Tools for Measuring Your Forest

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Woodland owners routinely want to measure property acreage, boundaries, ground slope, various characteristics of standing timber, and individual log volumes. Different tools are required for each of these tasks (Figure 1).

Forests and forest products can be measured efficiently and precisely with sophisticated, and often expensive, instruments. However, most measurements can be made with a few simple and inexpensive tools.

This publication discusses only those tools that are readily available, affordable, and appropriate for a woodland owner who has basic measurement skills. Table 1 (page 6) compares the accuracy and convenience of each type of tool for taking certain measurements.

Contents

The tools and how they work

Angle gauges and prisms—A mechanical or optical device for measuring basal area of trees in variable-plot radius sampling; that is, sampling where the size of each plot varies depending on the size of the trees in that plot. The most common is a wedge prism, a precisely ground-glass wedge that is calibrated in basal-area factors (BAF) from 10 to 70 (20 to 40 will meet most small woodland owners' needs). Another option for measuring basal area is an angle gauge. These are

Figure 1. Tools you'll use for some measuring tasks are (clockwise, from top left) a clinometer, a compass, an increment borer (with flagging tape attached, to make the borer easier to find if it falls on the ground), and a combination logger's tape.

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simple and inexpensive tools that cover multiple BAF. For more information on using variable radius plots, refer to *Basic Forest Inventory Techniques for Family Forest Owners* (PNW 630) in the OSU Extension Catalog (http://extension.oregonstate.edu/catalog/).

Clinometer—A rugged, hand-held instrument for measuring vertical angles such as ground slope, road grade, and tree height (Figure 2). Various models have degree and percent scales, percent and topographic scales, or degree and topographic scales. Recommended models include those containing the degree and percent scales. When using the percent scale, at a distance of 100 feet from the tree, heights can be measured directly, and ground slope is also directly read.

Combination logger's tape—A steel tape with a spring-loaded spool rewind containing measurements in various combinations on both sides of the tape. The recommended tape has inches and tenths of inches on one side, and length in feet and tenths of feet on the other. If a tape will be used for bucking logs, it is best to have a tape that measures feet and inches rather than tenths of feet (Figure 3) because these are the units used when selling logs. Standard tapes come in 50-, 75-, and 100-foot lengths. The 50-foot tape is recommended for use in logging, but if you are going to use the tape for tree measurements, the 75-foot tape is best.

Compass—A hand-held compass is a relatively rugged instrument that measures direction in degrees (Figure 4). Compasses are used most often when following transect lines to establish plots for timber measurements or cruise estimates, and in determining boundary or property lines. Placing the compass on a solid, nonmetal object can give more precise readings. Compasses are available in azimuth (0 to 360 degrees) or quadrant (0 to 90 degrees). Most woodland owners find the simpler azimuth compass easier to use.

Global Positioning System (GPS)—The GPS is a network of satellites orbiting Earth, transmitting very precise time and position data day and night. Signals from these satellites are broadcast to hand-held units on the ground. When the hand-held receiver receives signals from four or more satellites, it uses the distances from each of these satellites to determine the user's position on Earth. Hand-held units

Figure 2. The clinometer has a sighting hole and a suspended circular scale that can measure ground slope as well as tree height.

Figure 3. A combination logger's tape can measure tree diameter (above) in addition to log lengths and diameters (below).

Figure 4. Hand compasses such as this typical model are used to measure direction.

Figure 5. Consumer grade GPS units (above) are less expensive and less accurate than mapping grade GPS receivers (left), but they help make rough length or area measurements.

vary in cost from as little as $100 for consumer-grade receivers up to tens of thousands of dollars for survey-grade instruments (Figure 5). Many mobile devices such as smart phones now have built-in GPS receivers.

Accuracy of inexpensive GPS receivers and smartphones can be low, especially when trees or other obstacles don't allow a clear signal from satellites, but they can still be useful for making rough length or area measurements or for navigation in the field. More precise measurements, such as those involving property boundaries, require trained and licensed surveyors using expensive GPS receivers. High-end units most likely are not practical or cost effective for the average woodland owner.

Increment borer—This is a hand-operated drill with a hollow bit that extracts a wood core from the stem of a tree (Figure 6). Wood core samples are used in determining tree growth, age, and general health. Borer length varies in 2-inch increments, from an 8-inch minimum to a much larger maximum sampling depth. The largest is adequate for conveniently determining the age of trees up to about 30 inches in

Figure 6. A core sample obtained from a tree with the increment borer allows the user to determine a tree's growth rate.

diameter (including bark). Most woodland owners use the 8-, 10-, or 12-inch borers.

Log volume tables—A single sheet or an entire book that lists log volumes for each log length and scaling diameter. Tables are available for a number of board-foot and cubic-foot scales. The OSU Extension publication *Measuring Timber Products Harvested from Your Woodland* (EC 1127, available at http://extension.oregonstate.edu/catalog/) is a good source for log volume tables.

Pacing—This is a skill rather than a tool, but it can be—and commonly is—a substitute for tools when horizontal distance measurements do not need to be precise (Figure 7). The best way to determine your pace is to count your steps as you walk an accurately measured distance using the same kind of pace you use for everyday walking.

Rangefinder—Laser rangefinders accurately measure distances using a beam of light. Most units designed for forestry also include a digital clinometer. With this feature, a rangefinder can be used to measure horizontal and slope distance and also tree heights. Laser rangefinders cost from $400 to $3,000 depending on features and degree of accuracy.

Topographic map—A map that shows terrain (ridges, draws, and flat areas) by contour lines. The contour lines indicate locations of equal elevation and make it possible to measure the slope of the ground from the map. Widely spaced contour lines indicate flat or gentle ground; closely spaced lines indicate steep ground.

Tarif access tables—Tables that list the tarif number for individual tree species, such as Douglas-fir (Table 3, page 8) based on total tree height and diameter at breast height (dbh). Tarif is a ratio of a tree's volume to its basal area, so a low tarif number means the tree has much taper; a high tarif number means it has minimal taper. For details, see the OSU Extension publication *Measure Your Trees* (EM 9058, available at http://extension.oregonstate.edu/catalog/).

Tree volume tables—Tables that list the wood volume of individual tree species in board-foot or cubic-foot volumes. Table 2 (page 7), a sample, is based on tarif number, log length, and dbh for each tree.

Figure 7. Pacing can be a fast, easy way to estimate area and horizontal distances. However, pacing accuracy can range widely, with results from moderately accurate to very crude. Practice in order to develop a consistent pace. You might want to buy a pedometer, such as those sold in sporting goods stores, to count your paces.

Figure 8. The Woodland Stick is an easy-to-use and moderately accurate tool for measuring tree height and diameter. It must be held 25 inches from the eye; at any other distance, it gives incorrect readings.

More tree volume tables are in *Measuring Your Trees* (EM 9058), available at http://extension.oregonstate.edu/catalog/.

The Woodland Stick—Any of several sticks or other devices to help you make simple and relatively accurate estimates of tree height and diameter (Figure 8). The Woodland Stick also has an abbreviated log volume table for estimating log volumes in standing trees. This tool is more generally known as a Biltmore stick.

Comparing tools

Use Table 1 to compare tools that can be used for similar tasks. First, check the key at the top. The three numbers indicate the degree of precision and the degree of difficulty for using each tool. Determine what you want to measure and consider all the tools in the left column. Some are quick and easy to use but yield less-precise results. Others are more difficult to use—and may or may not give more precise results.

Select a tool that fits the objective. For example, if you want to measure a road grade, you can choose between a clinometer and a topographic map. The clinometer is rated at 2 for precision (that is, moderately precise) and 2 for ease of use (that is, moderately easy to use).

The topographic map is rated 1 for precision in measuring road grade (that is, less precise than the clinometer), and it's rated 2 for ease of use (moderately easy to use). Considering both methods of measurement, the clinometer would be the better option because it has a better degree of precision and is equally easy to use.

Tools discussed here are available from many sources. Most are stocked in local reforestation or logging supply stores; others can be obtained from online retailers. An Internet search for "forestry supplies" will yield several options. Tool and supply catalogs are also available in OSU Extension offices in many counties.

A new tool usually comes with instructions, but novices often need help with certain instruments. Ask the forester in the OSU Extension office nearest you for additional publications or sources of assistance.

Table 1. Rating precision and convenience of tools for various measuring tasks

Precision:
1 = less precise; 2 = moderate; 3 = more precise
Ease of use:
1 = difficult to use; 2 = moderate; 3 = easy to use

		Measurement Tasks													
		Boundaries					Logs			Trees					
		Area	Horizontal angles	Horizontal distance	Road grade	Ground slope	Diameter	Length	Volume	Age	Basal area	Current growth	Diameter	Volume	Height
Angle gauge ($)	Precision										2				
	Ease of use										2				
Clinometer ($$)	Precision				2	2									2
	Ease of use				2	2									2
Compass ($)	Precision		2												
	Ease of use		2												
Global Pos. Sys.[1] ($$–$$$)	Precision	3	2	3		1									
	Ease of use	1	1	1		1									
Increment borer ($$$)	Precision									3		3			
	Ease of use									2		2			
Logger's tape[2] ($$)	Precision	2		2			3	3					3		
	Ease of use	2		3			3	3					3		
Log volume table ($)	Precision								3						
	Ease of use								3						
Pacing ($)	Precision	1		1											
	Ease of use	3		3											
Rangefinder ($$$)	Precision			3	2	2									
	Ease of use			2	2	2									
Tarif access tables[3] ($)	Precision													3	
	Ease of use													2	
Topographic map ($)	Precision				1	1									
	Ease of use				2	2									
Woodland stick ($)	Precision						2						2	1	2
	Ease of use						3						3	3	3

Cost: $ = $0–$50, $$ = $50–$100, $$$ = $150+

[1] Global Positioning Systems come in a wide price range; price directly relates to accuracy.

[2] Logger's tape cartridges come with feet and inches on one side and tree diameter (inches) on the other side.

[3] Tarif access tables include tarif tables for individual species and tree volume table.

Table 2. Tree volume table (Scribner volume table 32″ logs to 5″ top)*

DBH (inches)	Tarif numbers																														
	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	40	41	42	43	44	45
7	10	10	10	10	10	10	10	10	10	10	10	10	10	10	20	20	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
8	10	10	10	10	10	10	10	10	10	10	30	30	30	30	30	30	30	40	40	40	40	40	40	40	40	40	40	60	70	70	70
9	20	20	20	20	20	20	20	30	30	30	30	30	40	40	40	70	70	60	60	60	60	60	60	70	70	70	70	70	70	80	80
10	20	20	20	20	20	30	30	30	30	40	40	60	70	70	60	60	60	70	70	80	80	80	80	80	90	90	90	90	90	90	90
11	20	20	20	30	30	30	30	40	60	60	70	70	70	70	70	70	80	80	80	90	90	100	100	100	100	100	100	100	110	110	130
12	20	20	30	30	30	40	60	60	80	80	80	70	70	80	90	90	90	90	90	100	100	100	100	120	120	120	150	150	150	150	150
13	20	30	30	30	60	60	70	80	80	70	80	80	90	90	90	110	110	120	120	120	120	120	120	130	150	150	150	150	160	200	200
14	30	30	30	60	60	70	80	90	80	80	80	110	110	110	110	120	120	120	150	150	150	180	180	180	180	190	190	200	200	200	220
15	30	30	60	70	70	80	90	80	80	110	110	110	110	140	150	150	150	150	150	170	180	200	210	210	210	220	230	230	230	240	240
16	30	60	70	70	90	90	80	100	110	110	140	140	150	150	150	170	170	170	190	200	210	210	210	220	230	230	250	260	280	280	280
17	50	60	70	90	90	110	100	110	140	140	140	150	170	170	170	170	170	220	220	230	230	230	250	250	250	270	280	280	280	280	310
18	60	70	80	90	110	100	130	140	140	160	160	170	170	190	190	190	220	220	230	230	270	280	280	300	300	310	310	340	340	340	370
19	70	80	80	110	110	130	140	160	160	160	190	190	190	190	190	240	260	260	270	270	280	300	300	300	380	380	380	380	400	430	430
20	70	80	110	110	130	130	160	160	180	190	190	190	220	220	240	260	260	310	310	340	340	340	370	380	380	380	400	400	430	440	440
21	80	80	110	140	130	160	160	180	180	190	220	220	220	280	290	300	310	310	330	340	420	420	430	450	450	450	450	500	510	510	520
22	80	100	140	140	150	180	180	180	220	220	220	260	260	280	300	360	360	380	390	420	420	420	450	450	490	510	540	550	550	590	600
23	80	110	140	160	170	180	210	210	220	260	260	260	330	350	350	360	380	380	460	460	480	490	490	510	510	530	580	580	590	600	670
24	100	140	160	150	180	210	210	250	260	260	310	310	330	390	400	420	420	460	460	480	540	560	560	560	610	620	630	640	690	710	710
25	100	140	160	170	210	210	250	260	310	310	310	370	390	400	400	420	500	510	530	530	560	560	590	610	680	690	740	750	770	770	860
26	130	160	180	170	210	250	250	310	310	350	350	370	440	450	470	500	510	530	590	610	620	650	650	670	730	740	740	820	820	850	910
27	130	160	180	200	250	250	300	310	350	350	400	420	440	450	530	560	590	590	610	620	700	700	760	780	780	840	870	870	900	950	970
28	130	180	210	200	250	300	340	350	350	400	420	490	510	530	560	590	640	660	660	700	700	740	760	830	920	940	950	1020	1020	1050	1050
29	150	180	210	240	300	340	340	400	400	460	480	500	560	580	610	640	660	660	780	780	820	840	910	910	920	990	1020	1020	1050	1120	1120
30	150	180	250	240	300	340	390	400	460	460	530	550	580	610	710	740	740	770	820	820	920	940	960	1010	1030	1070	1120	1140	1170	1170	1200
31	150	210	250	290	340	390	390	460	460	510	530	640	660	690	710	740	820	820	870	920	920	980	1010	1030	1150	1180	1200	1230	1290	1320	1340
32	150	210	250	330	340	390	450	460	510	590	620	640	710	760	780	790	820	860	980	980	1040	1060	1120	1140	1180	1260	1260	1290	1320	1320	1440
33	170	210	300	330	390	450	500	510	590	590	670	690	740	760	850	880	920	980	980	1020	1120	1190	1220	1250	1320	1340	1370	1450	1450	1510	1530
34	170	250	300	330	450	450	500	590	590	640	670	770	800	820	850	880	1000	1060	1100	1100	1180	1200	1280	1320	1340	1470	1480	1510	1550	1660	1720
35	170	250	340	380	450	500	580	590	640	660	730	770	820	920	960	1000	1050	1100	1160	1230	1240	1320	1340	1430	1450	1470	1510	1630	1650	1720	1730
36	170	250	340	380	500	580	580	640	700	720	820	850	900	920	1020	1060	1110	1160	1210	1230	1310	1450	1530	1560	1580	1700	1700	1740	1810	1880	1950

*Condensed from VARPLOT Scribner Volume Tables

Table 3. Tarif access table for Douglas-fir*

Height (feet)

DBH (inches)	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170
7		15	17	20	23	26	29	31	33	37	40	42	44																
8		15	17	19	22	25	27	30	32	35	38	39	42	44															
9		15	16	18	21	24	25	28	30	33	36	38	40	41	45														
10			15	17	21	22	25	27	29	31	34	36	38	39	41	44													
11			15	17	19	21	24	27	28	30	32	35	38	39	41	43	45												
12			15	16	18	21	23	25	27	29	31	34	36	38	40	42	43												
13			15	16	18	21	22	24	27	29	30	32	34	36	39	41	42	45											
14				15	17	19	21	24	25	28	30	32	34	36	38	40	41	43	45										
15				15	17	19	21	23	25	27	29	31	33	34	37	39	40	42	44										
16				15	16	18	21	23	24	27	28	30	32	34	36	38	39	41	43	45									
17				15	16	18	21	22	24	27	28	29	31	33	35	38	39	41	42	44									
18				15	16	18	19	21	23	25	27	29	31	32	34	36	38	40	41	43	45								
19					15	17	19	21	23	25	27	28	30	32	34	36	38	39	41	42	44								
20					15	17	18	21	22	24	27	28	29	31	33	35	36	38	40	42	43	45							
21					15	17	18	21	22	24	25	27	29	31	32	34	36	38	39	41	43	44							
22					15	16	18	19	21	23	25	27	28	31	32	33	35	37	38	40	42	43	45						
23					15	16	18	19	21	23	25	27	28	30	31	33	35	36	38	40	41	43	44						
24					15	16	17	19	21	23	24	26	27	29	31	32	34	36	38	39	41	42	44	45					
25					15	16	17	19	21	22	24	26	27	29	30	32	34	35	37	38	40	42	43	45					
26						15	17	19	21	22	23	25	27	28	30	32	33	35	36	38	39	41	43	44					
27						15	17	19	21	22	23	25	26	28	30	31	33	35	36	38	39	41	42	43	45				
28						15	17	18	20	21	23	25	26	28	29	31	32	34	35	37	38	40	41	43	44				
29						15	16	18	19	21	23	24	26	28	29	30	32	33	35	37	38	39	41	42	44	45			
30						15	16	18	19	21	22	24	25	27	28	30	31	33	34	36	38	39	40	42	43	45			
31						15	16	17	19	21	22	24	25	27	28	30	31	33	34	35	37	38	40	41	43	44			
32						15	16	17	19	21	22	23	25	27	28	29	31	32	34	35	37	38	39	41	42	44	45		
33						15	16	17	19	20	21	23	25	26	28	29	30	32	33	35	36	38	39	40	42	43	45		
34							16	17	19	20	21	23	24	26	27	29	30	32	33	34	36	38	39	40	41	43	44		
35							15	17	19	20	21	22	24	26	27	28	30	31	33	34	35	37	38	40	41	43	44	45	
36							15	17	18	19	21	22	24	25	27	28	29	31	33	34	35	37	38	39	41	42	44	45	

*Condensed from VARPLOT Tree Volume Tarif Access Tables (2002)

For more information

Oregon State University Extension Service publications available online at http://extension.oregonstate.edu/catalog/

Measuring Your Trees (EM 9058)

Tarif Access Tables: A Comprehensive List (EM 1609-E)

Measuring Timber Products Harvested from Your Woodland (EC 1127).

Land Measurement and Survey: An Introduction for Woodland Owners (PNW 581)

Basic Forest Inventory Techniques for Family Forest Owners (PNW 630)

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