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Mission Statement:

The Eastern Native Tree Society (ENTS) is a cyberspace interest group devoted to the celebration of trees of eastern North America through art, poetry, music, mythology, science, medicine, and woodcrafts. ENTS is also intended as an archive for information on specific trees and stands of trees, and ENTS will store data on accurately measured trees for historical documentation, scientific research, and to resolve big tree disputes.

ENTS Officers:

Editorial Board, *Bulletin of the Eastern Native Tree Society*:

Membership and Website Submissions:

Membership is free when you sign up for our discussion group, Native Tree Society BBS, at: http://www.ents-bbs.org/index.php. Submissions to the Native Tree Society website in terms of information, art, etc., should be made to Edward Frank at: ed_frank@hotmail.com.

The *Bulletin of the Eastern Native Tree Society* is provided as a free download in Adobe™ PDF format (optimized for version 5 or newer) through the Native Tree Society website. The Native Tree Society, the Eastern Native Tree Society, and the *Bulletin of the Eastern Native Tree Society* editorial staff are solely responsible for its content.

COVER: The sun peaks through rain clouds over the Mississippi River Alluvial Plain in eastern Arkansas near the small community of Parkin. Photo courtesy of Don C. Bragg.

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NEXT UP!?

Hard to believe, but this issue marks the 10th anniversary of the first *Bulletin of the Eastern Native Tree Society*…and, regrettably, my last! This time my "retirement" is for real—you may recall I had planned to step down 3 years ago, after I took over the helm as Editor-in-Chief of the *Journal of Forestry*. I soon changed my mind, and reduced to a more limited production schedule for the *Bulletin*, thinking that I'd be able to manage both of those tasks. Alas, between an increased workload at the *Journal of Forestry* (a good thing) and a steep decline in offerings to the *Bulletin* (a bad thing), it is no longer feasible for me to continue with the *Bulletin*.

However, this is not to say that the *Bulletin* needs to bow out, too. I have confidence that someone amongst the membership has the right kind of moxie to continue the important work this publication has provided over the last decade. I am more than willing to help a new Editor-in-Chief with the transition, including any bits of advice or tidbits of knowledge I have to offer, as well as "templates" for the various articles used in the *Bulletin*. While soliciting, editing, and publishing the *Bulletin* requires more time than I can currently invest, it is not all-consuming.

So, who's next up? Who would like to focus their creative energies into this worthwhile endeavor?

Don C. Bragg
Soon-to-be-retired Editor-in-Chief

A swamp of tupelo gum (**Nyssa aquatic*****) and scattered baldcypress (*****Taxodium distichum*****) in eastern Arkansas. Once very common across the region, agricultural "improvements" and logging have reduced these stands to a fraction of their former coverage. Large tracts of cypress-gum swamps can be found in the White River National Wildlife Refuge and other protected bottomlands in this part of the Natural State. Photograph by Don C. Bragg.***

ANNOUNCEMENTS AND SOCIETY ACTIONS

New Opportunities for Serious Tree Measurers— The National Cadre

Sponsors: American Forests, Native Tree Society, and Laser Technology, Inc.

The Native Tree Society and American Forests, with aid from Laser Technology, Inc., has been sponsoring a number of tree measurement workshops and training programs designed to develop a pool of highly skilled and accurate tree measurement gurus. Several workshops were held across the country in 2015, and more are planned for 2016. This National Cadre continues to grow, and will serve as the support and verification network for the measurement of champion trees in the United States. More tree measuring experts are needed to meet the demand, however—the Founder's Corner article in this issue of the Bulletin is an adaptation of one of Bob Leverett's ENTS BBS postings from earlier in 2015 that mentions some of the anticipated challenges and opportunities.

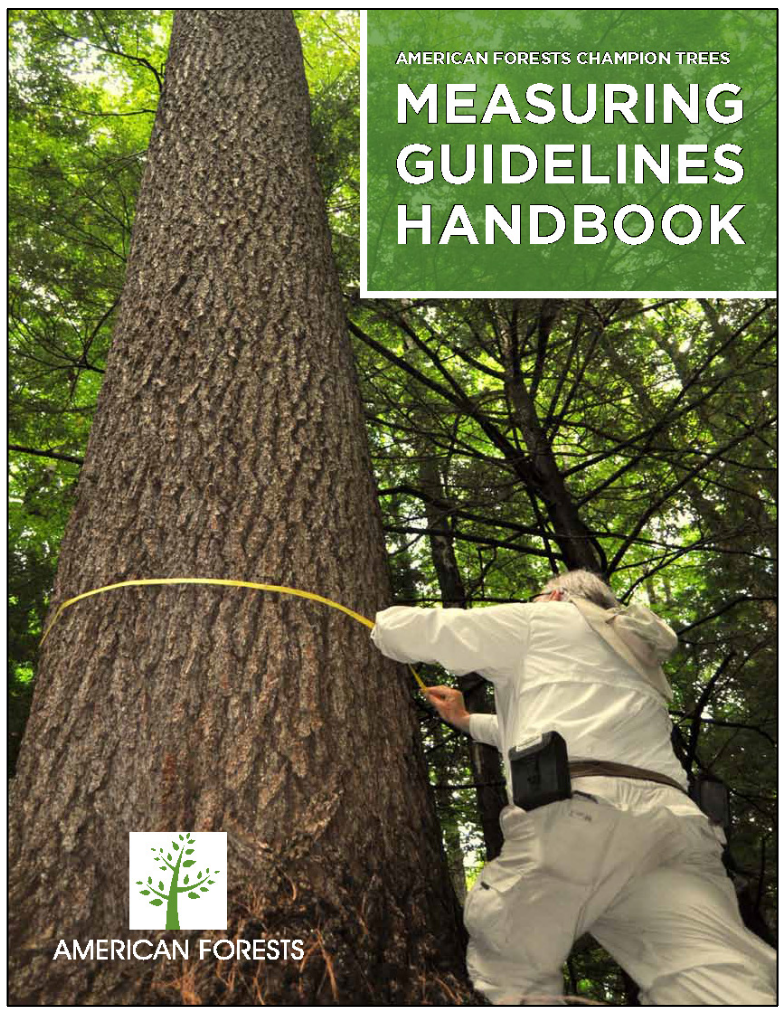
Note—this is a jointly developed offering from the Native Tree Society and American Forests, not a change in the overall goals or mission of the Native Tree Society, and was developed to help ensure the implementation of the best and most consistent measurement techniques (including the sine method). Please stay tuned for future workshops, and consider the opportunity to serve in this capacity!

American Forests Champion Trees Measuring Guidelines Handbook

Native Tree Society members have long known that Bob Leverett has "written the book" on big tree measuring—a statement that is now both figuratively *and* literally true! Bob Leverett and fellow guru Don Bertolette have co-authored the new, definitive set of guidelines issue by American Forests for use when measuring potential national champion trees. Packed in 86 useful pages, the new measuring guidelines handbook describes numerous means of describing the important attributes of champion trees, and for the first time recognizes the supremacy of the sine method of height determination (now the preferred approach).

Available for free download at:
www.americanforests.org/wp-content/uploads/2014/12/AF-Tree-Measuring-Guidelines_LR.pdf
this PDF can be used by a range of measurers with differing skill levels (thanks in part to color-coordinated sections), and is considered the standard for big tree coordinators and coordinating bodies registering their trees with American Forests.

This book offers many useful tips and tool suggestions for measuring tree heights, diameters, and crown dimensions, including advice on how to deal with most scenarios that tree measurers may encounter in the woods.



How to Use a Monocular with a Reticle to Measure Trunk Diameter, Limb Segments, and Trunk Frustum Volume

Robert T. Leverett[1] and Michael Taylor[2]

[1] Co-founder and Executive Director, The Native Tree Society

[2] Vice President, Western Native Tree Society

INTRODUCTION
Trunk circumference is one of the three measurements taken of a tree for championship competitions. Big tree hunters measure circumference by stretching a tape around the trunk at the prescribed height of 4.5 ft above mid-slope. The plane of the tape is oriented at 90 degrees to the central axis of the trunk. That axis is now considered to be the pith line as opposed to the geometrical centerline.

While there is no substitute for direct access to a tree, there are occasions when measuring trunk width from a distance serves an important purpose. Such measurements are common in forestry, but they also have a place in big tree hunting and championship competitions.

In the material that follows, we develop perhaps the most basic use for the monocular, calculating trunk width. We then introduce more advanced uses of the monocular to measure limb length and to aid in the modeling of trunk volume. These advanced uses require more calculations and raise questions about the sources and magnitudes of measuring errors. We conclude the main paper by presenting limitations and errors associated with the reticle. Mathematical derivations for the measuring techniques explained are provided in four appendices.

BASIC USE OF THE MONOCULAR—TRUNK WIDTH
Why would we want to measure diameter at a distance? A tree may be on the other side of a ravine, stream, fence, busy street, etc., where access is not feasible. Fortunately, with the right equipment, a reticle-based monocular and a laser range-finder, we can measure diameter without direct access to the trunk.

At this point, we should say width as opposed to diameter, because the monocular with reticle measurers the width of an object as seen through the lens with a superimposed reticle, usually graduated in both inches and millimeters. If the object is circular in cross-section, the width translates to diameter. Another use of the monocular with reticle is to measure the widths of individual trunks in a fusion of stems. Figure 1 suggests possibilities for measuring fused trunks. The yellow line is the width of the two trunks treated as one. The black lines suggest measurements of separate trunks. These three lines can be measured using a monocular with a reticle.

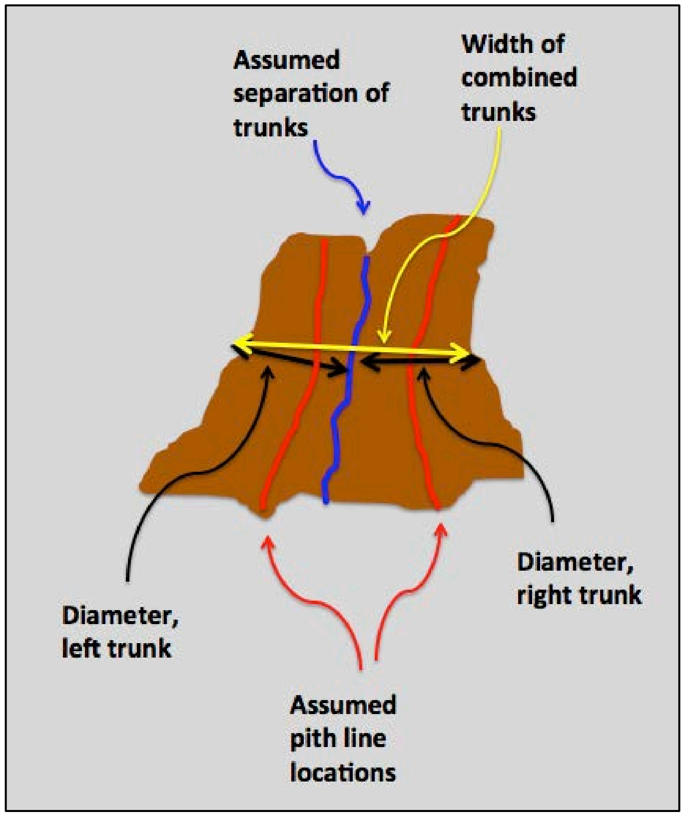


Figure 1. Possible use of a monocular to measure tree diameters.

READING THE RETICLE
In Figure 2, we see a foot ruler positioned at a distance of 23.102 ft from the middle of the monocular. A red beam construction laser was used to measure the distance, and the 23.102 reading showed on the display. The laser is accurate to ± 1.5 mm. In this illustration, we want to rule out distance errors.

The reticle markings covering the ruler span 44.4 units as best as I could read at the time I took the measurement. Better eyes may slightly improve on my reading, but the span is not less than 44 units or more than 45.

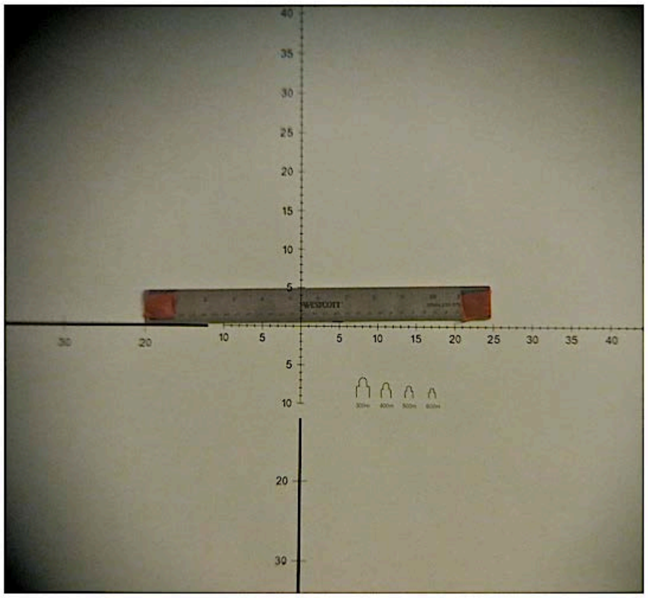


Figure 2. Example of how to read a monocular reticle.

We employ the simple formula to calculate the width of an object:

$$W = (M \times D)/F \quad [1]$$

where M is the reticle reading, D is the distance to the center of the object, and F is a factor associated with the monocular, supplied by the manufacturer. F = 1000 for the instrument employed. W is in the same units as D. The ruler is, and must be, oriented 90 degrees to the line of sight. Therefore, we have

$$W = (44.4 \times 23.102)/1000 = 1.025$$

The 0.025 ft translates to 0.3 inches. This is impressive accuracy. However, the error would be larger if D were, say, 100 ft away, which would be more typical for viewing a very large tree such as a redwood or sequoia. Basically, we want to get as close to the trunk as possible, while insuring that at least 99% or 99.5% level of the actual trunk width is visible. Later in this paper, we develop useful formulas to help the measurer insure a 99% or greater threshold of visibility.

If we assume that we can generally read the reticle to ± 1.0 marks, in this example, we can establish limits of 43.4 and 45.4, for the reticle reading. However, a reading of 43.24 translates to exactly one foot, which is the actual target length. So, the reading of 44.4 is actually high by 1.16 marks instead of 1.0. Still, 1.16 is sufficiently close to the ± 1.0 to support our contention that most readings are accurate to within ± 1.0 marks on the reticle.

High levels of accuracy, as demonstrated above, can be achieved for clearly visible targets that do not take up too much of the reticle. For targets up to 60 ft away, accuracies to with ± 0.5 inches are commonly attainable, and possible to within ± 0.25 inches, again provided that the target doesn't take up too much of the reticle. Visibility decreases and parallax errors increase at the margins of the reticle, which suggests moving back. However, to tackle situations where the target extends beyond the reticle, and moving back isn't an option, we can break the target up into segments, but this means that we have to recognize the boundaries of the segments - not always easy.

There will always be tradeoffs. Reading the outer edges of the reticle does introduce more error due to distortion of the lens. In the case of the Vortex Solo R/T 8x36, which was used above, it is better to use the region of the scale that is delineated in increments of one unit. This gives us 60 units on one side of the centerline and 10 units on the other. The remainder of the scale is marked at intervals of 10 units, making the whole scale 110 units. If all 70 delineated ticks are needed, shift the reticle view to utilize the area of increased tick resolution, which is absent on the left side.

What if the target line is at an angle relative to the horizon? The reticle can be aligned parallel with the target line. However, the line of sight must still be perpendicular to the plane that contains the target line in order to make use of the simple formula presented above. In Figure 3, lines A and B represent targets that lie in the same plane. The line of sight is perpendicular to each. The vertical reticle can be used to assist in this alignment by verifying it is parallel with the trunk form.

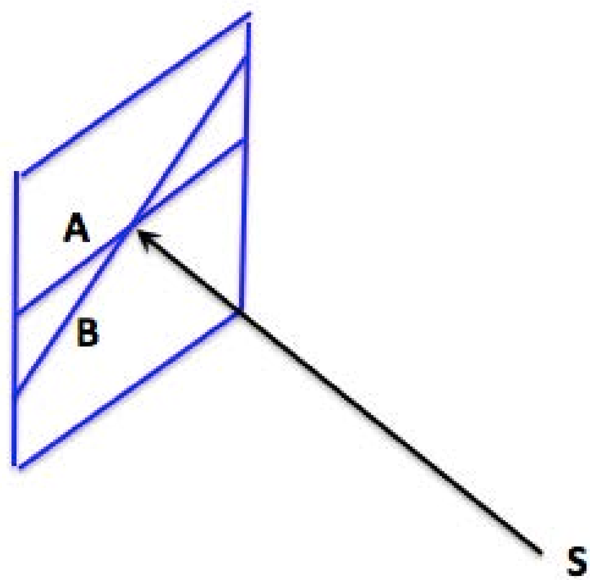


Figure 3. Positioning the reticle for a sloping target line.

CHECKING THE MANUFACTURER'S F FACTOR

The factor F used for the Vortex Solo R/T 8 x 36 is given by Vortex as 1000. On occasion, these factors are in error. You can check the value of F by setting up a target of known dimension such as a foot ruler. In an experiment, we set up a Solo R/T 8x36 to measure the length of a ruler positioned 90 degrees to the line of sight. The distance as measured from the front lens to the middle of the ruler was 23.085 ft by a BOSCH GLR825 and 23.090 by a BOSCH GLM80. We averaged the two readings to get 23.0875. The reading of the reticle was done repeatedly with the most prevalent reading being 43.5 millimeters. We next took the formula for width (equation [1]) and solved it for F:

$$F = (M \times D)/W = (43.5\,mm \times 23.0875\,ft)/1\,ft = 1004.3\,mm$$

While this isn't exactly 1000, it is very close, varying only slightly over 0.4%. Other experiments would need to be conducted before changing F, but the above process allows the measurer to check on F, if crudely.

EVALUATING THE IMPACT OF SMALL DISTANCE AND RETICLE READING ERRORS

We may wish to evaluate the impact of small distance and reticle reading errors. Appealing to calculus, we can use the concept of the total differential of measurement error of each independent variable through the following partial differential equation.

As per Goursat (1904, I, §15), for functions of more than one independent variable,

$$y = f(x_1, \dots, x_n) \qquad [2]$$

the partial differential of y with respect to any one of the variables x_1 is the principal part of the change in y resulting from a change dx_1 in that one variable. The partial differential is therefore $\frac{\partial y}{\partial x_1} dx_1$ and the total differential of W is therefore:

$$dW = \frac{\partial W}{\partial M} dM + \frac{\partial W}{\partial D} dD \qquad [3]$$

which leads to:

$$dW = \frac{\partial \frac{MD}{F}}{\partial M} dM + \frac{\partial \frac{MD}{F}}{\partial D} dD \qquad [4]$$

$$dW = \frac{1}{F}(DdM + MdD) \qquad [5]$$

We approximate dM and dD with small changes in M and D representing the errors in those quantities. Using the familiar symbols ΔM and ΔD represent the assumed measurement errors in D and M, we get the approximating formula for total error:

$$\Delta W = \frac{1}{F}(D\Delta M + M\Delta D) \qquad [6]$$

where ΔW = approximate error in target width, F = monocular factor, D = measured distance, M = reticle reading, ΔD = the assumed error in distance, and ΔM = assumed error in reticle reading. As an example, if F = 1000, M = 65 mm, D = 47 ft, ΔD = 1.5 ft, and ΔM = 0.5 mm, then:

$$\Delta W = \frac{1}{1000\,mm}\big(47\,ft(0.5\,mm) + 65\,mm(1.5\,ft)\big) = 0.121\,ft$$

or about 1.5 inches. Many measurers may think the error would be greater.

TARGET SHAPE AND POSITION CHALLENGES

The formula we presented above assumes that the line of sight is 90 degrees to the width being measured and that the line of sight extends to the width line, basically to a flat surface. But what if the object being measured is circular, such as the trunk of a tree. We will deal only with the case of the circle in this paper. Elliptical forms will be addressed in a future paper.

If we shoot to the middle of the front of the tree, we do not reach the location of the diameter being measured. We fall short by the radius of the trunk. The adjustment needed to the above formula to accurately measure W that captures the extra distance is:

$$W = \frac{MD}{F - 0.5M} \qquad [7]$$

We may eliminate the need for this adjustment by shooting to either edge of the trunk and using that hypotenuse distance as a substitute for the actual distance to the diameter being measured. However, visibility and instrument accuracy may make the adjustment preferable. See Appendix D for the derivation of the above equation.

As an example, suppose M = 65, D = 60, and F = 1000. Solving for W then yields:

$$W = \frac{(65mm)(60ft)}{1000 - 0.5(65mm)} = 4.03\,ft$$

Without the adjustment, the width would have been computed to be 3.9 ft. A second challenge is measuring diameter of a trunk at a vertical angle. If the angle is β, then the equation for W is:

$$W = \frac{MD}{F - \frac{0.5M}{\cos(\beta)}} \qquad [8]$$

In the case above, were we looking up at an angle of 35 degrees, W would be calculated as:

$$W = \frac{(65mm)(60ft)}{1000mm - \frac{0.5(65mm)}{\cos(35)}} = 4.06\,ft$$

Again, see Appendix D for the derivation.

ADVANCED USE—LIMB SEGMENTS

A novel use of the monocular with reticle is measuring the length of a limb or limb segment from a distance. The limb must be straight, or approximately so, but it can be oriented at an angle in both the horizontal and vertical planes. That is, we will not assume that the limb's axis is oriented at 90 degrees to the line of sight.

In Figure 4, we see a limb segment delineated by the red arrow. At point #1, the distance from the monocular is 44.8 ft. At roughly the midpoint of the limb, the distance is 46.2 ft, and at the far end, 48.3 ft. These distances were obtained using an LTI TruPulse 200X accurate to approximately 3 cm, and a reticle reading of 65 mm.

Figure 4. Calculating length of a branch segment.

Using the rather involved process described in Appendix C, we computed a limb length of 4.9 ft. The computational process is involved, and best automated using a spreadsheet. iPhone apps such as *Discount Spreadsheet* or Apple's *Numbers* can be used to do the sequence of calculations in the field, and the iPhone can be used to take an image of the limb segment. Of course, an advanced spreadsheet such as Excel is ideal. A fully functional Excel program can be obtained on a Windows 8.1 tablet.

As an alternative to an iPhone spreadsheet, a BASIC language interpreter such as *HotPaw Basic* can be used. A program to do the trapezoid calculations will be made available through the Native Tree Society.

While the full process is explained in Appendix C, we give the reader a feeling for the method (Figure 5). Figure 5 illustrates how we might visualize an isosceles trapezoid with a limb segment as its diagonal. The trapezoid's bases are D_1 and D_2 and W represents the length of the limb segment that we want to measure.

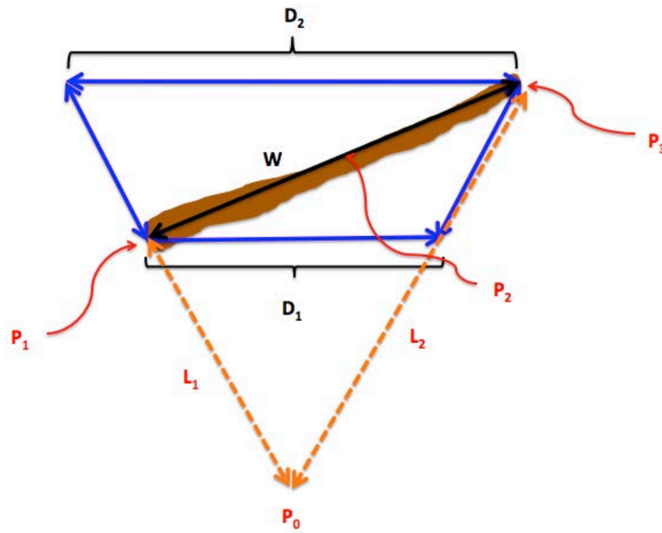


Figure 5. Trapezoidal calculation of branch segment length.

ADVANCED USE—TRUNK FRUSTUM VOLUME

Consider the following cloud point map (Figure 6) created by Michael Taylor showing two diameters perpendicular to the axis of the trunk.

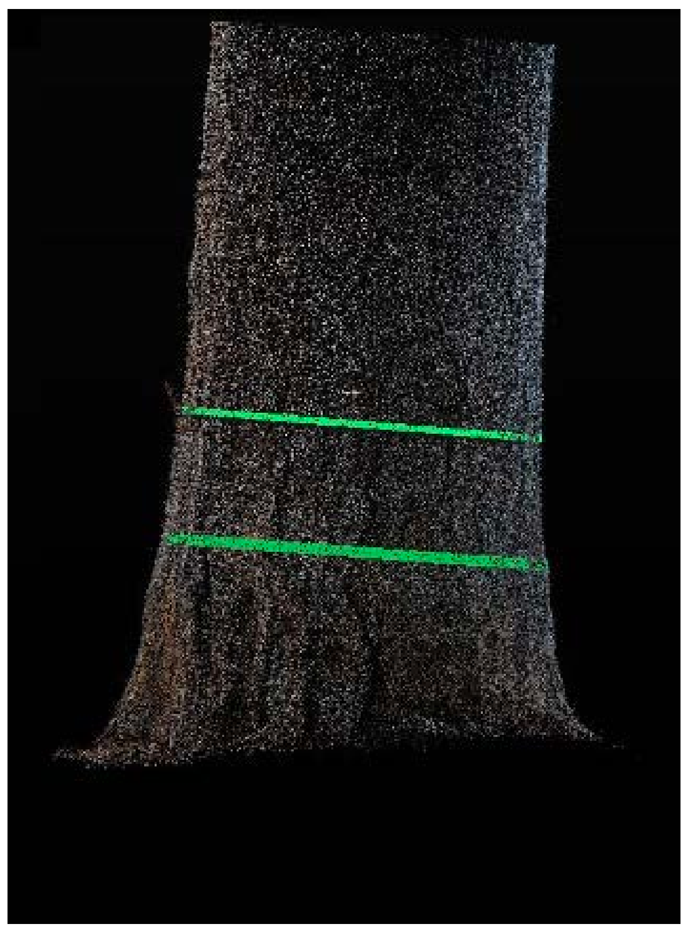


Figure 6 (right). Lidar point cloud of lower bole form.

We define the following variables:

D_1 = diameter of top
D_2 = diameter of bottom
H = distance between diameters (measure is 90 degrees to the diameters)
V = volume of frustum of cone

$$V = \frac{\pi H}{12}(D_1^2 + D_1 D_2 + D_2^2) \qquad [9]$$

As an example, suppose D_1 = 3.5, D_2 = 4.0, and H = 3.0, then V is determined as follows:

$$V = \frac{\pi(3ft)}{12}((3.5ft)^2 + (3.5ft)(4.0ft) + (4.0ft)^2) = 33.2ft^3$$

BOTTOM WEDGE VOLUME

Consider the following diagram (Figure 7):

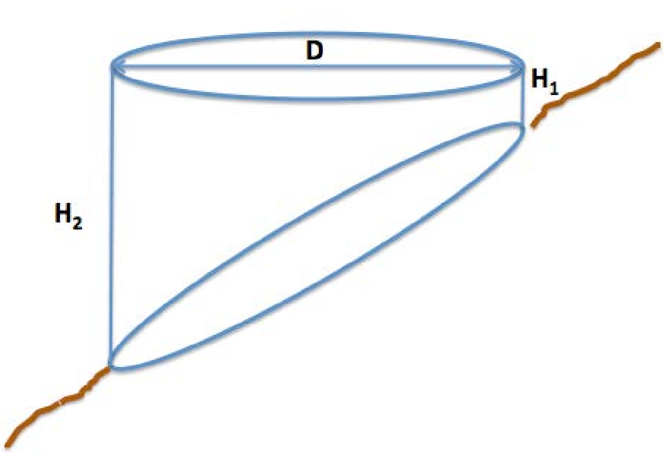


Figure 7. Hypothetical bole base on a slope.

A simple method for approximating the volume of this bottom section of the trunk uses the reticle to measure D and possibly H_1 and H_2, although they can be determined using conventional methods for calculating height (laser and clinometer or hypsometer). Note also that in Figure 7 the section is considered cylindrical. That will seldom be the case. A more complete solution will be provided in a future paper devoted to computing trunk and limb volumes using a variety of instruments and methods.

$$V = \frac{1}{2}\pi r^2(H_1 + H_2) \qquad [10]$$

where $r = D/2$. Figure 8 presents another model for computing the volume of the above ground section of the trunk, where the ground line intersects the upper base and exits at the lower base, creating a half-buried frustum.

We can employ the reticle to measure D_1 and S. Using an iPhone app such as *Theodolite*, we can easily measure the horizon angle and then use its complement δ (90 degrees minus the horizon angle).

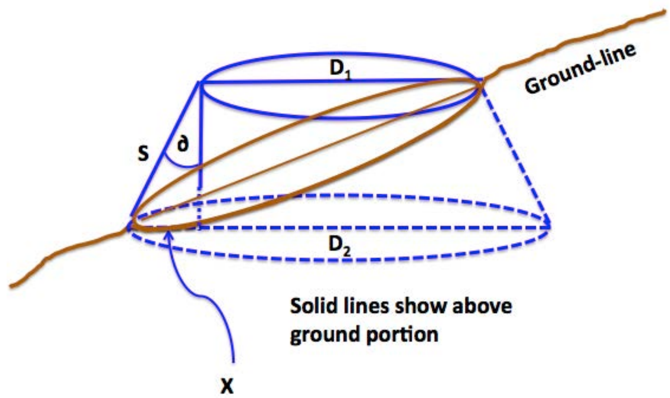


Figure 8. The aboveground section and the variables needed to compute its volume.

From these variables and the knowledge that $h = ((H_1+H_2)/2)$ (from Figure 7), we derive the volume V for half of the frustum as follows:

$$V = \frac{\pi h}{24}(D_1^2 + D_1 D_2 + D_2^2) \qquad [11]$$

where $x = S \sin(ð)$; $h = S \cos(ð)$; $D_2 = D_1 + x$. As an example, suppose ð = 20, S = 15 ft, and D_1= 18 ft, the volume of the part of the frustum above ground level is:

$$V = \frac{14.1\pi}{24}(18^2 + (18)(28.2) + 28.2^2) = 3002.6\ ft^3$$

PROBLEMS WITH MONOCULAR USE—SEEING THE FULL TARGET

With trees, as opposed to flat surfaces, we are immediately faced with a challenge. With flat surfaces, we can see to the outermost edges, but that is not the case with a circular object. If we are too close, we don't see the entire width (or diameter) of the tree. How much of a problem is this?

As a beginning example, suppose we have a 5-ft diameter tree. How far do we need to be away to see say 98.5% of the diameter? Questions like this can be most readily answered if the trunk is circular, but we can also handle elliptical shapes.

Case of circular trunk

We begin the investigation by defining four variables. Let:

r = radius of tree
δ = percent of radius that is visible (we'll use the equivalent decimal value)
y = straight-line distance to center of tree from the measurer's eye.
D = distance to the middle of the front of the tree, and $y = D + r$

With this in mind, the formula that we need in order to answer the question posed above turns out to be the following:

$$D = \frac{r}{\sqrt{1-\delta^2}} - r \qquad [12]$$

expressed as a distance from the eye to the face of the trunk, or

$$y = \frac{r}{\sqrt{1-\delta^2}} \quad [13]$$

as the distance from eye to the center of the trunk (see the appendix for equations derivations).

The distance D for the above example is a surprisingly close 12 ft or 14.5 ft for y. If we up the percentage to 99.5, the distance D increases to 22.5 ft—still close. A percentage of 99.8 requires a distance D of 37 ft, and 99.9% causes a jump to 53.5 ft. Thereafter the distance increases dramatically, but the error is completely insignificant.

Practical rules

From the foregoing, can we devise some handy formulas and rules of the road? For instance, how does a change in M or D, or both, change the value of W in the formula below?

$$W = \frac{M \times D}{F} \quad [14]$$

We express the change in W as follows:

$$\Delta W = \frac{1}{F}(M_1 D_1 - M_2 D_2) \quad [15]$$

For an F = 1000, if our reticle reading of 70 drops to 66 and our distance changes from 80 to 85, how much does W change?

$$W = \frac{1}{1000ft}[(70mm)(80ft) - (66mm)(85ft)] = -0.1ft$$

The changes almost completely cancel one another. This suggests another formula where we can see how changes to the four variables M_1, D_1, M_2, and D_2 exactly cancel one another. The following formula allows for this investigation:

$$M_1 D_1 = M_2 D_2 \quad [16]$$

For example, suppose M_2 = 70 and D_2 = 50. If we move 10 ft closer, making D_1 = 40 ft, M_1 becomes 87.5. Remember, in this kind of problem, it is the same tree—W does not change. $M_1 D_1$ and $M_2 D_2$ for any given W are also a constant.

If we're willing to settle for 99% or 99.5% of the trunk being visible to us, we can employ some simple rules of the road in understanding the distances we need to be at in order to see these percentages of the diameter. At the 99% level, the ratio of distance y to diameter is approximately 3.5 to 1, and 5 to 1 at the 99.5% level. These are handy multipliers. So, at the 99% level, a 16-ft diameter requires a y distance of approximately 56 ft to see 99% of it (D = 48), and a y distance 80 ft (D = 72) at the 99.5% level (remember, here D is the distance from the reticle to the middle of the front of the trunk).

Remember that the reticle may not cover the entire trunk at the distances shown. So a greater distance may be needed for optical reasons.

Obviously, we don't know the exact diameter of the trunk when we begin measuring, but by appealing to the above formulas and processes, we can position ourselves to achieve a high level of confidence in the results. Knowing whether we can be off by a little or a lot separates accomplished measurers from the beginners.

SUMMARY

The use of a monocular and reticle with a laser rangefinder provides us with a powerful capability to measure width at a distance to a surprisingly high level of accuracy. At its simplest, we multiply the distance to a target oriented 90 degrees to the line of sight by a reticle reading, and divide the result by the manufacturer's factor for the model of monocular. However, as is usually the case, there are complicating factors. How well can we read the reticle? What if the target is not positioned 90 degrees to the line of sight? How do we take into consideration the shape of the object? In this paper, we have addressed these factors and provided solutions. But those solutions hinge on the underlying mathematics. We present the necessary mathematical proofs in the appendices.

APPENDIX A

DERIVATIONS—MISSING PARTS OF DIAMETER

Deriving* y *and* D *for a circle

In the previously given case of circular trunk, we use the variables y and D. We first present a diagram that shows the visible and missing parts of the diameter. Our objective is to derive an equation for D and y, where $y = D + r$.

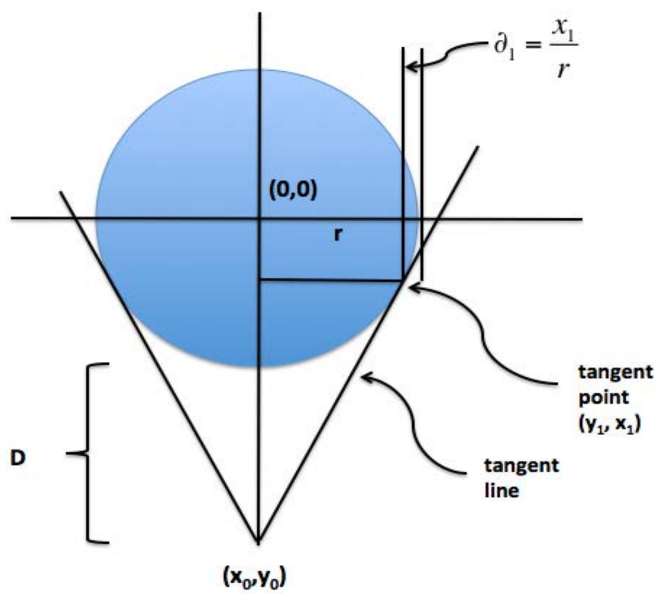


Figure A1. Schematic of deriving **y** *and* **D** *for a circle.*

The derivation of the equations for D and y is fairly involved (Figure A1). We begin by acknowledging that our line of sight to the edge of the trunk represents a tangent line to the circumference. The tangent line, by definition, touches the circumference at a single point. Beyond the tangent point, the remainder of the trunk is hidden from sight.

As part of the derivation, we must develop the equation for the tangent line from our eye to the circumference. There are several general forms for the equation for a straight line. The one we will use is:

$$y - y_1 = m(x - x_1) \quad \text{[A1]}$$

where (y_1, x_1) is a known point on the line, and m is the slope (rise/run). The slope m is usually computed by

$$m = \frac{y_2 - y_1}{x_2 - x_1} \quad \text{[A2]}$$

where (x_1, y_1) and (x_2, y_2) are known points on the line. We turn to differential calculus to give us the slope *m* of the tangent line. Remember, the tangent line runs from our eye, just touching the side of the trunk. The tangent line and the straight line that goes from center of the circle to our eye intersect at our eye.

To emphasize, *the point of intersection of the two lines is at our eye*. The point where the tangent line touches the circle gives us the x coordinate of the point that represents a specified percentage of the radius e.g. 98.5%. Of course, the missing piece of the radius is the other 1.5% that we don't see. We can convert the missing segment to an equivalent missed part of the circumference using:

$$\Delta C = 2\pi r(1 - \delta) \quad \text{[A3]}$$

Note that δ is actually the decimal equivalent of the percentage of missing radius, i.e. 0.985 instead of 98.5.

For very large trees, a significant amount of the circumference can be missed. As an example, suppose the radius is 10 ft and we set δ = 0.985. Then ΔC = 11.3 inches. At 99.5% of the radius, ΔC = 3.8 inches. At 99.8%, ΔC = 1.5 inches, and at 99.9%, ΔC = 0.75 inches. How far do we need to be from the middle of the trunk to get 99.8% of the radius? The answer is 148.2 ft, or 158.2 ft from the center of the trunk.

Had the radius been 5 ft, we would have had to be back 74.1 ft, half the distance of that for a 10-ft radius. At 99.8% level for a radius of 5 ft, we would miss 0.75 inches of circum-ference:

$$\Delta C = 2\pi 5(1 - 0.998)12 = 0.75$$

We see that the equations for *Y*, *D*, and ΔC provide us with lots of information. For instance, for a tree with a diameter of 8 ft, a distance *D* of about 24.4 ft will allow us to see 99% of the radius. We miss about 0.6 inches of circumference:

$$\Delta C = 2\pi 4(1 - 0.99)12 = 0.6$$

So basically we miss a half-inch of circumference, or a half-point on the champion tree formula. With a monocular, we can easily be farther back, reducing the missed diameter further.

We may want to determine the δ value associated with a specified distance *D* for a tree of a particular radius. For example, if we are positioned at 100 ft from the trunk of a tree with a radius of 3.0 ft, what percent of the radius is visible? We must solve the above equation for δ. The derivation is algebraic and requires a number of steps. It is easier to solve for *y* instead of *D*, remembering that *D* = *y* - *r*. The equation is:

$$\delta = \frac{\sqrt{y^2 - r^2}}{y} \quad \text{[A4]}$$

On the Cartesian coordinate system shown above, *y* is negative because it is below the x-axis. However, we will often treat it as positive where this simplifies a formula. Below are the steps to follow:

1. $x^2 + y^2 = r^2$ equation for a circle with center at the origin; circle represents the trunk of a tree;

2. $y_1 = -\sqrt{r^2 - x^2}$ solving for y_1, which is negative on the above diagram;

3. $\frac{dy}{dx} = -\frac{1}{2}\left(\frac{-2x}{\sqrt{r^2 - x^2}}\right)$ first derivative of *y* with respect to *x*;

4. $\frac{dy}{dx} = \frac{x_1}{\sqrt{r^2 - x_1^2}}$ slope value at tangent point x_1, y_1;

5. $y = -\sqrt{r^2 - x_1^2}$ value of y_1 is negative for the diagram;

6. $y - y_1 = \frac{dy}{dx}(x - x_1)$ general equation of tangent line;

7. $y = \frac{dy}{dx}x - \frac{dy}{dx}x_1 + y_1$ algebraic rearrangement at the point (x_0, y_0), $x_0 = 0$;

8. $y = \frac{dy}{dx}x_0 - \frac{dy}{dx}x_1 + y_1$ substituting (x_0, y_0) for *x* and *y*;

9. $y_0 = y_1 - \frac{dy}{dx}x_1$ simplifying with $x_0 = 0$;

10. $y_0 = -\sqrt{r^2 - x_1^2} - \frac{x_1}{\sqrt{r^2 - x_1^2}}x_1$ substituting for y_1 and dy/dx;

11. $y_0 = -\sqrt{r^2 - x_1^2} - \frac{x_1^2}{\sqrt{r^2 - x_1^2}}$ simplifying;

12. $x_1 = \delta_1 r$ defines x_1 as a percentage of *r*;

13. $y_0 = -\sqrt{r^2 - (\delta_1 r)^2} - \frac{(\delta_1 r)^2}{\sqrt{r^2 - (\delta_1 r)^2}}$ substituting;

14. $y = \frac{-(r^2 - (\delta_1 r)^2) - (\delta_1 r)^2}{\sqrt{r^2 - (\delta_1 r)^2}}$ simplifying;

15. $y_0 = \frac{-r^2 + (\delta_1 r)^2 - (\delta_1 r)^2}{\sqrt{r^2 - (\delta_1 r)^2}}$ simplifying;

16. $y_0 = -\frac{r^2}{\sqrt{r^2 - (\delta_1 r)^2}}$ simplifying;

17. $y_0 = -\frac{r^2}{r\sqrt{1-\delta_1^2}}$ simplifying;

18. $y_0 = -\frac{r}{\sqrt{1-\delta_1^2}}$ simplifying, y_0 is the distance from the center of the trunk to the eye, treated as a negative in diagram. Multiplying both sides of the equation by -1 leads to the more normal form of the equation:

19. $y = \frac{r}{\sqrt{1-\delta_1^2}}$

20. $D = \frac{r}{\sqrt{1-\delta_1^2}} - r$, where D is the distance from the front of the trunk to the eye.

Treating y as a positive magnitude, as per step [18], suppose our distance to the trunk is 36 ft and the radius is 4 ft, then:

$$\delta = \frac{\sqrt{(40)^2-4^2}}{40} = 0.99499$$

Let's check to see how well this δ value works in step [18] for distance:

$$y = \frac{r}{\sqrt{1-\delta^2}} = \frac{4}{\sqrt{1-0.99499^2}} = 44.0$$

This is the result we wanted.

Deriving* y *and* D *for an Ellipse

If the trunk is elliptical in cross-sectional area, we have to modify our formulas. The convention is to denote the semi-major axis as a, and the semi-minor as b. The major axis is at 90 degrees to the line of sight in the following formula (note that we're expressing distances as positives).

$$y = \frac{b}{\sqrt{1-\delta^2}} \quad [A4]$$

$$D = \frac{b}{\sqrt{1-\delta^2}} - b \quad [A5]$$

If the orientation of the ellipse is such that the minor axis is 90 degrees to the line of sight, then the role of a and b are reversed, and we have a slightly different version of equations [A4] and [A5]:

$$y = \frac{a}{\sqrt{1-\delta^2}} \quad [A6]$$

$$D = \frac{a}{\sqrt{1-\delta^2}} - a \quad [A7]$$

The corresponding equations for δ are:

$$\delta = \frac{\sqrt{y^2-b^2}}{y} \quad [A8]$$

$$\delta = \frac{\sqrt{y^2-a^2}}{y} \quad [A9]$$

In equation [A8] we see the semi-major axis a, and in the second case, we see the semi-minor axis b. A more complicated possibility is where our line of sight is not 90 degrees to either the major or minor axis. We do not cover that case.

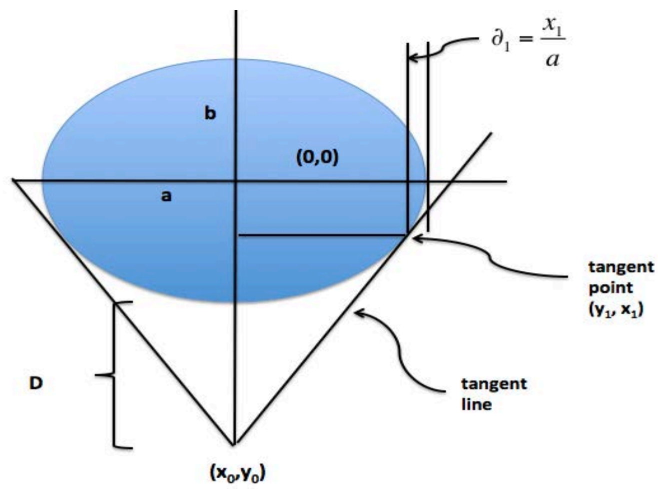


Figure A2. *Schematic of deriving* **y** *and* **D** *for an ellipse.*

Figure A2 shows the visible and missing parts of the diameter. Our objective is to derive an equation for D and y, where $y = D + b$. Below are the steps to follow:

1. $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ equation of ellipse with center at origin; ellipse represents trunk of tree;

2. $y = -\frac{b}{a}\sqrt{a^2 - x^2}$ solving for y, which will be negative for the above diagram;

3. $\frac{dy}{dx} = \frac{bx}{a\sqrt{a^2-x^2}}$ first derivative of y with respect to x;

4. $\frac{dy}{dx} = \frac{bx_1}{a\sqrt{a^2-x_1^2}}$ slope value at tangent point x_1, y_1;

5. $y_1 = -\frac{b}{a}\sqrt{a^2 - x_1^2}$ value of y_1 is negative for the diagram;

6. $y - y_1 = \frac{dy}{dx}(x - x_1)$ general equation of tangent line;

7. $y = \frac{dy}{dx}x - \frac{dy}{dx}x_1 + y_1$ algebraic rearrangement;

8. $y_0 = \frac{dy}{dx}x_0 - \frac{dy}{dx}x_1 + y_1$ substituting (x_0, y_0) for x and y;

9. $y_0 = y_1 - \frac{dy}{dx}x_1$ simplifies to this because $x_0 = 0$;

10. $y_0 = -\frac{b}{a}\sqrt{a^2 - x_1^2} - \frac{bx_1}{a\sqrt{a^2-x_1^2}}x_1$ substituting for y_1 and dy/dx;

11. $y_0 = -\frac{b}{a}\sqrt{a^2 - x_1^2} - \frac{bx_1^2}{a\sqrt{a^2-x_1^2}}$ simplifying;

12. $x_1 = \delta_1 a$ define x_1 as a percentage (δ) of a;

13. $y_0 = -\frac{b}{a}\sqrt{a^2-(\delta_1 a)^2} - \frac{b(\delta_1 a)^2}{a\sqrt{a^2-(\delta_1 a)^2}}$ substituting;

14. $y_0 = -\frac{b}{\sqrt{1-\delta_1^2}}$ which can be greatly simplified.

Taking the positive equivalent of y_0 yields:

15. $y = \frac{b}{\sqrt{1-\delta_1^2}}$

where y_0 (or more generally, y) is the distance from the center of the trunk to the eye. Therefore:

16. $D = \frac{b}{\sqrt{1-\delta_1^2}} - b$ distance from eye to middle of face of trunk.

Derivation of Equation for δ for a Circle
Suppose we know y and r, then determining the value of δ for values of r and y is a simple matter of solving the basic equation for δ in terms of r and y. In this case, for simplicity, we are treating distances as positive. Our original derivations used a Cartesian coordinate system, which left distances negative since they were along the negative part of the Y-axis.

1. $y = \frac{r}{\sqrt{1-\delta^2}}$

2. $y\sqrt{1-\delta^2} = r$

3. $\left[y\sqrt{1-\delta^2}\right]^2 = r^2$

4. $(y^2)(1-\delta^2) = r^2$

5. $y^2 - y^2\delta^2 = r^2$

6. $y^2 - r^2 = y^2\delta^2$

7. $\delta^2 = \frac{y^2-r^2}{y^2}$

8. $\delta = \sqrt{\frac{y^2-r^2}{y^2}}$

9. $\delta = \frac{\sqrt{y^2-r^2}}{y}$

The equivalent derivation for the ellipse produces

$$\delta = \frac{\sqrt{y^2-b^2}}{y} \quad \text{[A10]}$$

where the line of sight is perpendicular to the major axis and

$$\delta = \frac{\sqrt{y^2-a^2}}{y} \quad \text{[A11]}$$

where the line of sight is perpendicular to the minor axis.

APPENDIX B

TABLE OF DISTANCES AND CIRCUMFERENCE ERRORS
We will usually want to know how much the unseen part of the diameter translates to the equivalent missed part of the circumference, since each inch of circumference equals one point on the champion tree formula. At the 99% level, the table below gives us the circumference error in inches. If we go to the 99.5% level, we halve the values in the circumference column. This can be seen from the following:

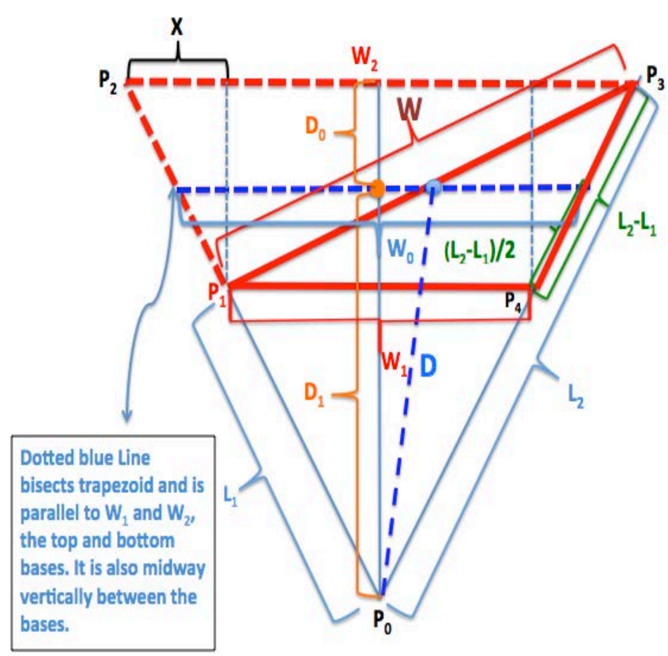
$$\Delta C = 2\pi r(1-\delta) \quad \text{[B1]}$$

$$(1-0.99) = 2(1-0.995)$$

We double the missed circumference when we go from δ = 0.995 to δ = 0.99. This makes sense when we use β = 1 - δ where β is the part we don't see of the diameter or circumference.

APPENDIX C

DERIVATION OF TRAPEZOID DIAGONAL FOR LIMB LENGTH
In the section entitles Advanced Use - Limb Segments for measuring limb segments using a reticle-based monocular, we show a segment in a photograph along with distances to each end and the distance to the approximate middle. Those distances and the reticle reading allow us to compute the limb's length, regardless of its orientation toward us. We use the diagonal of a trapezoid constructed around the segment. The following diagram contains the derivation of the length of the diagonal of an isosceles trapezoid used to measure limb length. In the diagram, the solid red diagonal line length is what we seek. The derivation of W follows the diagram.



***Derivation of* W**

1. $D_1 \approx D$ We measure D with a laser rangefinder and use it as an approximation of D_1.

2. $\frac{D}{D+D_0} \approx \frac{D_1}{D_1+D_0}$ We are interested in the ratio on the right and substitute it in subsequent steps.

3. $\frac{D_1}{D_1+D_0} = \frac{L_1+\left(\frac{L_2-L_1}{2}\right)}{L_2}$ applying the principle of similar triangles;

4. $\frac{D_1}{D_1+D_0} = \frac{L_1+L_2}{2L_2}$ simplifying;

5. $D_0 = \frac{L_2-L_1}{L_1+L_2} D_1$ solving for D_0;

6. $W_1 = \frac{(D_1-D_0)M}{F}$ calculate length of lower base of trapezoid, actually approximate length, since D is used as an estimate of distance D_1 (note M is reticle reading and F is reticle factor);

7. $\frac{W_2}{W_1} = \frac{L_2}{L_1}$ by the principle of similar triangles;

8. $W_2 = \frac{L_2}{L_1} W_1$ solving for W_2;

9. $W = \sqrt{\left(\frac{W_2+W_1}{2}\right)^2 + (2D_0)^2}$ employs the Pythagorean Relation to compute the trapezoid diagonal.

NOTES

1. Measurer is at P_0. Ends of limb are at P_1 and P_2.
2. Measurer constructs an isosceles trapezoid as shown in the diagram with vertices at $P_1P_2P_3P_4$.
3. The dotted blue line D is the distance to the approximate middle of the limb and is used as an estimate of D_1, the center of the median of the trapezoid. The horizontal dashed blue line is the median of the trapezoid.
4. **Measure L_1, D, and L_2 with a laser.** These are the only laser measurements taken.
5. Take the reticle reading M that corresponds to the limb segment P_1P_3, representing the limb segment W, the length of which is to be determined.
6. In simpler versions of this process, L_1 is used as an estimate of D_1, but D is a closer approximation. It calls for judgment of where the middle of W lies.
7. The objective is to compute the length W_0, the median trapezoid as a step in computing W.
8. D_1 is needed but can't be obtained directly, so D is used as an estimate. D is usually very close to D_1 for situations that involve the reticle.
9. Note that the dashed horizontal blue line is the computed length that will result from the reticle value M applied to the distance D_1 from the field of view taken up by the line P_1P_4.
10. Since the trapezoid is isosceles, the $P_1P_2 = L_2 - L_1$.
11. By shooting slightly to the left or right of the middle of P_1P_3, we come very close to the length D_1.
12. The calculations can be programmed into Excel or a smartphone spreadsheet or an app that allows successive calculations. Luminant Software's *Discount Spreadsheet* is an easy iPhone app that can be used. The Apple app *Numbers* can be used. Also, for programmers, *HotPaw Basic* is a simple language interpreter that can be used to develop a program solution.

APPENDIX D

DERIVATIONS FOR SHAPE AND POSITION CHALLENGES

Correcting the Distance - Case I

Consider Figure D1:

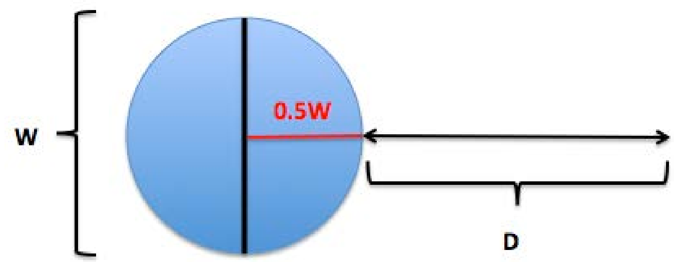


Figure D1. First example of how to correct for distance.

Deriving W from the distances shown above follows:

1. $W = \frac{M(D+0.5W)}{F}$

2. $FW = M(D + 0.5W)$

3. $FW = MD + 0.5MW$

4. $FW - 0.5MW = MD$

5. $W = \frac{MD}{F-0.5M}$

Note that the 0.5-factor applies to circles. The general factor δ can be substituted for 0.5, however, the measurer will not likely have any way of knowing what the value of δ would be, if not 0.5. For ellipses, the W corresponds to either the major '*a*' or minor '*b*' axis, but the measurer would need to take additional measurements to establish the ratio *a/b* to use in refining the above process. That will be done in a future paper.

Correcting the Distance - Case II

What kind of distance correction must we make if looking up to a point on the trunk at an angle of ß degrees? Consider the diagram in Figure D2.

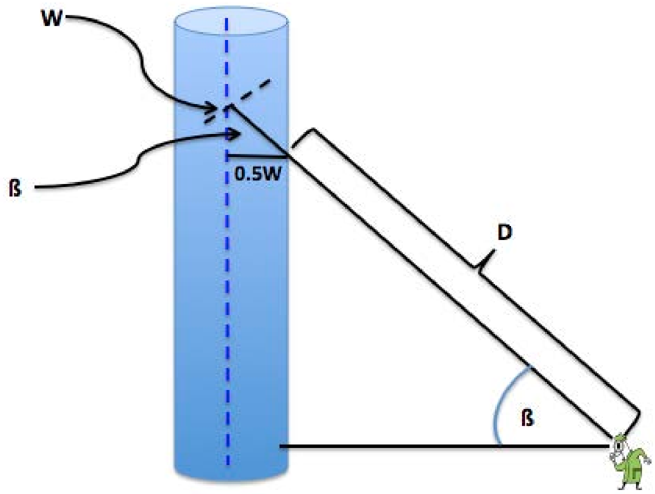


Figure D2. Second example of how to correct for distance.

The derivation of *W* for this case follows:

1. $W = \frac{M\left(D+\frac{0.5W}{cos\beta}\right)}{F}$

2. $FW = M\left(D + \frac{0.5W}{cos\beta}\right)$

3. $FW = MD + \frac{M0.5W}{cos\beta}$

4. $FW - \frac{M0.5W}{cos\beta} = MD$

5. $W\left(F - \frac{M0.5}{cos\beta}\right) = MD$

6. $W = \frac{MD}{F - \frac{0.5M}{cos\beta}}$

The spectacular coastal redwoods **(Sequoia sempervirens)** *present many great opportunities and challenges for big tree measurers, from their daunting heights to their complicated bole forms. Photograph by Don C. Bragg.*

HOW MANY BIG TREE LISTS?

Robert T. Leverett

Founder, Eastern Native Tree Society

Is it time to resurface the discussion on the number of big tree lists we would like to see? What's on the table driving the discussion? In my mind, the following points are most relevant:

1. The continuum of forms going from multi-stem shrubs to single-trunk trees. In his capacity as a key American Forests (AF) Measurements Guideline Working Group (MGWG) member, Don Bertolette did an exhaustive literature search on tree definitions and form considerations. This has been included in the appendices to the current AF guidelines handbook. However, everyone should feel free to continue to present information they think is relevant. Photographic documentation and analysis of forms keyed to each species is our focus now.
2. The dominance of multi-stem forms in the state and national registers. This is an obvious outcome of: (1) point #1, (2) heretofore inadequate rules for handling the complex forms, (3) some big tree hunters "gaming" the system, and (4) the natural outcome of competition. But the result is a big mess. I expect we all agree on that.
3. The AF budget for the Big Tree Program. AF operates largely through grants to run specific programs. Everything is governed by money. Expanding support services for the National Register requires funding. So, the money has to be available before the lists can be expanded since more trees means more reviews.
4. The state of the rules and methods for measuring circumference for multi-stem forms. Although we had rules in the past, they really didn't require the measurer to specifically qualify the form as a single tree or a composite of stems pressed together. So long as there was a continuous bark covering at 4.5 ft most big tree programs allow the measurer to stretch a tape around the form at 4.5 ft and treat the result as the measurement of a single trunk. With our new guidelines handbook, that has now changed. But with the change, we get questions and challenges. We're going in the right direction.
5. The opinions/desires of the public, big tree hunters, forest and tree professionals, etc. The National Register requires public support. Without that, we're fooling ourselves about what we're doing and why. So whatever we do, we have to sell the idea to the stakeholders. The AF decision makers never lose sight of the public nature of the National Register.
6. The unintended consequences of instituting a more complicated system. We've always acknowledged that big tree programs involve tradeoffs. That will continue, but when we've traded too much in one direction or another, we have to be willing to change directions. Too much complexity seen at the level of the public would be a turnoff to program support. We have to keep the front end, i.e. the exterior surface, simple. What's under the hood is a different matter.
7. The role of the National Cadre in settling disputes. The group that will bear the brunt of any changes is the National Cadre. The more complex system of judging the worthiness of a candidate, the more that Cadre members will be called to arbitrate disputes. That number will likely increase as we continue to offer our tree measuring workshops and beat the bushes for recruits. Because some states will require three or even four Cadre members, I think between 100 and 150 Cadre members will be needed to give adequate coverage. AF is working on a travel budget, but it may never cover all our expenses.

Some of you have advocated a simple system of asterisking entries when multi-stemmed. How complicated can it be to implementing something like that? Well, Don Bertolette advocated for that back in 2013 when the MGWG first began its work. The idea would be to have two champions listed if some multi-stem nomination outpointed the largest single-stem entry. We would still have to deal with the one tree versus more than one tree issue, which brings me to a point. Does anyone really think that a champion should be allowed to be two separate trees that just happen to be touching one another? Who thinks a champion should be allowed if multi-trunked, i.e., all trunks contributing to the circumference measurement? If we have a form that looks like two distinct trees pressed together, most of us would likely flinch at the thought of that form being crowned champion. However, as the form become more complex and hard to classify as a double at the height being measured for circumference, opinions will differ. This is where pith tracing really earns its way. But at the conceptual level, I cannot see the fairness of giving some forms a free ride because they are complicated—for example, that kind of sloppiness allowed an Ohio sycamore clump to be crowned champion.

In conclusion, the onus will increasingly be on the National Cadre to figure all these measurement-oriented things out. If we succeed, we'll probably be able to get AF to publish the listings we want.

INSTRUCTIONS FOR CONTRIBUTORS

SCOPE OF MATERIAL

The *Bulletin of the Eastern Native Tree Society* accepts solicited and unsolicited submissions of many different types, from quasi-technical field reports to poetry, from peer-reviewed scientific papers to digital photographs of trees and forests. This diverse set of offerings also necessitates that (1) contributors specifically identify what type of submission they are providing; (2) all submissions should follow the standards and guidelines for publication in the *Bulletin*; and (3) the submission must be new and original material or be accompanied by all appropriate permissions by the copyright holder. All authors also agree to bear the responsibility of securing any required permissions, and further certify that they have not engaged in any type of plagiarism or illegal activity regarding the material they are submitting.

SUBMITTING A MANUSCRIPT

As indicated earlier, manuscripts must either be new and original works, or be accompanied by specific written permission of the copyright holder. This includes any figures, tables, text, photographs, or other materials included within a given manuscript, even if most of the material is new and original.

Send all materials and related correspondence to:

Editor-in-Chief
Bulletin of the ENTS
dbragg@fs.fed.us

Depending on the nature of the submission, the material may be delegated to an associate editor for further consideration. The Editor-in-Chief reserves the right to accept or reject any material, regardless of the reason. Submission of material is no guarantee of publication, but does imply the consent to do so.

All submissions must be made to the Editor-in-Chief in digital format. Manuscripts should be written in Word (*.doc), WordPerfect (*.wpd), rich-text format (*.rtf), or ASCII (*.txt) format.

Images can be submitted in any common format like *.jpg, *.bmp, *.tif, *.gif, or *.eps, but not PowerPoint (*.ppt). Images must be of sufficient resolution to be clear and not pixilated if somewhat reduced or enlarged. Make sure pictures are at least 300 dots per inch (dpi) resolution. Pictures can be color, grayscale, or black and white. Photographs or original line drawings must be accompanied by a credit line, and if copyrighted, must also be accompanied by a letter with express written permission to use the image. Likewise, graphs or tables duplicated from published materials must also have expressly written copyright holder permission.

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All manuscripts must follow editorial conventions and styling when submitted. Given that the *Bulletin* is edited, assembled, and distributed by volunteers, the less work needed to get the final product delivered, the better the outcome. Therefore, papers egregiously differing from these formats may be returned for modification before they will be considered for publication.

Title Page

Each manuscript needs a separate title page with the title, author name(s), author affiliation(s), and corresponding author's postal address and e-mail address. Towards the bottom of the page, please include the type of submission (using the categories listed in the table of contents) and the date (including year).

Body of Manuscript

Use papers previously published in the *Bulletin of the Eastern Native Tree Society* as a guide to style formatting. The body of the manuscript will be on a new page. Do not use headers or footers for anything but the page number. Do not hyphenate text or use a multi-column format (this will be done in the final printing). Avoid using footnotes or endnotes in the text, and do not use text boxes. Rather, insert text-box material as a table.

All manuscript submissions should be double-spaced, left-justified, with one-inch margins, and with page and line numbers turned on. Page numbers should be centered on the bottom of each new page, and line numbers should be found in the left margin.

Paragraph Styles. Do not indent new paragraphs. Rather, insert a blank line and start the new paragraph. For feature articles (including peer-reviewed science papers), a brief abstract (100 to 200 words long) must be included at the top of the page. Section headings and subheadings can be used in any type of written submission, and do not have to follow any particular format, so long as they are relatively concise. The following example shows the standard design:

FIRST ORDER HEADING
Second Order Heading
Third Order Heading. The next sentence begins here, and any other levels should be folded into this format.

Science papers are an exception to this format, and must include sections entitled "Introduction," "Methods and Materials," "Results and Discussion," "Conclusions," "Literature Cited," and appendices (if needed) labeled alphabetically. See the ENTS website for a sample layout of a science paper.

Trip reports, descriptions of special big trees or forests, poetry, musings, or other non-technical materials can follow less rigid styling, but will be made by the production editor (if and when accepted for publication) to conform to conventions.

Table and figure formats. Tables can be difficult to insert into journals, so use either the table feature in your word processor, or use tab settings to align columns, but DO NOT use spaces. Each column should have a clear heading, and provide adequate spacing to clearly display information. Do not use extensive formatting within tables, as they will be modified to meet *Bulletin* standards and styles. All tables, figures, and appendices must be referenced in the text.

Numerical and measurement conventions. You can use either English (e.g., inches, feet, yards, acres, pounds) or metric units (e.g., centimeters, meters, kilometers, hectares, kilograms), so long as they are consistently applied throughout the paper. Dates should be provided in month day, year format (June 1, 2006). Abbreviations for units can and should be used under most circumstances.

For any report on sites, heights must be measured using the methodology developed by ENTS (typically the sine method). Tangent heights can be referenced, especially in terms of historical reports of big trees, but these cannot represent new information. Diameters or circumference should be measured at breast height (4.5 ft above the ground), unless some bole distortion (e.g., a burl, branch, fork, or buttress) interferes with measurement. If this is the case, conventional approaches should be used to ensure diameter is measured at a representative location.

Taxonomic conventions. Since common names are not necessarily universal, the use of scientific names is strongly encouraged, and may be required by the editor in some circumstances. For species with multiple common names, use the most specific and conventional reference. For instance, call *Acer saccharum* "sugar maple," not "hard maple" or "rock maple," unless a specific reason can be given (e.g., its use in historical context).

For science papers, scientific names MUST be provided at the first text reference, or a list of scientific names corresponding to the common names consistently used in the text can be provided in a table or appendix. For example, red pine (*Pinus resinosa*) is also known as Norway pine. Naming authorities can also be included, but are not required. Be consistent!

Abbreviations. Use standard abbreviations (with no periods) for units of measure throughout the manuscript. If there are questions about which abbreviation is most appropriate, the editor will determine the best one to use. Here are examples of standardized abbreviations:

inch = in	feet = ft
yard = yd	acre = ac
pound = lb	percent = %
centimeter = cm	meter = m
kilometer = km	hectare = ha
kilogram = kg	day = d

Commonly recognized federal agencies like the USDA (United States Department of Agriculture) can be abbreviated without definition, but spell out state names unless used in mailing address form. Otherwise, spell out the noun first, then provide an abbreviation in parentheses. For example: The Levi Wilcoxon Demonstration Forest (LWDF) is an old-growth remnant in Ashley County, Arkansas.

Citation formats. Literature cited in the text must meet the following conventions: do not use footnotes or endnotes. When paraphrasing or referencing other works, use the standard name date protocol in parentheses. For example, if you cite this issue's Founder's Corner, it would be: "…and the ENTS founder welcomed new members (Leverett 2006)." If used specifically in a sentence, the style would be: "Leverett (2006) welcomed new members…" Finally, if there is a direct quotation, insert the page number into the citation: (Leverett 2006, p. 15) or Leverett (2006, p. 16-17). Longer quotations (those more than three lines long) should be set aside as a separate, double-indented paragraph. Papers by unknown authors should be cited as Anonymous (1950), unless attributable to a group (e.g., ENTS (2006)).

For citations with multiple authors, give both authors' names for two-author citations, and for citations with more than two, use "et al." after the first author's name. An example of a two-author citation would be "Kershner and Leverett (2004)," and an example of a three- (or more) author citation would be "Bragg et al. (2004)." Multiple citations of the same author and year should use letters to distinguish the exact citation: Leverett 2005a, Leverett 2005b, Leverett 2005c, Bragg et al. 2004a, Bragg et al. 2004b, etc.

Personal communication should be identified in the text, and dated as specifically as possible (not in the Literature Cited section). For example, "…the Great Smoky Mountains contain most of the tallest hardwoods in the United States (W. Blozan, personal communication, March 24, 2006)." Examples of personal communications can include statements directly quoted or paraphrased, e-mail content, or unpublished writings not generally available. Personal communications are not included in the Literature Cited section, but websites and unpublished but accessible manuscripts can be.

Literature Cited. The references used in your work must be included in a section titled "Literature Cited." All citations should be alphabetically organized by author and then sorted by date. The following examples illustrate the most common forms of citation expected in the *Bulletin*:

Journal:

Anonymous. 1950. Crossett names giant pine to honor L.L. Morris. Forest Echoes 10(5):2-5.

Bragg, D.C., M.G. Shelton, and B. Zeide. 2003. Impacts and management implications of ice storms on forests in the southern United States. Forest Ecology and Management 186:99-123.

Bragg, D.C. 2004a. Composition, structure, and dynamics of a pine-hardwood old-growth remnant in southern Arkansas. Journal of the Torrey Botanical Society 131:320-336.

Proceedings:

Leverett, R. 1996. Definitions and history. Pages 3-17 *in* Eastern old-growth forests: prospects for rediscovery and recovery, M.B. Davis, editor. Island Press, Washington, DC.

Book:

Kershner, B. and R.T. Leverett. 2004. The Sierra Club guide to the ancient forests of the Northeast. University of California Press, Berkeley, CA. 276 p.

Website:

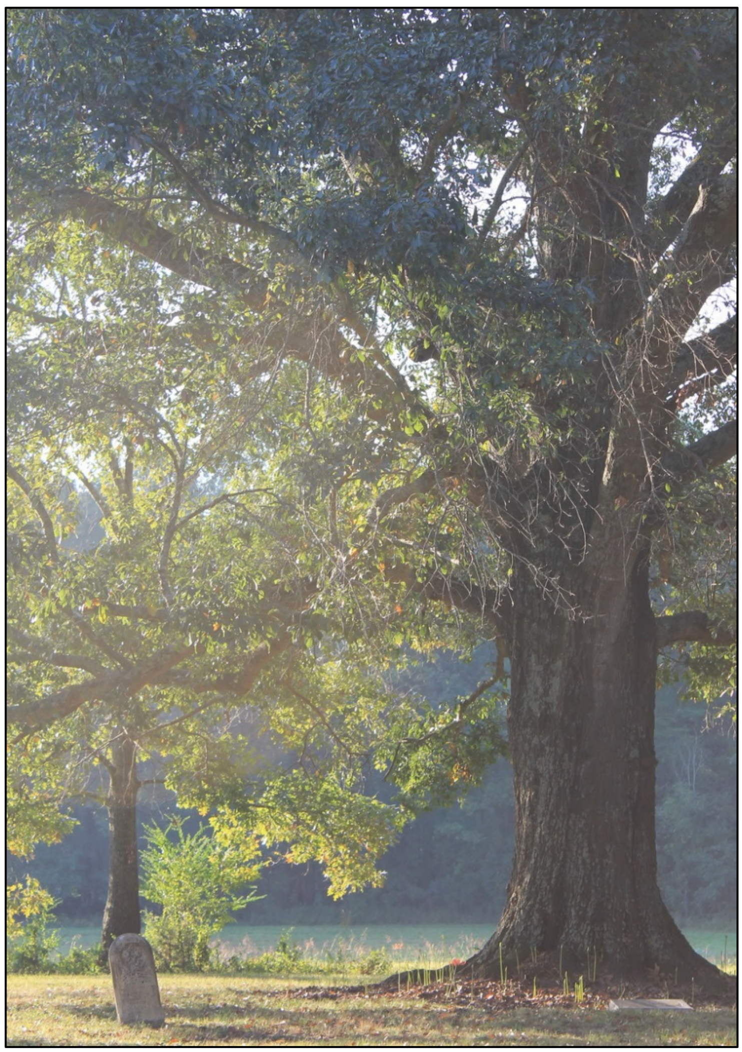
Blozan, W. 2002. Clingman's Dome, May 14, 2002. http://www.uark.edu/misc/ents/fieldtrips/gsmnp/clingmans_dome.htm. Accessed June 13, 2006.

Use the hanging indent feature of your word processor (with a 0.5-in indent). Do not abbreviate any journal titles, book names, or publishers. Use standard abbreviations for states, countries, or federal agencies (e.g., USDA, USDI).

ACCEPTED SUBMISSIONS

Those who have had their submission accepted for publication with the *Bulletin of the Eastern Native Tree Society* will be mailed separate instructions to finalize the publication of their work. For those that have submitted papers, revisions must be addressed to the satisfaction of the editor. The editor reserves the right to accept or reject any paper for any reason deemed appropriate.

Accepted materials will also need to be accompanied by an author contract granting first serial publication rights to the *Bulletin of the Eastern Native Tree Society* and the Eastern Native Tree Society. In addition, if the submission contains copyrighted material, express written permission from the copyright holder must be provided to the editor before publication can proceed. Any delays in receiving these materials (especially the author contract) will delay publication. Failure to resubmit accepted materials with any and all appropriate accompanying permissions and/or forms in a timely fashion may result in the submission being rejected.



A large oak shelters a small family cemetery in Arkansas County, Arkansas. Photograph by Don C. Bragg.