26	𝍸	𝍸	1111	111	111	111	1111	1111	1111	111			38
27	11	1	11	111		11		11		11			14
28	1	1	1		1	1	11	1	11				10
29													
30													
1													
2													
3													
4													
5													
6													
7													
8													
9													
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
TOTAL	20	18	14	13	11	16	19	13	18	18			

Sheet 1 of 2

Figure A6.10: Page 1 of completed "Method B" data collection form for Stratum VI.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD B

Section 3 - Details of height and diameter sample trees

No.	Species (code)	Dbh (cm)	Timber height (m)	Tariff number (round to nearest)
1	OK	26	21·5	46
2	OK	28	22·0	46
3	OK	23	21·0	45
4	OK	26	20·4	44
5	OK	25	21·7	46
6	OK	25	21·3	46
7	OK	24	22·0	47
8	OK	26	21·6	46
9	OK	22	20·9	45
10	OK	25	20·7	44
11	OK	26	20·3	44
12	OK	28	21·4	45
13	OK	23	20·7	45
14	OK	26	20·8	44
15	OK	25	20·7	44
16	OK	25	21·5	46
17	OK	24	21·7	46
18	OK	26	21·8	46
19	OK	22	22·4	48
20	OK	25	21·6	46
21				
22				
23				
24				
			Total:	909
			Mean tariff number: (Rounded down)	45

Sheet 2 of 2

Figure A6.11: Page 2 of completed "Method B" data collection form for Stratum VI.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD C

Section 1 - Basic stand information

Woodland: ROBIS WOOD
Stand/Stratum: VII
Species: SS
Age: 27
Gross Area: 37.5 ha
Net area: 32 ha

Total area of plots: 0·2 (ha)
Mean basal area: 0·03 m^2
Mean dbh: 19 cm
(estimated from mean basal area)
Date measured: 03/02/2011
Measured by: H. McDuff.

Section 2 - Details of number of trees and dbh's in plots

Dbh (cm)	Count of trees (use gate style, *i.e.* 𝍸) Plot number												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	
7													
8													
9													
0													
1													
2													
3													
4													
15													
16		\		\	\\	\\		\	\	\\			10
17	\	\				\	\\	\\	\				8
18	\\	\\	\\	\\	\\\		\\	\\	\\	\\\			22
19	\\\	\	\\\	\		\\\	\						13
20	\	\	\	\	\\	\\	\	\\\	\				13
21	\	\	\	\		\	\\						7
22	\\	\\\	\	\\	\\\	\\\		\	\\	\\\			21
23										\			1
24													
25													
6													
7													
8													
9													
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
TOTAL	10	10	9	8	11	9	10	9	8	11			

Sheet 1 of 2

Figure A6.12: Page 1 of completed "Method C" data collection form for Stratum VII.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD C

Section 3 - Details of height and diameter sample trees

No.	Species (code)	Dbh (cm)	Total height (m)	Tariff number (round to nearest)
1	SS	21	13·1	23
2	SS	19	13·6	24
3	SS	18	14·6	27
4	SS	18	15·0	27
5	SS	22	13·5	23
6	SS	21	13·6	24
7	SS	19	15·1	27
8	SS	18	13·9	25
9	SS	18	14·2	26
10	SS	22	13·6	23
11	SS	21	14·1	25
12	SS	19	13·2	24
13	SS	18	14·0	26
14	SS	18	14·3	26
15	SS	22	13·9	24
16	SS	21	13·4	23
17	SS	19	13·3	24
18	SS	18	13·9	25
19	SS	18	13·8	25
20	SS	22	14·0	24
21				
22				
23				
24				
			Total:	495
			Mean tariff number: (Rounded down)	24

Sheet 2 of 2

Figure A6.13: Page 2 of completed "Method C" data collection form for Stratum VII.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD C

Section 1 - Basic stand information

Woodland: Rob's Wood
Stand/Stratum: VIII
Species: LP
Age: 27
Gross Area: 37.5 ha
Net area: 32 ha

Total area of plots: 0·1 (ha)
Mean basal area: 0·01 m^2
Mean dbh: 11 cm
(estimated from mean basal area)
Date measured: 03/02/2011
Measured by: H. McDuff.

Section 2 - Details of number of trees and dbh's in plots

Dbh (cm)	Count of trees (use gate style, *i.e.* 𝍸) Plot number												
	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
7						1				1			2
8						1	1	1	11	1			6
9	𝍸	1	1	1	𝍸	𝍸	𝍸	𝍸	11	11			24
10	𝍸	𝍸	1	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸 1			33
11			𝍸	𝍸		𝍸	𝍸	𝍸	𝍸	11			21
12	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	11	1				22
13	𝍸	𝍸	𝍸	𝍸	𝍸								17
14	1		1	1									4
15	1	1		11	1					1			7
16	1		1		1								3
17													
18													
19													
20													
1													
2													
3													
4													
5													
6													
7													
8													
9													
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
TOTAL	15	11	15	17	13	16	12	13	14	13			

Sheet 1 of 2

Figure A6.14: Page 1 of completed "Method C" data collection form for Stratum VIII.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD C

Section 3 - Details of height and diameter sample trees

No.	Species (code)	Dbh (cm)	Total height (m)	Tariff number (round to nearest)
1	LP	10	8·4	18
2	LP	11	8·5	18
3	LP	8	8·0	19
4	LP	11	10·6	22
5	LP	11	7·9	17
6	LP	12	8·3	17
7	LP	13	10·3	20
8	LP	16	10·6	19
9	LP	12	9·6	19
10	LP	10	8·4	18
11	LP	9	9·2	21
12	LP	13	8·6	17
13	LP	15	9·2	16
14	LP	10	7·9	17
15	LP	13	9·5	18
16	LP	12	8·0	16
17	LP	10	7·5	17
18	LP	10	8·0	18
19	LP	9	8·5	19
20	LP	13	8·2	16
21				
22				
23				
24				
			Total:	362
			Mean tariff number: (Rounded down)	18

Sheet 2 of 2

Figure A6.15: Page 2 of completed "Method C" data collection form for Stratum VIII.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD B

Section 1 - Basic stand information

Woodland: Bob's Wood
Stand/Stratum: IX
Species: MB
Age: 11
Gross Area: 20ha
Net area: 17ha

Total area of plots: 1 (ha)
Mean basal area: 0·005 m^2
Mean dbh: 8 cm
(estimated from mean basal area)
Date measured: 04/02/2011
Measured by: R. Brown

Section 2 - Details of number of trees and dbh's in plots

Dbh (cm)	Count of trees (use gate style, *i.e.* 𝍸) Plot number												
	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
7	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸			29
8	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸			37
9	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸			16
10		𝍸	𝍸	𝍸		𝍸	𝍸		𝍸	𝍸			7
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													
31													
32													
33													
34													
35													
36													
37													
38													
39													
TOTAL	7	9	7	8	10	11	8	9	10	10			

Sheet 1 of 2

Figure A6.16: Page 1 of completed "Method B" data collection form for Stratum IX.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD B

Section 3 - Details of height and diameter sample trees

No.	Species (code)	Dbh (cm)	Timber height (m)	Tariff number (round to nearest)
1	BI	7	7.8	22
2	AH	7	8.1	23
3	BI	8	9.6	25
4	AH	8	10.5	26
5	AH	8	10.8	26
6	SH	9	9.6	24
7	AH	9	9.5	28
8	SH	7	8.5	23
9	BI	9	9.4	25
10	BI	9	10.6	27
11	BI	8	9.2	24
12	AH	8	8.6	26
13	AH	9	10.3	28
14	BI	9	10.6	27
15	BI	7	8.9	24
16	BI	7	7.9	22
17	BI	7	8.0	22
18	AH	8	8.4	26
19	AH	8	10.1	26
20	BI	8	9.6	25
21				
22				
23				
24				
			Total:	499
			Mean tariff number: (Rounded down)	24

Sheet 2 of 2

Figure A6.17: Page 2 of completed "Method B" data collection form for Stratum IX.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD A

Section 1 – Basic Assessment Information

Woodland: ROB'S WOOD **Stratum:** X
Species: AH **Total area of plots (ha):** 0·8
Date measured: 04/02/2011 **Gross area (ha):** 5
Measured by: R. BROWN **Net area (ha):** 4·5

Section 2 - Details of number of trees and dbh's in plots

Dbh (cm)	Count of trees (use gate style, *i.e.* 𝍸) Plot number												
	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
17			I				I						2
18	I		II	I		II		I					7
19			I		I		II	I					5
20	IIII	II	I	II	II	II	I	III					17
21	I	III		II	III	I	II	II					18
22		II	II	I	II	II	I	III					13
23	II		II	II	I	II	II	I					12
24	I		I			I		I					4
25			I				I						2
TOTAL	9	8	11	9	11	10	10	12					

Sheet 1 of 2

Figure A6.18: Page 1 of completed "Method A" data collection form for Stratum X.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD A

Section 3 – Details of height and diameter sample trees

N.B. For conifer species record total height; for broadleaved species record timber height. Tariff number should be rounded to the nearest whole number, except where stated otherwise.

No.	Species code	Dbh (cm)	Height (m)	Mid diameter (cm)	Volume (m)	Tariff no.
1	AH	24	15.6	11	0.15	11
2	AH	23	17.5	12	0.20	17
3	AH	20	16.4	15	0.29	33
4	AH	21	16.8	14	0.26	26
5	AH	20	15.8	11	0.15	17
6	AH	24	14.6	15	0.26	20
7	AH	20	15.8	10	0.12	13
8	AH	21	16.4	15	0.29	30
9	AH	21	16.2	16	0.33	34
10	AH	21	15.4	16	0.31	32
11	AH	20	15.9	13	0.21	24
12	AH	24	15.6	12	0.18	14
13	AH	22	16.7	12	0.19	17
14	AH	20	16.5	14	0.25	28
15	AH	20	16.0	16	0.32	36
16	AH	21	14.8	13	0.20	20
17						
18						
19						
20						
21						
22						
23						
24						
25						

Total (by species group): 372

Mean tariff number: 23

(Rounded down)

Sheet 2 of 2

Figure A6.19: Page 2 of completed "Method A" data collection form for Stratum X.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD A

Section 1 – Basic Assessment Information

Woodland: BOB'S WOOD **Stratum:** XI
Species: NS **Total area of plots (ha):** 0·8
Date measured: 04/02/2011 **Gross area (ha):** 5
Measured by: R. BROWN **Net area (ha):** 4·5

Section 2 - Details of number of trees and dbh's in plots

Dbh (cm)	Count of trees (use gate style, *i.e.* 𝍸) Plot number												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	
27													
28													
29													
30	𝍸					𝍸							2
31	𝍸	𝍸											2
32		𝍸		𝍸		𝍸	𝍸						5
33			𝍸	𝍸	𝍸			𝍸					8
34	𝍸		𝍸	𝍸	𝍸	𝍸	𝍸	𝍸					12
35	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸					22
36		𝍸		𝍸	𝍸	𝍸	𝍸						10
37	𝍸	𝍸		𝍸		𝍸	𝍸	𝍸					8
38	𝍸	𝍸				𝍸		𝍸					4
39								𝍸					2
40	𝍸		𝍸	𝍸	𝍸								3
TOTAL	7	8	10	11	10	11	10	11					

Sheet 1 of 2

Figure A6.20: Page 1 of completed "Method A" data collection form for Stratum XI.

CARBON ASSESSMENT DATA COLLECTION FORM METHOD A

Section 3 – Details of height and diameter sample trees

N.B. For conifer species record total height; for broadleaved species record timber height. Tariff number should be rounded to the nearest whole number, except where stated otherwise.

No.	Species code	Dbh (cm)	Height (m)	Mid diameter (cm)	Volume (m)	Tariff no.
1	NS	34	19.9	24	0.90	33
2	NS	40	20.5	23	0.85	22
3	NS	35	21.6	24	0.98	34
4	NS	36	21.8	26	1.16	37
5	NS	40	22.6	22	0.86	22
6	NS	35	22.7	25	1.11	38
7	NS	33	23.0	23	0.96	37
8	NS	37	20.4	24	0.92	28
9	NS	33	21.8	25	1.07	42
10	NS	34	21.3	21	0.74	27
11	NS	35	21.6	23	0.90	31
12	NS	36	21.7	23	0.90	29
13	NS	34	21.8	25	1.07	39
14	NS	35	20.6	26	1.09	38
15	NS	33	20.3	24	0.94	37
16	NS	33	22.5	23	0.93	36
17						
18						
19						
20						
21						
22						
23						
24						
25						

Total (by species group): 529

Mean tariff number: 33

(Rounded down)

Sheet 2 of 2

Figure A6.21: Page 2 of completed "Method A" data collection form for Stratum XI.

Appendix 7:
Blank Data Collection Forms

Section 1 - Basic stand information

Woodland: _____ **Gross Area:** _____ **ha**

Stand/Stratum: _____ **Net area:** _____ **ha**

Date measured: _____ **Plot area:** _____ **ha**

Measured by: _____ **Total area of plots:** _____ **ha**

Section 2 - Details of number of trees

Count of trees (use gate style, *i.e.* 𝍸)												
Species:		**Plot no:**		**Species:**		**Plot no:**		**Species:**		**Plot no:**		
Species:		**Plot no:**		**Species:**		**Plot no:**		**Species:**		**Plot no:**		

Total heights (cm)							
1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24

Number of heights measured _____

Sum of heights measured _____

Average height (total of heights ÷ number measured): _____cm.

Section 1 - Basic stand information

Woodland: _____ **Gross Area:** _____ **ha**

Stand/Stratum: _____ **Net area:** _____ **ha**

Date measured: _____ **Plot area:** _____ **ha**

Measured by: _____ **Total area of plots:** _____ **ha**

Section 2 - Details of number of trees

Count of trees (use gate style, *i.e.* 𝍸)											
Species:		**Plot no:**		**Species:**		**Plot no:**		**Species:**		**Plot no:**	
Species:		**Plot no:**		**Species:**		**Plot no:**		**Species:**		**Plot no:**	

Total heights (m)							
1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24

Number of heights measured _____

Sum of heights measured _____

Average height (total of heights ÷ number measured): _____m.

Section 1 – Basic Assessment Information

Woodland: _____ **Stratum:** _____
Species: _____ **Total area of plots:** _____ **ha**
Date measured: _____ **Gross area:** _____ **ha**
Measured by: _____ **Net area (ha):** _____ **ha**

Section 2 - Details of number of trees and dbh's in plots

Dbh (cm)	**Count of trees (use gate style, *i.e.* 𝍸)** **Plot number**												TOTAL
	1	2	3	4	5	6	7	8	9	10	11	12	
TOTAL													

Section 3 – Details of height and diameter sample trees

N.B. For conifer species record total height; for broadleaved species record timber height. Tariff number should be rounded to the nearest whole number, except where stated otherwise.

No.	Species code	Dbh (cm)	Height (m)	Mid diameter (cm)	Volume (m)	Tariff no.
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
					Total (by species group):	
					Mean tariff number: (Rounded down)	

Section 1 - Basic stand information

Woodland: ____________________

Stand/Stratum: _______________

Species: ______________________

Age: __________________________

Gross Area: ___________________ **ha**

Net area: ______________________ **ha**

Total area of plots: _________ **ha**

Mean basal area: ___________ **m^2**

Mean dbh: __________________ **cm**
(estimated from mean basal area)

Date measured: ____________

Measured by: _______________

Section 2 - Details of number of trees and dbh's in plots

Dbh (cm)	**Count of trees (use gate style, *i.e.* 卌)**												
	Plot number												
	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
7													
8													
9													
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
TOTAL													

Section 3 - Details of height and diameter sample trees

No.	Species (code)	Dbh (cm)	Timber height (m)	Tariff number (round to nearest)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
			Total:	
			Mean tariff number: (Rounded down)	

Section 1 - Basic stand information

Woodland: ____________________

Stand/Stratum: _______________

Species: ______________________

Age: __________________________

Gross Area: ___________________ **ha**

Net area: ______________________ **ha**

Total area of plots: _________ **ha**

Mean basal area: ___________ **m^2**

Mean dbh: __________________ **cm**
(estimated from mean basal area)

Date measured: ____________

Measured by: ______________

Section 2 - Details of number of trees and dbh's in plots

Dbh (cm)	**Count of trees (use gate style, *i.e.* 𝍸)**												
	Plot number												
	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
7													
8													
9													
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
0													
1													
2													
3													
4													
5													
6													
7													
8													
9													
TOTAL													

Section 3 - Details of height and diameter sample trees

No.	Species (code)	Dbh (cm)	Total height (m)	Tariff number (round to nearest)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
			Total:	
			Mean tariff number: (Rounded down)	

Woodland: _____

Stand/Stratum: _____

Species: _____

Age: _____

Gross Area: _____ **ha**

Net area: _____ **ha**

Total area of plots: _____ **ha**

Tariff number: _____
(based on top height)

Mean basal area: _____ **m^2**

Mean dbh: _____ **cm**
(estimated from mean basal area)

Date measured: _____

Measured by: _____

Dbh (cm)	**Count of trees (use gate style, *i.e.* 𝍸)**												
	Plot number												
	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
TOTAL													

Total heights (m)									
1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20

Top height (mean of total heights): _____m

Section 1 – Basic Assessment Information

Woodland: _____ **Compartment(s):** _____
Species: _____ **Gross area (ha):** _____
Diameter sampling fraction: 1: _____ **Net area (ha):** _____
Height sampling fraction: 1: _____

Date measured: _____ **Measured by:** _____

Section 2 – Details of height and diameter sample trees

N.B. For conifer species record total height; for broadleaved species record timber height and total height. Tariff number should be rounded to the nearest whole number, except where stated otherwise.

No.	Spp code	Dbh (cm)	H_{timb} (m)	H_{total} (m)	Tariff no.	No.	Spp code	Dbh (cm)	H_{timb} (m)	H_{total} (m)	Tariff no.
1						26					
2						27					
3						28					
4						29					
5						30					
6						31					
7						32					
8						33					
9						34					
10						35					
11						36					
12						37					
13						38					
14						39					
15						40					
16						41					
17						42					
18						43					
19						44					
20						45					
21						46					
22						47					
23						48					
24						49					
25						50					
				Total (by species group):						Total (by species group):	
				Mean tariff number: (Rounded down)						Mean tariff number: (Rounded down)	

Section 3 – Full tree tally

Species:					Species:				
Total number:					**Total number:**				

Section 4 – Diameter distribution & calculation of mean basal area.

	Species:				Species:			
(1) Dbh	**(2) tally**	**(3) n**	**(4) dbh^2**	**(5) $n \times dbh^2$**	**(2) tally**	**(3) N**	**(4) dbh^2**	**(5) $n \times dbh^2$**
7								
8								
9								
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
0								

Col. totals (Σ)				
Mean dbh^2 = Σ(5)÷ Σ(3)				
Mean ba = π × mean dbh^2 ÷ 40000		m^2		m^2
Mean dbh = sqrt(mean dbh^2)		cm		cm