http://tree.ltrr.arizona.edu/~hal/tgiants2.pdf

Tales Trees Tell

Story 2: A Day with the Giants

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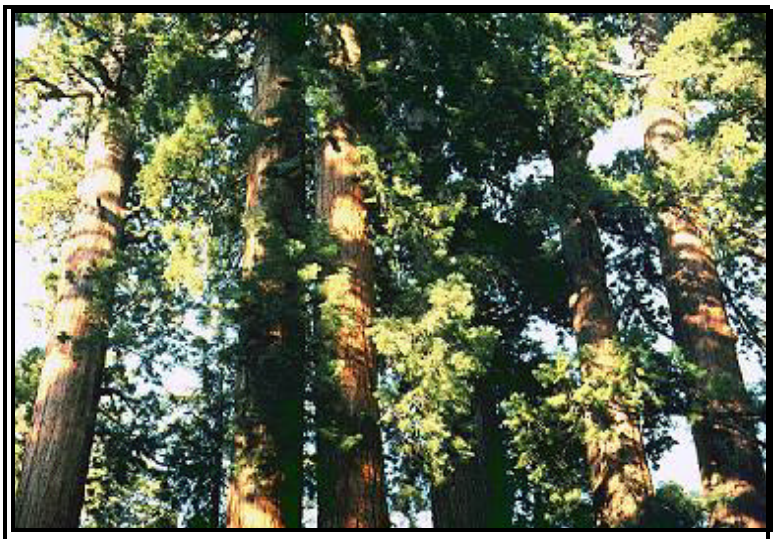
It is June 21, 1997. Miriam, my wife and long-time traveling and hiking companion, and I have been walking among the giants along the Congress Trail, Sequoia National Park, California. We are resting and I am lying on my back among the giant sequoia trees (*Sequoiadendron giganteum*). From my perspective I see pillars of cinnamon colored trunks ending in gnarled thick branches that ultimately become lost among the lacy bluish-green branchlets bearing scale-like needles. These giant redwood trees loom upwards reaching for the blue sky as white fluffy mashed-potato clouds drift by.

Looking skyward the sequoia trees loom upwards like a giant overarching cathedral Used with permission of David Sweet camping.guide@miningco.com http://camping.miningco.com

I imagine that around me are my different selves, the inner child trying to catch butterflies, the adolescent who is intrigued with these trees but wonders when we can start hiking again, the adult who is in charge at the moment, the scientist trying to sort out the facts, my higher self encouraging all to explore new ideas and places, and the poet-artist working feverishly to translate my thoughts into expressive words. My counselors (guides) are there too, ready to provide advice as a spontaneous thought or on rare occasions when they are asked for it. I sense unspoken love and oneness with God. If there are such things as benevolent tree spirits or devas, they must be perched in or living within these giants surrounding me. I sense an inner power flowing from these

giants. Yet I feel almost insignificant, like a dwarf, a speck, an insect compared to the great mass and majesty of these great sequoia trees.

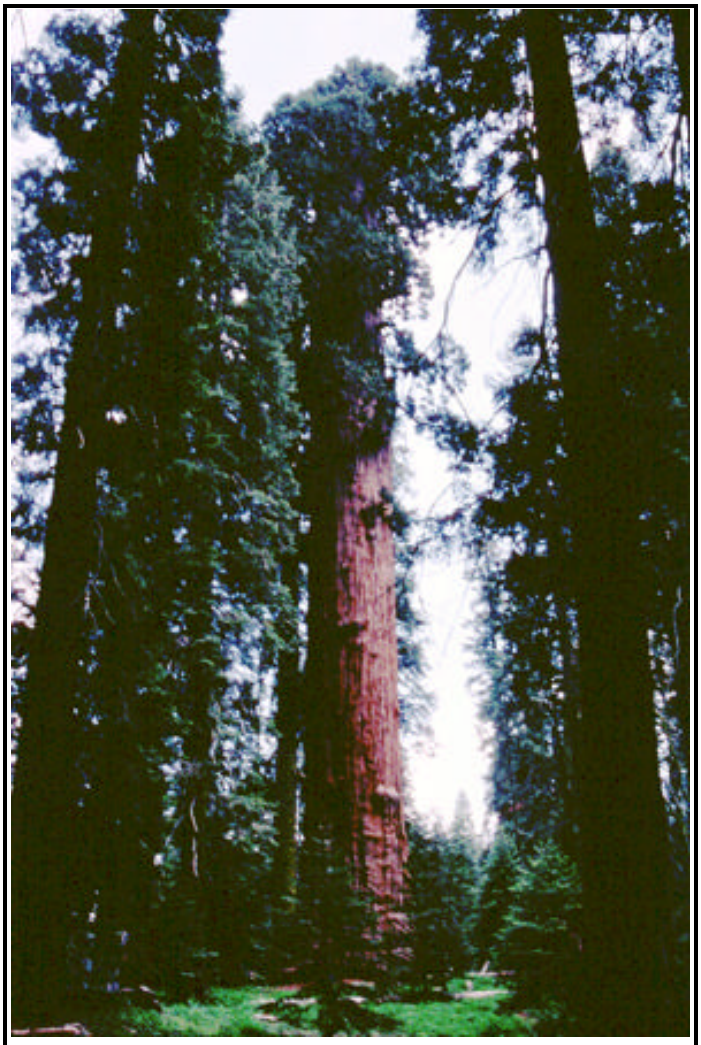


When the afternoon sun penetrates through an open canopy gap, light can penetrate even into portions of the innermost crown. Used with permission of David Sweet camping.guide@miningco.com http://camping.miningco.com/

I have spread out my jacket to soften the prickly sequoia scales, branches and cones scattered over the forest floor, and now I gaze up along these giant columns that hardly taper as they stretch to the sky. The afternoon sunlight streams through the openings in their massive crowns and penetrates gaps, even reaching the inner crown at times. In my imagination I visualize the light absorbed by the bluish green needles, delivering its energy to a complicated biological process called photosynthesis. This energy is used to remove the oxygen from the carbon in the carbon dioxide molecule and adding hydrogen to make

The scale like needles of the sequoia use the energy from sunlight to photosynthesize and make sugar that is the basic food used for growth of the tree.

sugar in the green tissue of the needles. The oxygen is released within the needles and moves into the free air through tiny holes, called stomates, on the needle surface. You and I must breathe this air and use the oxygen to live and grow.



One of the living giants along the Congress trail that has been photosynthesizing, transpiring and growing as many as 3000 years.

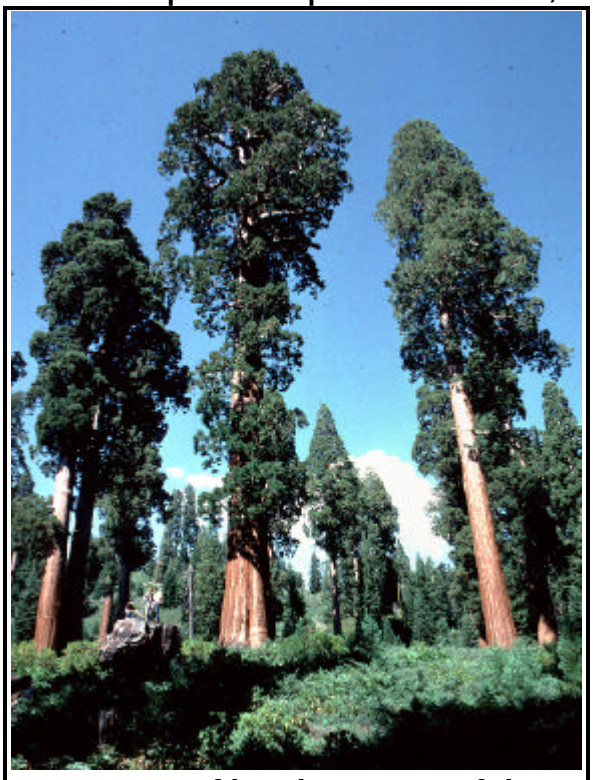
I know that water is also evaporating from the wet surfaces inside these needles, moving through the stomates in the needles and into the outside air, a process called transpiration. Water molecules in liquid form are strongly attracted to one another, so as one molecule evaporates, it pulls another into its place. This upward pull is transferred from one water molecule to the next into the branches, down tiny tubes called tracheids in the sapwood of the massive stem, a continuous path that, in a tall sequoia, may be as long as a football field. This path of water molecules extends to the small roots where water is drawn from the soil often by way of fungi living on the root surface. Very gradually this continuous chain of cohering water molecules moves up

from the roots through the massive stem to the tops of the trees, through the stomates and into the surrounding air where it is swept away by the wind.

I hear warblers singing in the highest branches, a junco scratching through the forest litter, the hermit thrush and western tanager calling in the distant forest. They seem to say “brighten up, beauty here.” A brown creeper chips her thin high-note “seee. . . .seee” searching for a tasty morsel or two as she haltingly works her way upwards through the furrows in the bark that surround and protect the stem.

The leopard lily seems to tell me that I am empowered because God has already given that spiritual power to me, to all of us, to use if we choose to do so. The columbine nods its head in approval. The shooting star exclaims “shoot for the moon if that is what you feel is important to do!”

There are all kinds of messages everywhere and things to see. All that is required is attention and focus in the directions from which they emanate. The wonder of these groves must have been felt by past explorers and discoverers, like Zenas Leonard, who was part of an expedition that crossed the Sierra



Because of logging, many of the magnificent stands now have only a few of the original large trees and a few smaller individuals. A dense layer of shrubs, seedlings and other plants cover what remains of the original forest floor. Courtesy of Tony Caprio

A venerable old giant that has probably been struck by lightning. Younger trees of different species are growing up around it. Note Miriam standing at the base for scale.

Nevada in 1833 and first reported these groves. Later, John Muir and his mule, Brownie, witnessed a sequoia forest fire in 1875 and stayed for days observing and admiring the beauty surrounding them.

Not all early visitors came to admire and enjoy these trees. Loggers began large-scale cutting of the giants late in the 1800s. Giant after giant thundered to the ground. Some were so large that it took a team of four men 22 days to topple a single tree. Finally the giant thundered to the earth and the roar of the crash echoed throughout the forest. Yet when the dust clouds settled its trunk lay in pieces shattered and worthless by the immense impact of the fall. Even many sound logs were left to rot, worthless because they were too large to haul away. Some people feared the redwood groves would completely disappear.

Public opinion was aroused and swayed by naturalist John Muir, publisher George W. Stewart and many others who cherished the beauty of these magnificent

groves. The United States Congress created Sequoia, General Grant and Yosemite National Parks in 1890; but the struggle over preservation or harvesting the great giants in surrounding groves continues to this day. We can choose to participate on behalf of these majestic beings or not. To make no choice is to give up hope for what miracles the future can bring.

Wet open meadows within the sequoia groves are strewn with skeletons old giants that have fallen and eventually become buried in the mud. Courtesy of Tom Swetnam

The sequoia are not the only occupants of this forest. Scattered among them, but of lesser stature, are the white fir (Abies concolor), sugar pine (Pinus lambertiana), incense cedar(Calocedrus decurrens) and the occasional red fir (Abies magnifica). The smaller shrub called chinquapin (Castanopsis sempervirens) grows most abundantly in forest openings or along the margins of the glades between the groves.

Many of the larger openings are wet meadows with insufficient oxygen for the

growth of sequoia roots. With fewer roots for support along the meadow edge, some old giants begin to lean and eventually fall, creating bridges to the center of the meadow and sometimes across them. We have walked along these bridges, balancing ourselves and carefully skirting the exposed roots or branches to discover the sedges, shooting stars, orchids, lilies, grasses and other wetland plants inhabiting the meadow below us. Older logs sinking into the blackened mud are more or less obscured by the vigorous upward growth of the meadow plants about them.

Green fleshy cones, about 2 and one half inches (just over 6 cm) long, can be seen clinging to the sequoia branches. It takes two years to grow a cone to maturity. They are green with fleshy scales while attached to the branch and many remain there for up to 20 years. I have read that a giant produces up to 2,000 cones each with 150 to 200 tiny dry seeds, and the largest trees can hold up to 40,000 cones at one time.

The Douglas squirrel or chickaree relishes the thick green cone scales but is uninterested in the dry seeds. After a visit by the squirrel the ground is littered with skeletons of the cones and numerous seeds. Tiny cone beetles lay their eggs on the cone, the larva tunnel as they

The forest floor is covered with sequoia branchlets, cones and seedlings that rarely survive more than one year unless they happen to fall on mineral soil and there is enough moisture from an occasional very moist winter or moist summer. Courtesy of Tony Caprio.

feed on the green scales. They devour the water delivery stem at the cone base, causing the infected cones to dry, turn brown and shrink. The dry scales open as the tiny seeds fall out. One third of the cones may be hosts to the beetle larva. During a fire, the intense heat from below can dry the cones, releasing the tiny seeds as they fall on the burned and blackened mineral soil of the forest floor.

The seeds must make contact with this mineral soil to grow and survive. Freshly burned soil washed by rains and melting snow provides optimum conditions for sequoia seedlings in the warmth of the spring.

Thousands will germinate after a fire, but only one in a million may take its place among the giants. The young seedling grows a tap root about 8 inches (20 cm) long followed by lateral roots, yet in most years the towering giants above draw out all of the moisture down to a foot (29 cm) or more, so only during occasional rainy summers will seedlings survive. Over half may disappear the first year, and after the second year only one out of 70 may remain. Many survivors will succumb

Chief Sequoia, one of the giants along the Congress trail. Note Miriam in her yellow blouse standing at the right of the base for scale.

as stronger and taller neighboring trees over-tower them, capturing the light or absorbing most of the moisture in the soil. Living as long as they do, the sequoia groves may persist if only one germinating seedling for each mature tree succeeds and takes its place among the giants over a period of 1000 to 2000 years.

Take a little time if you visit the park to be aware of these giants and to learn about their beauty and the gifts they provide. Those fortunate enough to experience them will never be quite the same again. These magnificent giants offer us so much more as a healthy living forest grove that can be visited and enjoyed for years to come than as a decimated landscape harvested for redwood lumber to provide temporary employment for local inhabitants and profits by a few.

Other things besides harvesting may threaten the future of these giant trees. I believe those leaders who set aside this land to preserve the groves assumed that an equilibrium, where the creative forces are in balance with the destructive forces, would maintain these giant groves for all time. But at that time few understood what controlled this balance.

During an early visit John Muir described a fire he observed in 1875:

"It came racing up the steep chaparral-covered slopes of the East Fork Cañon with passionate enthusiasm in a broad cataract of flames. . . . But as soon as the deep forest was reached the ungovernable flood became calm like a torrent entering a lake, creeping and spreading beneath the trees where the ground was level or sloped

gently, slowly nibbling the cake of compressed needles and scales with flames an inch high, rising here and there to a foot or two on dry twigs and clumps of small brushes and brome grass. Only at considerable intervals were fierce bonfires lighted, where heavy branches broken off by snow had accumulated, or around some venerable giant whose head had been stricken off by lightning."

Ground fires like this one frequently swept through the original forests, burning up into wounds from earlier fires called fire scars and creating a new wound in the actively growing tissue under the bark marking the year that the fire occurred in the annual growth ring. Courtesy of Tom Swetnam.

Forest managers also observed fires burning through the forest floor that were caused by a lightning strike, a visitor careless with a camp fire, or a thoughtless smoker. Unfortunately, most people are not comfortable with fires. Large fires blacken the trees and make the forest look ugly. Fires were thought to kill the younger trees and to reduce the productivity of the forest. The majority of people did not believe the type of forest was actually controlled by fire. All fires had to be stopped! Observation towers were constructed on the mountains to spot fires wherever they began and teams were organized

to extinguish the fires before large areas were burned. Smoky the Bear was painted on signs displaying "**Only you can prevent forest fires!**"

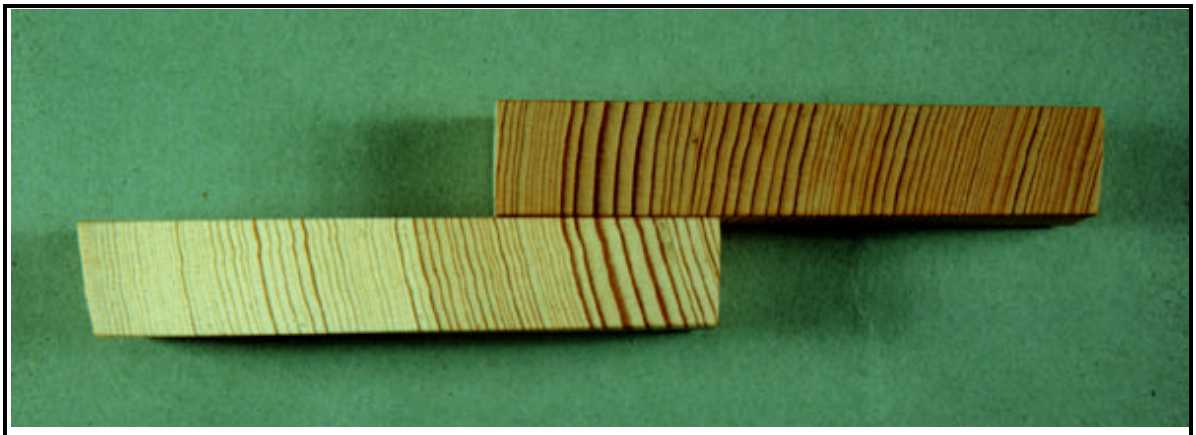
The whole effort was highly "successful." Few fires escaped man's watchful eyes until recent times. By then, so much forest litter had accumulated that once fires were ignited in these groves, they were hotter and often burned into the understory leaving the leftover remnants more blackened than before. In some forest types, it was more common for the flames to leap into the crowns producing a fire storm that consumed both large and small trees destroying large areas of forests. Only small patches of unburned forest, here and there, remained. Fortunately the largest sequoia trees were able to withstand most of these hotter fires.

All forests are dynamic systems with energy and power in motion all of the time. Forest managers, scientists and many insightful individuals have begun to understand more fully some of the dynamics in these forests. They observed what the trees had been trying to tell them. They noted declining numbers of young sequoia trees in the understory while the numbers of seedlings from other species increased several fold. They wondered

The growth rings on slabs were sampled from stumps of trees cut late in the 19th century. These slabs were sanded and dated against the chronology derived from coring living trees.
Courtesy of Tom Swetnam.

"What would happen in a thousand years or so if these other species thrive and grow? Why don't more sequoia seedlings survive?" They noted the presence of many scars on the older trees from past fires and wondered "Did fire suppression upset the dynamics of the complex forest system and cause these changes to occur?"

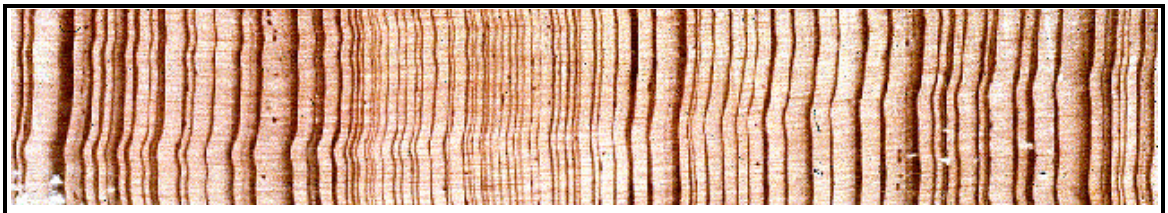
Dendrochronologists, my colleagues Malcolm Hughes, Tom Swetnam and Lisa Graumlich, and their students were called in to examine and date the tree rings and the associated fire scars in the sequoia groves. They read the story that the rings told about fires. These scientists did not have to destroy a single living tree to reveal the rings, as there were dead trunks lying in the wet areas and many exposed stumps from neighboring groves where most of the giant trees had been cut years ago. It was a simple matter to start with the current year and examine the rings in a few of the living trees, removing a slender pencil-size core from the massive trunk, with little injury to the tree. Sanding or a quick razor cut along the surface of these cores revealed the rings.



By matching the ring patterns in the core (on the left) with the stump section (on the right) the exact age of the stump and each annual ring can be determined and these patterns can be matched and used to date other stumps in the same or neighboring groves.

By matching the patterns of wide and narrow rings in the living trees with those in the dead stumps the age of each stump was determined. Large slabs could be cut from these stumps to see the fire scars and to date the rings. The dated rings from these cores and stump sections were measured. These measurements were averaged among many trees to develop a precisely dated chronology of wide and narrow rings from the present time back to 1372 BC (Before Christ).

Then by tracing the dated rings around the stump to each associated fire scar, that scar could be dated along with the individual fire event that caused it. By noting where within the structure of the annual ring the scar occurred, it

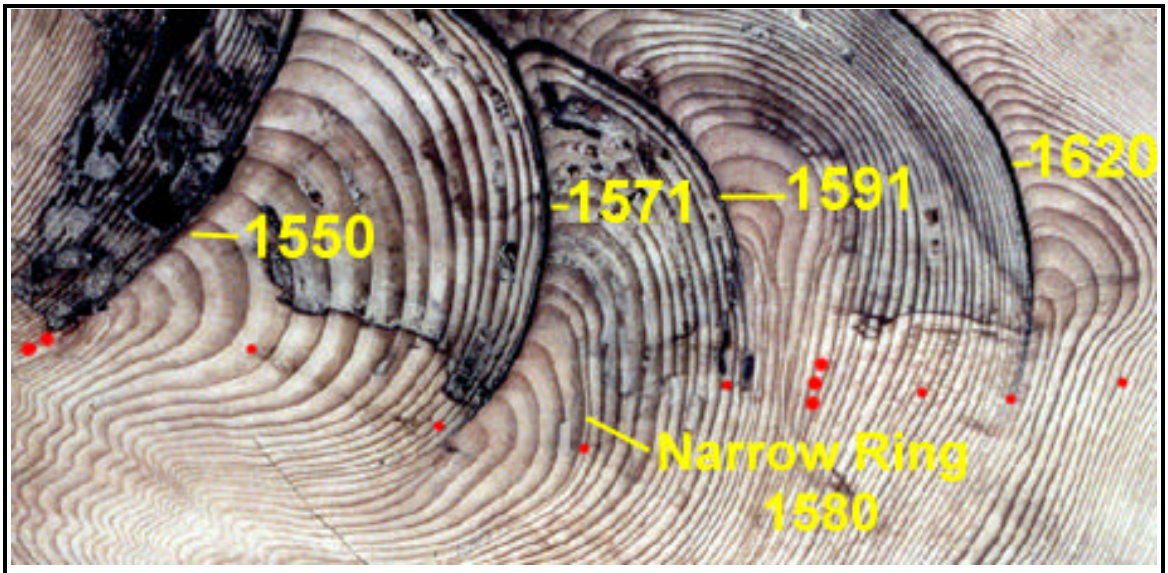


The patterns of wide and narrow rings in sequoia that can be observed from a core or cross-section tell a story of past growth conditions. Courtesy of Malcolm Hughes.

was often possible to determine what month the burn took place.

Usually adequate snow and rainfall favored rapid growth and large rings were produced. When growing conditions were poor, such as during a drought, the rings were narrow throughout all trees in the groves. If a mistake was made in the dating of the tree rings, a particular ring was indistinct in places or a break occurred leading to an error, the narrow rings in that specimen did not match the location of narrow rings in the other trees. Closer examination usually revealed where the mistake was made and the mistake could be corrected. Those few samples,

where the cause of the problem was not resolved, were set aside as not dateable. This procedure of matching the patterns of wide and narrow rings to assure that all rings used in a study are identified correctly as to the exact year in which the rings grew is called cross-dating.



Each slab revealed numerous fire scars buried within the tree. The dates of the rings were established and marked with three dots for centuries, two dots for the half century and single dots for decades . The individual fire scars were dated from their association with the dated rings The dates of the four scars are indicated as well as the narrowest ring of 1580 observed throughout the entire record (observable only near a scar where the growth was enhanced.) Courtesy of Tom Swetnam.

Cross-dating is the most critical and most important procedure to dendrochronology. Once all rings are accurately dated, the record of any event, such as fire, that is associated with the rings is placed precisely in time. The dated events can be compared, tabulated or averaged together even though they are noted on different trees. Then the yearly environmental history throughout the forest and neighboring groves can be reconstructed, revealing 1) the climate affecting ring-width growth, 2) injuries from fires, 3) the marks of the woodsman's ax, 4) episodes of forest

diseases, 5) frequency of landslides, 6) past earthquakes, 7) effects of volcanic eruptions, 8) drowning of forests from tidal waves, stream channel changes or beaver activity, 9) cutting dates when humans harvested wood planks to build a house, to make a panel for a Rembrandt painting, to construct a boat, to shape a beam used in an archeological structure or even a small charcoal fragment left after an old structure burned and 10) many other events, activities of man or environmental changes, that have influenced a growing tree including such features as wood density, cell structure and chemical content.

My colleagues who were working on the sequoia trees examined the weather records from nearby towns and noted that the years with narrow rings occurred when little rain and snow fell so that conditions of summer drought prevailed. They also noted that almost every one of the narrow rings before the fire suppression effort had begun were associated with fires except for the year 1580, which may have been an extremely cold year. Since most of the narrow rings were associated with dry years, fires were easily ignited and swept the forest floor about once every 3 to 12 years.

The thick bark is resistant to fire damage but the cambium in cracks in between the fissures is more susceptible. Used with permission of David Sweet camping.guide@miningco.com http://camping.miningco.com/

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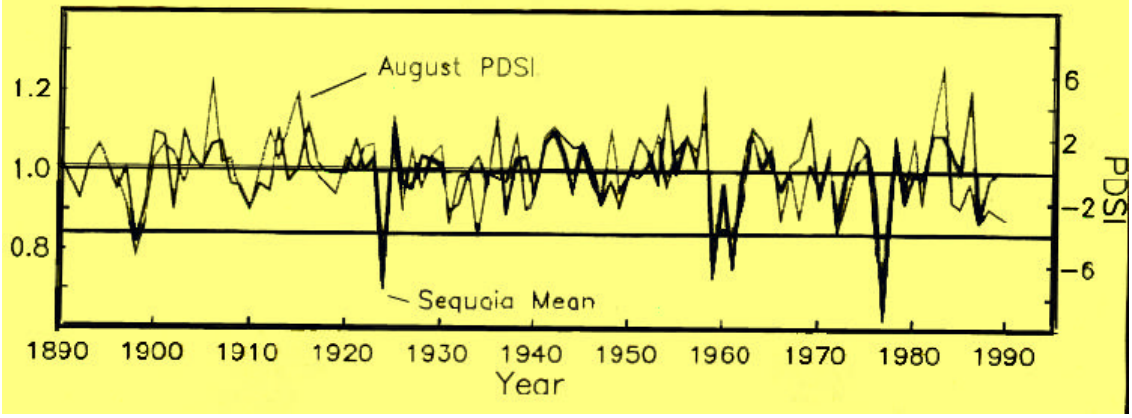


The relationship between ring width and drought is demonstrated by the similarity between relative variations in ring widths (thick line) and a measure of drought (PDSI - thin line) ending with August of each year. A low value of PDSI represents an extreme drought. Courtesy of Malcolm Hughes.

After each fire it took a number of years for enough forest litter to accumulate to carry a flame followed by a year of little moisture. Then a lightning strike or some other event was required to start the fire. During the last hundred years of fire suppression, scars were rare even during dry years when the rings were narrow. This work confirmed that a very critical element of the forest dynamics had been changed by quickly extinguishing all forest fires.

It is fascinating to walk through this park not only to admire the tallness and magnificence of these giant trees, but also to observe how individuals have coped with repeated fires. Often, on the uphill side the scale-like needles, branches and cones accumulate against the stem causing hotter fires that kill the thin tissue called cambium that grows new rings beneath the protective bark. The heavy bark is generally resistant to fire, but the thinner areas in the cracks are more susceptible. This wound stimulates the remaining living cambium that surrounds the injury to grow more rapidly, bulging out and eventually covering the blackened scar. If left alone for a decade or more the smaller fire scar may heal completely and be buried within the tree, erasing all surface evidence of the scar. Close examination of a cut stump can reveal dozens of these

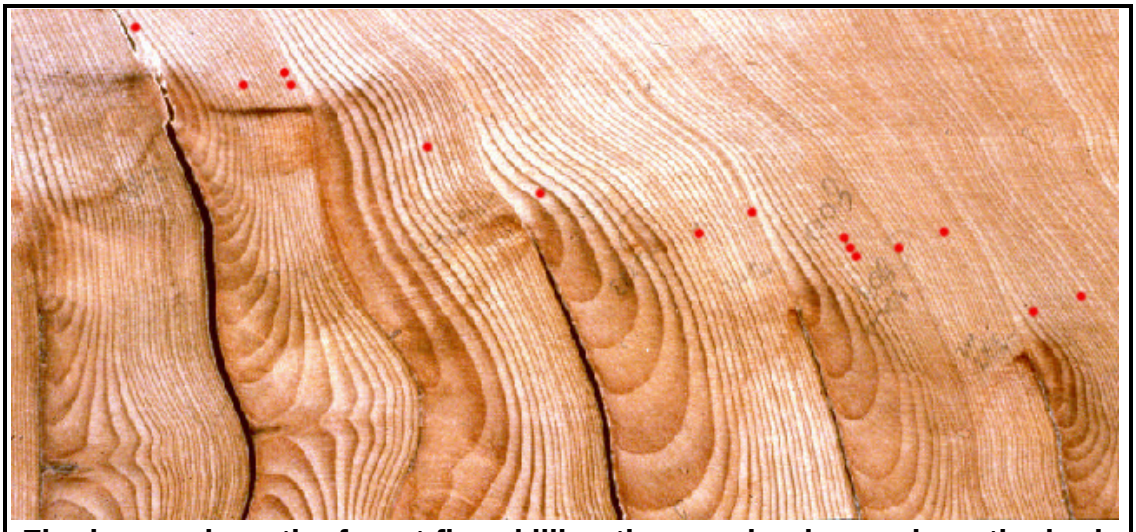
A typical stand with large fire scars from the natural fires of the 19th century that are still exposed today.

buried scars.

In larger scars, the exposed dry wood becomes fuel that subsequent fires ignite, deepening the blackened wound, killing more cambium and a new healing layer is formed. This can repeat itself over and over again producing a complex of deep multiple scars that heal, burn and heal again, time after time. Such scars can reveal a long history of repeated burning.

This ancient tree has been largely untouched by fire during the 20th century as evidenced by the moss cover on the old scar surface. It was recently burned producing a new scar in the blackened area. Courtesy of Tom Swetnam.

Occasionally the entire heartwood is consumed by fires producing a blackened hollow stem. If open at the top, the tree behaves like a furnace with a chimney, enabling fires to smolder and burn inside for days after the igniting surface fire is extinguished. Hollow giant tree trunks are common, and a variety of animals may seek them out for shelter, including man. One early pioneer built his house within a large fallen giant and grazed his animals in the lush wet meadows among the groves. That house is still standing today. At one time roads were constructed through some of these hollow giants, but now with larger cars many of these roads are blocked. These attractions can be reached only by foot by those interested in such things. Such efforts to exploit the natural features of these large trees are not as impressive to me as the wonder and natural beauty in the undisturbed giant forests.



Fire burns along the forest floor killing the growing layer where the bark is thinnest. In this tree the scars completely healed in about 14 years when the rings from both sides of the scar were joined. The three dots mark the year 800 AD. Courtesy of Malcolm Hughes.

If you visit these forests today, you may note some blackened areas where fire has burned. Forest managers are trying to restore fire as a natural part of the forest environment, but other problems remain. Tony Caprio, a fire ecologist, and Linda Mutch, who both worked with Tom Swetnam, along with MaryBeth Keifer, who worked with Lisa Graumlich are now full time researchers for the government and are stationed at the park. Tony is in charge of all data collected from a large-scale burning study conducted in a remote area that few people visit. MaryBeth is monitoring the effects of forest fires.

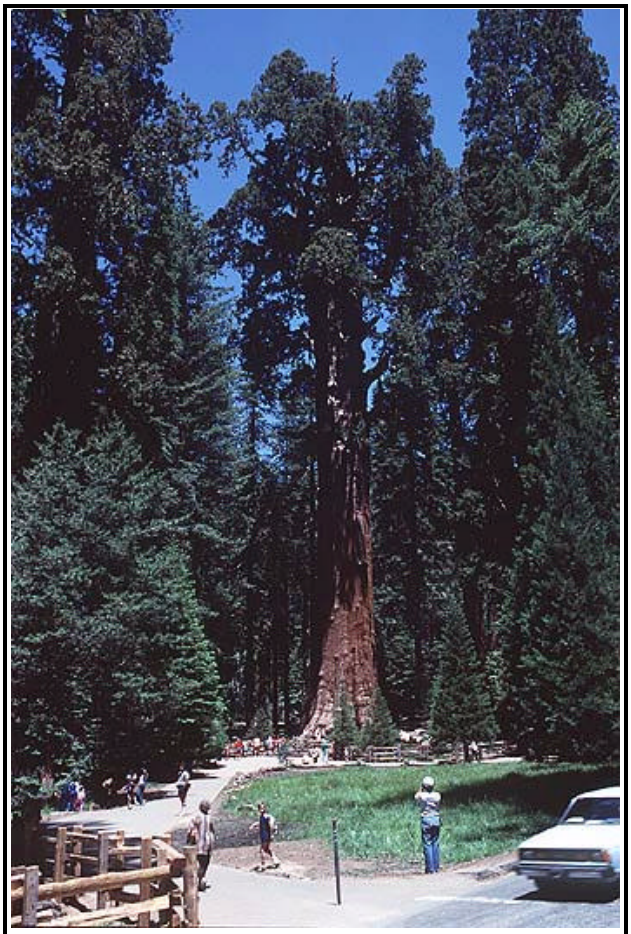
As mentioned earlier, ignited fires burn hotter now. Instead of burning across the forest floor as they did

Controlled burning is used today in an attempt to restore the forest to its original condition. Courtesy of Tony Caprio.

before, the hotter fires can easily reach the lower crowns of both small and large trees occasionally completely consuming a giant. One precaution is to set controlled burns in the cool season after rain or snow; another is to burn small areas one at a time.

There are strict rules for burning and they vary depending upon vegetation type, fuels that are present on the forest floor, location and access of the stand, potential of fires getting out of control , the threat to humans (both visitors and park staff-fire fighters), weather conditions, time of year, etc. When a location meets all criteria in the prescription the fires may be ignited.

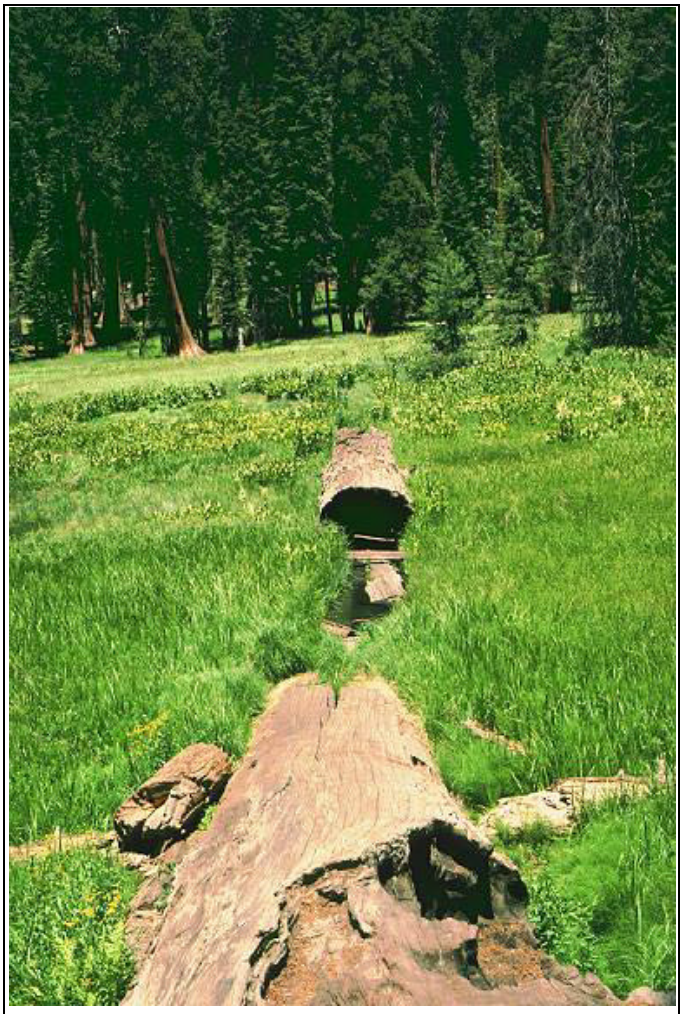
The goal is to use controlled burning to reduce forest litter to amounts present before the fire suppression effort began, reduce the number of smaller trees and raise the crowns of the larger trees so they can't ignite as easily.



The General Sherman Tree is the champion of all trees. It is the largest but not the tallest tree in the world, and it is protected from trampling by tourists with a rail fence. Tree height - 274.9 ft (83.9 m), Maximum diameter at base - 36.5 ft (11.1 m), Average crown spread - 106.5 ft (32.5 m) and Volume 52,500 cubic ft (1486.6 m). Photo by Gene Rose, Special to the Fresno Bee http://test.fresnobee.com/parks/gallery/s/

Once these conditions return, the forests can be treated as a natural system and allowed to burn on average every 3 to 12 years.

Other problems remain. Unfortunately for the giants, man has constructed buildings in many places encroaching upon the forest. There are major political and moral problems to be solved as to how much and where in the forest fires can be left to burn and what buildings and structures should remain. How much can we impose so called human progress and development on these ancient forests without changing them forever and jeopardizing both their and our future? The park began removing some structures in the summer of 1997.



This old giant toppled into the meadow years ago and is gradually decomposing releasing essential minerals and providing food for decomposing fungi and insects that inhabit the rotting stem. Used with permission of David Sweet
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Severe winds and floods may also exert their influence on these giants too. Just as we must balance our lives, so must these towering giants. If they begin to lean too much in one direction or some of the stabilizing roots die, burn and rot

away, they can lose their balance and come crashing to the forest floor usually in a heavy wind or severe storm. Giants that keep their balance and are not located near a stream or wet meadow where some roots can be undermined will live and survive. The oldest known sequoia is 3370 years old.

We even risk loving our giants to death. Road construction, path development and simple trampling by their admirers packs the soil around the roots, reducing the exchange of air and suffocating the roots. Barriers have been constructed around the most popular and largest giants to prevent trampling. Hikers are requested to remain on the trails; and not all groves are fully developed or accessible to the general public.

Of course these seemingly eternal trees will die eventually and topple to the forest floor or into a meadow where their skeletons decompose over hundreds of years. A row of young sequoias may mark where the falling trunk exposed the mineral soil. The rotting wood returns essential minerals to the soils and provides food and nourishment for all kinds of animals and plants. Even after death the

The magnificent giants along the Congress trail. Note the partially burned stump in the background.

spirit and heritage of each fallen giant can persist for thousands of years.

The birth, growth, death and decay of a giant remind me that life is eternal. You and I may have prospered and grown because of the rich inheritance left to us by our parents and many others that have preceded us. I am not really talking about money, although that is important too. We inherit a society, landscapes with parks, roads, pathways, bridges and maps, technologies (some that are more worthwhile than others), knowledge provided by libraries and data bases, and art rich with experiences of the human feelings often with expressions of beauty, love, joy, grief or anger. This very national park is a heritage we have received, one which all can enjoy for years to come. All of us are in a sense products of the past. We are the products of all kinds of teachers, experiences, friends and others that we may not even regard as friends.

Each one of us, like these magnificent giants, is building and will leave behind some kind of unique heritage for those that follow us. We, along with these giants, are creating our heritage with each minute in each day. As human beings, our thoughts, choices, actions, deeds, our love or hate, generosity or greed along with accumulated possessions will ultimately be all that is left for our children and those that follow. Will it be as magnificent as the heritage left in these groves by the old both living and decaying giants scattered over and buried under the forest floor? As I gaze on these forests, I ask myself “How many and what kind of riches will I leave to my children, friends, students and the many other living beings following me?” “Will I measure up against these giant trees?” Just as

these towering trees profit from sunlight, rain, abundant soil and even fire that releases minerals and prepares the soil for seedlings to grow, I can become enriched with more focus and attention on the joy, freedom, love and beauty surrounding me. I can build a richer heritage of quality without earning one cent more to save away.

The sequoia are living symbols of hope for a future in which all earthly creatures can flourish and grow

Troubles and trials will come at times. The giant trees have experienced adversity, too, such as the woodsman's ax, winds, ice storms, falling neighbors, diseases and insect pests. They tell us of patience and endurance through good and bad years along with injury from repeated fire. The sequoia must have courage of some kind as well as endurance for the sequoia have persisted from the dinosaur age. To me, they are living symbols of hope for brighter futures, for a better environment where both our children and their children and all earthly creatures can flourish and grow. The greatest gift to me this day is their shear presence and existence, even though confined to roughly 70 to 80 small groves in the vast Sierra Nevada forests of today.

More information in books and on the World Wide Web:

Wild or prescribed: two kinds of fire. http://www.nps.gov/seki/2fires.htm

Why does the National Park Service use fire?
http://www.nps.gov/seki/fire/index.htm

The Ultimate Tree-Ring Web Pages.
http://tree.ltrr.arizona.edu/~grissino/ henri.htm

Other web pages with pictures: http://camping.miningco.com/;
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