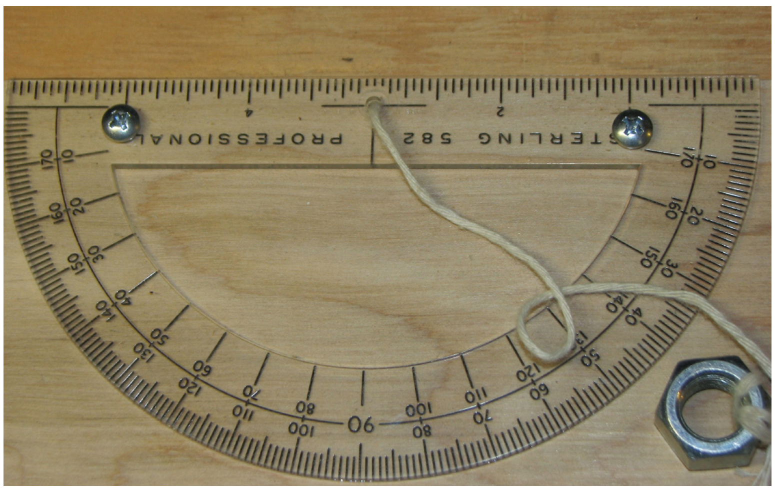
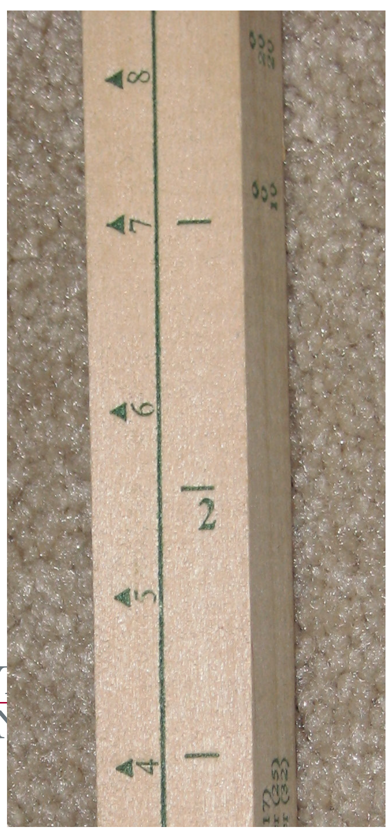
Simple Homemade Forestry Tools for Resource Inventories

WASHINGTON STATE UNIVERSITY EXTENSION • EM038E





Simple Homemade Forestry Tools for Resource Management

Introduction

Some forest landowners may hesitate to invest in expensive commercial quality forestry tools. This publication provides them with some low cost alternatives, although these tools cannot compete with commercially available tools, which are generally more accurate, easier to use, and last longer.

Purchased versus Homemade Tools

Homemade tools are useful to landowners just getting started with their forest inventory. These tools are inexpensive and accurate enough for most surveys. The tools described in this publication were made from scrap materials and their construction required only simple hand tools and average carpentry skills.

While it is beyond the scope of this publication to discuss the procedures for conducting an inventory, the Virtual Cruiser Vest is an excellent online tutorial containing 10 self-paced modules that discuss many aspects of forest inventory. These modules can be found at either http://forestandrange.org/Virtual%20Cruiser%20Vest/Quizzes/list.html or http://www.ruraltech.org/virtual_cruiser/index.htm.

Also, this publication does not include detailed instructions on how to use these tools. This information is available from numerous other sources, such as the cruiser vest modules previously cited as well as the Washington State University Extension Publication: Forest Inventory (Zobrist et al. forthcoming) available from WSU publications.

For landowners interested in commercial quality tools, a list of them can be found on the WSU Extension Forestry website at http://ext.nrs.wsu.edu/handtools/index.htm.

The Purpose of a Forest Inventory

An inventory is one of the cornerstones of forest stewardship planning and is an important part of creating and maintaining a healthy and productive forest, as well as meeting your objectives as a landowner in the long term. To assess the needs of your forest and plan for the future, it is important to know what resources you currently have. An inventory will quantify your resources and identify your needs and your opportunities concerning forest health, wildlife habitat, timber production, aesthetics, and carbon storage. An inventory also provides information on species composition, tree density, basal area, and volume, and it will help you track growth and change in your forest over time.

A forest inventory is conducted by measuring a representative sample of the forest ecosystem and then applying that sample to a full forest. This process is called a cruise. Often there are too many trees (or other resources) to measure within a reasonable amount of time and effort. Cruising allows you to measure the forest in an efficient manner.

What you measure or sample in any cruise must meet your specific objectives. If you need to know tree density, stocking levels, and species, it makes sense to sample that information. For many Forest Stewardship Plans, essential information may include:

- Trees and shrubs (species, number, spacing, health conditions, and growth rates)
- Soils (type, texture, porosity, and density)
- Water (stream types, temperature, water quality, turbidity, and pH)
- Fish (species present)
- Wildlife (species and their habitats)
- Cultural resources (artifacts from earlier forest habitation)
- Light (time of day and diversity on forest floor)
- Invasive species (species, number, spacing, health conditions, growth rates, and severity of threat)
- Debris (type, texture, density, and condition of logs and other downed material)

Useful and Inexpensive Homemade Tools

Diameter tape (D-tape)

A diameter tape, commonly called a D-tape, is used to determine the diameter of a tree. In the United States, all forestry volume tables use tree diameter as a variable, but with this tape, you actually measure the circumference of the tree trunk. The D-tape records your measurements in diameter units according to the formula:

$D = C/\pi$

Where D = diameter; C = circumference; and $\pi = 3.1416$

Thus, every 3.1416 inches of circumference equals 1 inch of diameter. For the commercial diameter tape (shown in Figure 1), the inch diameter equivalents are 3.1416 inches (79.8 mm) apart. Using a cloth tape and a permanent felt-tip pen, mark your tape with these diameter equivalents (see Table 1 for equivalents).

Commercial diameter tapes often have a sharp hook on one end (Figure 2) to hold the tape in place when measuring large diameter trees. This hook can be a nuisance when measuring small diameter trees, and we do not recommend adding one to your homemade D-tape.

The back of a commercial D-tape (Figure 3) is typically marked in feet, tenths of feet, and hundredths of feet. This scale is commonly used to measure a sample plot radius, distances between trees, and other linear distances. However, this tape is "not" scaled in inches,

Figure 1. Diameter measurement scale on a typical diameter tape.

Figure 2. Diameter tape showing end hook.

Figure 3. Reverse side of a typical commercial D-tape.

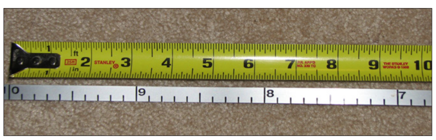


Figure 4. Diameter tape compared to carpenter's rule.

Table 1. Diameter equivalents on a D-tape.

Tree Diameter	Inches from zero on cloth tape	Tree Diameter	Inches from zero on cloth tape
1	3.14	21	65.97
2	6.28	22	69.12
3	9.42	23	72.26
4	12.57	24	75.40
5	15.71	25	78.54
6	18.85	26	81.68
7	21.99	27	84.82
8	25.13	28	87.96
9	28.27	29	91.11
10	31.42	30	94.25
11	34.56	31	97.39
12	37.70	32	100.53
13	40.84	33	103.67
14	43.98	34	106.81
15	47.12	35	109.96
16	50.27	36	113.10
17	53.41	37	116.24
18	56.55	38	119.38
19	59.69	39	122.52
20	62.83	40	125.66

which can be confirmed by comparing the scales for a D-tape and a carpenter's rule (Figure 4).

Diameter caliper

Figure 5 shows the four main sections of a homemade tree caliper. Sections 1 and 2 are the jaws and 3 and 4 are the base and slide, respectively. A tree diameter is measured by sliding the sections togeth-

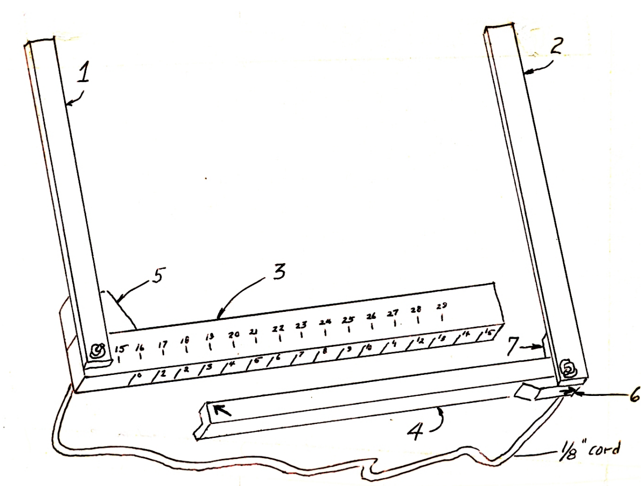


Figure 5. Tree caliper showing the four main sections.

er until the "jaws" are up against each side of the tree. The sliding sections of the caliper must be tight against each other to keep the jaws parallel.

The caliper dimensions are not overly important as long as the caliper is straight, dry, and smooth. The following materials are available at home improvement stores or lumberyards, and they have worked out well for constructing a caliper that allows diameter measurements of up to 29 inches.

Figure 6. Triangle-shaped reinforcement piece (section 5) on the left jaw.

Materials required:

- The jaws are made with pieces of 1 1/8 x 3/16 inch molding that are 14 and 15 ½ inches long, respectively.
- The base (section 3) is a 1 x 2 inch piece of lumber that is 18 inches long.
- The slide (section 4) is a piece of ¾ inch corner molding that is 16 inches long. For this section, a strong hardwood, like oak or mahogany, is best.
- Section 5 (shown in Figure 6) is a short reinforcement piece of 1 x 2 inch wood used to strengthen the joining of sections 1 and 3. For neatness, its right-hand edge can be cut at an angle.
- Section 6 (shown in Figure 7) is a short reinforcement piece of 3/8 x 3/4 inch molding used to strengthen the joining of sections 2 and 4. For neatness, its left-hand edge can be cut at an angle.
- Section 7 is a small spacer (shown in Figure 8) with the same thickness as the corner molding, which helps to keep the jaws parallel when the caliper is used. It is located on the reverse side of the right jaw (section 2). It is essential that the jaws of the finished caliper are parallel; otherwise, it will not provide accurate readings.

Figure 7. Section 6 reinforcement piece.

Instructions:

Start by gluing sections 1, 3, and 5 together. Use strong, fast-drying white carpenter's wood glue. Use a scrap of 1 x 2 inch wood to prop up the top end of the jaw, so it stays level while the glue is drying. Leave a space of 5/8 inch between the lower end of the jaw and the lower edge of the base. This will allow free movement of the slide.

Figure 8. Small spacer on the back of right jaw.

Similarly, glue sections 2, 4, and 6 together, using a carpenter's square to make sure the jaw is perpendicular to the base. Then glue section 7 onto the backside of section 2.

Make sure all the sections are aligned, and the jaws are perpendicular to the base. A carpenter's square also works well for this. Keep the sections in alignment by taping them to a work surface until the glue hardens. If available, a small brad nailer can help hold the sections in place until the glue sets up.

When the glue has hardened, slide the caliper together until the jaws touch. With a pencil, draw a line on the narrow edge of the base where the right-hand edge of the reinforcement piece meets the base. This is the zero line. Then, measure and place marks at 1, 2, 3, on up to 15 inches from the zero line. (You could make this a metric caliper by marking centimeters instead of inches.) Draw an arrow on the support piece that points toward its right-hand edge.

Next, open the jaws to "precisely" 15 inches and, where the left-hand edge of the slide meets the wide surface of the base, pencil in a line. On the left end of the slide, draw an arrow pointing to the mark just placed on the base. Then, along the base section, mark lines at 1 inch intervals to the right of the original line. Number these lines, left to right, from 15 to 29, to indicate the distance between the jaws. Go over all these marks, arrows, and numbers with a waterproof marker. You may also want to add a finish to protect the wood.

To keep the two sections of the caliper together when not in use, bore a 3/16 inch hole through the lower end of the left jaw and on through the base. Then bore a similar hole through the lower end of the right jaw and support piece. Cut a piece of 1/8 inch wide cord about 32 inches long, bring one end up through each hole, tie a figure-eight knot in each end of the cord and pull the cord back through the holes until the knots are tight.

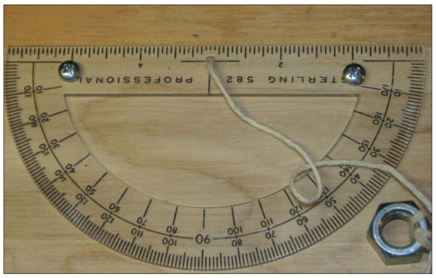


Figure 9. Plastic protractor made into an angle gauge.

If you have used the suggested dimensions, you can read tree diameters up to 15 inches from the right end of the slide and tree diameters between 15 and 29 inches from the left end of the slide.

Tree height angle gauge

A tree height angle gauge (depicted in Figures 9 and 10) is a useful tool for measuring the angle from the ground to the top of a tree, snag, cliff, and/or other object. Once this angle (in degrees) and the horizontal distance to the tree have been determined, the height of the tree or object being measured can be calculated using simple trigonometry (Figure 11). The tree height formula is:

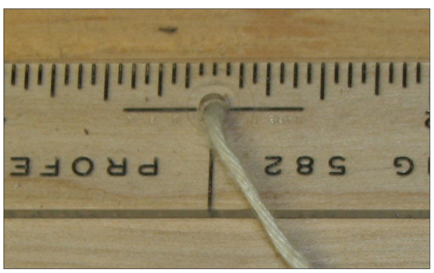


Figure 10. Plastic protractor made into an angle gauge (close up view).

Height = Distance * Tangent A

Where Distance is the horizontal distance in feet and the Tangent of A is the angle measured.

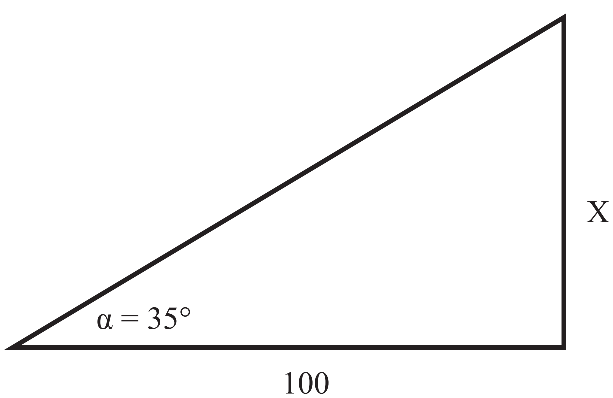


Figure 11. Calculating tree height using trigonometry.

Tangent functions are readily available on small hand-held calculators.

For example:

If the distance = 100 feet and the angle = 35 degrees

Then the height is:

100*0.7 = 70 feet

Materials required:

- Plywood or similar stiff material (½ inch thick)
- Waterproof string approximately 10 inches long
- One 6 inch plastic protractor
- One non-leaded weight (preferably rounded). We used a large nut (refer back to Figure 9).
- One small washer (optional)

Instructions:

- Cut the plywood precisely, so the top edge is straight and free from any edge distortions. We made ours from a scrap of plywood measuring 11 x 8.5 inches.
- Attach the protractor to the plywood with the flat edge parallel to the top.
- Drill a small hole at the pivot point of the protractor.
- Run the waterproof string through the hole at the pivot point and tie it off on the backside of the plywood, or attach it to the washer.
- Tie the other end of the string to the weight.

To use the height angle gauge, simply sight along the top of the plywood board while allowing the string to "plum bob." Read the angle at the corresponding location using the protractor.

A 100 foot tape

Any inexpensive 100 foot tape can be used for your forest inventory. We prefer tapes that are flexible and constructed with fiberglass because they are tough and will not kink. Metal tapes, while durable, tend to kink when used in brushy areas, and the sharp edges of some metal tapes can cut ungloved hands. A reel or retractable mechanism is very useful because it makes the tape much easier to use as well as to protect when moving from plot to plot.

Materials required:

- Non-stretchable rope or cord 100 feet or longer
- Permanent marking pens in red and black
- A ruler or yardstick

Instructions:

To construct a tape, use 100 feet of non-stretchable rope or cord, and mark it off in both 1 foot and 10 foot sections. Note that nylon rope or cord will stretch but polyester cord will not. If you intend to use the rope for plot radius measurements to determine "in" or "out" trees under variable plot cruising, then more precision is required. Mark off the tape using inches or tenths of a foot.

Cruiser or "Biltmore" stick

A cruiser stick is a piece of wood similar to a yardstick used for estimating tree diameters and tree heights. More advanced sticks will also allow you to estimate tree or log volumes. For this discussion, we will focus on diameter (Table 2) and height (Table 3).

Table 2. Diameter measurements.

Tree Diameter	Distance from left end in inches
1	1.0
2	1.9
3	2.8
4	3.7
5	4.6
6	5.4
7	6.2
8	7.0
9	7.7
10	8.5
11	9.2
12	9.9
13	10.5
14	11.2
15	11.9
16	12.5
17	13.1
18	13.7
19	14.3
20	14.9
21	15.5
22	16.0
23	16.5
24	17.1
25	17.7
26	18.2
27	18.7
28	19.2
29	19.7
30	20.2

Table 3. Height measurements.

Tree Height	Distance from left end of stick in inches
1	2.5
2	5.0
3	7.5
4	10.0
5	12.5
6	15.0
7	17.5
8	20.0
9	22.5
10	25.0
11	27.5
12	30.0
13	32.5
14	35.0

Materials required:

- A heavy wooden lath or four-sided wooden stick approximately 36 to 40 inches long
- Permanent marking pen
- A carpenter's ruler or similar ruler marked in inches and tenths of inches

For estimating tree heights, mark off 10 foot height intervals on the stick. These numbers are best written on the backside of the stick and written upright, since the stick is used vertically when estimating heights (Figure 12). You can also use the same side.

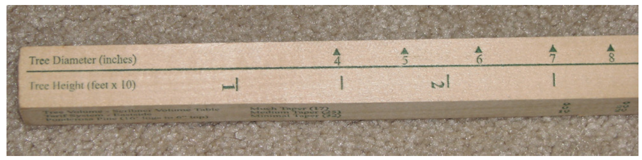


Figure 12. Cruiser stick (close up view).

Measuring tree diameter with a Cruiser stick

Place the stick against the tree as shown in Figure 13. Keep your eye positioned 25 inches from the stick and sight the "0" mark to the left. Read the diameter at the right without moving your head.

Figure 13. Positioning cruiser stick to measure diameter.

Measuring tree height

Position the cruiser stick, as shown in Figure 14, with the scale numbers moving upward. Stand 100 feet from the tree. Keep the stick 25 inches from your eye, and align the bottom of the stick with the bottom of the tree. Without moving your head, sight to the top of the tree, and read the tree height marked on the stick to the nearest 10 feet.

There is a short video demonstrating these techniques at http://forestandrange.org/Virtual%20Cruiser%20Vest/Quizzes/list.html.

Plot center staff

A fixed plot center staff is typically 5 feet long and should be rigid (made of wood, aluminum, or plastic) and should have a pointed tip

(Figure 15). A wooden hoe or shovel handle can sometimes work as long as it is straight. Sharpen the end of the staff (an axe, knife, or belt sander could be used for this) into a long tapered point, which allows you to force the staff into the ground more easily. If you use a recycled hoe or shovel handle, sand it smooth and coat it with wood finish, so it will last longer. Remove any residual ferrous metal from the handle.

Figure 14. Positioning cruiser stick to measure height.

Figure 15. Plot center staff (close up view).

If using a hand compass, do not use a ferrous metal staff made from materials such as rebar, electrical conduit, or fence posts. Aside from this type of staff being very heavy, it will influence the compass readings and thus introduce plot location bias.

Materials required:

- Non-metal dowel, shovel, or hoe handle approximately 5 feet long and 1 inch in diameter
- Sandpaper and wood finish

Plot radius rope

Fixed plot radius ropes are very useful in rapidly establishing circular plots. Inexpensive plastic or fiberglass ropes work well for this application.

Tie a loop in the end of the rope and place it over the plot center staff. Measure along the rope to the radius you want to establish. Refer to Table 4 in selecting the correct radius. Remember that the horizontal distance is measured from the plot center. Once the radius has been chosen, securely tie a piece of plastic surveyor ribbon onto the staff at this radius point.

Table 4. Radius selection.

Area in Acres	Radius in Feet
1	117.75
½	83.26
¼	58.88
1/10	37.24
1/100	11.78
1/1000	3.72

Use this formula to calculate area:

A=Þ x R2

Where A = Area in square feet
Þ = Pi (3.1416)
R = radius in feet

Plot squares

Plot squares are commonly used for very small subplots during a cruise to measure what is present on the forest floor. Plot squares made from metal or wood are best because they retain their shape and thus their known area. Shrubs, herbaceous plants and grasses, wildlife droppings, mushrooms, and even human artifacts can be sampled using this tool. Since these tools have a known area, commonly 1/10000 of an acre, many sample points may need to be taken to get an acceptable level of precision. Range management professionals use these squares as well as small hoops to measure the abundance of grasses along a straight-line transect. These small plot squares can also be used when invasive species are present.

Materials required:

- Molding that is 1 x 2 inches and approximately 10 feet long
- Corner fasteners such as nails or screws
- A small amount of white wood glue
- A carpenter's square

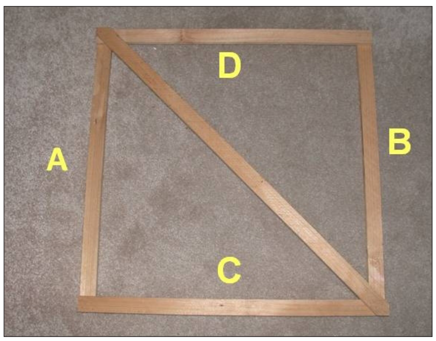


Figure16. Plot square assembly.

Instructions:

The 1/10000 plot square is assembled according to Figure 16, but note that sides A and B overlap sides C and D. What is important is that the area within the square equals 4.36 sq. ft., thus making the inside dimension equal to 2.09 sq. ft. The outside dimensions are unimportant and will depend on the width of the molding.

Fasten section A and D precisely at right angles and do the same for sections D and B. Attach each section half to make the square, dabbing a small amount of white glue between the sections. Nail or screw each corner together. Re-measure the right angles and the inside dimensions to ensure they are accurate before the glue sets. The diagonal piece serves as a handle and provides rigidity.

Measuring basal area with an angle gauge

Basal area is the cross-sectional area of a tree at 4.5 feet above ground. The basal area of all trees in a given land area indicates the degree to which a larger area is occupied by trees and is generally expressed in square feet per acre (ft2/acre).

Using an angle gauge for 5, 10, 20, or even a 40 basal area factor (BAF) is common in the Pacific Northwest. A homemade angle gauge can easily replace a more expensive commercial prism. The gauges (Figure 17) were constructed from scrap Douglas-fir lath using the dimensions provided in Table 5.

Figure 17. Three BAF angle gauges.

Table 5. BAF viewing widths.

BAF Factor	Viewing width in inches – using a 25 inch reach
5	0.54
10	0.76
20	1.08
40	1.51

To use this tool, sight over the black portion to determine "in" or "out" trees. A 25 inch lanyard can make this gauge easier to use.

Calibrating your thumb to measure a 10 basal area factor[1]

The basal area in a particular location can be estimated by holding an object (e.g., your thumb, a washer, or a penny) at a fixed distance from your eye (Figure 18). To calculate the distance you should keep between your thumb and your eye, use the following formula:

Distance from eye = width of object x 33

For example, a thumb width of 0.75 inches should be placed 24.75 inches away from your eye (0.75 x 33 = 24.75). Maintain this distance while stretching a string of the appropriate length between your eye and your thumb (Figure 18).

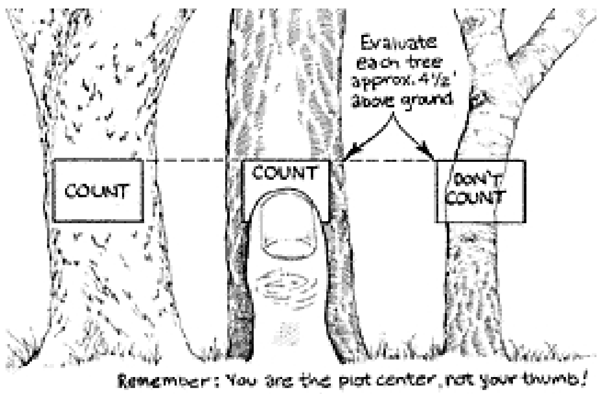


Figure 18. Calibrating your thumb in variable plot cruising.

Instructions:

To estimate basal area, stand in the center of a randomly selected location or plot. Hold your thumb at the appropriate distance from one eye and close the other eye. Then proceed through the following steps:

- Aim your thumb at a point on the tree's trunk that is 4.5 feet above the ground. Only consider live trees that are larger than 5 inches in diameter at that location.
- Count only trees with trunks that appear wider than your thumb. These trunks are considered "in." Tree trunks that are narrower than your thumb are considered "out."
- Include every other tree with a trunk that appears to be the same size as your thumb.
- Standing at plot center, evaluate all the trees in your viewing area by turning to the right until you return to your starting point.
- Repeat this procedure in several different locations. The more plots taken, the more accurate the data will be; however, lots should not overlap.
- Determine the average number of "in" trees by dividing the total number of "in" trees by the total number of plots.

---

[1] Making and Using Measurement Tools—Basal Area, Forest Management Practices Fact Sheet Managing Water Series # 12, Developed by Charlie Blinn, Department of Forest Resources, University of Minnesota, 1530 Cleveland Ave. North, St. Paul, MN 55108, cblinn@umn.edu

- Since we are using a basal area factor of 10, multiply the average number of trees per plot considered “in” by 10. This calculation will yield an estimate of the basal area per acre as shown in the formula:

  Basal area/acre = average number of trees counted x 10

  For example, assume that a total of 30 “in” trees were counted in 5 sample plots. The average number of “in” trees per plot would be 6. The basal area/acre would be 6 x 10 or 60 square feet/acre.

Conclusion

Although homemade forestry tools are not as accurate or as easy to use as commercial ones, they may be quite useful to the forest landowner who is not ready to invest in expensive tools. We hope that constructing and using these homemade tools will be an interesting, instructive, and enjoyable way for landowners to fulfill some of their forest inventory needs.

Educational Materials on Forest Measurements and Cruising

- The Virtual Cruiser Vest is an excellent online tutorial containing 10 self-paced modules that address many aspects of forest inventory. You can find this tutorial at either: (http://forestandrange.org/Virtual%20Cruiser%20Vest/Quizzes/list.html) or (http://www.ruraltech.org/virtual_cruiser/index.htm).
- Using forest inventory tools is discussed in the forthcoming Washington State University Extension Fact Sheet: *Forest Inventory*, which will be available through WSU Extension publications.
- For landowners interested in commercial quality tools, a list can be found on the Washington State University Extension’s Forestry website at http://ext.nrs.wsu.edu/handtools/index.htm.
- Numerous other publications discussing forest measurements, forest cruising, and forestry tools can be found on the Internet.

WASHINGTON STATE UNIVERSITY
EXTENSION

By **Donald P. Hanley**, Extension Forestry Professor Emeritus, and **J. Alan Wagar**, Forestry Professor Emeritus, University of Washington.

EM038E