Quick Estimates of Carbon in Loblolly Pine Plantations Using Carbon-Basal Area Ratios

Many people have concerns about global warming, climate change, depletion of the ozone layer, and related issues. These concerns make carbon released into the atmosphere a significant issue. Regardless of personal feelings about the politics of these issues, carbon sequestration and storage in forests is a necessity for life. Have you ever wondered how much carbon is sequestered and stored in your loblolly pine (*Pinus taeda* L.) plantation?

Recently, forest carbon markets have once again become an opportunity for forest landowners to receive some supplemental income. At a basic level, these markets allow industries that are emitting carbon during their production process to offset those emissions by purchasing carbon credits from others that are sequestering carbon beyond their usual practices. Carbon credits can be purchased from forest landowners who are sequestering carbon beyond what they normally would do without the presence of a forest carbon market—or their business-as-usual (BAU) forest management practices. Carbon markets allow these industries to offset their carbon emissions from landowners who are sequestering an additional amount of carbon beyond their BAU, hence the concept of additionality.

Increasingly, nonindustrial private forest (NIPF) landowners who own smaller acreages in Mississippi have access to forest carbon markets that allow them to participate more actively. Some refer to NIPF landowners as family forest owners. NIPF and larger public and private forest landowners alike will be interested in knowing how many metric tons of carbon and carbon dioxide equivalents (abbreviated as $MtCO_2e$) their plantation is sequestering and storing.

This publication describes a quick and low-cost means of obtaining a carbon per acre estimate. It then shows how carbon per acre is mathematically converted into metric tons, as well as how carbon is converted into metric tons of carbon dioxide equivalents ($MtCO_2e$) by using basic assumptions about the chemistry of wood. By using variable-radius sampling, we can take advantage of relationships between tree stem growth and carbon production, to ultimately estimate carbon per acre.

Estimating Carbon Using Variable-Radius Sampling and CBAR

Basal area per acre is a useful measure that provides information about the amount of site occupancy by the trees within a forest. Variable-radius sampling is highly advantageous because a very quick estimate of basal area can be obtained by merely counting the number of "in" trees,

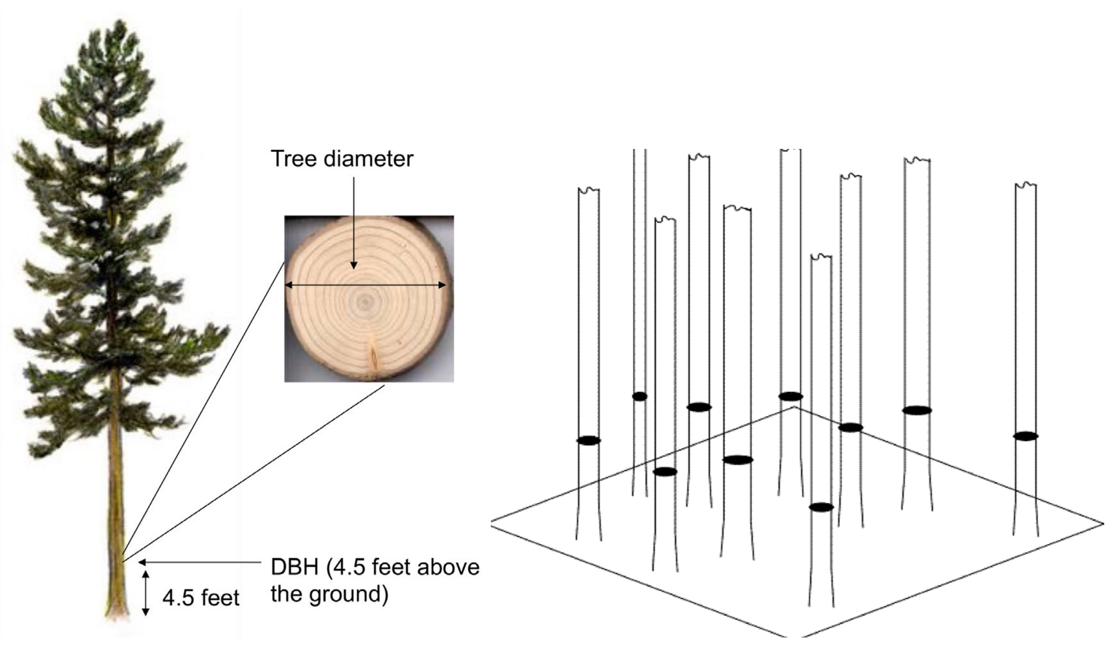

Figure 1. Basal area of a forest at a height of 4.5 feet above the ground (diameter at breast height or DBH) is a common measure used to quantify site occupancy of the overstory trees. It gives us an idea of the amount of competition for limited site resources of light, moisture, and nutrients. Subsequently, it is commonly used as a tool to determine when thinnings or other forest management techniques should be conducted. It is also an indirect measure of wildlife habitat structure.

Figure 2. There is often a strong relationship between the basal area of an even-aged shortleaf pine forest and the amount of carbon being sequestered and stored within the overstory trees. Additionally, basal area is often a very good predictor of understory biomass. If there is a strong relationship (or strong correlation) between basal area and carbon, then by knowing basal area per acre, you essentially know carbon per acre. We can use this to our advantage. Basal area can be quickly obtained using variable-radius sampling protocols, and then a regionwide carbon-basal area ratio (CBAR) can be used to estimate carbon per acre in the trees.

and then multiplying the number of "in" trees by a user-selected basal area factor (BAF).

Historically, volume-basal area ratios (VBARs) and weight-basal area ratios (WBARs) have been associated with variable-radius sampling. This publication introduces the concept of a carbon-basal area ratio (CBAR). We can assume that for each square foot increase in basal area, there is an associated increase in carbon.

Variable-radius sampling is known by a variety of names, including point sampling, horizontal-point sampling, angle-gauge sampling, horizontal-angle sampling, and prism sampling, among others. Due to the protocol of variable-radius sampling, for a particular BAF, an "in" tree always represents the same amount of basal area per acre. Therefore, if a 20 BAF is used, each "in" tree—or each sampled tree—represents 20 square feet of basal area per acre. The most common BAF in this region is 10, but a 20 BAF is often preferable, and a 5 BAF could be useful, as well. Remember, it is best to sample around 6 to 10 trees per sampling point. For the sake of convention, the term "point" is used rather than "plot" since we are referring to inventories being conducted using variable-radius sampling and not fixed-radius sampling.

When conducting quick assessments, it is often sufficient to estimate carbon based upon the easily and quickly obtainable basal area per acre. After obtaining an estimate of basal area per acre, the amount of carbon per acre can be obtained by simply multiplying that amount by an average CBAR. Thus, individual tree diameters and heights do not need to be measured. To estimate carbon per acre, for example, use the following formula after obtaining an estimate of basal area per acre:

$$\text{Carbon Per Acre} = \text{CBAR} \times \text{BA}$$

Where:

CBAR = average carbon-basal area ratio, and

BA = an estimate of basal area per acre from variable-radius points.

There are several methods for obtaining an estimate of basal area per acre:

- Simply use your thumb (Figure 3).
- Use the MSU Basal Area Angle Gauge.
- Perform a quick prism sweep of the forest.
- Use a Jim-Gem Cruz-All.

Calculations can be as simple as establishing three or four points within a forest and then averaging the three or four basal area per acre estimates. Or you can perform a more extensive inventory—one point per acre or the number of points necessary to meet some desired level of precision. The sampling approach described here is for those cases when a relatively low intensity of sampling is sufficient. This inventory protocol will provide only basic information about a landowner's forested condition. Basal area often can be estimated in 2 minutes and even less time at an individual point using a thumb, prism, or any other angle gauge to project horizontal angles.

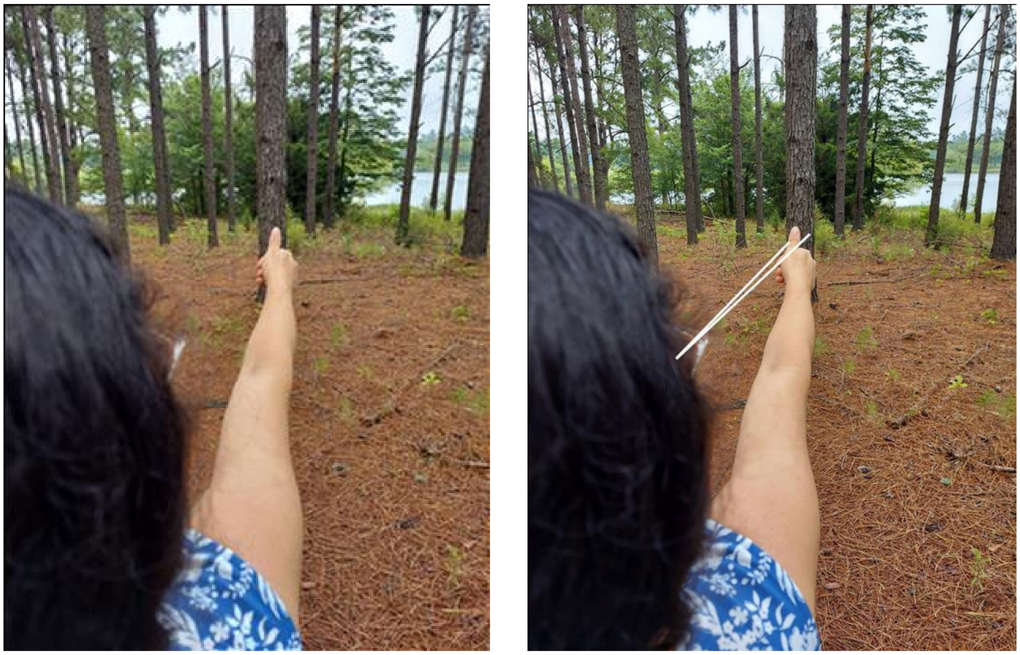

Figure 3. You can use your thumb to project an "imaginary" horizontal angle, which can be equated to a basal area factor (BAF). If you extend your thumb some distance from your eye, assuming the vertex of the angle (where the angle begins) is located in your eye, then an imaginary horizontal angle is projected out to your thumb and beyond (depicted on the right). This is the same approach used for stick angle-gauges, Cruz-All tools, etc. Depending on the width of your thumb and your arm distance, you can use this approach to generate your own BAF. Whenever the width of your thumb is smaller than the tree at DBH, the tree is "in." To obtain basal area per acre, just multiply the number of "in" trees at each point by your thumb-specific BAF.

The Importance of Knowing the Definition of Carbon

If you have been associated with forest carbon or participated in forest carbon markets, you know there is a wide range of interpretations, verbiage, definitions, units, and carbon pools that can be included or excluded from a particular analysis and market. The term "carbon pool" refers to the components of a forest that are sequestering carbon. From a forest carbon market perspective, it refers to the components of a forest that are being evaluated for their sequestration and storage.

When we talk about the amount of carbon being stored in a plantation, there are terms that need definition. For instance, are we talking about the amount of carbon within tree stems, or are branches included? Are roots and foliage also included? Within a loblolly pine plantation, is it just the planted trees, or does it also include loblolly pine wildlings (nonplanted loblolly pine), other pine species, or any hardwoods such as oak, hickory, or sweetgum? For the trees, is it only the living material or dead material, as well? Is the understory vegetation carbon pool being considered? Carbon markets have also tried to monitor the amount of carbon sequestered and stored within harvested wood products obtained from forests. What is the long-term carbon storage of lumber, plywood, paper, or other products?

As you can see, it is essential that you know what carbon pools are being included in your estimate. Also, what units of measurement are you using—pounds, tons, or metric tons? Are you measuring basal area in square feet per acre or square meters per hectare?

For this publication, carbon estimates are only for the *living* trees sampled during the basal area inventory. Additionally, the amount of carbon being sequestered, or stored, includes only the woody components of a tree, so the foliage is not included in the carbon estimate. Both aboveground and belowground components are estimated. Therefore, the carbon estimates presented here are not exhaustive.

Converting Carbon into Metric Tons

Carbon is often reported, described, and discussed in terms of metric tons, where a metric ton is about 2,205 pounds. To use the approach described in this publication, any carbon estimate must first be in pounds or converted to pounds. After converting the estimate to pounds, divide it by 2,205.

Users may also see carbon reported in metric units such as kilograms. To convert from kilograms to pounds, multiply the kilogram estimate by 2.205.

Occasionally carbon is reported in tons—not metric tons. In these instances, divide the carbon in pounds by 2,000.

Always make sure that you clearly understand the units of a carbon measurement.

Converting Carbon into Metric Tons of Carbon Dioxide Equivalents

Many people talk about metric tons of carbon dioxide equivalents, which is often abbreviated as $MtCO_2e$. You can calculate a carbon dioxide equivalent based on the atomic weights (mass) of carbon and oxygen. Carbon has an atomic weight around 12, and oxygen has an atomic weight around 16 ($12 + [16 \times 2] = 44$). If we divide 44 from carbon dioxide by 12 from carbon, we get a multiplier for carbon dioxide equivalency of $44 \div 12 = 3.667$. To obtain the amount of carbon dioxide being sequestered within a forest, multiply any carbon estimate by 3.667. This constant applies whether carbon is in pounds, kilograms, tons (2,000 pounds), or metric tons (2,205 pounds). For simplicity, we assume this exact multiplier applies to all tree species.

Estimating Carbon

Example 1. Estimating Carbon per Acre of Loblolly Pine

Landowners have heard a lot about forest carbon markets and the benefits of carbon sequestration for our environment, so they are curious about how much carbon is "sequestered" in the pine trees in their 10-year-old plantation.

This example assumes that you use the thumb method to obtain an estimate of basal area per acre. For this example, assume that your thumb has a BAF of 8. You establish three points, and there is a total of 24 "in" trees. Thus, across the three points, there is an average basal area per acre of 64 square feet (8 BAF × 8 "in" trees per point on average = 64). For simplicity, to use Table 1, round the 64 square feet per acre to 65 square feet. Based on Table 1, you obtain a CBAR of 358 pounds. Then multiply 358 by 64 square feet; this yields an estimate of around 22,912 pounds of carbon per acre being stored in your plantation. Now, let's convert the carbon into metric tons (2,205 pounds per metric ton). Divide 22,912 pounds per acre by 2,205 pounds. Therefore, you estimate your 10-year-old plantation is "sequestering" around 10.39 metric tons per acre in this example.

You can calculate metric tons of carbon dioxide equivalents ($MtCO_2e$) based on the atomic weights (mass) of carbon and oxygen. Carbon has an atomic weight around 12, and oxygen has an atomic weight around 16 ($12 + [16 \times 2] = 44$). If we divide 44 from carbon dioxide by 12 from carbon, we get a multiplier for carbon dioxide equivalency of $44 \div 12 = 3.667$. Thus, in this example, your forest has a carbon dioxide equivalent of around 38.1 metric tons, or 38.1 $MtCO_2e$.

Example 2. Estimating Carbon per Acre of Loblolly Pine and Hardwoods

Let's assume that you are meeting with an Extension specialist or consulting forester and decide to "walk" your property. After visiting a loblolly pine plantation that also contains some hardwoods, you have questions about carbon sequestration and storage in this stand. You are not sure of the age of the plantation because you recently inherited the property. Out of curiosity, the consultant decides to quickly measure three variable-radius sampling points by using a 10 BAF prism. Across the three points, the average loblolly pine basal area per acre is estimated to be 120 square feet per acre. In addition, the basal area per acre of hickory is 10 square feet, sweetgum is 20 square feet, and ash is 3.33 square feet. How do you get 3.33 square feet when using three points? Since you don't know the plantation age, and you want to estimate carbon for species other than loblolly pine, you must use Table 3. If you knew the plantation age, only for loblolly pine, you could first use Tables 1 or 2 and then use Table 3 to estimate carbon for all other species.

Remember, the average basal area per acre estimate is across the three points. Thus, at two points there were no "in" ash trees; at one point, there was one ash tree sampled. Since the consultant used a 10 BAF prism, across the three points, on average, there is 3.33 square feet per acre ($10 \div 3$). Also, notice in Table 3 that there is no CBAR specifically for ash trees. Thus, ash is lumped into the "other hardwood" category, and you will use a CBAR of 489 pounds per square foot of basal area. Therefore, your estimate is 1,628.37 pounds of carbon per acre in ash (489 pounds × 3.33 square feet of basal area per acre).

A similar procedure is used for the hickory and sweetgum, resulting in 6,070 and 8,960 pounds per acre of carbon in these trees, respectively. For loblolly pine, since you don't know the age, you cannot use Tables 1 and 2, so you need to use Table 3. In this example, you have 120 square feet per acre of basal area for loblolly pine. And the number of pounds per square foot of basal area is 591. Therefore, your estimate is around 70,920 pounds per acre of carbon in these trees.

Example 3. Estimating Carbon per Acre of Loblolly Pine and Other Pine Species

In this example, let's assume you want to find out how much carbon is "sequestered" in the pine trees of a 25-year-old plantation. However, it includes some pine species other than loblolly pine. In this case, you establish two points using the MSU Basal Area Angle Gauge, which has a BAF of 10. Across the two points, there are 14 sampled loblolly pine trees, or "in" trees. Thus, across the two points, the basal area is 140 square feet; since there are two points, you must divide that number by two to obtain an average basal area per acre of 70 square feet (10 BAF × 14 "in" trees on two points, average = 70). Table 2 provides an estimate that the 25-year-old plantation is sequestering 20.12 metric tons per acre. When using Table 1, the same value is obtained (634 × 70 square feet per acre, and then dividing by 2,205).

In addition to the loblolly pine trees, there are also three "in" trees of longleaf pine, across the two points. Thus, three sampled trees multiplied by 10 square feet of basal area equals 30 square feet; when divided by two points, we obtain an estimate of 15 square feet of basal area per acre. We can use the "other pine" category in Table 3 for these longleaf pine trees. For the "other pine" category, the amount of carbon is estimated to be 610 pounds per square foot of basal area. Therefore, after doing the math (610 × 15 square feet of basal area), we estimate there is around 9,150 pounds of carbon per acre. For metric tons, we can divide the 9,150 pounds by 2,205 (pounds per metric ton) and get 4.15 metric tons per acre.

For $MtCO_2e$, the carbon dioxide equivalency multiplier of 44 ÷ 12 = 3.667 should be used. Remember that, in forestry, we often make simplifying assumptions given the costs of obtaining more detailed measurements, so we assume across all species that the 3.667 constant is applicable. Thus, this landowner's forest has a carbon dioxide equivalent of around 73.78 $MtCO_2e$ for the loblolly pine and around 15.22 $MtCO_2e$ for the longleaf pine. These two values total to 89.00 $MtCO_2e$.

Other Potential Applications

Carbon estimates obtained using this CBAR approach can also be used to quickly validate carbon estimates obtained through other sampling protocols. For example, inexperienced foresters could quickly double-check their carbon estimates to ensure their estimates when using another approach is reasonable. Consulting foresters can provide a quick estimate of carbon per acre when initially meeting with landowners.

There are likely other applications of the presented average CBARs. For instance, LiDAR (*light detection and ranging,* a remote sensing method) often provides an acceptable estimate of basal area per acre, but the approach currently does not directly provide estimates of sufficient quality for carbon. Thus, the CBAR approach described here could be used to provide estimates of carbon per acre when using LiDAR to conduct inventories. Alternatively, for loblolly pine, the per acre values in Table 2—based upon the CBARs in Table 1—could be used along with the LiDAR basal area estimate.

Note: In the following tables, carbon estimates are only for living trees with DBH of 1 inch and greater and for the entire woody component of a tree, both aboveground and belowground, but excluding foliage.

Table 1. CBARs (in pounds) presented below can be used for loblolly pine based on the basal area per acre estimate (at DBH, 4.5 feet above the ground) and when stand age is known.[1]

Basal area per acre (sq ft)	10-year-old stand	15-year-old stand	20-year-old stand	25-year-old stand	30-year-old stand	35-year-old stand	40-year-old stand	45-year-old stand
10	273	393	479	545	599	645	684	719
15	291	412	497	563	618	663	703	738
20	304	425	510	577	631	676	716	751
25	315	435	520	587	641	687	726	761
30	323	443	529	595	649	695	735	770
35	330	450	536	602	656	702	742	777
40	336	457	542	608	662	708	748	783
45	341	462	547	614	668	714	753	788
50	346	467	552	618	673	718	758	793
55	351	471	557	623	677	723	762	797
60	355	475	560	627	681	727	766	801
65	358	479	564	630	685	730	770	805
70	362	482	568	634	688	734	773	808
75	365	485	571	637	691	737	777	812
80	368	488	574	640	694	740	779	814
85	371	491	576	643	697	743	782	817
90	373	494	579	645	699	745	785	820
95	376	496	581	648	702	748	787	822
100	378	498	584	650	704	750	790	825
105		501	586	652	706	752	792	827
110		503	588	654	709	754	794	829
115		505	590	656	711	756	796	831
120		507	592	658	713	758	798	833
125		509	594	660	714	760	800	835
130		510	596	662	716	762	802	837
135		512	598	664	718	764	803	838
140		514	599	665	720	765	805	840
145		515	601	667	721	767	807	842
150		517	602	669	723	769	808	843
155			604	670	724	770	810	845
160			605	672	726	772	811	846
165			607	673	727	773	813	848
170			608	674	729	774	814	849
175			609	676	730	776	815	850
180			611	677	731	777	817	852
185				678	732	778	818	853
190				679	734	779	819	854
195				681	735	781	820	855
200				682	736	782	821	856
205				683	737	783	822	857
210				684	738	784	824	859

[1]CBARs are calculated using CBAR = -516.321 + 45.71438 × ln(baacre) + 296.9672 × ln(Age), n = 590, Adj. R2 = 0.7107. After calculating the amount of carbon per acre in pounds based on the CBAR and basal area, divide by 2,000 for tons of carbon or 2,205 for metric tons of carbon.

Table 2. Metric tons of carbon per acre (2,205 pounds per metric ton) estimates based on the CBARs presented in Table 1.

Basal area per acre (sq ft)	10-year-old stand	15-year-old stand	20-year-old stand	25-year-old stand	30-year-old stand	35-year-old stand	40-year-old stand	45-year-old stand
10	1.24	1.78	2.17	2.47	2.72	2.92	3.10	3.26
15	1.98	2.80	3.38	3.83	4.20	4.51	4.78	5.02
20	2.76	3.85	4.63	5.23	5.72	6.14	6.50	6.81
25	3.57	4.93	5.90	6.65	7.27	7.79	8.23	8.63
30	4.39	6.03	7.19	8.10	8.83	9.46	10.00	10.47
35	5.24	7.15	8.51	9.56	10.42	11.14	11.77	12.33
40	6.10	8.28	9.83	11.03	12.02	12.85	13.57	14.20
45	6.97	9.43	11.17	12.52	13.63	14.56	15.37	16.08
50	7.85	10.58	12.52	14.02	15.25	16.29	17.19	17.98
55	8.75	11.75	13.88	15.53	16.88	18.03	19.02	19.89
60	9.65	12.93	15.25	17.05	18.53	19.77	20.85	21.80
65	10.56	14.11	16.63	18.58	20.18	21.53	22.70	23.73
70	11.48	15.30	18.02	20.12	21.84	23.29	24.55	25.66
75	12.41	16.51	19.41	21.66	23.51	25.06	26.41	27.60
80	13.34	17.71	20.81	23.22	25.18	26.84	28.28	29.55
85	14.28	18.93	22.22	24.77	26.86	28.63	30.15	31.50
90	15.23	20.15	23.63	26.34	28.55	30.42	32.04	33.46
95	16.18	21.37	25.05	27.91	30.24	32.21	33.92	35.43
100	17.14	22.60	26.48	29.48	31.94	34.01	35.81	37.40
105		23.84	27.91	31.06	33.64	35.82	37.71	39.38
110		25.08	29.34	32.65	35.35	37.63	39.61	41.36
115		26.33	30.78	34.24	37.06	39.45	41.52	43.34
120		27.58	32.23	35.83	38.78	41.27	43.43	45.33
125		28.83	33.68	37.43	40.50	43.10	45.34	47.33
130		30.09	35.13	39.04	42.23	44.93	47.26	49.33
135		31.35	36.58	40.64	43.96	46.76	49.19	51.33
140		32.62	38.05	42.25	45.69	48.60	51.11	53.34
145		33.89	39.51	43.87	47.43	50.44	53.05	55.35
150		35.17	40.98	45.49	49.17	52.28	54.98	57.36
155			42.45	47.11	50.91	54.13	56.92	59.38
160			43.92	48.73	52.66	55.98	58.86	61.40
165			45.40	50.36	54.41	57.84	60.80	63.42
170			46.88	51.99	56.17	59.70	62.75	65.45
175			48.37	53.63	57.92	61.56	64.70	67.48
180			49.85	55.26	59.68	63.42	66.66	69.51
185				56.90	61.45	65.29	68.61	71.55
190				58.55	63.21	67.16	70.57	73.59
195				60.19	64.98	69.03	72.54	75.63
200				61.84	66.75	70.90	74.50	77.67
205				63.49	68.52	72.78	76.47	79.72
210				65.14	70.30	74.66	78.44	81.77

Table 3. Average CBARs by species or species group.

Species/Species Group	Number[1]	CBAR (pounds)	CBAR (metric tons) CBAR × 2,205	CBAR ($MtCO_2e$) CBAR × 2,205 × 3.667
Loblolly pine	590	591	0.2679	0.9825
Hickory	37	607	0.2754	1.0100
Oak	156	658	0.2986	1.0948
Sweetgum	230	448	0.2033	0.7454
Other pine	48	610	0.2766	1.0142
Other hardwood	258	489	0.2220	0.8139
Other softwood[2]	24	354	0.1608	0.5895
All hardwood species	**681***	**521**	**0.2361**	**0.8658**

[1]Number refers to the sample size used to estimate the species specific CBAR. (*Exceeds 590 because some FIA plots have more than one hardwood species or species group).

[2]Other softwood includes eastern redcedar and baldcypress.

Appendix

Development of Carbon-Basal Area Ratios

For this publication, average CBARs were calculated using USDA Forest Inventory and Analysis (FIA) inventories of loblolly pine plantations within Mississippi. Within FIA, only those plots classified as loblolly pine (FORTYPCD = 161 within the FIA database) and a plantation (STDORGCD = 1 within the FIA database) were selected. Only plots 6 years or older were included. Plots with site indexes (base age 25) less than 45 feet and greater than 90 feet were deleted. All FIA plots with a basal area per acre (across all species) less than 10 square feet and greater than 225 square feet were deleted. Site index at base age 25 used the FIA-reported site index at base age 50 along with the appropriate equation from Schumacher and Coile (1960). After meeting these criteria, the average plantation age was 22 years old, and the oldest plantation was 43 years old.

In addition to the CBAR for loblolly pine itself, a CBAR was also calculated for all other species within these plantations. CBARs were calculated for sweetgum (*Liquidambar styraciflua* L.) and select groups of several species. Select groups were oaks (*Quercus* spp.), hickories (*Carya* spp.), other pine (*Pinus* spp.) species ("other pine"), all other softwood species ("other softwood"), and then all other hardwood species ("other hardwood"). Finally, for those who just want an estimate when grouping together all hardwood species, see Table 3 ("all hardwood species").

Summary of Data Used to Produce CBARs

Following is a summary of the data used to produce the CBARs presented in Tables 1 to 3. **Please note** that carbon estimates in this publication are only for the **living** trees sampled during the basal area inventory. Additionally, the amount of carbon being sequestered is **only** of the woody component; thus, the foliage is not included in the carbon estimate. Both aboveground and belowground components are estimated. However, forests contain many more carbon pools, such as dead trees, understory vegetation, and mushrooms. For these other carbon pools, there are both the aboveground and belowground components. Thus, the carbon estimates presented here are not exhaustive.

The following tables summarize the USDA Forest Service Forest Inventory and Analysis (FIA) plot data for trees classified as merchantable (living trees with a minimum DBH of 5 inches). Volume and tons per acre are based on a 1-foot stump to a 4-inch top diameter outside-bark (DOB) limit. Tons per acre is based on 2,000 pounds per ton.

Trees Per Acre

Species/species group	Number	Mean	Min	Max
Loblolly pine	590	162	6	584
Hickory	37	8	6	24
Oak	156	15	6	102
Sweetgum	230	17	6	108
Other pine	48	15	6	72
Other hardwood	258	15	6	78
Other softwood	24	8	6	36
All species	**592**	**180**	**6**	**590**

Basal Area Per Acre

Species/species group	Mean	Min	Max
Loblolly pine	103	3	217
Hickory	4	1	16
Oak	8	1	76
Sweetgum	6	1	51
Other pine	9	1	36
Other hardwood	7	1	74
Other softwood	6	1	29
All species	**112**	**1**	**217**

Volume Per Acre

Species/species group	Mean	Min	Max
Loblolly pine	2,564	12	6,497
Hickory	69	5	299
Oak	176	8	1,921
Sweetgum	117	3	1,087
Other pine	248	6	990
Other hardwood	126	8	1,909
Other softwood	97	9	533
All species	**2,730**	**4**	**6,497**

Tons Per Acre

Species/species group	Mean	Min	Max
Loblolly pine	63.8	0.1	201.3
Hickory	1.7	0.1	9.0
Oak	4.7	0.2	50.8
Sweetgum	2.6	0.1	24.9
Other pine	6.6	0.2	28.8
Other hardwood	2.8	0.2	28.6
Other softwood	1.9	0.3	12.4
All species	**67.7**	**0.1**	**204.5**

Below is a summary of the USDA Forest Service FIA plot data for all living trees of DBH 1 inch and greater. Carbon is measured in metric tons (2,205 pounds) per acre.

For these loblolly pine plantations, site index (base age 25) averaged 65 feet and ranged from 45 feet to 89 feet. Site index at base age 25 used the reported site index at base age 50 along with the appropriate equation from Schumacher and Coile (1960).

Trees Per Acre

Species/species group	Number	Mean	Min	Max
Loblolly pine	592	229	6	2,007
Hickory	82	112	6	675
Oak	294	137	6	900
Sweetgum	335	176	6	936
Other pine	52	40	6	336
Other hardwood	400	236	6	1,505
Other softwood	41	71	6	750
All species	**592**	**579**	**6**	**3,156**

Basal Area Per Acre

Species/species group	Mean	Min	Max
Loblolly pine	108	18	217
Hickory	4	0	16
Oak	8	0	76
Sweetgum	11	0	63
Other pine	10	1	36
Other hardwood	11	0	90
Other softwood	7	1	34
All species	**128**	**28**	**225**

Carbon Per Acre

Species/species group	Number	Mean	Min	Max
Loblolly pine	592	29.4	0.72	72.5
Hickory	82	0.9	0.04	5.1
Oak	294	2.1	0.04	26.0
Sweetgum	335	1.8	0.03	15.0
Other pine	52	2.8	0.10	11.3
Other hardwood	400	1.9	0.03	23.6
Other softwood	41	1.0	0.05	6.4
All species	**592**	**33.1**	**1.25**	**74.3**

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