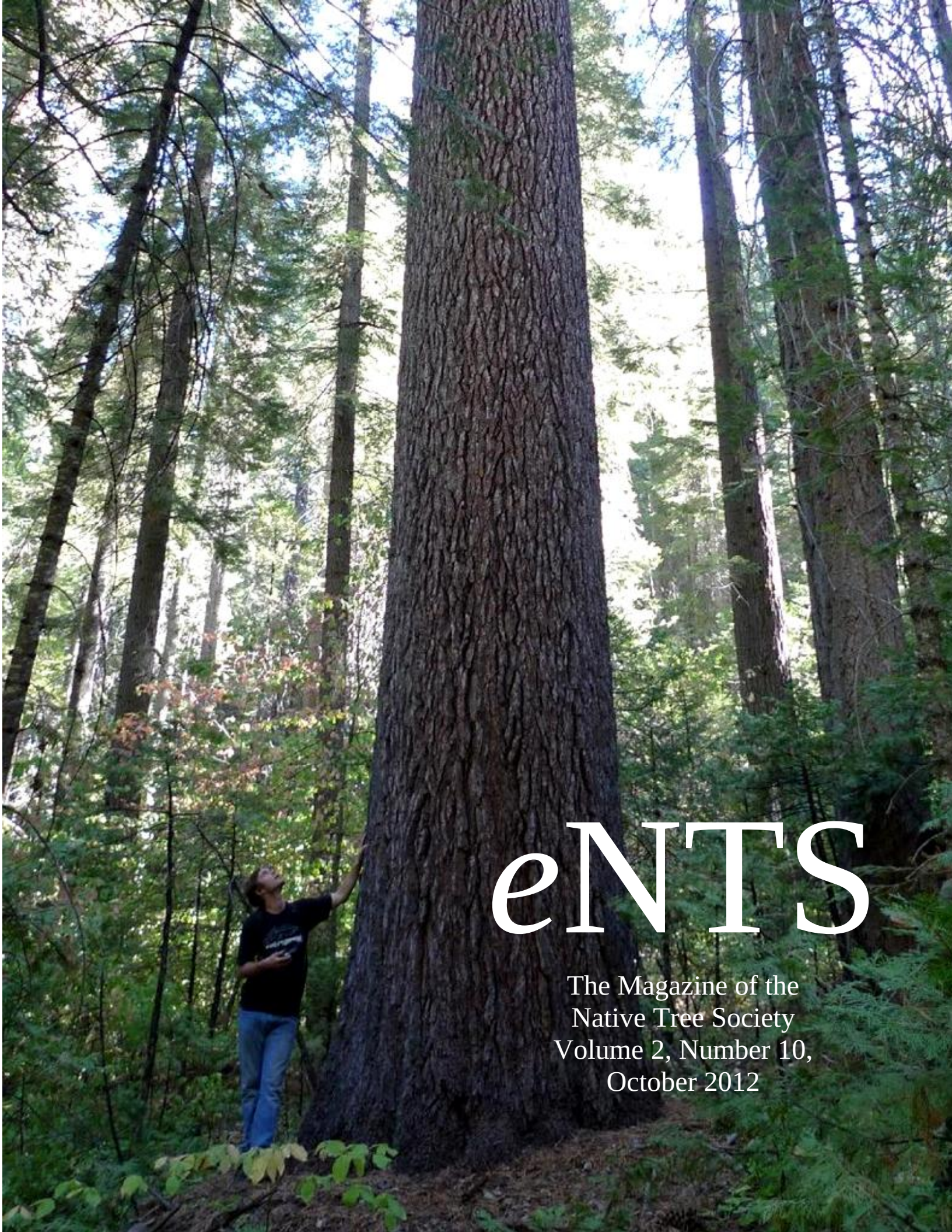

eNTS

The Magazine of the
Native Tree Society
Volume 2, Number 10,
October 2012

*e*NTS: The Magazine of the Native Tree Society

The Native Tree Society and the
Eastern Native Tree Society
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http://www.ents-bbs.org

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Mission Statement:

The Native Tree Society (NTS) is a cyberspace interest groups devoted to the documentation and celebration of trees and forests of the eastern North America and around the world, through art, poetry, music, mythology, science, medicine, wood crafts, and collecting research data for a variety of purposes. This is a discussion forum for people who view trees and forests not just as a crop to be harvested, but also as something of value in their own right. Membership in the Native Tree Society and its regional chapters is free and open to anyone with an interest in trees living anywhere in the world.

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COVER: World's tallest sugar pine at 264 feet, CA. Photo by Michael Taylor, 2012.

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I want to remind the readers of this magazine that the articles presented here are only a part, usually just the beginning, of the discussions being held on our BBS at http://www/ents-bbs.org . The full discussion can be read by clicking on the link embedded in the title of each individual article. - Edward Frank

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Editor's Corner

By Edward Frank

Each month I try to figure out what to post as an editorial introduction to that month's issue. It is difficult because I have lived with the months worth of posts to the BBs. I read them all and respond to many of them. Sometimes an event or find really stands out and that can be the subject of the editorial. Sometimes it is some organizational structure discussion or change I want to emphasize. I admit at times I have simply chosen one of Robert Leverett's discussions of the past and future of the NTS and use that as a de facto guest editorial. That is what I originally intended to do this month, with his overview of the big MTSF Advanced Tree Measuring workshop. But, events overtook that intention.

We had a fantastic Advanced Tree Measuring Workshop conducted by Robert Leverett at Mohawk Trail State Forest http://www.ents-bbs.org/viewtopic.php?f=26&t=4592

We had poetry by Ryan leClair – The Moosewood Tree http://www.ents-bbs.org/viewtopic.php?f=317&t=4495

Tom Howard Posted a series of reports from upstate New York: http://www.ents-bbs.org/viewtopic.php?f=105&t=4595

The was a series on the Evaluation of various types of laser rangefinders: http://www.ents-bbs.org/viewtopic.php?f=235&t=4585

A really important consideration for the NTS is the beginnings of listing the various groups the NTS has worked with and with whom we have had informal or formal partnerships: http://www.ents-bbs.org/viewtopic.php?f=281&t=4560

Michael Taylor found another record – the new world's tallest Sugar Pine 264' (80.4m) the "Sugar Tower". http://www.ents-bbs.org/viewtopic.php?f=69&t=4588

A beautiful series of photos and reports from Colorado by James Robert Smith starting with: http://www.ents-bbs.org/viewtopic.php?f=70&t=4583

Michael Gatonska continued his series of natural soundscapes with Thumper Mountain Sunrise: http://www.ents-bbs.org/viewtopic.php?f=246&t=4608

New member Zane Moore post about the tallest hardwoods he has found in west coast with some new height records: http://www.ents-bbs.org/viewtopic.php?f=69&t=4601

An article appeared in the National Park Travelor Tallest Native Hardwood Tree In North America Is Located In A National Park
Submitted by Jim Burnett on October 24, 2012 featuring the tallest tuliptree found by NTS last spring. http://www.ents-bbs.org/viewtopic.php?f=297&t=4632

Our European contingent, with Kouta Rasanen, Joroen Philippona, and Michael Spraggon started a series of posts on a summer expedition to the Balkans in several former Yugoslav republics: http://www.ents-bbs.org/viewforum.php?f=386 including the Sgerm Spruce which is the tallest native European tree: http://www.ents-bbs.org/viewtopic.php?f=386&t=4642

Mario Vaden reports on his discovery of a new Maple height record for Bigleaf maple: The Humbolt Honey at 157.8 ft**.** in northern California: http://www.ents-bbs.org/viewtopic.php?f=69&t=4644

Brian Beduhn posted about numerous trips this month and included excellent photos of the Middleton oak and Angel Oak in South Carolina: http://www.ents-bbs.org/viewtopic.php?f=9&t=4582

There were many more posts by people new to the organization and by NTS founders Robert Leverett and Will Blozan. There is just too may things that have happened in this past month that warrants mention that I simply can't fit them all into on editorial. So I guess all of you will need to read this issue of the magazine and click on the incorporated links to read the full discussions, or visit the BBS at http://www.ents-bbs.org and dive into the discussions.

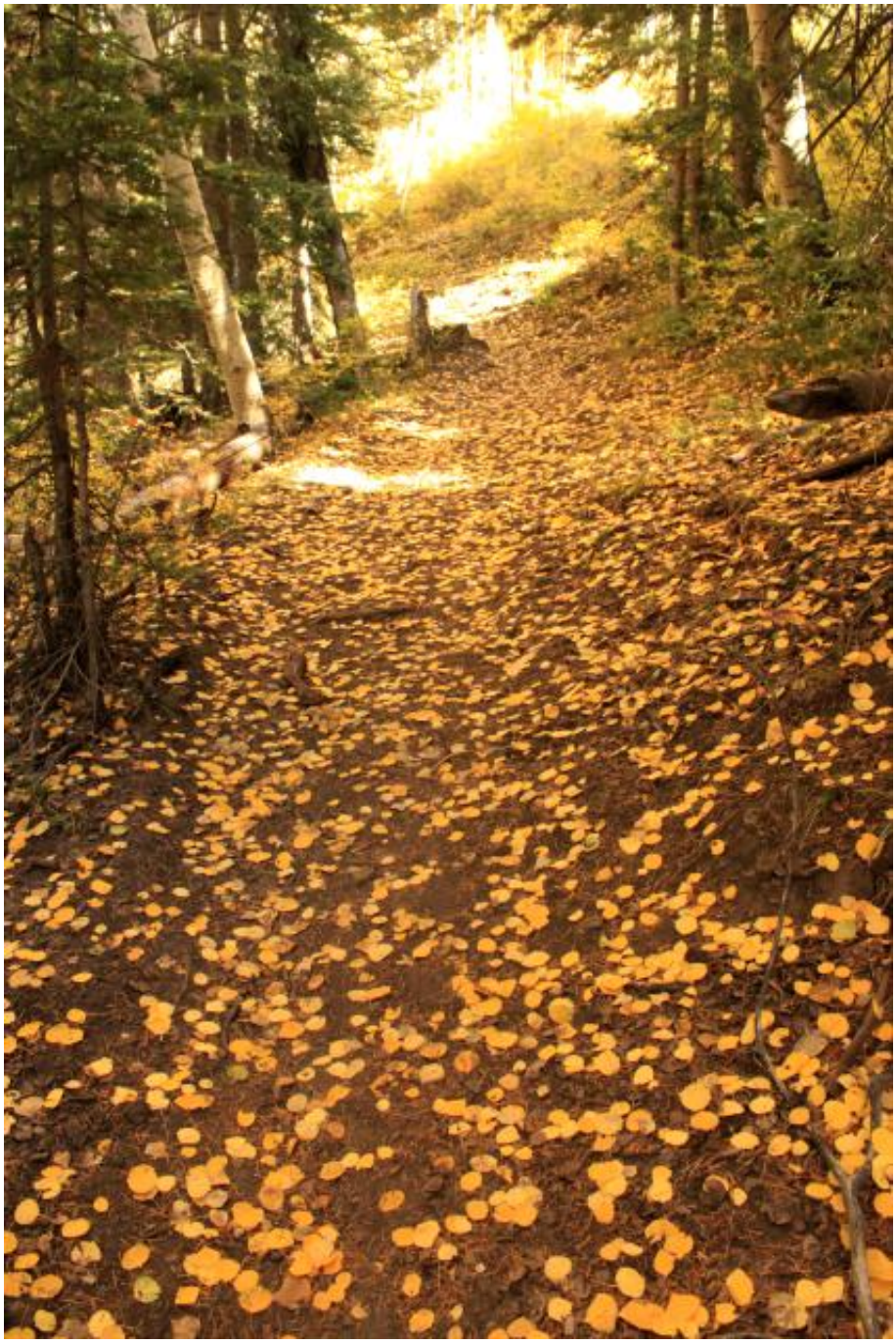
Goulding Creek Trail , CO - Bob Leverett's Suggested Hike

by **jamesrobertsmith** » Mon Oct 01, 2012 11:26 am

We took Bob's advice to hike to the aspen groves on the Goulding Creek Trail for our last hike before leaving the mountains to head to Denver for the flight out. This trail by that time was really easy for me, after struggling to acclimate my body to the ridges and passes of the San Juans where I had stayed between 11K and almost 13K feet for eight solid days. I practically ran up the Goulding Creek Trail, surprised to find that there was no Goulding Creek. At least not as such (with water in it).

What are these scrubby little oaks?

At one point you have to go through a gate where some rancher leases grazing lands. Close the gate!



Just past this cabin is where I turned around to head back.

Why are some aspens pure gold while others are more red?

Leaves upon the ground!

http://youtu.be/C98Fct9TNYE

James Robert Smith

Re: Biltmore Estate Trees

by **bbeduhn** » Mon Oct 01, 2012 4:22 pm

I spent some more time with the hemlock grove that contains the 143.6'. I'll call it the Underpass Grove, as it begins just after traveling under Route 40. I have a slightly adjusted height for that tree and the rest should all be new trees.

old	current	Biltmore#
143.6'	143.9'	168
	113.7'	4388
	127.9'	4389
	126.6'	4383
	134.1'	4384
	144.2'	4386
	123.8'	1341
	112.3'	1342
	108.0'	4225
	127.4'	no#
	129.9'	no#
	136.1'	4214

There are yet more to be measured in the grove, which is flanked by tall white pines. I couldn't hit the tops of a couple next to the 144 footer.

Brian Beduhn

In 'Music Of Trees,' A Symphony In The Key Of Cedar

by **edfrank** » Mon Oct 01, 2012 8:55 pm

In 'Music Of Trees,' A Symphony In The Key Of Cedar
http://www.npr.org/2012/10/01/162110681/in-music-of-trees-a-symphony-in-the-key-of-cedar

20121001_atc_08.mp3

Re: Metasequoia Glyptostroboides (Dawn Redwood)

by **bbeduhn** » Tue Oct 02, 2012 8:41 am

Some more finds:

Rt 191 So. Furn. Liq. 64.4' 65.7' 66.6'

Rt. 191 Bent Ck. Bapt. Ch. 64.8' 70.6' 70.8'

Biltmore Forest
Forest Rd. 96.9' 100.7'

WNC Arboretum
At main entrance 119.7' 105.0' 79.2'
113.7' 101.7' 115.0' 119.3' 117.8'

Really nice row of 8!

Gardens 6 sheridan Spire variety 25-30'

These appear to be identical aside from sprouts growing from the trunk.

Brian Beduhn

Scenery from Colorado

by **jamesrobertsmith** » Tue Oct 02, 2012 5:32 pm

If John Muir knew about this place, he must have kept it to himself.

Very deep in the Weminuche. If you're this far along and need help...you're screwed.

James Robert Smith

Global Warming could cripple SW forests

by **Joe** » Mon Oct 01, 2012 9:17 am

Climate Change Could Cripple Southwestern U.S. Forests: Trees Face Rising Drought Stress and Mortality as Climate Warms

http://www.sciencedaily.com/releases/2012/09/120930142106.htm

Re: Global Warming could cripple SW forests

by **jamesrobertsmith** » Mon Oct 01, 2012 7:47 pm

Last week we passed through what seemed to be endless miles of dead Lodgepole pine forests, killed off due to rising temperatures which allowed beetles to fell them from horizon to horizon. Human-caused global warming is here, it's too late to do anything about it, so prepare for the freaking worst.

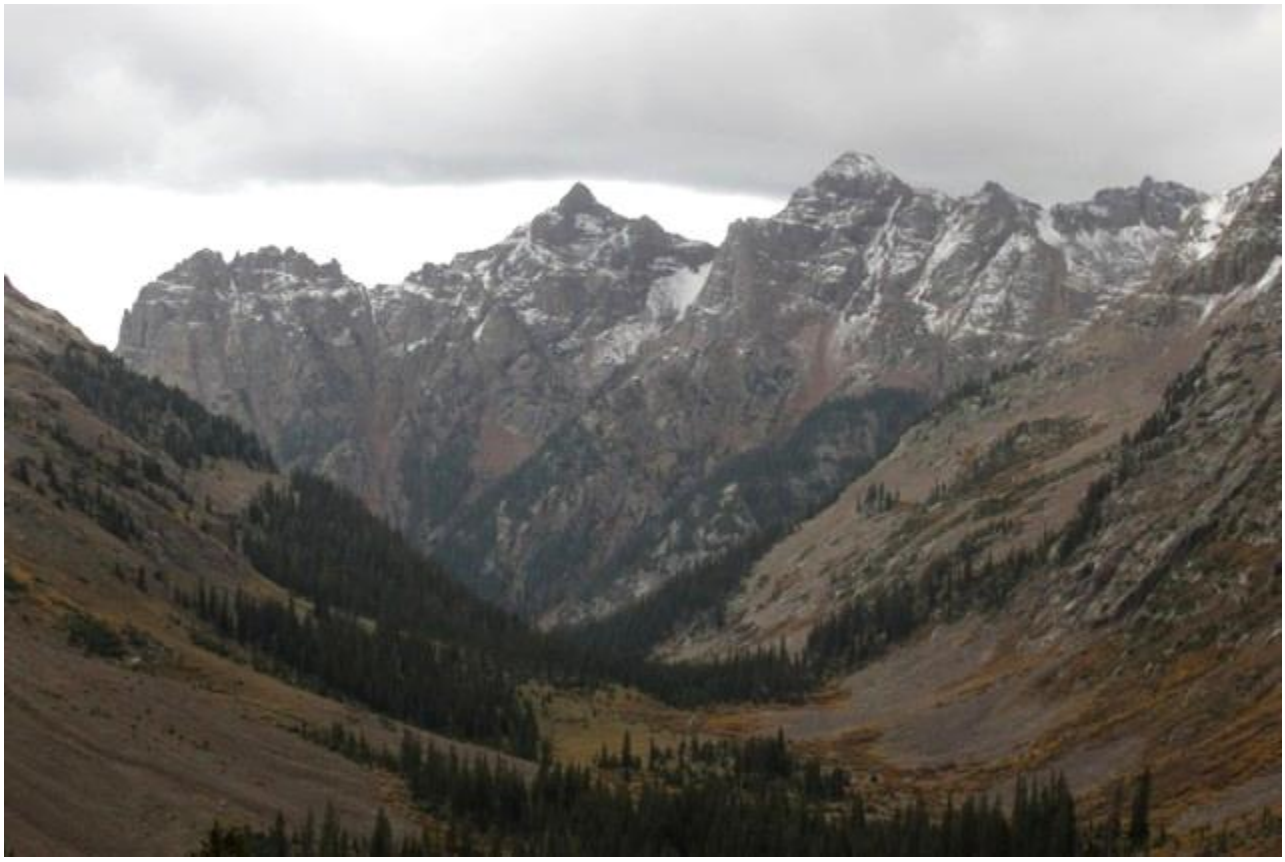
Most of the trees in this vista were dead from pine beetle infestation.

James Robert Smith

Re: Scenery from Colorado

by jamesrobertsmith **» Tue Oct 02, 2012 8:47 pm**

We ventured about as deep into the San Juans as you can, I reckon. Most of the trip was grand, but there was one day that was pure Hell. We were trying to get over Columbine Pass to Chicago Basin, but a freight train of thunderstorms (during heavy snow) would not allow us to move up to the 12K-foot level and we had to retreat and camp in a very uncomfortable spot then try again the following morning. I have to say...the experience was horrid. I was cold, wet, exhausted, suffering from altitude sickness, and frankly depressed.



This was taken shortly before the thunderstorms raked the pass and kept us from going over.

James Robert Smith

Middleton Oak and Angel Oak

by **Larry Tucei** » Tue Oct 02, 2012 5:26 pm

Brian, If you get to the Middleton Oak a cookie was cut from one of the limbs that fell off a couple of years ago. Vic Shelburn back in 09 was getting the cookie aged I wonder what happened with that? http://groups.google.com/group/entstrees/browse_thread/thread/9eeb857ef5cdd528?hl=en I'll see if I can contact Vic. We all were curious as to the age of the tree the limb cut would help narrow its age down. I would guess in the 300 year old range but I've learned many things from NTS- great size doesn't always mean great age. I've measured the rowed Live Oaks at Oak Alley and got from 29' 11" to 16' 3" CBH. These were all planted around the same year time period about 280-290 years ago. What a large difference in growth rates must be genetics. I would love to measure the Angel Oak and the Middleton Oak. The next time I get up your way I must make my way to Middleton and to the Angel Oak. Both are beautiful trees and are as big as any Live Oaks I've seen!

Larry Tucei

Re: Middleton Oak and Angel Oak

by **Larry Tucei** » Wed Oct 03, 2012 10:03 pm

All, I emailed Vic Shelbourne the other day and this was his response on the Cookie. *"As for the Middleton oak, the cookie showed a ring count of less than 200 years (about 190) for a limb less than 20 feet off the ground and near the main stem. Based on those data, it would seem that the Middleton oak is NOT nearly as old as people have believed—300-400 yrs plus which people conjecture, It may be barely 200 which I think would surprise a lot of people. Live oaks just grow a lot faster than people realize. I have yet to find someone to corroborate the ring count (except students) so I have not advertised that fact. SO that is where we stand. The 6" thick cookie is about 2 feet by 3 ft in diameter (oblong) and must weigh over 100 lbs. It is not going anywhere in our wood shop! "*

Larry Tucei

Re: Middleton Oak and Angel Oak

by **bbeduhn** » Thu Oct 04, 2012 12:43 pm

Upon further research, two dates stand out for me. 1741 was the year the gardens were started. It would seem logical that the oak was planted in that year or shortly thereafter. Given its prominent location, it would seem that it was planted. Another date is 1786, when Michaux visited. This seems more arbitrary but does jibe fairly well with Larry's guess of just barely 200, 226 to be exact. these are just guesses but appear to be plausible. The oak is fairly vibrant in appearance, indicating some degree of youth but also isn't putting on girth, and indication of greater age. The Angel Oak appears to be older but is certainly putting on girth somewhat rapidly for its age. It's a mystery for now but it is obvious that it isn't in the 400 year old range.

Re: Middleton Oak and Angel Oak

by **Larry Tucei** » Thu Oct 04, 2012 3:40 pm

Brian, That was an age estimate that Vic Shelbournes team from University of Clemson came up with. I believe they are still getting more opinions on that. I would have guessed the Middleton Oak to be between 200-300 years old. I was not surprised by the age estimation due to measuring Live Oaks these last few years. But 6 years ago I to would have thought that a tree of its size would be well over 300-400 years old. So many factors influence growth rates. One thing for sure Live Oaks have faster growth rates than previous thought. I have learned from NTS and experience that estimations can be very wrong. Hopefully Neil Pederson will weigh in on this he is one our experts on tree ring study.

Larry Tucei

Leica Disto D8

by **KoutaR** » Mon Sep 17, 2012 6:44 am

NTS, I was measuring trees with a German tree hunter yesterday and I had an opportunity to try out his Leica Disto D8. It is a precision instrument with a lot of programs, modes and settings, but tree measuring with the sine method is impossible: Disto's beam is too weak and you get no reflection from tree tops. In Leica Disto D8, there are two settings for its beam intensity, but even the stronger setting is not enough. Branches are ok, but from tree tops we did not get any single measurement.

Could you list the rangefinders which make the sine measuring possible, including more expensive instruments? Specifically, which rangefinders make the sine measuring possible without an external clinometer, like Nikon Laser 550A S, Nikon Forestry 550 and Nikon Forestry Pro?

Kouta Rasenan

Re: Leica Disto D8

by **dbhguru** » Mon Sep 17, 2012 8:55 am

Kouta, Laser Technology Inc's TruPulse 360 line, TruPulse 200 line, and Impulse 200 line all allow sine-based measurements. [They all have built in clinometers] and the accuracy of the tilt sensors is better than advertised. I've done many tests and posted some of the results in the Measurement and Dendromorphometry section.

Bob Leverett

Re: Leica Disto D8

by **M.W.Taylor** » Mon Sep 17, 2012 5:54 pm

Even cheaper is the Optilogic. Cost about $330. Too bad the Leica D8 laser is too weak to bounce off a tree top. http://www.opticsplanet.com/opti-logic- ... 800lh.html Make sure it's the [LH} model which has the Hypsometer function. The 1000 yard vesion is only $350.

Michael Taylor

Re: Leica Disto D8

by **Karlheinz** » Mon Oct 01, 2012 6:37 pm

Leica Disto D8 benefits by measuring short distances, where Nikons and TruPulses do fail. When measuring a tree by tape drop method Disto can scale the rest in treetop by sin-method, but in field-test it was not always so easy.

In http://www.fs.fed.us/eng/pubs/pdf/10191803.pdf (Effective April 2010) the foresters described a few of rangefinders (Disto, Optilogic, TruPulse, Vertex and LaserAce) and they made comparison measurement series to evaluate accuracy and precision, focus on horizontal distance to an unobstructed target and through dense brush.
One result of this test is, that OptiLogic, commonly used by foresters, is the cheapest but clear-cut the most inexactly. Therefore Optilogic is not shortlisted for me.

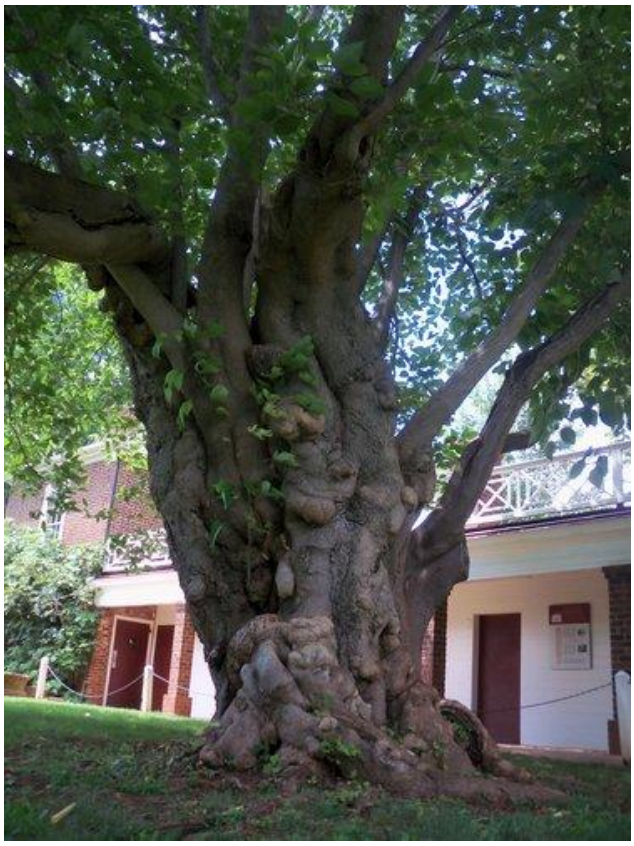
LaserAce was the most exactly one. Look at Trimble website for the current LaserAce 1000: http://www.trimble.com/mappingGIS/laser ... lications& The LaserAce has compared to the TruPulse shorter range but higher accuracy. Could be the best solution for tree heights occurring in Europe. I am very interested to learn what experiences at tree height measurements are with the LaserAce, is the Laser strongly enough to bounce off the tree top

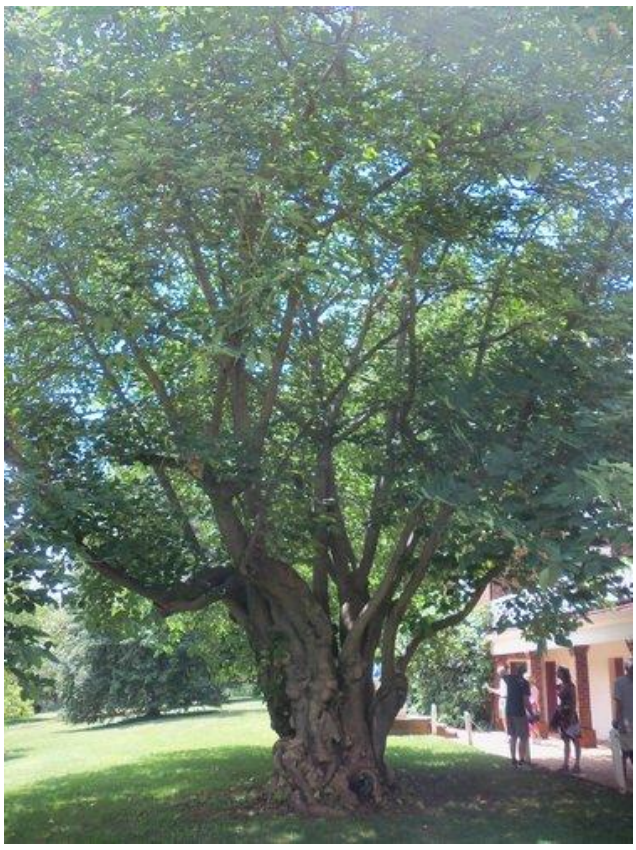
Karlheinz Brüne

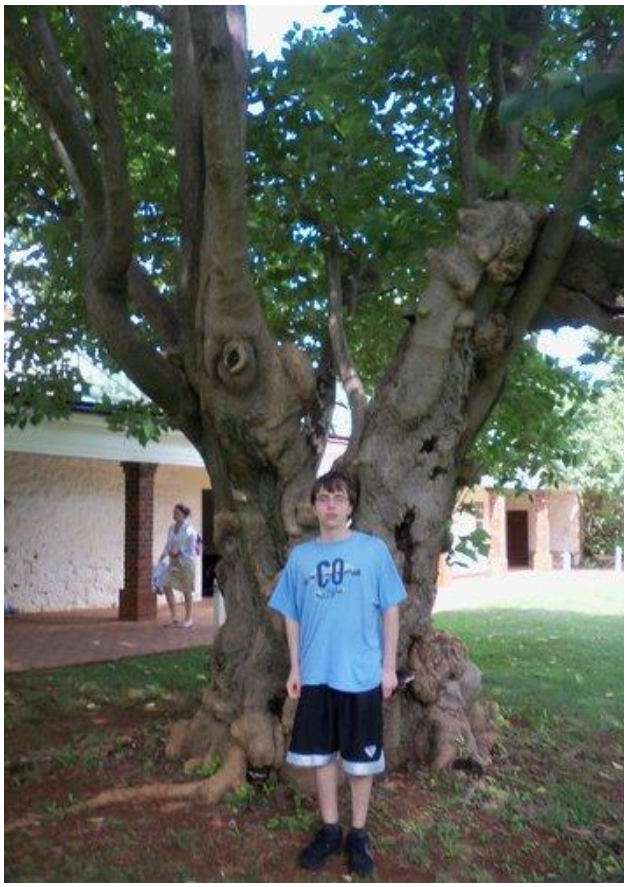
Enchanting Paper Mulberry (Broussonetia papyrifera), VA

by **RyanLeClair** » Sun Oct 07, 2012 3:06 pm

This amazing tree was at Monticello. The various mulberries are considered tasteless in our time, but apparently our forefather Jefferson was convinced of the opposite, for large swaths of his Virginia residence are/were decorated with these trees. This particular paper mulberry is to be found near the large kitchen.







Ryan LeClaire

#1) Measurement Exercises for October 12th

by **dbhguru** » Mon Oct 01, 2012 9:48 am

NTS,

The Oct 12th advanced tree measuring workshop nears. I intend to be ready. I've picked out most of tree demonstration trees. One is the Cabin Pine. I've attached an Excel spreadsheet that shows the tree and measurements as of yesterday. This relatively young, vigorously growing white pine holds promise of being a future super performer. It's present height is 161.0 feet and it has a healthy, multi-candle top that should push upward for several decades to come. It is located in a relatively protected spot and is growing in a moist location.

The attached spreadsheet shows the plan for the demonstration trees. I suppose I could have gotten GPS coordinates for the measurement location. I may yet do that and add the coordinates. I'm reluctant to give precise location information on the Mohawk pines.

As can be seen, the top of this tree is almost exactly over its base. It has a slight lean, but self-corrects. Some of the trees in the demonstration will reflect a difference between sine and tangent methods of at least 20 feet. I'm striving to include every shape so that attendees can get a better understanding as to why things can go right in one case and badly wrong in another.

So far NTS attendees for the Oct 12th event include Andrew Joslin, Bart Bouricius, Ed Ritz, Dale Luthringer, Carl Harting, Joe Zorzin, Jack Sobon, and yours truly. DCNR is funding Dale's participation. I haven't heard from John Eichholz, nor Doug Bidlack. I'm hoping a few other Ents will be able to make it. The big disappointment is that Will and Lee will not be able to attend this year's event. Bummer. But their spirits will be there. Unfortunately, Ed Frank won't be able to attend either. However American Forests and LTI will be present.

There will be more representatives from the forestry profession at this event there probably any other. Attendees get continuing education credits toward license renewal, so the incentive is definitely there. Well, its off to Mohawk again to develop more spreadsheets for the demonstration trees we'll be measuring.

MTSF-CabinPineWorksheet.xlsx

Robert T. Leverett

Statistics for Cabin Pine: Mohawk Trail State Forest				
TruPulse 200	Distances in feet, angles in degrees			
Target	SD	Inc	VD	HD
Top Target	219	39.9	140.4774693	168.0091682
Bottom Target (reflector)	170	-4.6	-13.63381714	169.4524093
Bottom Target to Base			-6.9	
Sine Height			161.0112864	
Tangent Height			162.2180233	
		Difference	1.206736859	1.44324109

Notes:

1. The top is almost perfectly centered over the trunk.

The horizontal difference is

169.452409-168.009168 = 1.44324109 feet by calculation. This translates to a height difference between sine and tangent determinations of the following.

$$D_h = (169.452409 - 168.009168)\tan(39.9) = 1.20673686$$

The sine height is the correct one.

2. The pre-season height of the Cabin pine was 160.3 feet. This season's growth appears to be 0.7 feet. However, the candles grow at different rates.

3. The Cabin Pine's girth is 8.9 feet. The trunk volume is approximately 365 ft^3

4. The tree's age is not known, but likely around 125 years based on the bark characteristics, especially on the upper trunk.

5. Height measurements were all determined using a LTI TruPulse 200.

6. Date of measurement was 9-30-2012 by Bob Leverett, Native Tree Society.

7. On the next spreadsheet, we see a profile of the pine in the first image and in the second image, we see the highest candle identified by the red arrow. As can be seen, the high point does not appear to be the highest, because the apparent high point is actually on a branch that is closer to the measurer. The high point is not visible in the first image.

8. There are several growth candles that are between 158 and 160 feet, showing the challenge of identifying the highest point in the crown.

9. The location of the measurement is across the road from Cabin #6.

October 12th Advanced Tree Measuring Workshop

by **dbhguru** » Tue Oct 09, 2012 3:39 pm

NTS, The attachment is what I'll be handing out to the attendees of the referenced workshop. Some of you who can't attend may find it useful.

Advanced Tree Measuring WorkshopOrig.doc

Robert T. Leverett
Co-founder and Executive Director
Eastern Native Tree Society
Co-founder and President
Friends of Mohawk Trail State Forest

Advanced Tree Measuring Workshop

Mohawk Trail State Forest

Conducted by Bob Leverett

Oct 12, 2012, 9:00AM – 4:30PM

Cosponsored by

Massachusetts Department of Conservation and Recreation

Native Tree Society

Friends of Mohawk Trail State Forest

Massachusetts Audubon

Trustees of Reservations

American Forests

Laser Technology Inc.

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Introduction

The Native Tree Society (NTS) has developed this handout to illustrate four methods of measuring tree height: sine, tangent, external baseline, and similar triangles. The material in this guide can be freely used and distributed, courtesy of NTS. If you distribute or extract material, please credit the Native Tree Society as the source.

The preferred measurement method is sine; however, if the measurer doesn't possess the necessary equipment, one of the other techniques can be used, albeit cautiously. All the methods are based on mathematical assumptions. It is essential to understand the assumptions and insure they are fulfilled, if measuring errors are to be avoided. The sine method results in the smallest errors, but requires the most sophisticated and expensive equipment.

Sine Method

NTS commonly measures tree height using the sine method. To apply this method, visualize three parallel, horizontal planes, one through the highest top, one through the measurer's eye, and one through the base of the tree. Height is defined as the vertical distance between the top and base planes. Thought about in another way, there are two targets (top and base of the tree), and the objective is to measure the vertical distance between the two without making any further assumptions about their positions relative to one another. For example, it is not necessary to assume that they are vertically aligned.

While keeping your eye in the middle horizontal plane, you measure the slope distances from the eye to the top and eye to base (hypotenuses of two right triangles) with an infrared laser rangefinder, and the corresponding angles with a clinometer or tilt sensor. Then you make the following calculations (see diagram on next page):

Height to top = slope distance to top x sine(angle to top)

Height to base = slope distance to base x sine(angle to base)

Total Height = Height to top + Height to base

(if top is above and base is below eye level)

Total Height = Height to top - Height to base:

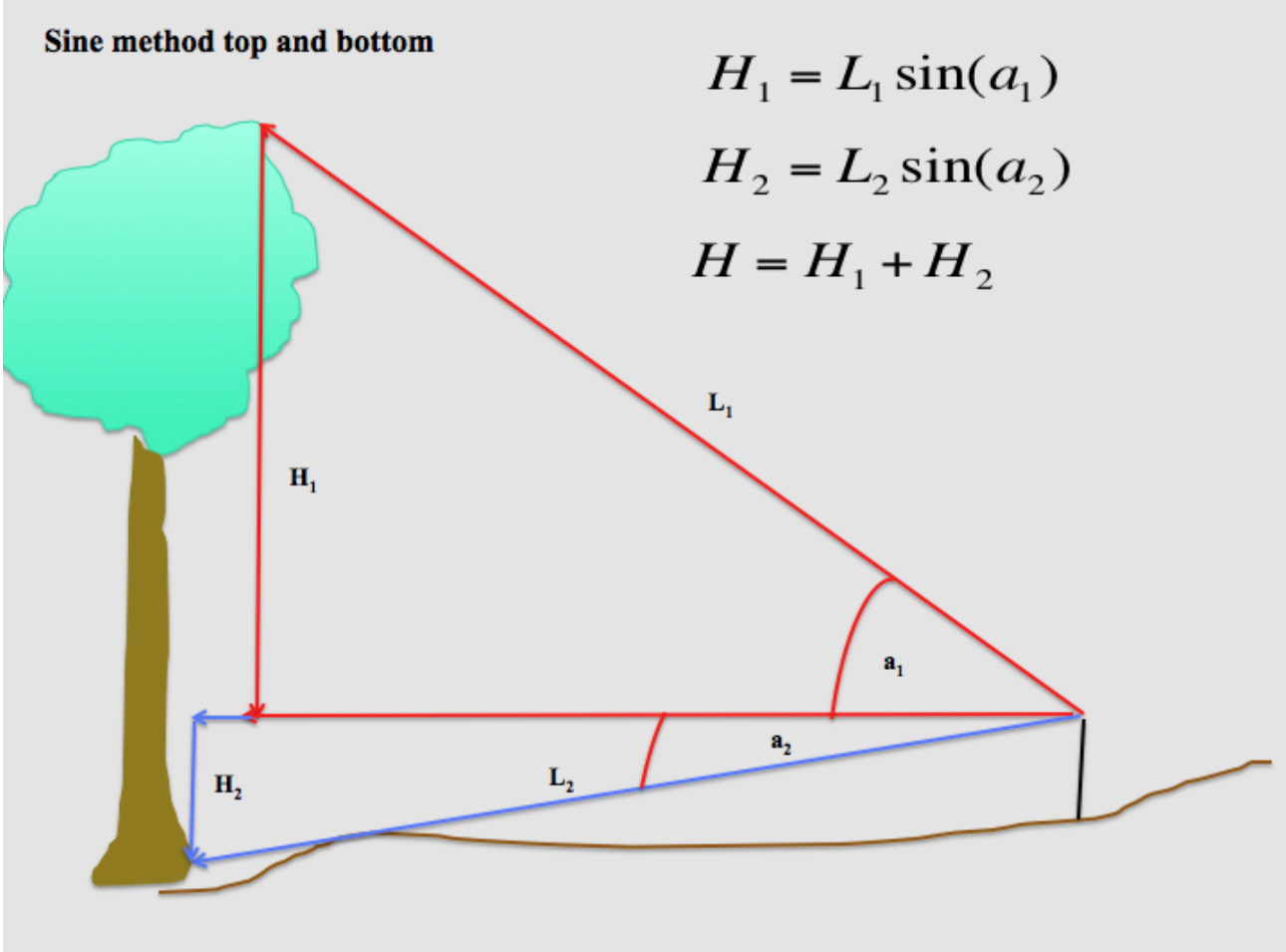
(if both top and base are either above or below eye level)

Where the two height components are added, the assumption is that both angles are treated as positive values. However, angles above eye level are usually considered positive and those below as negative. If the angles are treated as signed values, the last formula works in all cases.

What is special about this method? It eliminates the problem of the top not being positioned vertically over the base. In the accompanying diagram, the highest point is not positioned vertically over the base, unlike diagrams accompanying clinometers and in Internet descriptions for measuring tree height. These diagrams typically show a single baseline to the trunk of the tree with angles taken to the top positioned vertically over the base.

In essence, measuring the full height of a tree requires two baselines or their hypotenuse equivalents. Trigonometrically speaking, the problem has never been one using a common baseline to the top and base. Nor is it necessary that the triangles exist in the same vertical plane. For a more complete explanation, see NTS guidelines for measuring tree height at www.nativetreesociety.org. You can also visit the NTS BBS and sign up as a member. There are no dues. You can then visit the Measuring and Dendromorphometry posts and read full discussions of the tree measuring methods to include sources of error and how to evaluate and control them.

Here is the diagram for the sine method as described above.



Note that the top of the tree is horizontally in front of the trunk. Were the measurer using a tape and clinometer to measure height, extending the baseline all the way to the trunk and taking the angle to the top would lead to an over-calculation of the tree's height above eye level. Conversely if the top of the tree is behind the trunk relative to the measurer, using the distance to the trunk as a baseline leads to an under-calculation of the tree's height.

To reiterate what was previously said, measuring the height of a tree is a two-baseline or hypotenuse problem. The tree must be visualized as an irregularly shaped object in 3-dimensional space. A connection of base to top does indeed occur through the trunk, limb, branch, and twig structure, but the connection is seldom through an absolutely vertical pathway involving the trunk. Plantation spruce trees are an exception that often comes close to fulfilling the vertical pathway model.

We now turn to the most popular method for measuring tree height, the tangent or slope method. This method has been implemented in hypsometers and clinometers. We begin with the idealized method that employs a single baseline to the trunk.

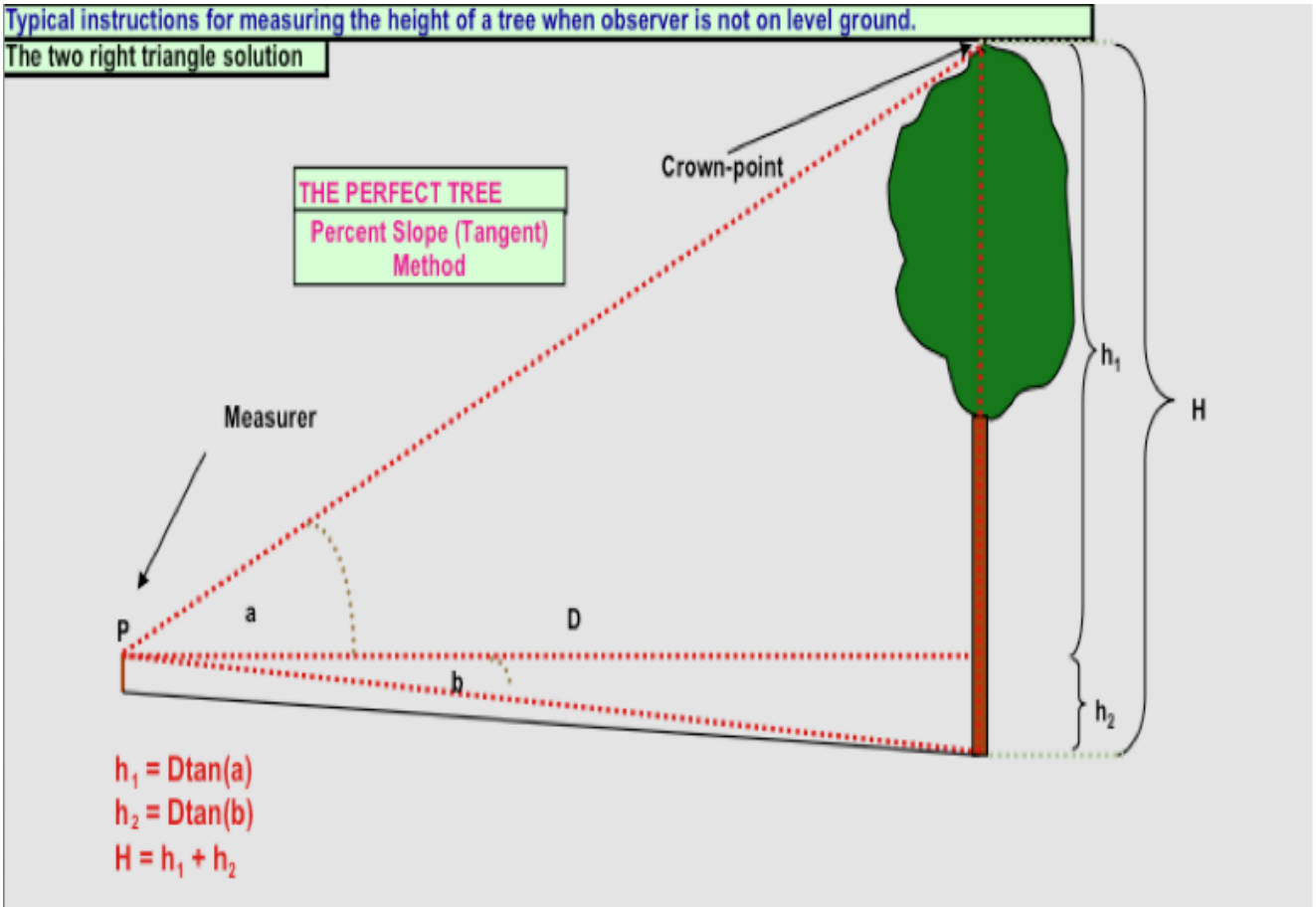
Traditional Tangent Method

Height to top = baseline distance to top x tangent(angle to top)

Height to base = baseline distance to base x tangent(angle to base)

Total Height = Height to top + Height to base (if top is above and base is below eye level)

Total Height = Height to top - Height to base: (if both top and base are either above or below eye level)



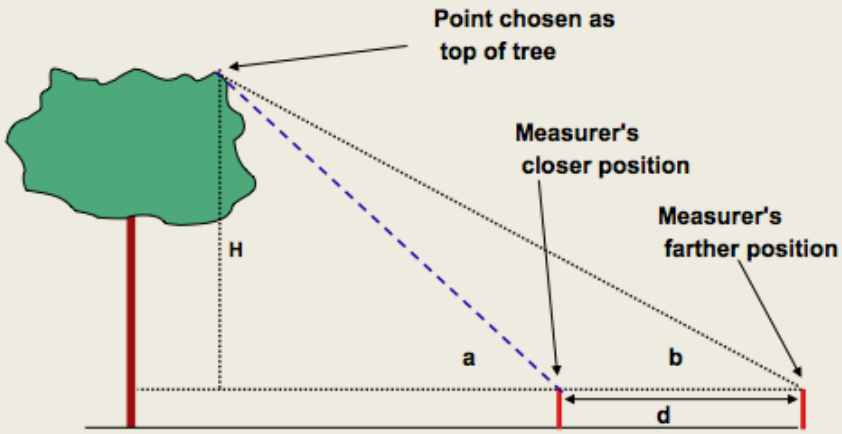
Note that in the above drawing, a common baseline is used for top and base, denoted by the variable D. If the top is not vertically positioned over the base, crown-offset measurement errors occur with the tangent method. One way to get around this problem is with the External Baseline Method as show in the diagram below. The method is illustrated for the height component above eye level, but can be extended to include the lower component.

External Baseline Method Variation

Advanced use of tangent method: External Baseline Method

Compute tree height using tangent method when crown-point being sited is not over base and no easy way to determine crown-point offset

$$H = \frac{d\tan(a)\tan(b)}{\tan(a)-\tan(b)}$$



Notes:

1. **The baseline is represented by d in the above diagram. It does not reach the trunk.**
2. **In this version of Extended Baseline, the baseline is level.**
3. **In a more advanced version, the assumption of a level baseline is lifted.**

If the baseline from the closer to more distant position is not level, measure the angle from the farther position to the closer one (position of eye at each location). The distance d is the slope distance between eye positions. The following formula then works.

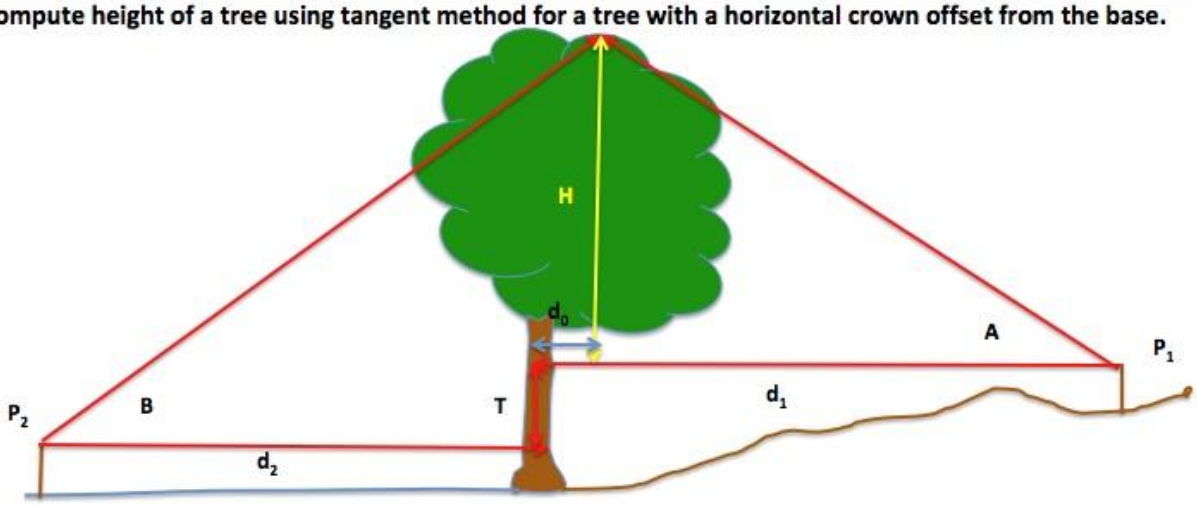
$$H = \frac{d\tan(a)\cos(c)\left(\tan(b) - \tan(c)\right)}{\tan(a) - \tan(b)}$$

Because three angles are being measured, this version of the Extended Baseline Method is especially sensitive to angle and distance errors. Do not use this method if you can't make extremely accurate measurements of the input variables.

Double Tangent Method

The high point of the crown of a tree may be offset from the base and also visible from points that are diametrically opposite, i.e. 180 degrees apart. This won't happen often, but when it does, it opens the door to a rather novel solution to determining height, as shown the diagram below.

Compute height of a tree using tangent method for a tree with a horizontal crown offset from the base.



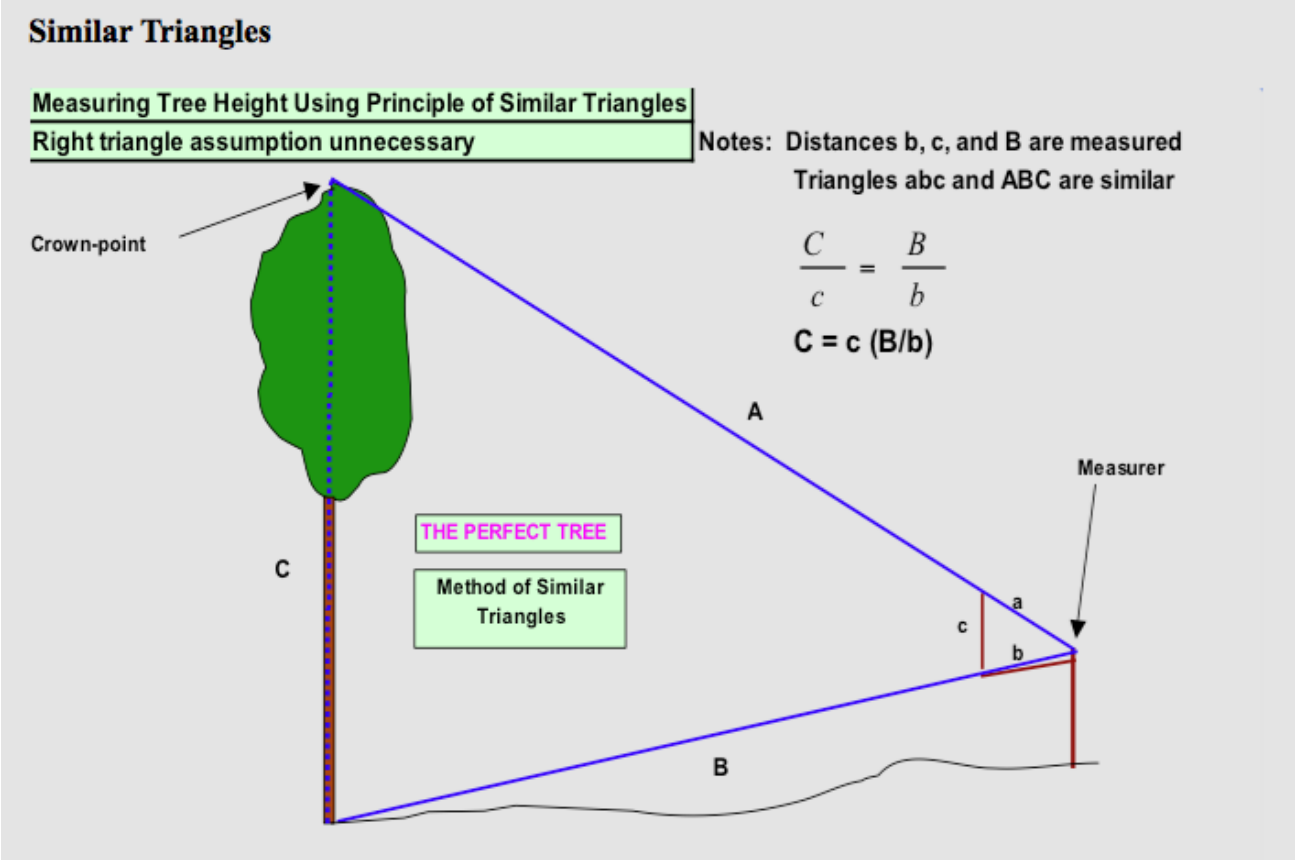
$$H = \left[\frac{\tan B\left(d_1 + d_2\right) + d_0}{\tan A + \tan B} \right] \tan A$$

Notes:

1. **The objective is to compute height of the top of the tree above station P_1.**
2. **The top must be visible from opposite sides of the tree. Consequently, this method will usually not be able to be applied. It is, however, a tool in the toolkit.**
3. **P_1 and P_2 represent the positions of the measurer's eye on the opposite sides of the tree.**
4. **if P_2 is lower than P_1 the T>0 else T<0. The diagram shows P_2 lower than P_1.**
5. **The equation for H represents an algebraic derivation that first computes d_0, then $d_1 - d_0$ The quantity in brackets is equal to d1 - d0.**
6. **Once H is computed, then height below eye level from station A is computed by a conventional application of the tangent method.**

Similar Triangles

We now turn to the last of the methods, the method of similar triangles. Similar triangles are triangles that have the same shape, i.e. corresponding angles are equal.



The use of similar triangles is often presented as the "stick method" on websites featuring champion tree lists. Basically, it is an attempt to create a method for measuring tree height that minimizes the use of mathematics, but greatly over-simplifies what is required.

The primary source of error for this method occurs when the two triangles are not actually similar, and/or c, b, B, or a combination, are mis-measured. Early hypsometers often used this method to measure tree height, but it is error-prone and there is no easy way to adjust for a crown-to-base horizontal offset distance. For example, the vertical side of the small triangle is supposed to shadow the vertical side of the large triangle, which is the line connecting the top of the tree to the base. But what if this line is not vertical, which it often won't be, because the top of the tree is not positioned vertically over the base. Then the triangles are not similar and the simple ratio and proportion of similar triangles does not apply.

Next we look at a way of evaluating angle and distance errors. We use formulas from calculus to approximate the impact of small errors in the input variables.

Formulas to Calculate Impact of Instrument Error

Tree measurers need a straightforward way to calculate the error associated with instrument errors for a combination of distances and angles. For example, suppose we measure a tree with a laser rangefinder and clinometer using the sine method. If the hypotenuse distance is actually 150 feet and the angle is actually 40 degrees, but we read 148.5 feet as the distance, and 39.8 degrees as the angle, what is the effect on the height? We could give an analogous situation for the tangent method. The following formulas allow the measurer to calculate the impact of relatively small instrument errors.

Sine-based formula for error investigation

L = actual hypotenuse distance to target

A = actual angle to target

dA = error in angle in radians

dL = error in distance to target

dH = error in height due to dA and dL

$$dH = L\cos(A)dA + \sin(A)dL$$

Tangent-based formula

D = baseline distance to trunk

A = angle to target

dA = error in angle in radians

dD = error in baseline distance

dH = error in height due to dA and dD

$$dH = \frac{D}{\cos^2(A)}dA + \tan(A)dD$$

Examples

In the example posed above, the impact on height would be as follows.

$$dH = 150\cos(40)(-0.2\rho/180) + \sin(40)(-1.5) = -1.365$$

The impact of a -0.2 degree error in the angle and -1.5 feet in the distance is -1.365. The actual impact is -1.362. The difference is because we are using differentials to calculate impact. Note that to convert degrees to radians, multiply by $\rho/180$.

Next, we provide a version of the measuring worksheet set up to do a single measurement. You can skip rows A, B, C, and T if you don't have a TruPulse 360 or a compass. The worksheet utilizes the LTI TruPulse 360, but you can use any laser rangefinder and clinometer with a scientific calculator.

Advanced Tree Height Worksheet

Tree Height Measuring Worksheet (Native Tree Society: for LTI TruPulse 360 - dist ft/mtrs, ang = degrees)		
SPECIES:		**LOCATION:**
Same top and base must be measured for each trial		
Var.	**Definition**	
A	**Azimuth of crown point** (AZ return of TruPulse)	
B	**Azimuth of base point** (AZ return of TruPulse)	
C	**Angle between crown and base** abs(B -A)	
D	**Crown slope distance**(SD return of TruPulse)	
E	**Crown angle** (INC Return of TruPulse)	
F	**Crown horizontal distance**(HD return of TruPulse) D x cos(E)	
G	**Crown vertical distance** (VD return of TruPulse) D x sin(E)	
H	**Tan hgt using correct baseline for crown** F x tan(E)	
I	**Base slope distance** (SD return of TruPulse)	
J	**Base angle** (INC return of TruPulse)	
K	**Base horizontal distance** (HD return of TruPulse) I x cos(J)	
L	**Base vertical distance** (VD return of TruPulse) I x sin(j)	
M	**Tan hgt using correct baseline to base** K x tan(J)	
N	**Total vertical hgt** (sine-based calculated height or ML-VD return of TruPulse) G - L	
O	**Trunk distance near eye-level** (HD return of TruPulse used in HT below)	
P	**HT** (3-point tangent-based height calculation for TruPulse)	

Q	**Hgt diff** (sine versus tan) abs(N - P)	
R	**Crown to base horiz offset** abs(F - K)	
S	**Vertical Impact of offset** R x tan(E)	
T	**Full horiz crown-base offset** (ML-HD return of TruPulse) SQRT(F^2+K^2-2*F*K*cos(C))	
Notes:	**TruPulse dist in feet or meters.**	**Same top and base must be measured for each trial**
Rows A, B, C, and T to get full crown offset are optional		

Note: This worksheet takes the measurer through the process of measuring the height of a tree using the sine method, with a comparison to the tangent method having the correct baselines to top and base. In this case, sine and tangent yield the same results. We then compare these results to the tangent height as commonly used with a single baseline to the trunk. Hypsometers often employ this technique, i.e distance to trunk, angle to top, angle to bottom. The unstated assumption is that the top point is positioned vertically over the base. Most mature trees do not meet this assumption. In addition, if the measurer is too close, what is taken for the top is often the end of an upturned branch that is horizontally offset from the base by a significant distance. Next, we present a simplified worksheet to do sine and tangent measurements.

Simplified Tree Height Worksheet

Tree Height Measuring Worksheet (Native Tree Society: for LTI TruPulse 360 - dist ft/mtrs, ang = degrees)		
SPECIES		PROPERTY:
LOCATION	Lat	Long
	SINE METHOD	
Variable	Definition	
A	**Crown slope distance** (SD return of TruPulse)	
B	**Crown angle** (INC Return of TruPulse)	
C	**Crown horizontal distance** (HD return of TruPulse) **A x cos(B)**	
D	**Crown vertical distance** (VD return of TruPulse) **A x sin(B)**	
E	**Base slope distance** (SD return of TruPulse)	
F	**Base angle** (INC return of TruPulse. Angles below eye are negative)	
G	**Base horizontal distance** (HD return of TruPulse): **E x cos(F)**	
H	**Base vertical distance** (VD return of TruPulse) **E x sin(F)**	
I	**Total Sine-based height** **D - H**	
	TANGENT METHOD - Common application	
J	**Trunk horizontal distance**: (HD return of TruPulse)	
K	**Crown angle** (INC return of TruPulse. Angles below eye are negative)	
L	**Base angle** (INC return of TruPulse. Angles below eye are negative)	
M	**Total Tangent-based height**: **J x [tan(K) -tan(L)]**	
N	**Diff between sine and tangent**: **I - M**	
P	**HT** (3-point tangent-based height calculation for TruPulse)	

The major source of error for the sine method is instrument error. The major source for the tangent method is crown-offset not taken into account.

Appendices

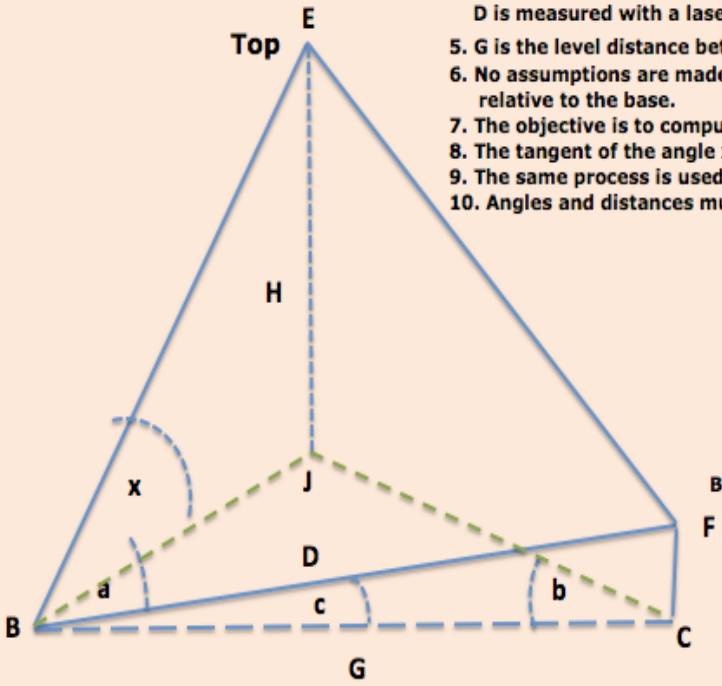
Top of Jake Swamp White Pine: 171.0 feet

I. Parallax Method for Tree Height

Compute tree height above or below eye level using a lateral external baseline, one vertical angle, and two horizontal angles.

Notes:

1. Compute the height of point E above point B using a lateral external baseline.
2. Baseline runs laterally from B to F. Its slope distance is D.
3. The baseline is not aligned with the target E.
4. Angles a,b, and c are measured with a compass. Angle x is measured with a clinometer. D is measured with a laser rangefinder or tape.
5. G is the level distance between the ends of the baseline.
6. No assumptions are made about where the top of the tree is relative to the base.
7. The objective is to compute the level distance BJ, where J is vertically beneath E.
8. The tangent of the angle x times the distance BJ gives the height EJ.
9. The same process is used for heights below eye level.
10. Angles and distances must be determined accurately for this method to work.



B and F are positions of the eye.

Where E and J are not in vertical alignment

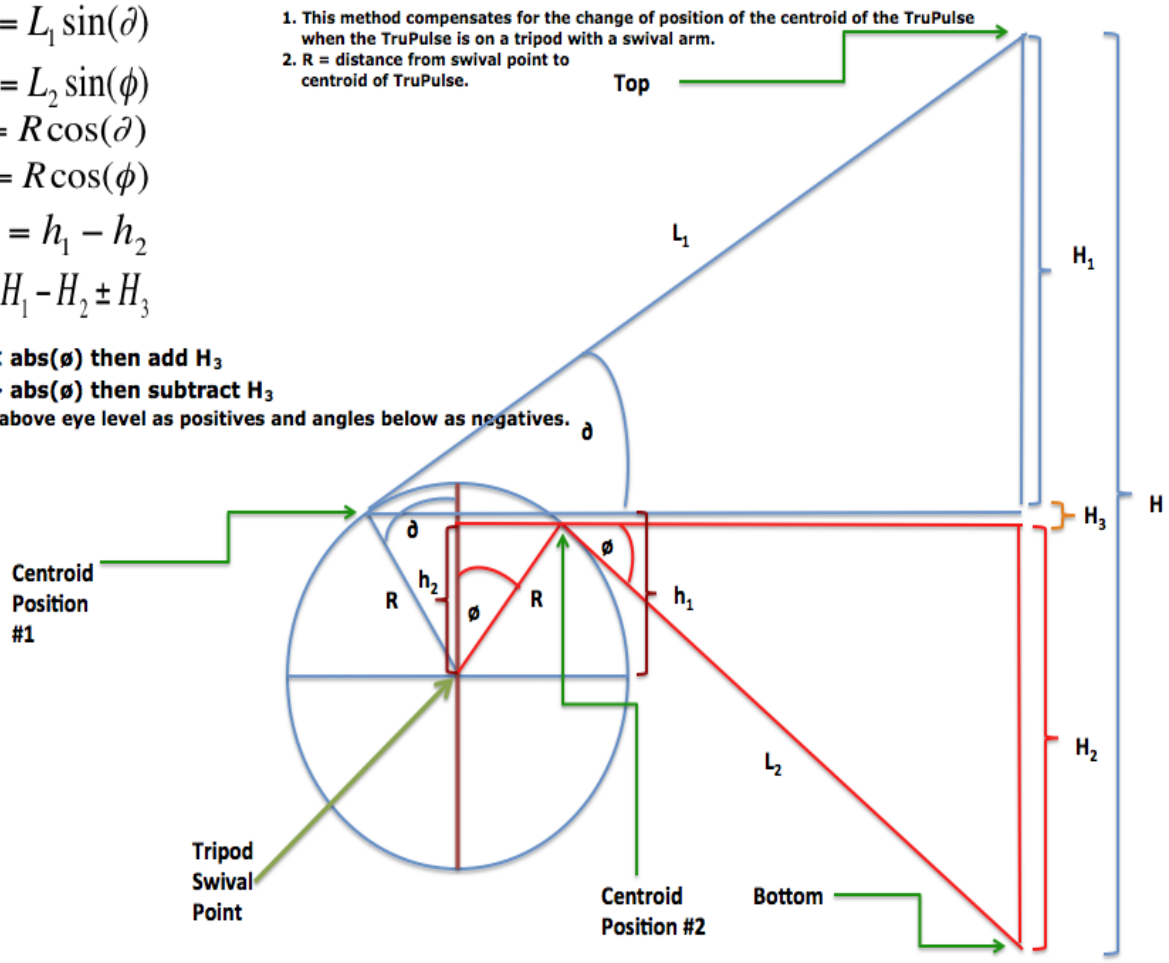
$$H = \left[\frac{D\cos(c)\tan(b)\tan(x)}{\left[\tan(a)+\tan(b)\right]\cos(a)} \right] \qquad G = D\cos(c)$$

The parallax method offers a flexible approach to measuring tree height when the base cannot be reached and an external baseline cannot be established that is in alignment with the target. However, the method is extremely sensitive to angle errors. It is presented here for completeness.

II. **Adjusting for Movement of the Centroid of the Instrument**

A minor source of error for either technique is head or instrument swivel when shooting the top versus the bottom of a tree. The centroid of the instrument can be moved out of the middle horizontal plane. When using the sine method, a tripod is always advisable to avoid handshake. The next topic deals with a solution.

Computing Tree Height with Centroid Adju Notes:

$$H_1 = L_1 \sin(\partial)$$
$$H_2 = L_2 \sin(\phi)$$
$$h_1 = R\cos(\partial)$$
$$h_2 = R\cos(\phi)$$
$$H_3 = h_1 - h_2$$
$$H = H_1 - H_2 \pm H_3$$

If abs(∂) < abs(ø) then add H_3
If abs(∂) > abs(ø) then subtract H_3
Enter angles above eye level as positives and angles below as negatives.