UNIVERSITY OF GEORGIA
Warnell School of Forestry & Natural Resources

Publication WSFNR-20-22C

April 2020

Extreme Trees: Tallest, Biggest, Oldest

Dr. Kim D. Coder, Professor of Tree Biology & Health Care / University Hill Fellow
University of Georgia Warnell School of Forestry & Natural Resources

Trees have a long relationship with people. They are both utility and amenity. Trees can evoke awe, mysticism, and reverence. Trees represent great public and private values. Trees most noticed and celebrated by people and communities are the one-tenth of one-percent of trees which approach the limits of their maximum size, reach, extent, and age. These singular, historic, culturally significant, and massive extreme trees become symbols and icons of life on Earth, and our role model in environmental stewardship and sustainability.

What Is A Tree?

Figure 1 is a conglomeration of definitions and concepts about trees from legal and word definitions in North America. For example, 20 percent of all definitions specifically state a tree is a plant. Concentrated in 63% of all descriptors for trees are four terms: plant, woody, single stem, and tall. If broad stem diameter, branching, and perennial growth habit concepts are added, 87% of all the descriptors are represented.

At its most basic level, defining a tree is not species based, but is a structural definition. A tree is represented by a type of plant architecture recognizable by non-technical people. The most basic concepts for defining a tree are — a large, tall, woody, perennial plant with a single, unbranched, erect, self-supporting stem holding an elevated and distinct crown of branches, and which is greater than 10 feet in height and greater than 3 inches in diameter. Everyone tends to have their own tree definition.

The structure and architecture of a tree help define its past, present, and future appearance and continued growth. The four tree metrics most people list to represent maximum limits of tree expression are height, girth, mass, and longevity.

HEIGHT — TALLEST

Measuring tree height is fraught with problems, and errors can be significant (>12% error). The two accepted means of measuring accurate tree height is by a climber dropping a measuring tape down from the top of a tree, or by using laser range finders. Carefully measured (not estimated) height values are available for many trees. The tallest trees alive and standing are provided here. In the past, tall tree lists had error-prone measures and estimates, plus some involved rough paced measures of downed trees. In some cases, old tall trees previously listed have been logged or damaged.

Figure 2 lists the twenty-four tree species which contain the tallest trees in the world greater than 269 feet in height. These are scientifically confirmed measures of living trees. The height in feet is listed for the tallest individual within each species, as of the date of this publication. Redwood (*Sequoia*

sempervirens – a gymnosperm) is by far the tallest tree on the planet. *Shorea* / meranti represents the tallest tropical tree and the tallest angiosperm. Height records fall rapidly with inclusion of more species, providing a maximum height for most trees of less than 150 feet.

World-wide, there are more than 20 tree species individuals with an estimated or measured height greater than 250 feet not listed here. Some of these claims are difficult to verify, and many repeat old measures, primarily due to remoteness of the tree. Only living trees measured with climbers or laser instruments are here provided.

Figure 3 is a list of the 20 tallest individual trees, regardless of species, in the world. All these trees exceed 300 feet in verified height. Redwoods (*Sequoia sempervirens*) occupy the first twelve spots. The tallest tree in the world with a confirmed height measure is the Hyperion redwood at 380 feet. It should be noted the tallest trees grow in isolated areas of moist cloud forests in temperate climatic zones (mountain slopes in California, USA, and Tasmania, Australia), and in isolated valleys of dense tropical rainforests of Southeast Asia (Borneo).

In the past there have been claims of taller trees than currently listed. In the Western coastal forests of the United States, four trees were measured and cited as the tallest, but were logged or killed: 1) a redwood (*Sequoia sempervirens*) 390 feet tall (1905 record); 2) a coastal Douglas-fir (*Pseudotsuga menziesii*) 466 feet tall (1897 record); 3) a coastal Douglas-fir (*Pseudotsuga menziesii*) 393 feet tall (1897 record); and, 4) a giant sequoia (*Sequoiadendron giganteum*) 320 feet tall. Note none of these heights could be verified.

In Australian eucalyptus forests, two species and four trees were cited for extreme height: 1) blue gum (*Eucalyptus globulus*) 331 feet tall; 2) mountain-ashe (*Eucalyptus regnans*) 459 feet tall (1872 record); 3) mountain-ashe (*Eucalyptus regnans*) 435 feet tall (1872 record); and, 4) mountain-ashe (*Eucalyptus regnans*) 375 feet tall (1884 record). Note all of these trees were logged. None of these heights could be verified.

GIRTH — LARGEST DIAMETER

Tree diameter / circumference is usually simple to measure. This measure is made at a standard height, usually at 4.5 feet above the soil surface (i.e. known as dbh). The 4.5 feet above the ground measuring point clears many buttress roots and root base / stem base swellings. Usually a tape is pulled around the circumference passing over any indentations while maintaining the tape at 4.5 feet above the ground. These circumference inches are then divided by *pi* (3.14159) to yield a diameter measure (in the same units). A commercial diameter tape marked in *pi* inches is easy to use.

Figure 4 is a list of the twenty-four species of trees which contain individuals with the largest measured stem diameters (dbh). In older popular literature, the girth (circumference) of stem bases was measured anywhere between ground level and 60 inches above the ground. These older measures may have included multiple stems and buttressed stem bases, and so have been discarded.

The largest trees in diameter are Montezuma cypress (*Taxodium mucronatum*), baobab (*Adansonia digitata*), and giant sequoia (*Sequoiadendron giganteum*). A number of trees with large diameters are not necessarily the tallest, and tall trees are not always the largest in diameter. Some trees shrink and swell significantly over a growing season and can produce variable diameter measures, like baobabs (*Adansonia* spp.). Multi-stemmed trees, or trees with many consolidated aerial roots around the stem base degrade any diameter measure. There are more than 60 tree species which have individuals with diameters claimed to exceed 14 feet dbh.

BIGGEST — GREATEST STEM VOLUME

Measuring tree volumes is extremely difficult. Trunk measures, plus branches and root systems, can add large volumes to total tree tissues. For almost all volume measures, only the above ground main stem is measured, or estimated by calculation, without providing for cull or accounting for cavities, decay, or openings. Volume estimates are made in cubic feet. The largest volume occurs in trees with large diameters, tall stems, and small tapors.

Figure 5 presents eleven species individuals with the largest volumes, reliably measured. Giant sequoia (*Sequoiadendron giganteum*) and redwood (*Sequoia sempervirens*) trees enclose extremely large volumes of space filled with both living and dead woody material. There are 12 individual giant sequoias (*Sequoiadendron giganteum*) larger in stem volume than the next largest individual of any other tree species. There are muti-stem clonal tree systems which represent greater weight and volume measures than any tree listed here.

One great impact on human perceptions of tree importance is represented by crown size and extent. Figure 6 lists fifteen tree species with individuals having the largest crown diameters in the world. Many trees with large stem diameters do not have large crown widths. Many of the trees with the largest crown widths or diameters, tend to grow in large open spaces without crown competition from other trees, and many are not found growing with large crown widths within their native range (i.e. many are planted trees). Note branch form and associated wood strength play great roles in crown width limits. Of the 15 widest crowned tree species, only two are gymnosperms, while five are from the oak (*Quercus* spp.) genus.

OLDEST — LONGEST LIVED

Longevity is one defining component for trees. Aging trees is fraught with huge inaccuracies. Age of a tree is difficult to determine, and older trees are associated by humans with large tree diameters. Many large trees are younger than you think. This is why trees which do reach immense size, without the aid of human exaggeration or ignorance, are so unique and rare.

Some trees have been properly aged only upon death through full examination of the stem base. For living trees, estimates from branches, increment cores, and wedge-shaped dead areas have been used. In one case, a seedling from the original Bodhi tree of the Buddha was documented as planted in 288 BC, and is the oldest historic record of a living, human-planted tree at more than 2,300 years old.

Tree age is most accurately determined by counting annual growth increments using increment cores taken from the stem. Accuracy of the count depends upon whether a microscope or naked eye is used. In addition, height above the ground where a core was removed represents a count of annual growth increments above that point. The number of annual growth increments to reach that height must be added to the total count.

Indistinct annual increments, false rings, wood decay, and wood cavities (especially within the center of the tree stem base) conspire to make aging trees difficult. Fallen or cut-branch aging has many additional problems, especially with sprout-origin branches. Ring-porous temperate trees usually present the most clear annual increment demarcations. Some diffuse porous architecture trees require a careful microscopic examination for accurate aging. Some tropical trees may show wet / dry season increments, or no increments at all.

Figure 7 provides the best estimate for 15 non-clonal tree species individuals which have lived longer than 1,600 years. Great basin bristlecone pine (*Pinus longaeva*) by far represents the eldest of all

tree species with an individual reaching greater than 5,000 years of age. Note there are two bristlecone pines on the list, Great Basin bristlecone pine (*Pinus longaeva*) and Rocky Mountain bristlecone pine (*Pinus aristata*) — the latter living half as long as the former.

Human Perception Issues

A large-growing tree species on a resource-rich site can grow quickly to a large size. In contrast, a small statured tree may still be very old. For example, a Southern live oak (*Quercus virginiana*) on a great site was found to be adding and sustaining more than 3/4 diameter inches per year over a one hundred year period, generating a large girth tree, but relatively young in age. Age and diameter are not strongly related, which leads to large errors when using aging formulae, human memory / comparisons, or "estimates." For all their great height, the oldest redwood (*Sequoia sempervirens*) is far younger than individuals of many tree species.

Humans can continue to add years to trees without scientific basis. For example, in the case of one famous Southern live oak (*Quercus virginiana*), over a 25 year period of time, a tourism development group added more than 300 years to the tree's age without additional input. There are a number of trees where circumstantial evidence, folklore, and exaggerations retold many times have generated old age claims. Sometimes due to inner cavities and decay, an accurate measure can not be made, but may be estimated based on average growth rates. A number of trees have been claimed to be old, but these claims can not be verified. In some cases, tree owners and/or conservators do not want an accurate age determined.

There are some individual trees around the world which have been claimed to be of great age. Figure 8 provides a list of tree age claims by species which may be accurate, but which can not be verified. Some of these trees are now dead.

SPECIAL OLDEST / BIGGEST — CLONAL TREES

Trees which vegetatively reproduce can hold and control a site for many centuries. Stem portions may have grown and fallen, but root tissues continue to resprout new stems. Many generations of stems with identical genetic components are grown. Root portions have also grown / expanded and died. Some root tissues with identical gene sets may not be attached to one another anymore, but are still generating identical stem sprouts. In addition, some trees generate new trees through layering, where branches recline on the ground, form roots and then new shoots, moving the clonal tree outward away from the initial stem.

Clonal trees present a number of issues in determining tissue volume, total organism size and age. For many people, the basic single stem tree definition prohibits consideration of root mass / stem mass in age determinations. Figure 9 presents a selected list of clonal trees which have been brought forward as the oldest "trees" on Earth. Given this view of clonal trees, there are sure to be many hundreds more clonal trees present which would challenge for age and size records.

Clonal tree group "Pando" is comprised of a Utah mountain hillside of male quaking aspen (*Populus tremuloides*) covering more than 100 acres with almost 50,000 stems, each averaging 130 years of age. Pando is estimated to have existed on the site for nearly 80,000 years. The Palmer oak (*Quercus palmeri*) clonal tree system is a traditional oak regeneration system where new shoots continue to be generated from old root systems. In this case, one of these identical gene set oak groups is estimated to be 13,000 years old.

The huon-pine (*Lagarostrobus franklinii* – a podocarp, not in the pine family) can reproduce vegetatively with individual trees living less than 4,000 years, but identical gene sets on the site have existed for more than 10,000 years. In Sweden, many (i.e. >15) Norway spruce (*Picea abies*) trees have vegetatively layered away from parent stems to generate clonal trees. The oldest identical gene set group found so far is estimated to be >9,500 years old. Each short Norway spruce stem lives no more than 500-600 years, but root age can be more than 18 times older.

CONCLUSION

Trees which are tall, large, and old capture people's attention. Beyond knowing the growth limits of individual trees and species, tree extremes help place important trees into human context. People's communities, civilizations, structures, and even our own size and age, can be dwarfed by trees.

Citation:

Coder, Kim D. 2020. Extreme Trees: Tallest, Biggest, Oldest. University of Georgia, Warnell School of Forestry & Natural Resources Outreach Publication WSFNR20-22C. Pp.14.

The University of Georgia Warnell School of Forestry and Natural Resources offers educational programs, assistance, and materials to all people without regard to race, color, national origin, age, gender, or disability.

The University of Georgia is committed to principles of equal opportunity and affirmative action.

descriptor	percent	cumulative percent
PLANT	20%	
WOODY	16	
SINGLE STEM	14	
TALL / HEIGHT	13	
		63%
BRANCHED	9	
PERENNIAL	8	
GIRTH / DIAMETER	7	
		87%
ELEVATED CROWN	4	
DISTINCT CROWN	3	
SELF-SUPPORTING	3	
		97%
LOWER STEM WITHOUT BRANCHES	2	
ERECT STEM	1	
		100%

Figure 1: Relative frequency of descriptors defining a tree. (155 descriptors in 45 definitions)

UNIVERSITY OF GEORGIA
Warnell School of Forestry & Natural Resources

TALLEST

#	height	scientific name	common name
1	380 ft	Sequoia sempervirens	redwood
2	331 ft	Shorea faguetiana	yellow meranti
		(tallest tropical -- tallest angiosperm)	
3	330 ft	Eucalyptus regnans	mountain-ashe
4	329 ft	Pseudotsuga menziesii	coastal Douglas-fir
5	317 ft	Picea sitchensis	sitka spruce
6	314 ft	Sequoiadendron giganteum	giant sequoia
7	310 ft	Cupressus cashmeriana	Kashmir cypress
8	302 ft	Eucalyptus globulus	Tasmanian blue gum
9	299 ft	Eucalyptus viminalis	manna gum
10	295 ft	Abies procera	noble fir
11	290 ft	Dinizia excelsa	angelin
12	288 ft	Eucalyptus delegatensis	alpine-ashe
12	288 ft	Petersianthus quadrialatus	Philppine rosewood
13	282 ft	Eucalyptus obliqua	brown-top stringbark
14	281 ft	Koompassia excelsa	mengaris
15	279 ft	Eucalyptus diversicolor	karri
16	278 ft	Shorea argentifolia	dark red meranti
17	277 ft	Shorea superba	magnificent meranti
17	277 ft	Eucalyptus nitens	shining gum
18	274 ft	Pinus lambertiana	sugar pine
19	273 ft	Tsuga heterophylla	Western hemlock
20	272 ft	Hopea nutans	giam
21	270 ft	Shorea smithiana	light red meranti
21	270 ft	Shorea johorensis	meranti maja

Figure 2: Ranked list of tree species (24 species) which contain the tallest (feet) individuals in the world (>269ft).

TALLEST INDIVIDUAL TREES

#	height	scientific name	common name	tree name / location
1	380 ft	Sequoia sempervirens	redwood	Hyperion, CA, USA
2	376 ft	Sequoia sempervirens	redwood	Helios, CA, USA
3	371 ft	Sequoia sempervirens	redwood	Icarus, CA, USA
3	371 ft	Sequoia sempervirens	redwood	Stratosphere Giant, CA, USA
4	369 ft	Sequoia sempervirens	redwood	Lauralyn, CA, USA
4	369 ft	Sequoia sempervirens	redwood	National Geographic Society, CA, USA
4	369 ft	Sequoia sempervirens	redwood	Orion, CA, USA
4	369 ft	Sequoia sempervirens	redwood	Paradox, CA, USA
4	369 ft	Sequoia sempervirens	redwood	Rockefeller, CA, USA
5	368 ft	Sequoia sempervirens	redwood	Mendocino, CA, USA
6	367 ft	Sequoia sempervirens	redwood	Federation Giant, CA, USA
7	363 ft	Sequoia sempervirens	redwood	Deadalus, CA, USA
8	331 ft	Shorea faguetiana	y. meranti	Menara, Borneo
9	330 ft	Eucalyptus regnans	mt.-ashe	Centurion, Tas, AUS
10	329 ft	Pseudotsuga menziesii	Douglas-fir	Doerner Fir, OR, USA
11	325 ft	Sequoia sempervirens	redwood	Stout Tree, CA, USA
12	318 ft	Eucalyptus regnans	mt.-ashe	Icarus' Dream, Tas, AUS
12	318 ft	Shorea faguetiana	y. meranti	Sabah, Borneo
13	317 ft	Picea sitchensis	sitka spruce	Raven's Tower, CA, USA
14	314 ft	Sequoiadendron giganteum	giant sequoia	CA, USA

Figure 3: List of the twenty tallest (exceeding 311 feet in height) individual trees in the world.

UNIVERSITY OF GEORGIA
Warnell School of Forestry & Natural Resources

LARGEST DIAMETER

#	diameter	scientific name	common name
1	38 ft	Taxodium mucronatum	Montezuma cypress
2	35 ft	Adansonia digitata	baobab
3	30 ft	Sequoiadendron giganteum	giant sequoia
4	29 ft	Adansonia za	za baobab
4	29 ft	Sequoia sempervirens	redwood
5	28 ft	Platanus orientalis	Oriental plane tree
6	27 ft	Cinnamomum camphora	camphor tree
7	25 ft	Hopea beccariana	salangan / merawan
7	25 ft	Eucalyptus jacksonii	red tingle
8	24 ft	Ceiba pentandra	kapok
8	24 ft	Ficus albipila	poison fig
9	22 ft	Eucalyptus obliqua	Australian oak
10	21 ft	Eucalyptus regnans	swamp gum / mt. ashe
11	20 ft	Thuja plicata	Western redcedar
12	19 ft	Eucalyptus delegatensis	alpine-ashe
13	18 ft	Picea sitchensis	sitka spruce
13	18 ft	Dracaena draco	Canary Is. dragontree
13	18 ft	Agathis australis	kauri
14	17 ft	Cryptomeria japonica	sugi
15	16 ft	Fitzroya cupressoides	alerce
16	15 ft	Quercus robur	English oak
17	14 ft	Pseudotsuga menziesii	coastal Douglas-fir
17	14 ft	Quercus petraea	sessil oak
17	14 ft	Taxus baccata	European yew

Figure 4: Ranked list of tree species (24 species) with individuals having the greatest stem diameter (dbh in feet) in the world.

LARGEST VOLUME

#	volume	scientific name	common name
1	52,521 ft^3	Sequoiadendron giganteum	giant sequoia
2	38,322 ft^3	Sequoia sempervirens	redwood
3	26,490 ft^3	Taxodium mucronatum	Montezuma cypress
4	18,225 ft^3	Agathis australis	kauri
5	15,900 ft^3	Thuja plicata	Western redcedar
6	13,810 ft^3	Eucalyptus regnans	mountain-ash
7	13,000 ft^3	Eucalyptus globulus	Tasmanian blue gum
8	12,327 ft^3	Pseudotsuga menziesii	coastal Douglas-fir
9	11,903 ft^3	Picea sitchensis	sitka spruce
10	11,900 ft^3	Eucalyptus obliqua	Australian oak

Figure 5: Ranked list of living tree species (10 species) with the largest volume (cubic feet) of single stem individuals in the world. Note the top twelve individual trees are all *Sequoiadendron giganteum* species.

WIDEST CROWN

#	crown diameter in feet	scientific name	common name
1.	591 ft	Ficus benghalensis	banyan
		(with branch supporting aerial roots)	
2.	239 ft	Eucalyptus microtheca	coolibah
3.	210 ft	Platanus orientalis	oriental plane
4.	207 ft	Samanea saman	raintree
5.	201 ft	Ceiba pentandra	silky-cotton tree
6.	182 ft	Taxus baccata	European yew
		(widest crowned gymnosperm)	
7.	181 ft	Quercus margarettae	sand post oak
8.	177 ft	Quercus cerris	Turkey oak
9.	176 ft	Ficus macrophylla	Moreton Bay fig
9.	176 ft	Quercus coccinea	scarlet oak
9.	176 ft	Quercus agrifolia	coast live oak
10.	175 ft	Taxodium mucronatum	montezuma cypress
11.	170 ft	Eucalyptus pilularis	blackbutt
11.	170 ft	Quercus virginiana	live oak
12.	169 ft	Platanus occidentalis	sycamore

Figure 6: Ranked list of tree species (15 species) with the widest crown (crown diameter in feet) on a single stem individual in the world.

UNIVERSITY OF GEORGIA
Warnell School of Forestry & Natural Resources

OLDEST

#	age in years	scientific name	common name
1	5,068 yrs	Pinus longaeva	Great Basin bristlecone pine
2	3,648 yrs	Fitzroya cupressoides	alerce
3	3,201 yrs	Sequoiadendron giganteum	giant sequoia
4	2,624 yrs	Taxodium distichum	baldcypress
		(oldest verified tree age in Eastern USA -- NC)	
5	2,460 yrs	Pinus aristata	Rocky Mountain bristlecone pine
6	2,419 yrs	Adansonia digitata	African baobab
7	2,307 yrs	Ficus religiosa	sacred fig
		(oldest verified human planted tree)	
8	2,230 yrs	Juniperus przewalskii	Przewalski juniper
9	2,200 yrs	Juniperus occidentalis	Western juniper
10	2,111 yrs	Pinus balfouriana	foxtail pine
11	1,943 yrs	Larix lyalli	subalpine larch
12	1,890 yrs	Juniperus scopulorum	Rocky Mountain juniper
13	1,805 yrs	Cryptomeria japonica	sugi
14	1,719 yrs	Pinus flexilis	limber pine
15	1,677 yrs	Thuja occidentalis	Northern whitecedar

Figure 7: Ranked list of tree species (15 species) with the oldest (in years) verified living non-clonal individuals in the world.

? ? ? AGE ? ? ?

age claimed	species	common name
4,020 yrs	Cupressus sempervirens	Mediterranean cypress
4,000 yrs	Lagarostrobus franklinii	huon-pine
4,000 yrs	Taxus baccata	European yew
3,500 yrs	Olea europaea	olive
3,050 yrs	Juniperus occidentalis	Western juniper
3,000 yrs	Cryptomeria japonica	sugi
3,000 yrs	Castanea sativa	sweet chestnut
2,200 yrs	Sequoia sempervirens	redwood
2,065 yrs	Platanus orientalis	oriental plane
2,500 yrs	Agathis australis	kauri
1,980 yrs	Larix decidua	European larch
1,900 yrs	Cinnamomum camphora	camphor tree
1,800 yrs	Podocarpus totara	totara
1,800 yrs	Araucaria araucana	monkey-puzzle
1,659 yrs	Quercus robur	English oak
1,500 yrs	Adansonia gregorii	boab
1,500 yrs	Quercus virginiana	Southern live oak

Figure 8: List of tree age claims which may be accurate, but which can not be / have not been, verified.

OLDEST CLONAL

#	age in years	scientific name	common name
1	80,000 yrs	Populus tremuloides	quaking aspen
2	13,000 yrs	Quercus palmeri	Palmer oak
3	10,000 yrs	Lagarostrobos franklinii	huon-pine
4	9,550 yrs	Picea abies	Norway spruce

Figure 9: Ranked list of tree species with the oldest (years) living clonal individuals in the world.