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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: In the spring, "devils-tongue" or eastern prickly pear cactus* (Opuntia humifusa) *provide a splash of brilliant color to the Warren Prairie in south-central Arkansas. Photograph by Don C. Bragg.

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THROUGH SPACE AND TIME

Recently, I finished a couple of days as a volunteer excavating a historic archeological site in southwestern Arkansas once used by many travelers heading to lands unknown (well, to them at least), and next week I'm volunteering for an archeological dig on a site thought to be one of the many Indian villages visited by Hernando de Soto's 1540s expedition through the southeastern United States. I can only wonder about the landscapes these peoples experienced—the forests they encountered, the rivers and lakes they crossed, the wildlife that surrounded them…

What I do know for certain is how important wood was to these people. It provided them shelter, warmed them on cold nights, cooked their food, provided their tools, and for many, their livelihoods. We often encounter decaying wood in our archeological digs (especially the more recent historic sites), but these provide only a hint of the contributions this material played in the everyday lives of those that used it. While I cannot witness what they saw, I can still feel a connection with the past through the forests that still cover most of this area, and I share in their sense of place as I excavate artifacts of daily life from decades or even centuries (and millennia!) before…

Don C. Bragg
Editor-in-Chief

Fire and water dominate the forest floor in this small bottomland near the Gum Springs Recreation Area on the Kisatchie National Forest in central Louisiana. Photograph by Don C. Bragg.

Announcements and Society Actions

Preliminary Advanced Tree Measuring Workshop Agenda

Current Sponsors:
Native Tree Society (NTS), Massachusetts Department of Conservation and Recreation (DCR), Laser Technology, Inc. (LTI), and the Massachusetts Audubon Society

Mohawk Trail State Forest, Charlemont, Massachusetts

October 12, 2012

TIME	ACTIVITY (ALL EVENTS WILL BE FILMED)
9:15—9:45 AM	Opening comments (1) DCR representative (5 min) (2) NTS representative (15 min) (3) Others to be identified (10 min)
9:45—10:00 AM	Massachusetts Champion Tree Program (Ken Gooch, DCR)
10:00 AM—12:00 PM	Headquarters Measuring Workshop (NTS representatives) (1) sine top-sine bottom (15 min) (2) tangent top-tangent bottom (15 min) (3) sine top-tangent bottom (10 min) (4) parallax (20 min) (5) extended baseline (15 min) (6) similar triangles (15 min) (7) sources of measurement error (30 min)
12:00—1:00 PM	Lunch
1:00—4:15 PM	Concurrent Programs I. Tall pines measurement exercises (NTS representatives) (1) Headquarters Pine (15 min) (2) Massassoit Pine (15 min) (3) Special ceremony for the late Chuck Bellows (15 min) (4) Cabin Pine (20 min) (5) Jake Swamp Pine (30 min) (6) Algonquin Pine (15 min) (7) Frank Decontie Pine (15 min) (8) Double Mast Pine (20 min) II. LTI equipment demonstrations - at Headquarters (LTI reps) III. Tree climbing demonstration for height measuring (Will Blozan and Bart Bouricius)
4:15—4:30 PM	Closing comments at headquarters and handouts (NTS & LTI reps) (1) Measuring techniques (2) LTI Equipment

New Native Tree Society Special Publications

Several recent additions have been made to the Native Tree Society's (NTS) special publications archive (found at the NTS website http://www.nativetreesociety.org/ under "Special Publications"). These include several previously unpublished reports written by Bruce Kershner on old-growth sites in the northeastern US and Canada and Ed Frank's recent work on the trees and forests on the islands along the Allegheny River in Pennsylvania.

As always, please check out all of the NTS special publications—your Society at work!

Ed Frank's Advice Regarding the Trees Database

Ed Frank recently posted the following message to the Native Tree Society (NTS) Bulletin Board System (BBS):

"There are more and more people participating in the Native Tree Society and who are out there measuring trees. For those people measuring trees I strongly encourage you to submit your measurements not only to the BBS, but to post them to our Database as well (http://www.treesdb.org/). Mitch Galehouse has done an excellent job of creating the database (some of it is still under construction). Please read our tree measuring guidelines before submitting tree measurement data:
http://www.nativetreesociety.org/measure/Tree_Measuring_Guidelines-revised1.pdf

"I want to offer two items of caution for people submitting their measurements to the database. The heights must be measured using one of three methods: 1) NTS laser rangefinder/clinometer sine-top/sine-bottom methods outlined in our tree measuring guidelines, 2) climb and tape drop measuring the top of the tree, also as outlined in our tree measuring guidelines, or 3) by a pole measurement where the height is directly measured using a pole. If you have measured the tree in some other fashion, then the data does not meet our standards and should not be posted to our database. If you have entered trees whose height has been measured by other than the methods listed above, please go back and delete these entries.

"The second item of caution is the inclusion of multitrunk trees. We have discussed this subject many times (for example, http://www.ents-bbs.org/viewtopic.php?f=235&t=3948 or http://www.nativetreesociety.org/multi/index_multi.htm). For measurement purposes, the girths of trees with more than one trunk must not be intermixed with those for trees with single trunks. A single trunk tree is one that has a single pith at ground level. If the tree has more than one pith at ground level, it is a multitrunked tree. It doesn't matter if it is genetically the same, or growing from the same root stock, by definition used in our guidelines, if it would have more than one pith at ground level it is a multitrunk tree and must be differentiated from single trunk trees. Presently there is no place in the database structure to enter data for multitrunk trees. If you have measured one, and want to enter it into the database, please note that it is a multitrunk tree in the comments field, and we can fix it later when the database is complete.

"Trees have been entered in the database that clearly appear in the photograph to be multitrunk trees, yet there are no indications in the comments that they are anything but single trunk trees. Yes, it is up to the measurer to make the final determination in the case where there is a debate about whether something is single trunk or multitrunk, but in some of these cases there is no doubt the trees are multitrunk trees. If you have entered a tree that is multitrunked, but failed to indicate that it is multitrunked in the comments section, please go back and edit the submission to reflect this fact. As an organization we need to maintain and protect the integrity of our data set."

Please make sure you're following Ed's sage advice while working with this potentially powerful new online tool!

LESSONS FROM COOK FOREST: PART I

Robert T. Leverett

Founder and Executive Director, Eastern Native Tree Society

INTRODUCTION

If I do say, the Native Tree Society's (NTS) Advanced Tree Measuring Workshop organized by Dale Luthringer and yours truly at Cook Forest State Park, Pennsylvania, on April 18-19, 2012, was an unqualified success! I was pleased with and appreciative of the enthusiasm and participation of the attendees. Hopefully, the workshop planned for Mohawk Trail State Forest in Massachusetts on October 12-13, 2012, will go as well. To this end, after the Cook event, I began thinking about how to take the agenda further. In particular, I see a need to concentrate on the crown-offset problem that tape and clinometer users routinely face. Since many measurers are unaware of the problem, the crown-offset challenge should be a prime focus of our attention, and consequently, is the main topic of this article.

Big tree aficionados who hunt the largest members of each species cannot help notice that large trees have complex, irregular forms that stand in sharp contrast to the simple regular forms of straight-trunked plantation conifers, often the focus of forest management operations. The complex forms of the big trees require effort to model and measure whereas the plantation forms can be dealt with simply and quickly. More to the point, measuring the complex forms with an acceptable degree of accuracy involves challenges that far exceed those of the pencil-straight, narrow-crowned plantation conifers. This applies to all dimensions, but is especially true for height measurements. Yet, if we rely on the measuring diagrams provided by the makers of clinometers, the two forms are not portrayed or distinguished. The diagrams show fairly symmetrical trees with their tops positioned squarely over their bases. For measuring purposes, the forms shown in the diagrams are the equivalent of telephone poles. But the irregular forms that characterize many large, old trees must be distinguished from the simple forms if accuracy is to be obtained in measuring their heights.

The main difference between the simple and complex forms, in terms of height measurements, can be summarized in a single phrase—horizontal crown-point offset distance. Simply defined, the horizontal crown-point offset distance, or crown-offset for short, is the horizontal distance between the highest point of the crown and the center of the base of the tree. Drop a vertical line from the highest twig of the crown down to the level of the base, and the horizontal distance from the vertical line to the center of the base is the crown-offset. For straight-trunked conifers, the crown-offset can be small, less than 6 or 7 ft, often only 2 or 3. But for large spreading hardwoods, the offset can easily be 10 to 20 ft, and sometimes more. In addition, if not too tall, narrow-crowned conifers allow the measurer to see the actual top from relatively close distances. Conversely, the true tops of tall, broad-crowned hardwoods can be completely obscured. So, what is the measurer measuring in these cases? The measurer sees the tips of upturned limbs, one of which is taken to be the actual top. But mistaking the end of a branch for the actual top carries profound consequences in terms of measuring height. Height errors can be in the tens of feet.

It is reasonable for us to believe that the measuring implications of simple versus complex forms have long been understood by timber professionals and big tree hunters, but sizable measurement errors continue to occur, and go apparently unrecognized by the certifiers of trees submitted to the National Register and the state champion tree programs. So this topic needs as much attention as we can give it, and is one reason we held the advanced tree-measuring workshop at Cook Forest. Our goal is to help would-be tree measurers, regardless of background or professional affiliation, cope with the variables that define tree measuring, and to specifically concentrate on height measurements and the crown-offset problem for the benefit of tape and clinometer users.

DAY 1—INDOOR AND OUTDOOR EXERCISES

We started early on April 18 with a presentation by this author introducing *Dendromorphometry* and the kinds of tree measurements that hold our interest in NTS. I didn't know the backgrounds of most of the attendees, so I dampened down the mathematics that I normally include. It worked, and to my relief, my explanations seemed to have held their interest. I got good questions throughout the presentation, but the real test of how successful I'd been would be in the outdoor part of the program. At the end of the indoor session, we adjourned and reassembled in a small field near the Nature Center. The objective was to demonstrate our measuring techniques and investigate the sources of measurement error on a live tree.

The tree Dale Luthringer and I chose was a tallish white pine with a flat top, leaning slightly out in the direction of the field. On the previous day, we established its height as 121 ft, give or take 0.5 ft. Once in the field with the group, we established a circular arc around the pine with a radius of 66 ft to the trunk—the length of a surveyor's chain. At this distance, the absolute top of the pine was not visible, but at the time, this was not known to the participants.

At the 66-ft baseline distance, participants got heights as high as 156 ft using the tangent method. Obviously, they were measuring the tips of forward reaching branches, but didn't necessarily realize it. We then moved back, and established a circular arc at 100 ft from the trunk. Heights measured using the tangent method at this distance ranged up to 136 ft. From approximately 130 ft out, the top was generally visible, but the highest sprig, mixed in with other clusters of needles, was not obvious to the measurers. Using the tangent method, heights varied and were in error typically by 5 to 8 ft. Moving back to nearly 200 ft, we finally got heights using the tangent method that were fairly close and reflected the actual crown-offset of the top. At this distance and oriented about 70% to the vertical plane containing the top and base, the tangent method yielded results often within ±3.0 ft of true height.

A review of the results of the exercise showed participants that the measurements of the pine's height from closer than 130 ft carried significant error, and the numbers were literally all over the map. The lesson clearly conveyed is "Don't get too close to your target!" But how close is close? As a general rule, if the tree is tall and has a large crown, 100 ft is much too close. In the case of the pine, a baseline of at least 130 ft was needed. One way to minimize the problem is to go far enough back so that the angle reading does not exceed 45˚—independent of height or crown size.

The results of the field exercise amply illustrated that the tangent method can produce highly variable results, even on a tree that doesn't look complicated, and that the reasons are principally two: (1) different tops or limb extensions are being measured, and (2) when a specific target top is measured, an incorrect baseline is used for it. One attendee from Pennsylvania State University explained to me that the exercise had cleared up a lot of confusion for him about what works and what doesn't. The benefits of the sine method over the tangent method, as explained in the indoor session, became clear to all participants.

For me, the lesson learned is that live field exercises are needed in addition to indoor lectures. In future advanced tree measuring workshops, I plan to choose several trees for participants to measure, illustrating the advantages and challenges associated with each measurement method. In particular, since many people will continue to use it, I want to show precisely where the tangent method succeeds and fails.

DAY 1—RE-MEASURING THE LONGFELLOW PINE

As a digression from the crown-offset problem, after the outdoor exercise we had lunch, and then Dale led us up the Longfellow Trail to measure old-growth white pines and eventually re-measure the champion Longfellow Pine—the tallest tree of any species in the Northeast. Throughout the afternoon's event, we operated in pure sine method mode. Barring instrument calibration problems or misreading an instrument, the sine method produces results that are very near the actual height of the target being measured—regardless of crown complexity. Crown-offset is not an issue with the sine method, but that didn't mean we had been given a free pass. The principal challenge for anyone measuring a tree using the sine method is getting laser bounces off the selected target. With this challenge, we are often at the mercy of the designers of the infrared laser being used. Intervening clutter can result in the laser beam being intercepted by something other than the intended target, resulting in erroneous target distances. If there is too much clutter, the tree may not lend itself to being measured without spending a lot of time. Some brands of laser rangefinders perform better than others when it comes to penetrating clutter. On the inexpensive side, the Nikon's Prostaff 440 has been our best instrument for penetration of clutter, but the 440 has been discontinued by Nikon, and replacement models do not perform well. I have the Nikon Prostaff 440, the Prostaff 550, and the Forestry 550. The 440 continues to be the workhorse for distance shots, and is used by virtually all members of NTS who measure trees. However, the Prostaff 440 is not the most accurate of the competing instruments. Laser Technology's (LTI) TruPulse line out-performs them all and its tilt sensor is especially good. When I am in a hurry and can't find the target with the TruPulse because of intervening clutter, I use the 440 for distance and the TruPulse for angle. If I can clearly see the target, it is the TruPulse for distance and angle. One way of finding the target better with the TruPulse when clutter is involved is putting it on a tripod. One needs a bag of tricks to deal with challenging measuring situations. An important trick is to ensure the TruPulse is set to farthest mode.

There are ways to cross-check results of sine-based measurements when target visibility is poor, but those methods can immerse the measurer in more work than they may be willing to do, especially if the measuring process has traditionally been: point, shoot, and read a result. Regardless, in a closed canopy forest, and irrespective of measurement method, there is no way to avoid searching for the highest point of the target tree by testing different twigs, except for absolutely pencil-straight conifers. The reason is simple. As humans, our binocular vision doesn't resolve complex crown structures well enough for us to recognize which of competing twigs is actually the highest when they are fairly close together, and differ little in height. The farther away we are from the crown tips, the more they appear to be at the same distance. But a more distant twig within the crown, lying at a lower angle from the point of observation, can be the highest point. This is where the sine method exerts its decided superiority over the tangent method. With the tangent method, one is seldom sure if the baseline chosen is appropriate to the twig being tested unless a labor-intensive cross-triangulation process is employed, and that can be a challenge inside of a forest and/or in uneven terrain—easier said than done. Where the baseline for the crown measurement is set as the level distance to the trunk, errors are virtually guaranteed.

Once at the Longfellow Pine, Dale and I took up positions we each had previously used to measure that tree in the past. In particular, on April 17 I had gone to the Longfellow and repeatedly measured it from my chosen vantage point. I didn't want any surprises the next day. After at least 20 shots, I was very confident that the top was between 183.0 and 185.0 ft in height, based on using my Nikon Prostaff 440 for distance and TruPulse 360 for angle. Examining the distribution of the measurements, I suspected the actual height of the Longfellow to be around 183.0 ft, but I gave the great tree the benefit of the doubt, settling on 184.0 ft. I could reproduce that measurement, although it was not the most frequent result. This is where knowing your instrument plays a crucial role along with some statistics. But, the tallest tree in the Northeast deserved any benefit of the doubt until it could be conclusively proven to be a lesser height, so I left it at 184 ft.

The re-measurement exercise with the group on April 18 didn't change the prior day's result, and that exercise involved multiple measurers, so I suppose the result was more of a committee finding, because variances remained. Since Steve Colburn from LTI was present, I wanted to try to get a total measurement using an LTI product. From a better vantage point, my TruPulse 360 gave me a return of 183.0 on one of the trials. Most were 182.5 ft. However, my particular TruPulse often shoots a half-foot short at the distances we were at, so a height of 183.0 ft is reasonable for the LTI product. Other TruPulses may be dead on. Periodically the measurer needs to check the calibration of their instrument.

I should mention that the total variation of my measurements from the entire combination of instruments and at least 30 trials over the two days was 2.0 ft. This isn't bad, especially for the distances I was shooting. Although I didn't compute it, the average was likely to be right on 183.0 ft. Even so, on April 18, others got 184.0 to slightly more. So we placed Longfellow's height at an official 184.0 ft. It will probably grow a 3-4 inch internode this year, so we can feel confident that our measurements will be within a foot of true height by July 2012.

As a point of comparison, had we attempted to use the tangent method, our numbers would have varied considerably because the highest point of Longfellow is not over its base. From the distances and orientations we were shooting, the tangent method to the top twig yielded results within the range of ±5 ft. Some tangent shots under-estimated the true height. Others went over, depending on the location of the shot.

Before leaving the Longfellow Pine, I should point out that observing its crown from the distances we have to be at to see its multiple tops allowed me to demonstrate where the sine method really shines. Which sprig is the absolute highest? What appears to be the highest sprig from either of the two major vantage points is not really the top. This point cannot be emphasized too heavily. Consider the following hypothetical example. In Table 1 I have provided distances and angles to four tops and their corresponding heights.

Table 1. Hypothetical height (HT) differences between the sine and tangent methods.

Distance (ft)	Angle (°)	Sine HT (ft)	Actual ---- baseline	Trunk (ft) ----	Tangent HT (ft)	Error at chosen top (ft)
150	40.0	96.4	114.9	100.0	83.9	12.5
153	39.5	97.3	118.1	100.0	82.4	14.9
156	39.0	98.2	121.2	100.0	81.0	17.2
159	38.5	99.0	124.4	100.0	79.5	19.5

Suppose sine and tangent measurers agree to measure the above hypothetical tree. Through visual inspection, they settle on a top and each shoots that top. If the first top is chosen, as shown in the table, the sine measurer announces a height of 96.4 ft and the tangent measurer 83.9 ft. Assuming all instruments are in good working order, what accounts for the difference in the measurement results? The answer lies in the baseline used by the tangent measurer. In the case of the first top, the baseline is 14.9 ft too short. A vertical line dropped from the first top down to the level of the measurer's eye would be 114.9 ft distant on the level—not 100 ft. Similar explanations hold for the other tops had any of them been chosen by mutual agreement as the top.

An experienced sine measurer would test each top and discover that the fourth one is actually the highest although it lies at the lowest angle. The tangent measurer would likely select the highest appearing top, since selection of any others would automatically result in a lower height for the common baseline to the trunk. Were one of the other tops selected by the tangent measurer, it would be largely as an act of faith.

In this example, tangent measurers employing a baseline to the trunk will under-measure every single top, and will conclude that the first and actually lowest, is the top of the tree. The solution is to establish a correct baseline to the target. But establishing correct baselines is extremely difficult to do without a laser and clinometer. With laser and clinometer, the measurer can do the following calculation:

$$B = L \cos A \quad [1]$$

where B = true baseline distance to the target, L = direct or straight line distance to target, and A = angle to target. But if the measurer has this capability, there is no reason to use the tangent method. The measurer uses the following formula:

$$HT = L \sin A \quad [2]$$

where HT is the height. Note that L is the hypotenuse of the right triangle that goes from the eye to the target (hypotenuse), vertically down to eye level (height leg), and horizontally back to the eye (base leg).

To summarize the important points, if each measurer works alone without communication with the others, at the end of the exercise, the tangent measurer would announce that the height of the tree (above eye level) is 83.9 ft and the sine measurer would announce 99.0 ft. They would have measured different tops, and the tangent measurer would have mis-measured their chosen target. The sine measurer would have determined the height of each candidate within the accuracy tolerances of the instruments used.

As my final point, if the tangent measurer begins by considering the four tops as candidates, why wouldn't they realize that the candidates cannot all share the same baseline? If all tops appear at about the same angle above the eye, selecting one as the high point would constitute more an act of faith than reason. Wouldn't this call the validity of the tangent method into question? If the measurer correctly concludes that the baseline to each top needs to be confirmed, how would they go about doing this for a complex crown? None of these real field situations are addressed in the simplistic drawings accompanying clinometers and hypsometers.

It is my experience that the above kinds of measurement hypotheticals are typically handled in one of the following ways by tangent measurers: (1) the questions do not occur to the measurer, (2) the measurer believes the instrument(s) being used according to the instructions provided for measuring tree height compensate for baseline differences, (3) if challenged, the measurer perfunctorily invokes the teachings of an instructor from their college or blindly follows a clinometer diagram, (4) the measurer does recognize the problem, has no solution, crosses fingers, and follows standard protocol of shooting to the trunk, or (5) the measurer does their best to estimate each baseline by some method. Those following method #5 are in the minority, perhaps the extreme minority.

DAY 2—MEASURING THE HEIGHT AND VOLUME MODELING THE COOK PINE

On April 19 Dale led us to one of the white pine giants of Cook Forest, the Cook Pine. The group (in sine mode) measured it from different locations and we were about to agree on 162 ft give or take a few inches. From my vantage point, I had settled on 161.7 ft. Then one of the participants, Steve Halow's wife, got bounces from almost directly under the tree that indicated a height possibly of 164 ft. I initially confirmed that number using my Nikon Prostaff 440 and TruPulse 360 combination. My exact calculation was 163.8 ft. However, long-term testing of my Prostaff 440 shows it to be off by an average of one foot too much. Factoring this into the calculation, the re-computation yields (162.0 – 1.0) × sin(77.8) + 5.5 = 162.9 ft.

Allowing for a tilt sensor error of ± -0.2 degrees, the height of the Cook Pine can be placed within the range of 162.7 and 163.0 ft, which falls with the ± -0.25 ft that we commonly attain when we repeatedly measure a tree and resolve the sources of error. The only remaining consideration is whether the 77.8-degree shot was to the top or bottom of the tuft of needles identified as the top. But I was shooting from below… The top of the tuff could be 3 to 4 inches higher than the laser return, if I hit the bottom of the tuft. All factors considered, I confidently place the Cook Pine at between 163.0 and 163.5 ft.

After measuring its height, we modeled the Cook Pine for trunk volume. Steve Colburn used his RD1000 to get diameters aloft. He is highly experienced with that state-of-the-art device, so I was happy to turn the task over to him. The volume came out to be 888 ft^3 based on a series of conical frustums. Limb volume was not included, but likely increases the total wood volume to around 950 ft^3. On such a quick modeling, the percentage error could easily be as much as ±5%.

For those interested in board feet equivalencies, the portion of the pine that represents the commercial volume is probably close to 800 ft^3. At 12 board feet per cubic foot, without loss, we get 9,600 bdft. Actual salvageable value would likely be around 60% of the 9,660 amount or 5,760 bdft. Typical plantation pines in the Northeast average around 150 ft^3 at the time of cutting. So the commercial Cook Pine volume is equivalent to between 5 and 6 commercially mature plantation pines. The tree does make a visual impact.

TRACKING DOWN THE SOURCES OF ERROR FOR THE TANGENT METHOD

The Cook event reinforces the need for us to get serious about investigating the sources of measurement error associated with the tangent method. Several of us in NTS have written on topics relating to tree measuring, often comparing different techniques. I have written articles specifically designed to explore the use of the tangent method. I try to be even-handed and make room for all techniques. But I've always recognized that the tangent method is a much riskier technique than our tried and true sine method. Still, the use of the tangent method persists, and will likely be the method of choice within the timber profession where quick estimates of many trees are often the norm, and where most tree heights are measured to a commercial top (say, 6 inches in diameter). So, at a minimum, foresters should be aware of the major risks of staying with the tangent method, and I would guess that this is not being done in forestry courses. The remainder of this article is devoted to analyzing those risks.

Sources and Impacts of Tangent-based Errors

Instrument precision/accuracy, instrument calibration, and incorrect use of instruments/reading errors are sources that will occur to most measurers. It turns out that they are not the major source, but there is much to discuss here. So, let's dispense with them first. Most infrared laser rangefinders are accurate to between 0.5 and 3.0 ft and clinometers can be misread or be off by 0.25 to 0.5 degrees. What are the consequences? Suppose a tree is exactly 100 ft tall, straight with the top vertically over the base and growing on nearly level ground. Let's assume the measurer's eye is level with the base of the tree, and positioned 100 ft from the center of the trunk. Let's further assume the true angle to the top is 45 degrees. If the measurer shoots the distance to the top with a laser that is accurate, the number should be close to 141.42 ft. Depending on the laser, the instrument will read to the nearest yard (or meter), half yard, foot, or half foot. In the case of my TruPulse 200 or 360, I would likely get 141.5. With these theoretical values, the measurer can do either of the following calculations:

$$HT = 100 \times \tan(45) = 100$$

$$HT = 141.42 \times \sin(45) = 100$$

So, if the distances and angle are correct, since it is the same right triangle, the sine and tangent methods will yield the same result. Let's now assume that through either a calibration problem or a misreading, the angle determination is in error by plus 0.5 degrees. What is the impact on height calculations for both tangent and sine? If we let D = baseline distance (in this example, 100 ft), A = angle to top (45^o), E_a = angle error (0.5^o), L

= straight-line distance to top, E_t = error in height from tangent calculation, and E_s = error in height from sine calculation, for the tangent the following are true:

$$E_t = D\,[\tan(A + E_a) - \tan(A)] \quad [3]$$

and solving for E_t you get E_t = 100 [tan (45 + 0.5) – tan(45)] = 1.76 ft. Here is the comparable calculation for the sine:

$$E_s = L\,[\sin(A + E_a) - \sin(A)] \quad [4]$$

and solving for E_t you get E_s = 141.42 [sin (45 + 0.5) – sin(45)] = 0.87 ft. At 45 degrees, the impact of an angle error is greater for tangent as compared to sine by 0.89 ft. This isn't so bad, but the problem gets progressively worse at higher angles. At 55 degrees, the tangent error for the above distances is 2.69 ft and for sine is 0.703 ft.

Now, assume there is no error in the angle, but distance measurements are off by 1.0 ft (use the same angle for all measurements, but add 1 ft to the distance measures). How does this distance-only error impact sine and tangent? At 45 degrees, the height errors spawned from distance errors are almost the same for the two methods. Had the angle been 20 degrees, the sine error would have been 0.342 ft and the tangent error would have 0.364. This shows that at mid to low angles, the impact of distance errors on sine and tangent are comparable. At 60 degrees, the impact of a 1.00 ft distance error for the above problem is 0.866 for sine and 1.732 for tangent. The magnitude of the error grows for both sine and tangent but faster for tangent. An error in one or both dimensions clearly affects the tangent calculation more than the sine, a fact not widely understood. This is the reason that most professional foresters are taught to avoid top angle readings of more than 45 degrees.

Computational Routine for Errors

Turning to calculus and using total differentials, we can closely approximate the impact of relatively small error in distance and/or angle from one formula. In the case of the tangent measurement, the impact on height errors in the angle (*a*, in radians) and/or distance is given by:

$$dHT = \frac{D}{cos^2 a}da + (\sin a)dL \quad [5]$$

where D = baseline distance. For the impact of angle and/or distance on sine-based errors:

$$dHT = (L\cos a)da + (\sin a)dL \quad [6]$$

where L = direct distance to the target (hypotenuse of the right triangle). In the above formulas da, dL, and dD represent small errors in the angle a, the baseline D, and the slope distance L, respectively. While small is relative, think in terms of one degree or less for da, and 2 ft or less for dL and dD. As an example of using differentials, suppose the baseline for a tangent calculation is 150 ft, the angle is 40 degrees, the error in angle is 0.5 degrees, and in distance is 1.5 ft. For this combination, the actual height would be 125.9 ft (150 tan(40) = 125.9). The error in height from the 0.5-degree and 1.5-foot errors would be:

$$dHT = \frac{150}{\cos^2(0.69813)}(0.008727) + \tan(0.69813)\,(1.5) = 3.49$$

For the equivalent sine-based calculation, the error in height is:

$$dHT = 195.83\cos(0.69813)\,(0.008727) + \sin(0.69813)\,1.5 = 2.27$$

For this combination, the impact of the tangent error is obviously more than the sine error, but the difference of 1.22 ft is not overwhelming. Let's look at another example. Suppose the height of the tree is 150 ft, the baseline is 100, the angle error is 0.5 degrees, and the distance error is 1.5 ft. We're dealing with the same angle and distance errors and the same baseline, but with a much taller tree. The tangent-based error becomes 5.09 ft and that of the sine, 2.12 ft. The difference of 2.97 ft is significant, especially when it exceeds the maximum error of the laser rangefinder.

If an error of +0.5 degrees is made for the top and it is a calibration issue, a +0.5 degree error will likely be made for the base. In the above calculations, we're not considering an offsetting error from the base. If we were, the composite sine error would be reduced to relative insignificance, but the tangent error would remain significant. As an illustration, suppose the baseline distance to the trunk is 66 ft, the angle to the crown 60 degrees, and the angle to the base 15 degrees. If the angle error is over by 0.5 degrees and the distance error over by 1.00 ft, what is the combined impact on tangent? For the top, the height error is:

$$dHT = \frac{66}{\cos^2(1.0472)}(0.008727) + \tan(1.0472)\,(1.0) = 4.036$$

Note angles are in radians. For the base, the corresponding error is -0.88653 and the combined error is 4.036 – 0.88653 = 3.151 ft. The below-eye error does not cancel the above-eye error. For sine, the top error is 1.4831 and the bottom error is -1.4509. The combined error is -0.0322 ft. This is an almost complete cancellation. So what is the principle to glean from this analysis? ***The combinations of distances and angles are infinite, but the overall lesson is that errors tend to impact tangent-based height determinations more than those for the sine; and where errors are made in the same direction for the top and bottom of a tree, the sine errors almost cancel out, but the tangent ones do not.***

What if we compare the impact of angle errors made at high versus low angles on tangent and sine? For tangent calculations, we define R_t as the ratio of the error at high angle versus low angle. To keep matters simple, we assume that the same angle error is made at both top and bottom, e.g. +0.5°. It can be shown that R_t can be closely approximated by:

$$R_t = \left[\frac{\cos(a_1)}{\cos(a_2)}\right]^2 \quad [7]$$

where a_1 is the lower angle and a_2 is the upper one. For example, if a_1 = 15 degrees and a_2 = 50 degrees, then so long as the error in the upper and lower angles are the same, the ratio of the upper to lower height error in this case is 2.26, which is equivalent to saying that the upper error is 226 percent of the lower error. Obviously it helps to keep the angles lower in tangent-based calculations, meaning that you must move farther back from the target. For sine-based calculations, the corresponding formula is:

$$R_s = \frac{\cos(a_2)}{\cos(a_1)} \quad [8]$$

For the angles of 50 and 15 degrees the ratio R_s is 0.665. The impact of the upper angle error is less than that of the lower angle error—the reverse of the tangent.

If the errors in the upper and lower angles are of different magnitude with da_2 being the upper error and da_1 being the lower, the preceding formulae become:

$$R_t = \left[\frac{\cos(a_1)}{\cos(a_2)}\right]^2 \frac{da_2}{da_1} \quad [9]$$

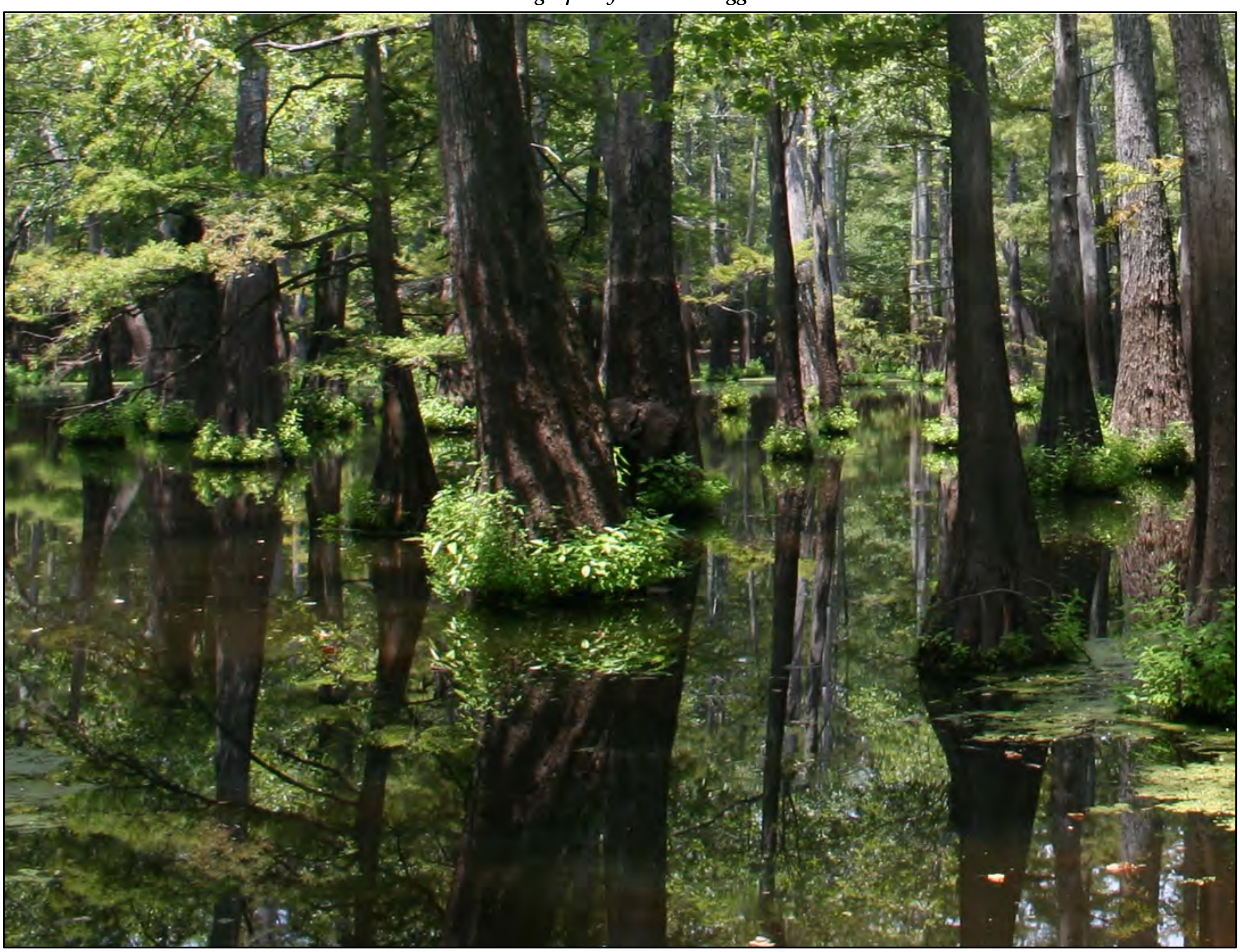
and

$$R_s = \frac{\cos(a_2)}{\cos(a_1)} \frac{da_2}{da_1} \quad [10]$$

respectively, where the differentials are expressed in radians. Is there a way to summarize this information? Tall trees and short baselines cause the most trouble. In many of the scenarios, there isn't much difference between the errors generated by tangent versus sine-based determinations, but then come the eye-openers. A serious measurer must be aware of when to worry and when the likelihood of instrument error won't have an exaggerated impact.

EDITOR'S NOTE: *Part II of this treatise will be given in the next Bulletin of the Eastern Native Tree Society!*

Tupelo gum and baldcypress mirrored in the still waters of Bangs Slough in Calhoun County, Arkansas. Photograph by Don C. Bragg.



WHAT CAN TIMBER PROFESSIONALS LEARN FROM THE NATIVE TREE SOCIETY?

Robert T. Leverett

Founder and Executive Director, Eastern Native Tree Society

EDITOR'S NOTE: *This message from Bob helps to explain why the Native Tree Society continues to offer a number of tree measuring workshops to the public, particularly targeting those employed in the timber business. All photographs are by Robert T. Leverett.*

It may not be clear why the Native Tree Society (NTS) is putting on a series of advanced tree-measuring workshops. We have held several over the years, with the most recent being at Cook Forest State Park in Pennsylvania in April of 2012. Since we are inviting timber professionals who measure trees, a legitimate question is what could they learn from us? The simple answer—quite a lot! I'll give an example.

A tall, slender eastern white pine, named the Monica Pine, grows in the back of our house in Florence, Massachusetts. The forest surrounding it has tuliptrees and northern red oaks ranging in height from 100 to 115 ft for the oaks and 118 to 130 ft for the tuliptrees. The Monica Pine, to the best of my ability to measure it, is between 134 and 135 ft (I presently have it as 134.5 ft). To accurately measure the Monica Pine, I have to piece it together through a number of measurements beginning on the other side of the house from the pine.

Figure 1 is a telephoto look at the pine's crown seen above the top of the house from the pine's downhill base:

Figure 1. The growing leaders at the top of the Monica Pine.

From my vantage point in front of the house, I set up a tripod with my LTI TruPulse 360 and took the measurements to different crown points. The results are shown in Figure 2 (next page). The first number is the linear distance to the crown-point as measured by the 360 (slope distance (SD) return). The second number is the height of the crown-point (vertical distance (VD) return). Since the TP360 reads to the nearest foot, all numbers are to the half-foot. From my measuring spot, the greatest angle of all tops was 35.8 degrees, and a couple other points were 35.7. But 35.8 was the highest angle and that twig was not the top of the tree as shown in the preceding image. If nothing else, this exercise illustrates the work involved in determining the highest point of a pine such as Monica's Pine.

Now to an important point: I haven't found a location where one can stand and see both the top and bottom of the Monica Pine. There are too many obstructions. Here are two views of the pine within its forest setting. The first (Figure 3) shows the pine among its companions (Monica's Pine has the red dot). The two trees of roughly equal size to the left of the pine are tuliptrees, one of which is 125 ft tall and the other is 130 ft. The pine has competition and that creates a lot of canopy clutter when searching for a viewing location.

Figure 3. Dense forest surrounding the Monica Pine (identified by the red dot) make finding both the base and top of the tree very hard.

The next image (Figure 4) shows the Monica Pine looking up its trunk through the clutter. You can't see its top, only its side limbs, so standing at the base and shooting up with a laser rangefinder is pointless. Moving back to a more distant location doesn't work because of the thick hardwood canopy.

Figure 4.

As a consequence of the position of this pine, none of the routine methods of measurement that employ tape and clinometer, or the TP360's built-in tree height routine, can be successfully applied. One must approach the problem by constructing a series of horizontal planes, measure the vertical distances between them, and then adding up the pieces. In the case of the Monica Pine, I had to use five planes to get the result of 134.5 ft.

Members of NTS who are serious tree measurers learn these techniques, but to my knowledge they are not taught in standard courses. Their success depends on the infrared laser, a tilt sensor/clinometer, and a lot of trigonometry. Thus, the reason for our workshops—we break these advanced techniques into "cookbook recipes" that everyone can use.

Figure 2. Different slope distances (first number) and vertical distances (second number) for the various leaders of the Monica Pine. The number highlighted in red is the highest vertical height value from this vantage point.

TAHQUAMENON FALLS STATE PARK, MICHIGAN: JUNE 2012

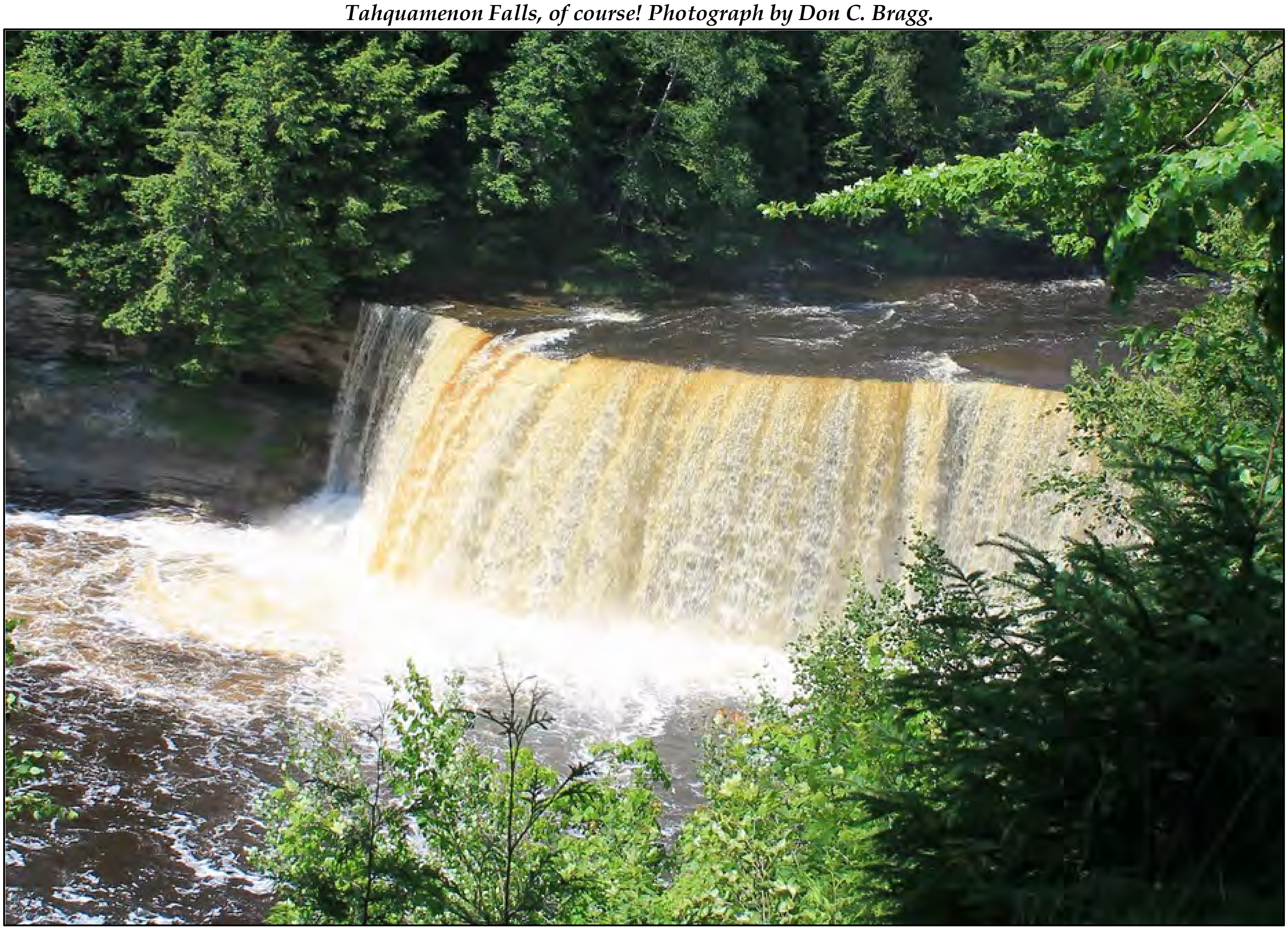
Don C. Bragg

Research Forester, USDA Forest Service, Southern Research Station, Monticello, Arkansas

Other field trip reports on the Eastern Native Tree Society website have reported on Tahquamenon Falls State Park along the south shore of Lake Superior in the eastern corner of Michigan's Upper Peninsula (UP). This superlative site is one of many jewels in the UP's crown, and though easily accessed via a good paved highway, thoroughly developed for the casual American tourist, and divided up by numerous trails, it is still possible to get a taste of the wildness that used to cover the whole region.

I recently vacationed with my family in this portion of Michigan, and we visited a number of beautiful sites, including hours beach-combing the shores of Lake Superior, hiking a few of the many trails of Pictured Rocks National Lakeshore, and exploring the backroads of the Lake Superior State Forest. Even with all of these adventures, it was hard to surpass the splendor of Tahquamenon Falls (the Upper Falls is pictured below). Tahquamenon Falls is one of the largest waterfalls in the eastern United States—it is not the height of this falls that impresses (only about a 50-ft drop at the Upper Falls), but rather the width and flow of the Tahquamenon River. A number of viewpoints of both the Upper and Lower Falls can be easily accessed by wide, paved trails, which while comfortable to use are also swarming with many of the 500,000+ tourists that visit this park every year. Yet, it is easy to find solitude in the 46,000-plus acres this park encompasses. The rest of this report will focus on my afternoon of such solitude found along a trail just off of the busy Upper Falls.

The premier feature of Tahquamenon Falls State Park in the eastern corner of the Upper Peninsula of Michigan—Tahquamenon Falls, of course! Photograph by Don C. Bragg.



Just before the main trail to the Upper Falls descends a wooden staircase to provide visitors with overlooks of the falls right at river level, a rather nondescript trail branches off past a couple of service areas into some of the old-growth northern hardwood-eastern hemlock forest that remains in the park. This trail is called the "Giant Pines Trail" (for obvious reasons) and it is a strong draw for someone interested in measuring big trees.

This relatively short (3.5 mile) loop is not hard to follow, is easy to hike, and passes through old-growth forest most of the way. Most of the living timber in this area is hardwood (particularly red and sugar maples, with some American basswood and yellow birch). Unfortunately, much of the American beech along this trail is dead or declining, perhaps due to beech bark disease.

It was not hard to find impressively large trees along the trail, and I immediately pulled out my TruPulse 200 and D-tape and began checking out the timber. Given that I didn't have a lot of time, I stuck mostly to the trees right along the trail, and only picked the best examples to report (Table 1).

Table 1. Dimensions of large trees along the Giant Pine Trail in Tahquamenon Falls State Park, Michigan, measured in June of 2012.

Species	DBH (inches)	Circumference (feet)	Height (feet)
Red maple	28.0	7.3	89.5
Eastern hemlock	28.4	7.4	98.5
Red maple	32.3	8.5	97.0
Eastern hemlock	32.4	8.5	98.0
Eastern white pine	58.2	15.2	127.0
Eastern white pine	56.1	14.7	119.5
White spruce	18.0	4.7	97.0
Eastern white pine	33.9	8.9	105.0
Balsam fir	12.2	3.2	68.0
Eastern hemlock	33.6	8.8	96.0

As can be seen in Table 1, the Giant Pine Trail does indeed have two particularly large specimens of *Pinus*. The eastern white pine, as in most northern forests, proved to be the largest of the tree species (in both height and girth) found along this trail. While most other species struggled to exceed 100 ft tall, eastern white pine regularly grew taller. It is likely that eastern white pine in this region will probably not grow much above 130 ft tall, given the frequency of windstorm, lightning, and ice/snow damage to the tops of these trees.

A second giant eastern white pine is located within 100 ft of the biggest pine, and is almost as impressive (if looking somewhat more sickly than the first). Some years ago, a sign was posted near this pine with the following "Prayer of the Woods" inscribed upon it: "I am the heat of your hearth on the cold winter nights, the friendly shade screening you from the summer sun, and my fruits are refreshing draughts quenching your thirst as you journey on. I am the beam that holds your house, the board of your table, the bed on which you lie, and the timber that builds your boat. I am the handle of your hoe, the door of your homestead, the wood of your cradle, and the shell of your coffin. I am the bread of kindness and the flower of beauty. Ye who pass by, listen to my prayer: harm me not." According to what I could find online, this prayer is an old Portuguese verse, but I can't confirm that—regardless of its intent and meaning, it seemed out of place along this quiet trail. To me, the silent grace of these giant pines was their own prayer, and they needed not the pronouncements of man…

The biggest of the giant pines at Tahquamenon Falls State Park measures almost 5 ft in diameter and nearly 130 ft tall. Photograph by Don C. Bragg.

Perhaps the most notable contrast on this trip is the condition of the forest at Tahquamenon Falls and that on a parcel of land just outside of the nearby Pictured Rocks National Lakeshore. This area, known as the Kingston Plains, was lumbered at the turn of the 20th Century, then burned, and now exists as a very slowly reforesting stump field populated by stunted pines and hardwoods, an abundance of reindeer moss, and slowly decaying stumps, pretty much as far as the eyes can see. I'll write more on that location later…

The "smaller" of the two giant eastern white pines along this trail at Tahquamenon Falls State Park.

A birdseye sugar maple growing near the giant pines. Photograph by Don C. Bragg.

As much as I wanted to linger amongst these giant pines, I had quite a hike still awaiting me, and I had to move on. There were many eastern hemlocks of large dimension (at least for this region) along the Giant Pine Trail—far too many to measure in such a short time period. These hemlock, though suffering some mortality due to breakage (most likely arising from the combination of decay and wind), are still generally quite healthy. So far, the hemlock woolly adelgid is still only a distant threat.

The Giant Pine Trail, while it has a number of big pine, really impressed me more with the hemlock growing along its length. I did not stop to count the rings on a number of hemlocks that had fallen across the trail, and been cut to improve access, but I have full confidence that most of these mature hemlocks are centuries old. I was also heartened to see good hemlock regeneration in most of the stands I walked through, particularly in some of the gaps formed by the deaths of the overstory beech and hemlock. It thus appears that deer overbrowsing is of only minor concern in this area (at least for now). I also saw no real evidence of exotic earthworm invasion (at least along this trail).

Before I conclude, I wanted to say something about a unique and relatively rare occurrence in sugar maple that has particular significance to me—birdseye. While I was angling for a better view of the top of one of the giant white pines, I found myself near a sugar maple tree that had a lower bole appearance I have long recognized as characteristic of birdseye maple trees. A quick inspection of the outer bark of this individual confirmed my suspicions—it most definitely was birdseye!

The picture above is a close-up of the bark of this sugar maple, and though they may not be particularly apparent, to the trained eye it is easy to see an abundance of the eye-shaped indentations in the outer bark that signify the presence of this grain abnormality. It has been my personal experience that old-growth northern hardwood stands, at least in the northern Lake States, are full of birdseye maple, even if not in the most commercially valuable form. I have no worries that this tree will ever be cut for its timber—but it was good to see I still apparently have the eye for birdseye!

A few of the many large eastern hemlock found along the Giant Pine Trail at Tahquamenon Fall State Park. Photograph by Don C. Bragg.

SEVEN WISHES

Robert T. Leverett

Founder, Eastern Native Tree Society

A couple of times a year I go into strategic planning mode, thinking about the Native Tree Society (NTS). I begin with where we started as an organization, look to where we are presently, and think about where we are pointed in terms of a future direction.

The NTS electronic bulletin board (BBS) continues to be a success, though it is not without its challenges. It can be a little overwhelming, but Ed has provided ways to manage the volume of traffic. I wouldn't dream of returning to the older system. And I'm sure the BBS has contributed handsomely to our expanding membership, and our excellent new contributors are inspiring. We have a steady flow of interesting material. Michael Gatonska's recent contributions have been very exciting. They are remindful of how broad and accomplished our membership is. Will Blozan's post on Savage Gulf reminds us that there is a lot of serious work going on under the umbrella of or at least connected to NTS. Then there is the recently concluded Advanced Tree Measuring Workshop in Cook Forest, Pennsylvania. We are getting excellent tree and site reports from afar, and the corps of accomplished tree measurers is expanding. I could go on, but the point is that our outreach has never been greater and with the *eNTS* magazine and *Bulletin*, there is a good paper trail for researchers to follow.

The future is bright, but there can always be improvement. Going into dream mode, if I could have a few wishes come true, what would they be? Here is my wish list:

First, I'd like to see each Ent take ownership of a favorite site or two and keeping the information up on the chosen site(s) in a special place on the BBS set aside for that. At this point, I would dispense with formats and let each site custodian free form it. We can agree on a minimal format in time. The key here is to maintain an up-to-date set of descriptions that a newcomer can go to. It's that simple. It is fairly obvious who the site custodians are for a good two dozen sites, if not more. There can be joint custodianship. Whatever works…

My second wish is for a place on the BBS for big tree facts. Some people would call it tree trivia, but regardless, it should always reflect the superlatives in updated form. For instance, if someone wants to know what the tallest tree we know about in the country, the West, the East, North, South, etc., where would that person go? How much research must be done to ferret out the 191.9-ft tuliptree that Will and company climbed in the Smokies? How many posts have been made about the Long-fellow Pine? Will a researcher settle on 184.7 or 184.0? The data on tree superlatives obviously changes, and there is no spot where one can confidently go to get the most current information. Where does one find a ranked listing of Rucker Indices? I could go on, but the point I'm sure is clear. How to best implement a "NTS Book of World Records," so to speak, I have no idea. I think I know a few folks with the expertise to figure it out...

My third wish is for the import capability to the NTS database to be completed so that I can get spreadsheet information into the database. Like most of you, Excel will function as the primary tool to initially organize information from site visits, because extracts can easily be sent to others in the appropriate format for the receiver. I send many spreadsheets custom-made for the recipient.

My fourth wish is for us to expand our tree measuring workshops. Success at Cook has spurred my enthusiasm. One individual from Penn State commented to me on how valuable the workshop had been for him. It cleared up a lot of questions. So, we're getting the format down. In terms of the future, I can see progress being made within certain elements of the academic community, among naturalists, and with big tree hunters. After October in MTSF, a workshop out in say Ohio might be something to pursue.

My fifth wish is that we gain ground more rapidly in being a backup to the state champion tree programs. It is true that more individual coordinators are finding their way into NTS. At the Cook event, we had Turner Sharp, coordinator for West Virginia and Scott Wade, coordinator from Pennsylvania present. Present coordinators such as Turner Sharp, Scott Wade, Michael Taylor, Don Bertolette, and Robert Van Pelt are the ones who will have to bring this to pass. I think it has to be an inside job, and one that I don't envy them. I do not possess the patience, but it is an important mission to pursue—if for no other reason than to help get the junk out of the lists.

My sixth wish is related to number five. I hope for more progress in cooperative ventures with American Forests (AF). I sense that they are serious about making progress. NTS has a role to play in their progress. That role became ever clearer at the Cook event when Sheri Shannon of AF gave an excellent presentation on the history of the National Register of Big Trees. She mentioned a couple of big performers who presently have the most champions listed. I'll forgo names. However, my buddy Will Blozan and I met the chaps once and attempted to train them into the better method of measuring tree height. Will got wind that they had rejected the better technique because they get higher heights going the tape and clinometer route. What more needs to be said?

My seventh wish is that the connections we've made to Laser Technology Inc. (LTI) continue to grow. LTI is the "Cadillac" of infrared laser technology for business and sporting purposes. We are the Cadillac of tree measuring organizations. I think the two organizations now recognize each other's dominance. LTI will be at Mohawk Trail State Forest in October. At Cook there was a hint that LTI might be willing to make an equipment donation to NTS. That would be way cool! So things are moving, I guess I'm just a little too impatient…

A scenic stretch of a river in northern Wisconsin during a typical spring run-off. Photograph by Don C. Bragg.

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.

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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:

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Monticello, AR 71656

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.

Shriveled by drought, the Cut River flows about 160 ft below this vantage point on the bridge on US Highway 2 in the eastern Upper Peninsula of Michigan. The river's destination: Lake Michigan. Photograph by Don C. Bragg.