

Forest Measurements

Tools for Measuring Your Forest

As a landowner, you frequently may want to measure property boundaries, ground slope, standing timber size, and log volume. You need tools for each of these tasks.

You can measure forests and forest products most efficiently and precisely with the aid of sophisticated, and often expensive, instruments. However, you can make most necessary measurements with a few simple and inexpensive tools.

This publication discusses only those tools that are readily available and appropriate for a landowner with basic measurement skills. On page 7, you will find a list of the tools that compares the accuracy and convenience of each for various measurement tasks.

The tools—and how they work

Abney hand level (abney). This delicate instrument consists of a sighting tube and a level bubble with attached scales. The scales are usually graduated in degrees or percent. The abney measures vertical angles and is useful for determining ground slope, road grade, and tree height (see figures 1 and 2).

Angle gauge. A mechanical or optical device for selecting trees in variable plot sampling. The most common is a wedge prism—a precisely ground glass wedge that is

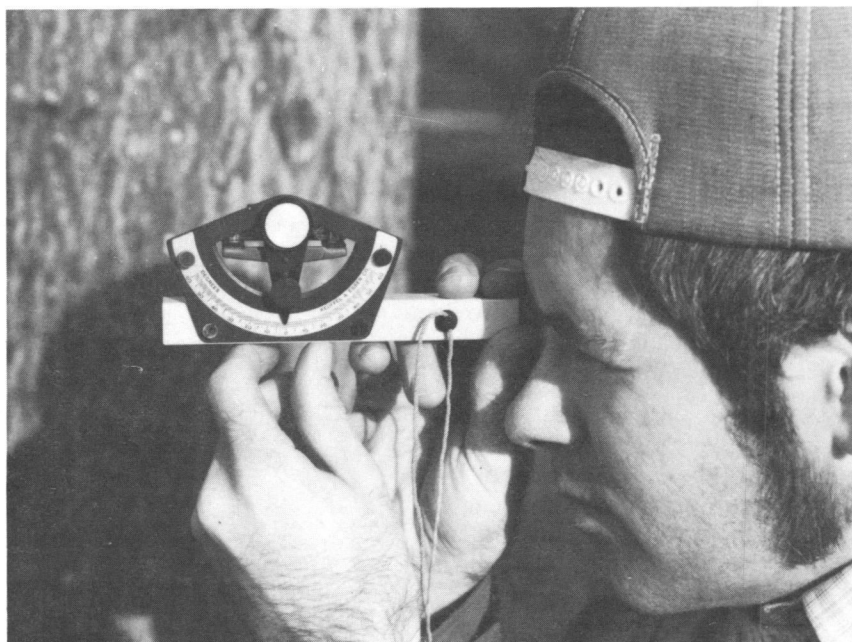


Figure 1.—To use an abney level, sight an object through the telescope and move the level bubble to the center position. The number on the scale is the correct reading.

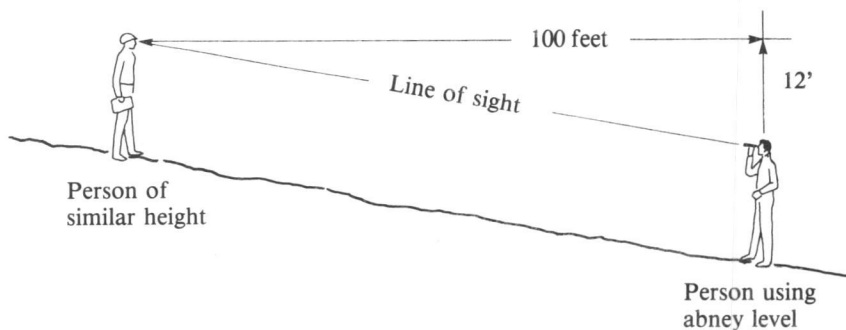
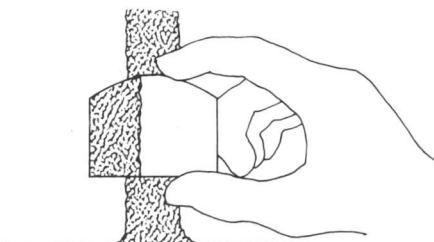


Figure 2.—Measuring the slope of a hill with an abney. (The reading is +12 on a percent scale.) Both people are the same height so the lower person can sight at the eyes of the upper person.

Figure 3.—(right) A wedge prism—one of the angle gauges available for estimating the basal area of a stand of trees.



calibrated in basal area factors (BAF) (see figure 3). You need different BAF prisms for different diameter classes of timber.

Biltmore stick. One of several similar sticks or other devices to aid you in making simple but crude estimates of tree height and diameter (see figures 4 and 5). You can purchase or make one easily.

Clinometer. A rugged hand-held instrument for measuring vertical angles. Most models have both degree and percent scales. You can use clinometers for the same tasks as abney levels; however, they provide less precise readings (see figures 6, 7, and 8).

Compass. A hand-held compass is a relatively rugged instrument that measures horizontal angles or direction (see figure 9). You can make more precise readings when you place the compass on a solid, nonferrous object.

Diameter tape. A steel tape that measures the circumference of a tree. It is calibrated to permit direct tree diameter readings (see figure 10).

Increment borer. A hand-operated drill with a hollow bit that extracts a wood core from the stem of a tree (see figure 11). Borers vary in length, but the maximum sampling depth is about 16 inches. This is adequate for conveniently determining the age of trees up to about 30 inches in diameter (including the bark). The wood core also provides a record of a tree's diameter growth in previous years.

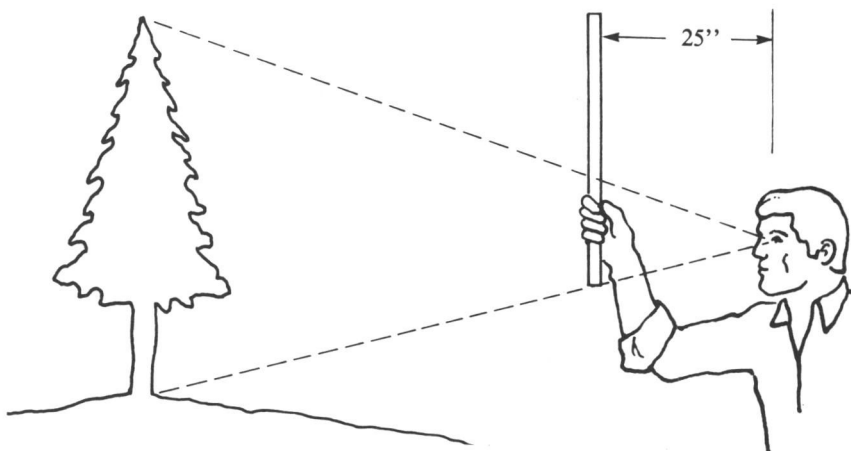


Figure 4.—Measuring tree height with a Biltmore stick. Most sticks are made to be held 25 inches from the eye—any other distance causes incorrect readings.

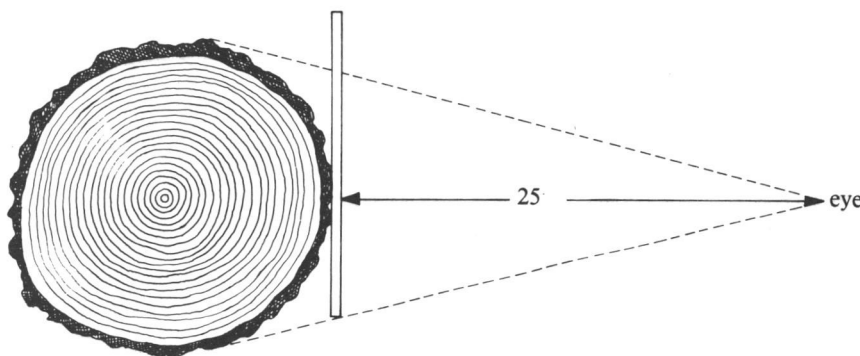


Figure 5.—Measuring tree diameter with a Biltmore stick.



Figure 6.—(right) The clinometer has a sighting hole and a suspended circular scale.

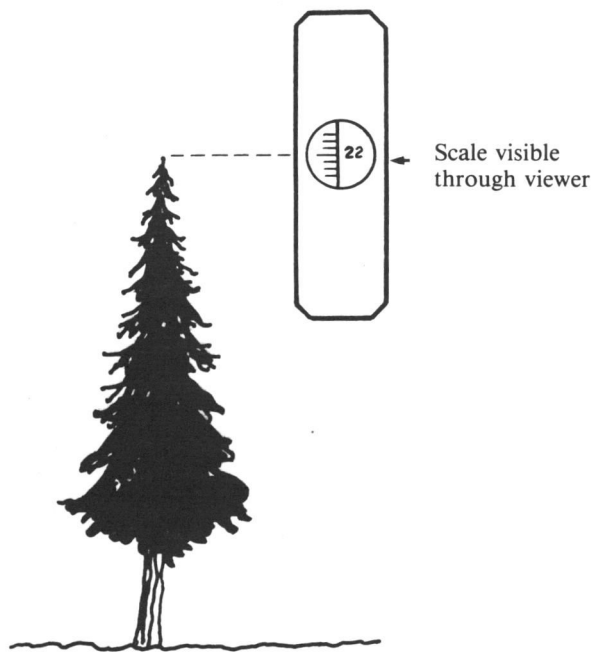


Figure 7.—Viewing a tree top with a clinometer. (View the tree with the left eye and read the clinometer scale with the right eye.)

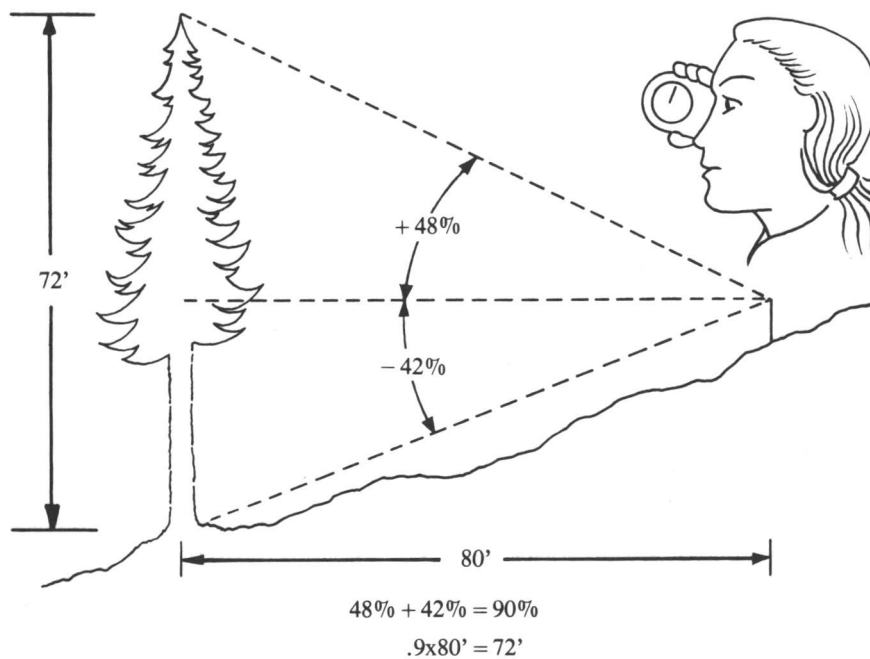


Figure 8.—Estimating tree height with a clinometer.

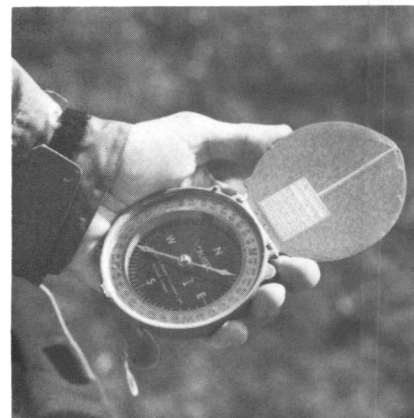


Figure 9.—(both photographs above) Hand compasses typical of the models available.



Figure 10.—Measuring tree diameter with a diameter tape.

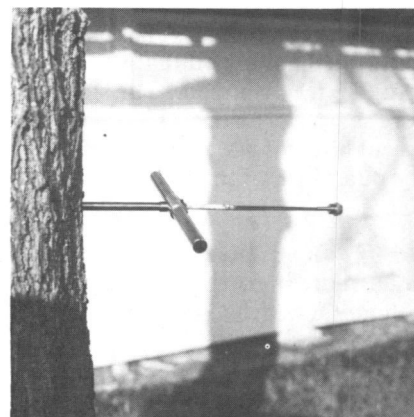


Figure 11.—Increment borer extracting a core sample from a tree.



Figure 12.—An increment hammer is used to obtain a sample of a tree's outer inch.



Figure 13.—A rangefinder is useful for estimating distance.

Increment hammer. A hammerlike tool with a hollow bit that you drive into the tree by impact. The short core sample provides a record of recent growth, which is limited to the outer inch of the tree (see figure 12).

Log volume table. A single sheet or an entire book that lists log volumes for each log length and

small-end diameter (see table 1). The tables are available in board-foot and cubic-foot measurements. Oregon State University Extension Service Circular 1127, *Measuring Timber Products Harvested from Your Woodland* (in press, 1983), also contains a log volume table.

Pacing. This is a skill rather than a tool, but it can be—and commonly is—substituted for tools when horizontal distance measurements do not need to be precise.

Rangefinder. A convenient optical device, this tool provides horizontal measurements that are more precise than most pacing, but less precise than taping. Rangefinders are particularly useful for a person working alone (see figure 13).

Tape. A narrow, flexible band or strip that measures linear distance. Tapes are made of modern materials to resist rust, wear, breakage, and length change. The most convenient tape for forestry use is the 50- or 75-foot "logger's tape," which hooks on a belt and rewinds automatically when not in use.

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.

Tree volume tables. Single sheets or books of tables that list the wood volume of trees in board or cubic feet, or both (see table 2). The tables are based on the height of the entire tree or a specified portion (total stem, stem to a 4-inch minimum top, stem to a 6-inch minimum top, etc.), and diameter at breast height (d.b.h.).

(Text continues on page 7)

Table 1.—Log volume table; Scribner log rule, board-foot volume

		Log length (feet)																																					
Small-end diameter of log (inches)		8	9	10	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	40					
	4	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	20	20	20	20	20	20	20	20	20	20	20	20	20	30	30	30	30	30				
	5	10	10	10	10	10	10	10	10	20	20	20	20	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	40	40	40	40	40	40				
	6	10	10	10	10	10	20	20	20	20	20	20	20	20	20	30	30	30	30	30	30	30	30	40	40	40	50	50	50	50	60	60	60	60	60				
	7	10	10	10	20	20	20	20	20	20	30	30	30	30	30	30	40	40	40	40	40	40	50	50	50	50	50	60	60	60	70	70	70	70	70				
	8	10	10	20	20	20	20	20	20	30	30	30	30	40	40	40	40	40	50	50	50	50	50	60	60	70	70	70	80	80	80	80	90	90					
	9	20	20	20	20	30	30	30	30	40	40	40	40	50	50	50	50	60	60	60	70	70	70	70	70	90	100	100	100	100	110	110	110	120	120				
	10	30	30	30	30	40	40	40	50	60	60	60	60	70	70	70	80	80	90	90	90	100	100	100	110	110	120	130	130	130	140	140	140	150	150				
	11	30	30	40	40	40	50	50	60	70	70	80	80	80	90	90	100	100	100	110	110	120	120	130	130	140	150	160	160	170	170	180	180	180	180				
	12	40	40	50	50	60	60	70	70	80	80	90	90	100	100	110	110	120	120	130	130	140	140	150	150	160	160	170	170	180	180	190	190	200	200				
	13	50	50	60	70	70	80	80	90	100	100	110	110	120	130	130	140	150	150	160	160	170	180	180	190	190	200	210	210	220	220	230	240	240	240				
	14	60	60	70	80	90	90	100	110	110	120	130	140	140	150	160	170	180	190	190	200	210	210	220	230	240	240	250	260	260	270	280	280	290	290				
	15	70	80	90	100	110	120	120	130	140	150	160	170	180	190	200	200	210	220	230	240	250	260	270	280	280	290	300	310	320	330	340	350	360	360				
	16	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400	400				
	17	90	100	120	130	140	150	160	170	180	200	210	220	230	240	250	270	280	290	300	310	320	330	350	360	370	380	390	400	410	420	430	440	450	460				
	18	110	120	130	150	160	170	190	200	210	230	240	250	270	280	290	310	320	330	350	360	370	390	400	410	430	440	450	470	480	490	510	520	530	530				
	19	120	130	150	160	180	190	210	220	240	250	270	280	300	310	330	340	360	370	390	400	420	430	450	460	480	490	510	520	540	550	570	580	600	600				
	20	140	160	170	190	210	230	240	260	280	300	310	330	350	370	380	400	420	440	450	470	490	510	520	540	560	580	590	610	630	650	660	680	700	700				
	21	150	170	190	210	230	250	270	280	300	320	340	360	380	400	420	440	460	470	490	510	530	550	570	590	610	630	650	670	690	710	730	740	760	760				
	22	170	190	210	230	250	270	290	310	330	350	380	400	420	440	460	480	500	520	540	560	580	610	630	650	670	690	710	730	750	770	790	810	840	840				
	23	190	210	240	260	280	310	330	350	380	400	410	450	470	490	520	540	560	590	610	630	660	680	710	730	750	780	800	820	850	870	890	920	940	940				
	24	200	230	250	280	300	330	350	380	400	430	450	480	500	530	550	580	610	630	660	680	710	730	760	780	810	830	860	880	910	930	960	980	1010	1010				
	25	230	260	290	320	340	370	400	430	460	490	520	540	570	600	630	660	690	720	750	770	800	830	860	890	920	950	980	1000	1030	1060	1090	1120	1150	1150				
	26	250	280	310	340	370	410	440	470	500	530	560	590	620	660	690	720	750	780	810	840	870	910	940	970	1000	1030	1060	1090	1120	1160	1190	1220	1250	1250				

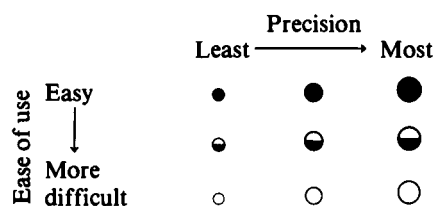
Table 2.—Example of a tree volume table^a

TOTAL TREE CU.FT. VOLUME						D B H	VOLUME TO A 4 INCH TOP IN CUBIC FEET			VOLUME TO A 6 INCH TOP												D B H			
INCLUDING TOP AND STUMP			INCLUDING TOP ONLY							CUBIC FEET			BOARD FEET SCRIBNER										BOARD FEET INTERNATIONAL 1/4 16 FOOT LOGS		
													16 FOOT LOGS			32 FOOT LOGS									
VOL	V/BA	GM	VOL	V/BA	GM		VOL	V/BA	GM	VOL	V/BA	GM	VOL	V/BA	GM	VOL	V/BA	GM	VOL	V/BA	GM				
0.3	14.6	0.3	0.3	13.0	0.3	2																2			
1.0	20.1	1.0	0.9	18.6	0.9	3																3			
2.2	25.6	1.5	2.1	24.1	1.4	4																4			
4.0	29.1	2.0	3.8	27.8	1.9	5	2.0	14.4	2.2													5			
6.2	31.5	2.5	5.9	30.3	2.4	6	4.4	22.2	2.6													6			
8.9	33.2	2.9	8.6	32.0	2.8	7	7.2	26.9	3.1	2.7	10.2	3.3	9.	33.9	12.1	7.	27.5	9.9	15.	54.6	17.9	7			
12.0	34.5	3.4	11.6	33.3	3.3	8	10.5	30.0	3.5	6.4	18.3	4.0	24.	68.5	17.4	19.	55.7	14.2	35.	100.6	22.9	8			
15.7	35.5	3.9	15.2	34.3	3.8	9	14.2	32.1	3.9	10.7	24.3	4.6	44.	98.6	21.7	35.	80.2	17.7	60.	135.9	26.8	9			
19.8	36.3	4.4	19.2	35.1	4.2	10	18.3	33.6	4.4	15.5	28.4	5.0	67.	123.1	25.3	55.	100.1	20.6	88.	162.2	29.9	10			
24.4	37.0	4.8	23.6	35.8	4.7	11	22.9	34.7	4.8	20.7	31.3	5.3	94.	142.4	28.4	76.	115.9	23.1	120.	181.6	32.8	11			
29.5	37.5	5.3	28.5	36.3	5.1	12	27.9	35.5	5.2	26.1	33.3	5.7	124.	157.7	31.3	101.	128.4	25.5	154.	196.1	35.5	12			
35.0	38.0	5.8	33.9	36.8	5.6	13	33.4	36.2	5.7	32.0	34.7	6.0	157.	169.9	34.1	127.	138.3	27.8	191.	207.1	38.3	13			
41.0	38.4	6.2	39.7	37.1	6.0	14	39.3	36.7	6.1	38.1	35.7	6.3	192.	179.7	36.9	156.	146.4	30.2	231.	215.6	41.1	14			
47.5	38.7	6.7	46.0	37.5	6.5	15	45.6	37.1	6.5	44.7	36.4	6.7	230.	187.8	39.8	188.	153.0	32.5	273.	222.5	43.9	15			
54.4	39.0	7.2	52.7	37.7	6.9	16	52.3	37.5	7.0	51.5	36.9	7.1	272.	194.6	42.6	221.	158.6	34.9	318.	228.0	46.9	16			
61.8	39.2	7.6	59.9	38.0	7.4	17	59.5	37.8	7.4	58.8	37.3	7.5	316.	200.3	45.6	258.	163.4	37.3	367.	232.7	49.9	17			
69.7	39.4	8.1	67.5	38.2	7.8	18	67.2	38.0	7.9	66.5	37.6	7.9	363.	205.3	48.6	296.	167.6	39.8	418.	236.7	53.0	18			
78.0	39.6	8.6	75.5	38.4	8.3	19	75.2	38.2	8.3	74.6	37.9	8.3	413.	209.7	51.6	337.	171.3	42.3	473.	240.1	56.2	19			
86.8	39.8	9.0	84.0	38.5	8.7	20	83.8	38.4	8.7	83.1	38.1	8.7	466.	213.6	54.6	381.	174.5	44.8	531.	243.2	59.3	20			
96.0	39.9	9.5	92.9	38.6	9.1	21	92.7	38.5	9.2	92.0	38.2	9.1	522.	217.0	57.6	427.	177.5	47.4	591.	245.9	62.5	21			
105.7	40.0	9.9	102.3	38.8	9.6	22	102.1	38.7	9.6	101.3	38.4	9.6	581.	220.2	60.7	476.	180.2	50.0	655.	248.3	65.7	22			
115.8	40.1	10.4	112.1	38.9	10.0	23	111.9	38.8	10.0	111.1	38.5	10.0	643.	223.0	63.7	527.	182.6	52.6	723.	250.5	68.9	23			
126.4	40.2	10.8	122.4	38.9	10.5	24	122.1	38.9	10.5	121.3	38.6	10.4	709.	225.6	66.8	581.	184.9	55.2	793.	252.5	72.2	24			
137.5	40.3	11.3	133.0	39.0	10.9	25	132.8	39.0	10.9	131.9	38.7	10.8	777.	227.9	69.8	637.	186.9	57.8	867.	254.4	75.4	25			
148.9	40.4	11.7	144.2	39.1	11.3	26	144.0	39.0	11.3	142.9	38.8	11.3	848.	230.1	72.9	696.	188.9	60.4	944.	256.0	78.6	26			
160.9	40.5	12.2	155.7	39.2	11.8	27	155.5	39.1	11.8	154.4	38.8	11.7	923.	232.1	75.9	758.	190.7	63.1	1024.	257.6	81.8	27			
173.3	40.5	12.6	167.7	39.2	12.2	28	167.5	39.2	12.2	166.3	38.9	12.1	1000.	233.9	78.9	822.	192.3	65.7	1107.	259.0	84.9	28			
186.1	40.6	13.1	180.1	39.3	12.6	29	179.9	39.2	12.7	178.7	39.0	12.6	1080.	235.5	81.9	889.	193.9	68.3	1194.	260.3	88.1	29			
199.4	40.6	13.5	193.0	39.3	13.1	30	192.8	39.3	13.1	191.5	39.0	13.0	1164.	237.1	84.8	959.	195.3	70.8	1284.	261.5	91.3	30			
213.1	40.7	14.0	206.3	39.4	13.5	31	206.1	39.3	13.5	204.7	39.0	13.4	1250.	238.5	87.7	1031.	196.7	73.4	1377.	262.6	94.5	31			
227.3	40.7	14.4	220.0	39.4	14.0	32	219.9	39.4	14.0	218.3	39.1	13.9	1339.	239.8	90.7	1106.	198.0	76.0	1473.	263.7	97.6	32			
242.0	40.7	14.9	234.2	39.4	14.4	33	234.0	39.4	14.4	232.4	39.1	14.3	1431.	241.0	93.5	1183.	199.2	78.5	1572.	264.6	100.7	33			
257.1	40.8	15.3	248.8	39.5	14.8	34	248.6	39.4	14.8	246.9	39.2	14.7	1526.	242.1	96.4	1263.	200.3	81.1	1674.	265.5	103.9	34			
272.6	40.8	15.8	263.9	39.5	15.3	35	263.7	39.5	15.3	261.8	39.2	15.2	1624.	243.1	99.1	1345.	201.3	83.7	1779.	266.3	106.9	35			

^aTarif number 36.5 in *Comprehensive Tree-Volume Tarif Tables*, 3rd ed., State of Washington, Department of Natural Resources, October 1980.

Table 3.—*Precision and convenience of tools for various tasks*

Task to measure	Tools												
	Abney hand level	Angle gauge	Biltmore stick	Clinometer	Compass	Diameter tape	Increment borer	Increment hammer	Log volume table	Pacing	Range finder	Logger's tape	Topographic map
Boundaries													
Horizontal angles					●								
Horizontal distance										●	○	●	
Road grade	◐			●									○
Ground slope	◐			●									●
Logs													
Diameter			◐			○						◐	
Length												●	
Volume									●				
Trees													
Age							◐						
Basal area		◐				○							
Current growth							◐	●					
Diameter			●			◐							
Height													
Distance										●	●	◐	
Vertical angle	◐		○	●									
Volume													○



Comparing the tools

Use table 3 to compare tools that you can use for the same tasks. First, check the key at the bottom. Note that the three *sizes* of circles indicate the degree of precision; the black-to-white *range* indicates degree of difficulty in use. Now find in the left column the factors you intend to measure—and consider all the tools shown on each line. Some are quick and easy to use—but yield rough results. Others are more difficult to use—and may or may not give precise results.

Select the tool that fits your need. For example, if you want to measure the grade of a road, you can choose among three tools: the abney hand level, the clinometer, and the topographic map.

The abney level shows a *large circle* (indicating high relative precision) that is *half-black* (indicating it is somewhat difficult to use).

The clinometer shows a *middle-sized circle* (it is quite precise) that is *all black* (it is easy to use).

The topographic map shows a *small circle* (least precise of the

three) that is *half-black* (relatively easy to use).

The tools discussed here are available from many sources. Some are stocked locally, but you can obtain others only from distant suppliers. You can browse tool and supply catalogs in many Extension Service offices.

Instructions may be included with a tool when you purchase it, but novices frequently need help with certain tools. Ask your Extension agent for additional publications or other sources of help.

The Woodland Workbook is a collection of more than 50 publications prepared by the Oregon State University Extension Service specifically for owners and managers of private, nonindustrial woodlands. The Workbook is organized into 10 sections containing information of long-range and day-to-day value for anyone interested in wise management, conservation, and use of woodland properties. The sections are Management Planning, Forest Measurements, Reforestation, Stand Management, Logging, Marketing Forest Products, Multiple Use, Forestry Issues, Business Management, and Woodland Assistance.

Although each woodland publication is intended to be complete in itself, you may wish to purchase the entire set of publications in a three-ring Woodland Workbook binder with tabbed dividers for each section. If you wish to purchase only the three-ring binder for filing copies of our woodland publications, you may obtain the binder and dividers as a package. Or you may purchase individual Workbook publications as you need them.

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Extension's forestry program improves Oregonians' knowledge of forest resources and their options for expanding benefits from these resources. This educational program assists forest owners, managers, processors, and users in understanding small woodland production and management and use of all forest lands. Priority subjects are reforestation, growth, management, harvesting, processing and use of wood, protection of soil and water, and other multiple uses and values.

This publication was prepared by Steve Woodard, Benton and Lane County Extension agent, Oregon State University. Use of trade names is for illustration only and does not constitute endorsement by the OSU Extension Service.

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