CHAPTER

12

BASAL AREA

Basal Area

Assume you just had a forest inventory completed on your property. Your forester reports that your forest stand has an estimated basal area of 90 square feet and an average diameter at breast height (DBH) of 10 inches. What does that mean? From the description, can you visualize what the stand looks like? Maybe. Or maybe not.

Basal area is one of the most commonly used terms by foresters, but it also may be one of the most misused and misunderstood terms as well. This chapter is designed to help you understand what basal area is and why it is an important forest measurement.

WHAT IS BASAL AREA?

Basal area is a forest measurement that is used often for making forestry and wildlife management decisions. Knowing basal area along with trees per acre can help you have a better idea of how dense your forest is. Knowing that larger-diameter trees will make up a forest with a higher basal area per acre value than the same number of smaller trees can help you judge relative densities of different forest stands.

Basal area is also commonly used for setting forest thinning targets and creating forested wildlife habitat. Having a better understanding of this term and how the values are calculated can help you make more informed decisions about your property and have more meaningful conversations with land management professionals.

Part of the confusion about the term basal area may be that it can be thought of in two different ways:

- The basal area of a tree is defined as the cross-sectional area (usually in square feet) of a **single tree** at breast height, or 4½ feet above the ground.
- Basal area also can be expressed as the cross-sectional area of **all stems** of a species or all stems in a stand measured at breast height and expressed as per unit of land area.

BASAL AREA VS. TREES PER ACRE

Trees per acre (TPA) is a common measure of the number of standing trees that are found on an acre of land. It is also a relatively easy way to calculate stand density, or how crowded trees are in a stand.

Trees per acre does not account for the size of trees. Instead, it is based on the distance between trees or the spacing of trees on a site. In a forest plantation, the number of trees per acre can be estimated by the spacing within a row of trees and the distance between rows. Similarly, we can count the number of trees on a fixed-area plot and multiply by plot size to estimate trees per acre.

Trees per acre alone is appropriate for describing stand density in some instances; but as trees grow and become more valuable, using trees-per-acre numbers in combination with basal area can be a better description of the forest.

For example, a stand of 6-inch DBH trees averaging 100 trees per acre does not contain the same amount of wood as a stand that has 100 trees per acre of 16-inch DBH trees. Similarly, forest stands can have the same basal area yet look very different. The diameter of trees at DBH determines how many trees per acre it takes to make a given basal area. Figure 12.1 illustrates how many trees of 6, 10, 14, and 18 inches DBH you would have on a 1/5-acre circular plot to make 60 square feet of basal area.

Knowing basal area along with trees per acre can help you estimate forest density.

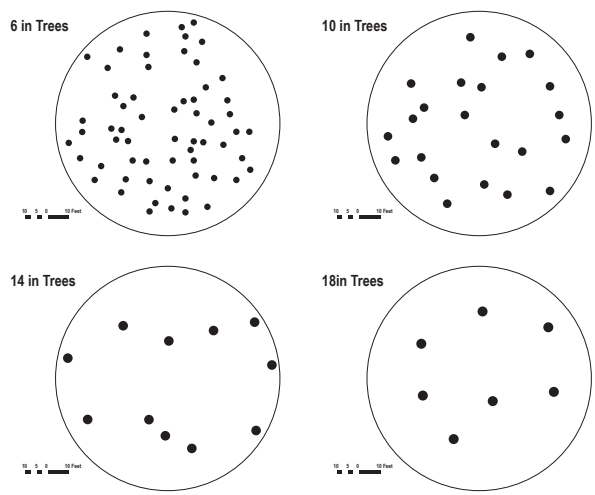

Figure 12.1. Example of the number of trees of 6, 10, 14, and 18 inches DBH it would take on a 1/5-acre circular plot to make 60 square feet of basal area.

HOW BASAL AREA IS CALCULATED

Picture an acre of trees cut off at DBH (4½ feet above the ground on the uphill side). The total surface area of the top of the stumps in square feet would be the basal area of that acre. In mathematical terms, we calculate the square feet (ft.^{2}) of basal area of a single tree as follows:

$$[\pi \div (4 \times 144)] \times (\text{DBH})^2 = 0.005454 \times (\text{DBH})^2$$

π = 3.14; DBH = diameter breast height; 0.005454 = the forester's constant, which converts the measured inches into square feet

HOW TO DETERMINE BASAL AREA USING A FOREST PLOT

Basal area per acre can be determined using a fixed-radius plot:

1. Measure the DBH of each tree on the plot.
2. Compute each tree's square feet of basal area.
3. Add each tree's basal area value to get the total square feet of basal area represented by that plot.
4. Multiply the total square feet of basal area for the plot by plot size to convert it to an estimate of square feet per acre represented by that plot.

The example tally card in table 12.1 illustrates how to calculate square feet of basal area for the plot and per acre using a 1/20-acre fixed-radius (circular) forest plot. If we total the basal area (ft.^{2}) for all trees on the plot and multiply by plot size, we get an estimate of basal area per acre in square feet represented by this plot:

5.0334 ft.^{2} × 20 = 100.7 ft.^{2} of basal area per acre

If we want to know how many square feet of basal area per acre we have in hardwood trees on this plot, we add up the square feet of basal area for just the hardwoods and multiply by 20. In this example, we have two hardwood trees. To calculate basal area per acre we use this calculation:

0.1835 ft.^{2} + 0.2029 ft.^{2} = 0.3864 ft.^{2} per plot
0.3864 ft.^{2} × 20 = 7.7 ft.^{2} basal area per acre in hardwoods

To determine the square feet of basal area per acre for pines based on this plot, we subtract the basal area per acre we calculated for hardwoods from the total per-acre basal area we calculated for the plot:

100.7 ft.^{2} basal area per acre (for the total plot) – 7.7 ft.^{2} basal area per acre (hardwoods) = 93.0 ft.^{2} per acre basal area for pines

Using what we have learned in prior chapters we can also calculate trees per acre represented by this plot.

Total trees per acre based on this plot:
8 trees × 20 = 160 trees per acre

Hardwood trees per acre:
2 trees × 20 = 40 trees per acre

Pine trees per acre:
6 trees × 20 = 120 trees per acre

Based on this sample plot, we estimate that this forest has approximately 101 square feet of basal area and 160 trees per acre. Note that in a complete inventory, multiple plots are taken across the forest, and the average of those plots (trees per acre, square feet of basal area, etc.) is used to obtain stand estimates.

Table 12.1. Calculating Total and Per-acre Basal Area in Square Feet

Names: Hunt and Land Plot number: 1			Date: 19 May 2021 Plot size: 1/20-acre fixed-radius plot	
Species (pine/ hardwood)	**DBH (in.)**	**Height (ft.)**	**DBH² × 0.005454**	**Basal Area (ft.²)**
Hardwood	5.8	53	$5.8^2 \times 0.005454$	0.1835
Pine	11.7	81	$11.7^2 \times 0.005454$	0.7466
Pine	14.2	84	$14.2^2 \times 0.005454$	1.0997
Hardwood	6.1	60	$6.1^2 \times 0.005454$	0.2029
Pine	9.4	75	$9.4^2 \times 0.005454$	0.4819
Pine	10.9	79	$10.9^2 \times 0.005454$	0.6480
Pine	8.5	70	$8.5^2 \times 0.005454$	0.3941
Pine	15.3	93	$15.3^2 \times 0.005454$	1.2767
		Total basal area (in square feet) on the plot		5.0334
		Basal area (in square feet) per acre (5.0334 sq. ft. × 20 = 100.7 sq. ft. per ac.)		100.7

YOUR TURN

Using the sample tally card determine the square feet of basal area per acre for all species, the pines, and the hardwoods. Also determine the total trees per acre represented by this plot.

Table 12.2. Sample Tally Card

Names: Hunt and Land Plot number: 2			Date: 19 May 2021 Plot size: 1/20-acre fixed-radius plot	
Species (pine/ hardwood)	**DBH (in.)**	**Height (ft.)**	**DBH² × 0.005454**	**Basal Area (ft.²)**
Pine	14	80		
Pine	11	70		
Pine	12	70		
Hardwood	13	60		
Hardwood	10	70		
Pine	13	70		
		Total basal area (in square feet) on the plot		
		Basal area (in square feet) per acre		

Answers to Sample Tally Card Calculations

Names: Hunt and Land Plot number: 2			Date: 19 May 2021 Plot size: 1/20-acre fixed-radius plot	
Species (pine/ hardwood)	**DBH (in.)**	**Height (ft.)**	**DBH² × 0.005454**	**Basal Area (ft.²)**
Pine	14	80	$14^2 \times 0.005454$	1.0690
Pine	11	70	$11^2 \times 0.005454$	0.6600
Pine	12	70	$12^2 \times 0.005454$	0.7854
Hardwood	13	60	$13^2 \times 0.005454$	0.9217
Hardwood	10	70	$10^2 \times 0.005454$	0.5454
Pine	13	70	$13^2 \times 0.005454$	0.9217
			Total basal area (in square feet) on the plot	4.9032
			Basal area (in square feet) per acre	98.0

To determine the square feet of basal area per acres for hardwood trees represented by this plot, add up the square feet of basal area for each hardwood tree then multiply by your plot size of 20.

0.9217 ft.² + 0.5454 ft.² = 1.4671 ft.² per plot
1.4671 ft.² × 20 = 29.38 ft.² basal area per acre in hardwoods

To determine the square feet of basal area per acre for pines based on this plot, we subtract the basal area per acre we calculated for hardwoods from the total per-acre basal area we calculated for the plot:

98.0 ft.² basal area per acre (for the total plot) – 29.38 ft.² basal area per acre (hardwoods) = 68.7 ft.² per acre basal area for pines

Total trees per acre: 6 trees × 20 = 120 trees per acre
Hardwood trees per acre: 2 trees × 20 = 40 trees per acre
Pine trees per acre: 4 trees × 20 = 80 trees per acre

Based on this sample plot (table 12.2), we estimate that this forest stand has approximately 98 square feet of basal area and 120 trees per acre. Notice how the basal area is not much different for this plot compared to the sample plot in table 12.1. However, there are fewer trees per acre represented by this plot (120 trees per acre) compared to the sample plot in table 12.1 (160 trees per acre). This is because the trees found on this plot are larger overall than the ones in table 12.1; therefore, not as many trees are needed to make that same amount of square feet per acre.