Committee on Resources

Subcommittee on Forests & Forest Health

Statement

Testimony to Committee on Resources,
Subcommittee on Forests and Forest Health
Oversight Hearing on
Preventing Wildfires Through Proper Management of the National Forests,
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I thank the Committee for inviting me here to testify today. The problem of increasingly large and severe crown fires in forests of the western United States is very serious and requires urgent attention and action. The Cerro Grande wildfire, and the many dozens of other large fires of the past several months, have made this abundantly clear. I have two main points to make in this testimony: The first is that long-term climate forecasts and assessments of regional conditions should be explicitly incorporated into fire management planning and implementation. The second point is that forest restoration using both prescribed fire and mechanical thinning of trees is imperative, but reducing density of small diameter tress should be the primary target of this work.

Before I explain these main points in more detail, I thought I would briefly describe my personal and professional background. I was raised in New Mexico. I grew up in Jemez Springs, a mountain village located about 50 miles northwest of Albuquerque. Jemez Springs is just "over the hill", so to speak, from Los Alamos. My father was a District Ranger with the U.S. Forest Service for 35 years. While growing up in the Jemez, and later while attending the University of New Mexico, I watched several enormous wildfires erupt in our surrounding mountains. The sight of enormous smoke columns looming over Los Alamos has become all too familiar to us New Mexicans. These massive fires have brought destruction and long-term damage to our forests and watersheds.

My childhood experiences of growing up surrounded by forests and fires led me to the scientific research that I conduct today. I am a dendrochronologist - that is, a tree-ring scientist. For the past 20 years I have used tree-rings to study the histories of forest fires, forest insect outbreaks, and climate change over time periods of years to millennia. The modern science of dendrochronology was invented at the Laboratory of Tree-Ring Research, University of Arizona, where I am Director and Professor of Dendrochronology and Watershed Management. My predecessors at the Tree-Ring Lab used tree-ring techniques to date the ancient cliff dwellings of the Southwest, and today my colleagues and I carry out studies all over the world, investigating historical climates, ecosystems, and cultures. My studies have taken me to the most spectacular forests in the world, from the magnificent giant sequoia groves of the Sierra Nevada in California, to the vast pine forests of central Siberia. I have always returned, however, to the mountains of the Southwest because this is home, and because these forests contain such a rich history of natural and cultural change. These histories have lessons to teach us.

For example, our tree-ring studies, and the work of many other scientists, including Dr. Wally Covington and his associates, have been central in identifying the roots of the wildfire and forest health problems that we face today. I think the Committee is already aware of most of the salient historical facts, so I will only provide a very brief summary here:

A primary fact that we have learned is that forests have evolved with fire over eons of time. Our tree-ring studies have shown that, until the 20th century, frequent surface fires were as important to the long-term integrity of pine and mixed conifer forests as sunshine and rain. Indeed, in Southwestern ponderosa pine forests, the only natural events more frequent and regular than fire were the changing seasons. These frequent fire regimes ended abruptly when settlers brought large numbers of sheep, goats, horses and cattle into this landscape (**Figure 1**). By the 1930s and 40s land management agencies were effectively suppressing most of the fires that ignited in this changed landscape. Tree-ring studies, repeat photography, and re-measurements of trees in old research plots clearly show that many late 20th century forests have become very dense and crowded with hundreds to thousands of trees per acre. One consequence of these increased stand densities is that wildfires are increasing in size and severity (**Figure 2**). Many of the fires we are seeing today in ponderosa pine forests, such as large portions of the Cerro Grande fire, are anomalous from a long-term historical perspective. By "anomalous", I mean that the intensities and the ecological and geological impacts of these fires are far outside the historical and natural range of what these areas have sustained in the past several hundred years, and probably for many thousands of years. The burned and eroded areas resulting from these anomalous fires are "landscape scars" that will probably persist for centuries, and perhaps millennia.

Climate and Fire

Most of these historical facts about changed forests and fire regimes are already familiar to most informed people, as they have been documented and described many times by scientists and federal and state fire managers. There are, however, a few facts about the long term history of fire and climate in the United States, that are not so well known, and have not yet been adequately used in fire management planning. [Please see the list of published papers at the end of this document for scientific literature supporting and relating to these facts.]

First, it is essential to recognize that climate is tremendously variable across all time scales and time frames (**Figure 3**), and this variability leads to enormous wildfires during certain years. Droughts and wet periods lasting from seasons to decades are a fundamental feature of the climatology of the Southwest, and much of the rest of the semi-arid western U.S. Seasonal, annual, and decadal rainfall and drought conditions in these regions are partly controlled by the state of the Pacific Ocean. In particular, the climatic patterns known as the El Niño-Southern Oscillation and the recently discovered Pacific Decadal Oscillation have considerable influence on rainfall and stream flow amounts in the western and Southeastern U.S. During El Niño events the Southwest and Southeast generally receive much more winter and spring rainfall, and during La Niña events, such as this year, winter and spring rainfall is often reduced. Furthermore, during some La Niña events drought persists through the spring and summer months, affecting the Great Basin and Northern Rockies, resulting in huge forest fires across the western U.S. The La Niña-related droughts and fires of

1988-1989 and 1999-2000 are examples of this climate-fire pattern. Not all El Niño or La Niña events have the same strength or effects on climate, weather and fire, but on a historical, climatological basis, these patterns have sufficient consistency to be of some use in fire management planning. For example, inter-seasonal climate forecasts based on the state of the Pacific Ocean are currently available and, during La Niña years, they can provide fire managers with warnings as early as the winter months preceding the summer fire season (**Figure 4**).

Forecasts for extreme drought persisting into the spring and summer were available this past winter, and they were discussed at length in a workshop my colleagues and I held at the University of Arizona in February with fire managers from throughout the western U.S. and Florida. We knew that a bad fire season was probably coming, but these warnings did not materialize into management actions at the regional to local level that might have averted the Cerro Grande disaster. I am not saying that fire managers could have prevented all or even most of the major wildfires that have occurred this summer if they had paid more attention to the long-term climate forecasts. Drought conditions are extreme this year, and perhaps no amount of preparation in the short span of a few months could have prevented this from becoming a record setting year. However, if the land management agencies had better organizational mechanisms and information tools to make use of long-range climate forecasts, and to take stock of broad-scale fuel and moisture conditions, it is conceivable that the Cerro Grande disaster, arising from an escaped prescribed fire, could have been avoided. For example, if local managers had fully recognized the high state of fire hazard at lower and middle elevations in the Los Alamos area, and in the rest of the Southwest, or if they had been fully aware of the high climatological probability of high winds in early May in the Bandelier area, perhaps they would not have proceeded with the prescribed fire on May 4th. Alternatively, in recognizing the high fire hazard at broader scales than the area and time period they were planning to burn, they might only have proceeded if more fire fighting forces were available.

Current planning and approval procedures for prescribed burns do not explicitly incorporate the broad-scale perspectives of regional conditions and climatic patterns that I have described. For this and other reasons it is unfair to place the entire blame for the Cerro Grande disaster on local managers at Bandelier. What is needed is better interagency coordination by regional decision makers who are monitoring broad-scale climate and fuel conditions and fire fighting resources, and who have authority to suspend prescribed burning in any or all management areas during certain seasons when the risks are too high. Extra fire fighting forces and contingency resources may be required if prescribed burning operations are to be carried out during extreme regional drought conditions -- even if local conditions for the prescribed burn are suitable for the prescription. Because of the possibility of continued warming conditions at global scales, and more extreme droughts in the years and decades ahead, the need for regional and continental climatological perspectives in fire management planning has become all the more urgent.

This brings me to a second major point about climate and fire, which is that long term climatic trends and changes may be partly responsible for the increasing extent and severity of fire in the western U. S. during the past 20 or 30 years. The 1990s decade was certainly the warmest decade we have experienced in the northern hemisphere in the past century, and it was probably the warmest decade in at least the past 600 years (**Figure 5**). Some of the evidence for unusual climate change comes from tree-rings in trees growing here in the Southwest. For example, ancient limber pine trees growing at the top of the Sandia Mountains above Albuquerque suggest that the past 20 years have been exceptionally wet and warm resulting in tree-ring growth that is unprecedented during the past millennium (**Figure 3**). An unusually frequent string of extreme El Niño events from the mid 1970s to late 1990s was partly responsible for generally wet winters in the Southwest during these decades. Warm and wet conditions lead to increased growth of grasses, shrubs, and tree leaves, providing abundant "fine fuels" that become explosive during intermittent dry seasons and years. The accumulated heavy fuels (logs, tree stems, etc.) from a century of fire suppression, plus the accumulated light fuels from the recent warm and wet decades have primed the Southwest for conflagrations during La Niña droughts, such as we have just experienced this year.

There is another worrisome development in climatic conditions that has bearing on this situation. Ocean-atmosphere indicators in the Pacific Ocean suggest that we may now have shifted out of the multi-decadal wet climatic state of the 1970s to 1990s into a state that is similar to conditions that existed during the late 1940s and 1950s when the most extreme drought of the past 400 years struck the Southwestern and Southeastern United States. These indicators, primarily involving sea surface temperatures in the northern Pacific Ocean, have been termed the "Pacific Decadal Oscillation". It is too early to tell if this is indeed the case, but if it is, we can expect extreme drought conditions in the Southwest in the coming decade and many more catastrophic wildfires. On the positive side of this rather gloomy outlook is the fact that we have learned a great deal about these seasonal to decadal climate patterns (although we have much more to learn), and some aspects of these patterns offer forecasting capabilities that could help us in our planning and preparation. This planning and preparation could include identifying seasons and years when prescribed burning is less risky, as well as times when extra caution should be exercised in prescribed burning and most efforts should be directed toward increasing fire fighting capabilities and readiness. Again, my key point here is that fire management planning and implementation should more explicitly include consideration of these broad scale and long-term climate patterns.

Forest Restoration

The final set of points I wish to make involve the efforts needed to restore our forests and woodlands to conditions that are less susceptible to anomalous, catastrophic crown fires. At your invitation, my colleagues Dr. Penny Morgan and Dr. Leon Neuenschwander of the University of Idaho, and I prepared written testimony for your June 7th hearing in Washington DC., but we were not able to attend the hearing because of other commitments. In brief, our major points in this testimony were that:

· Thinning of small diameter trees is urgently needed in many forests of the western United States to reduce fire hazards and to restore more natural forest conditions. In many areas thinning with chainsaws combined with intensive fuel treatments by hand and with machines will be needed. Prescribed burning should be used wherever it is safe and practical to treat accumulated fuels and the new fuels generated by thinning, to maintain open stands, and to reintroduce and maintain key ecological processes, such as nutrient cycling. Prescribed fire alone as a fuel treatment and thinning agent may be appropriate in some cases, particularly in large wilderness areas and parks where the threat of escaped fires and damage to private property is minimized.

· Small diameter trees comprise the vast majority of trees that need to be thinned to reduce catastrophic crown fire damage in Southwestern forests. Ponderosa pine forests usually had open stand conditions in the pre-settlement era and large trees occurred in clumps rather than in continuous unbroken canopies. Logging in the past century has further reduced the number and density of large diameter trees. There are very few places today where interlocking canopies of large diameter ponderosa pine trees exist over continuous, extensive areas. The continuous fuels that are the primary fire hazard are the small diameter, stunted trees that have grown up beneath the surviving pre-settlement trees. These small diameter trees should receive primary emphasis in thinning operations, whereas large diameter trees (of pre or post-settlement origin) should be preserved on these landscapes wherever possible.

· It is very important to understand the historical patterns and processes that persisted in forests for centuries and millennia before European settlement. We must know the past in order to understand the present (and vice versa). Natural patterns and processes can provide a partial guide to conditions that are most likely to impart resilience and sustainability to current and future forests. Historical conditions, however, should not be used as a rigid template for restoration of forests. Returning Southwestern forests to the precise conditions that existed in the late 1800s will probably restore some vigor to currently overcrowded and stressed forest stands. Nineteenth century forest conditions, however, may not necessarily optimize the chances for sustaining our forests in the 21st century, particularly as we may be facing continued extreme and unprecedented climatic changes in coming years and decades. Drought-induced tree mortality is of particular concern because Southwestern forests and woodlands are susceptible to dieoffs during prolonged droughts. Urgent action is needed, but uncertainty about future climate changes and uncertainty about ecological responses of restored forests to these climate changes argues for some caution in the initial stages of forest restoration. These uncertainties also call for adaptive management, but this will require a stepwise approach that does not immediately commit very large areas to the same kinds of intensive, all at once, thinning treatments designed to immediately restore 19th century stand densities.

Recommendations

1. Consideration of long-term climatic conditions and regional fuel and fire hazard conditions should be more explicitly included as a part of the fire management planning process. For example, when moderate to extreme La Niña events have occurred and regional moisture during the cool season has been significantly reduced, fire managers should anticipate expanding and positioning fire fighting forces in the critical regions and seasons (e.g., spring and early summer in the Southwest and Southeast, late summer in the Great Basin, northern California and Northern Rockies). Likewise, during regional droughts prescribed burning activities should be implemented only with a heightened degree of caution and preparation (even when local fuel conditions may be moderate), including sufficient emergency fire fighting forces on hand to catch escaped fires. Following winter-spring drought conditions in the Southwest, at some point during the spring, it may be advisable to suspend all prescribed burning at regional-scales. This suspension should be a coordinated decision by federal and state agencies, and it should be based on the best available meteorological and climatological forecasts, generalized fuel moisture conditions, and assessments by experienced fire managers, fire behaviorists, fire meteorologists and climatologists. The existing fire management interagency coordination centers and fire managers in regional offices are probably the logical places and people to work together in making these decisions.

2. The research branch of the Forest Service and other federal agencies with expertise and mandates for ecosystem and climate-related research (e.g., NOAA, USGS, etc.) should expand their efforts to improve our understanding of climate-fire relationships at time scales of seasons to decades and spatial scales of regions to continents. Fire and climate researchers also need to take a leadership role in developing communication and technology transfer tools that can provide timely, long-term forecasts and warnings tailored for fire managers. For example, El Niño-Southern Oscillation based inter-seasonal forecasts might be coupled with fire behavior models, and satellite and ground-based data on fuels that could provide useful, reliable forecasts of current and upcoming fire hazard conditions. These fire hazard-specific forecasts should be accessible to all levels of fire management organizations, including managers planning and implementing prescribed fires.

3. Forest restoration involving tree thinning should be viewed as a necessary investment to reduce fire hazard and the unacceptable risks of resource loss and threats to human lives and property. This is likely to

be a costly investment requiring decades to accomplish. Wherever ecologically justifiable, feasible, and safe, the restoration of forests should involve reintroduction of the fire process. It is probably unrealistic to expect that forest restoration projects required to accomplish ecological goals and hazard reduction can fully pay for themselves in most cases. In most Southwestern forests, small diameter trees should be the main targets of tree thinning projects; cutting of large diameter trees should be minimized, and based primarily on ecological justifications, rather than solely economic ones.

4. There is a great deal of work to be done, jobs to be created, and useful wood by-products that can be obtained through this massive restoration undertaking. Small businesses and communities in rural areas can benefit from thinning contracts and from innovative uses of small-stem wood products. These kinds of innovative and community based operations involving local people and small businesses should be encouraged by the Forest Service, public and governmental partnerships, and private foundations.

I thank the Committee for inviting me to testify and offer these recommendations. This concludes my testimony.

Published Scientific Literature Relating to this Testimony

Publications on fire, climate, forest and cultural history in the Southwest:

Allen, C. D. and D. D. Breshears. 1998. Drought-induced shift of a forest-woodland ecotone: Rapid landscape response to climate variation. Proceedings of the National Academy of Sciences 95:14839-14842.

Allen, C. D., J. L. Betancourt, and T. W. Swetnam. 1998. Landscape Changes in the Southwestern United States: Techniques, Long-term Data Sets, and Trends. Pages 71-84, In T. Sisk, editor, Perspectives on the Land Use History of North America: A Context for Understanding our Changing Environment. U.S. Geological Survey, Biological Science Report. USGS/BRD/BSR-1998-0003. 104 pp.

Allen, C. D., R. Touchan, and T. W. Swetnam. 1995. A landscape-scale fire history study supports fire management actions at Bandelier National Monument. Park Science Summer 1995, pages 18-19.

Baisan, C. H., and T. W. Swetnam. 1997. Interactions of fire regimes and land use in the Central Rio Grande Valley. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Research Paper RM-RP-330, 20p.

Dahm, C. W., and B. W. Geils. 1997. An assessment of ecosystem health in the Southwest. USDA Forest Service General Technical Report **RM-GTR-295**.

Grissino-Mayer, H. D., and T. W. Swetnam. 2000. Century scale changes in fire regimes and climate in the Southwest. The Holocene 10(2):207-214.

Kaufmann, M. R., L. S. Huckaby, C. Regan, and J. Popp. 1998. Forest reference conditions for ecosystem management in the Sacramento Mountains, New Mexico. USDA Forest Service General Technical Report **RMRS-GTR-19**.

Swetnam, T. W., and J. L. Betancourt. 1990. Fire-Southern Oscillation relations in the Southwestern United States. Science 249:1017-1020.

Swetnam, T. W., and J. L. Betancourt. 1992. Temporal patterns of El Niño/Southern Oscillation - wildfire patterns in the southwestern United States. pages 259-270 In Diaz H. F. and V. M. Markgraf, eds., El Niño: Historical and Paleoclimatic Aspects of the Southern Oscillation, Cambridge University Press, Cambridge.

Swetnam, T. W., and J. L. Betancourt. 1998. Mesoscale disturbance and ecological response to decadal climatic variability in the American Southwest. Journal of Climate 11:3128-3147.

Swetnam, T. W., C. D. Allen, and J. L. Betancourt. 1999. Applied historical ecology: Using the past to manage for the future. Ecological Applications 9(4):1189-1206.

Publications on long-term climate variability and change:

Crowley, T. J. 2000. Causes of climate change over the past 1,000 years. Science 289:270-277.

Dettinger, M. D., D. R. Cayan, H. F. Diaz, and D. Meko. 1998. North-south precipitation patterns in western North America on inter-annual-to-decadal time scales. Journal of Climate 11:3095-3111.

Grissino-Mayer, H. D. 1996. A 2129-year reconstruction of precipitation for northwestern New mexico, USA. In, J. S. Dean, D. M. Meko, and T. W. Swetnam eds., Tree Rings, Environment, and Humanity, 17-21, May 1994, Tucson, Arizona. Radiocarbon, pages 191-204.

Mann, M. E., R. S. Bradley, and M. K. Hughes. 1998. Global-scale temperature patterns and climate forcing over the past six centuries. Nature **392**:779-787.

Mantua, N. J. S. R. Hare, Y. Zhang, J. M. Wallace, and R. C. Francis. 1997. A Pacific interdecadal Ocean climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78:1069-1079.

Figure 1. Chronologies of fire events in 55 forest stands in Arizona, New Mexico, and northern Sonora, Mexico, 1600-2000, reconstructed from tree-ring analyses of fire-scarred trees. Each horizontal white line represents a fire chronology from a single forest stand. The red and yellow vertical tick marks are the fire dates recorded by the fire-scarred trees sampled in each stand. The red tick marks represent regional fire years that were recorded by fire scarred trees in 10 or more of the sampled stands. Many of these regional fire years occurred during droughts that were probably associated with La Niña events. Note the very striking decrease in sites recording fires after circa 1890, coinciding with the introduction of large numbers of livestock, and organized suppression of fires by government agencies (see Swetnam et al. 1999 for additional explanation).

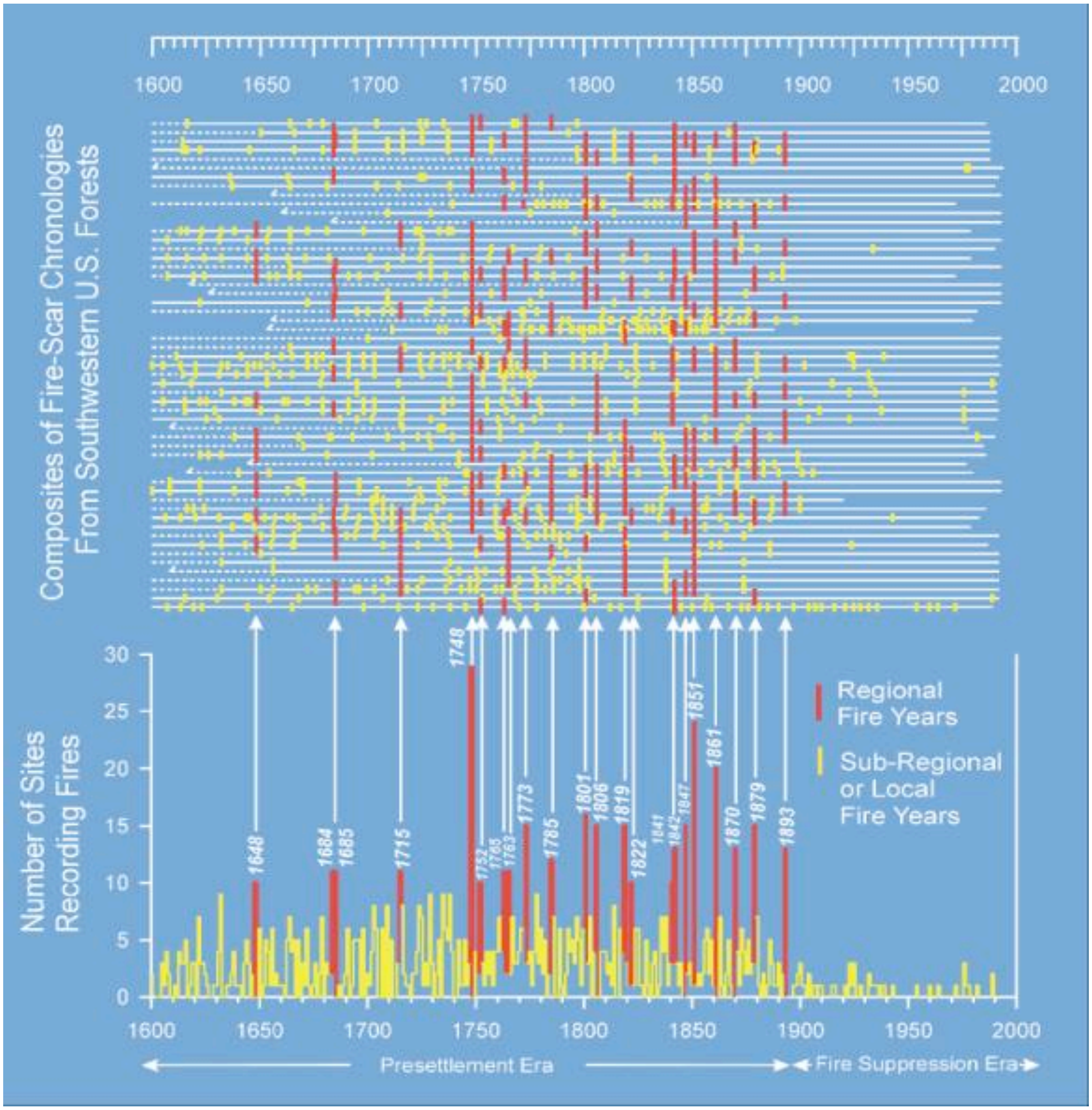


Figure 2. Reported area burned in the 11 states western states (1916-1996) and in Arizona and New Mexico (1916-2000 [as of 8/8/00]). The increasing area burned after 1980s may be related to a combination of increasing fuels and climate changes.

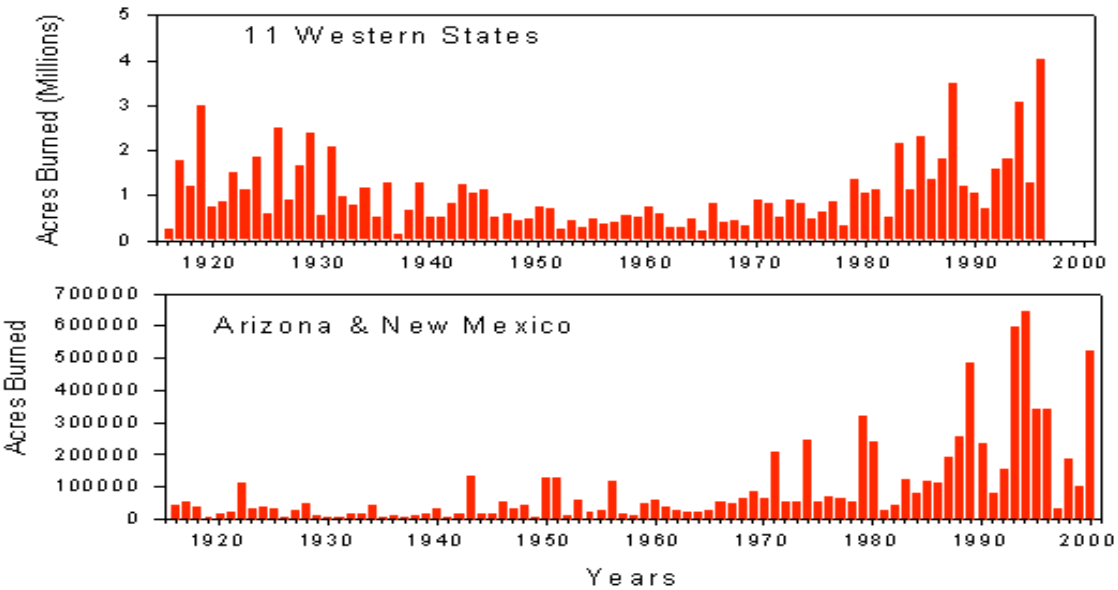


Figure 3. The upper graph shows average tree-ring growth in six drought-sensitive forest sites in Arizona and New Mexico compared with November to June precipitation during the 20th century. The lower graph shows the past 1,000 years of tree-ring growth in the same sites. Note the high variability of wet and dry years and decades, and the remarkable increase in growth in the late 20th century (Grissino-Mayer 1996, Swetnam and Betancourt 1998).

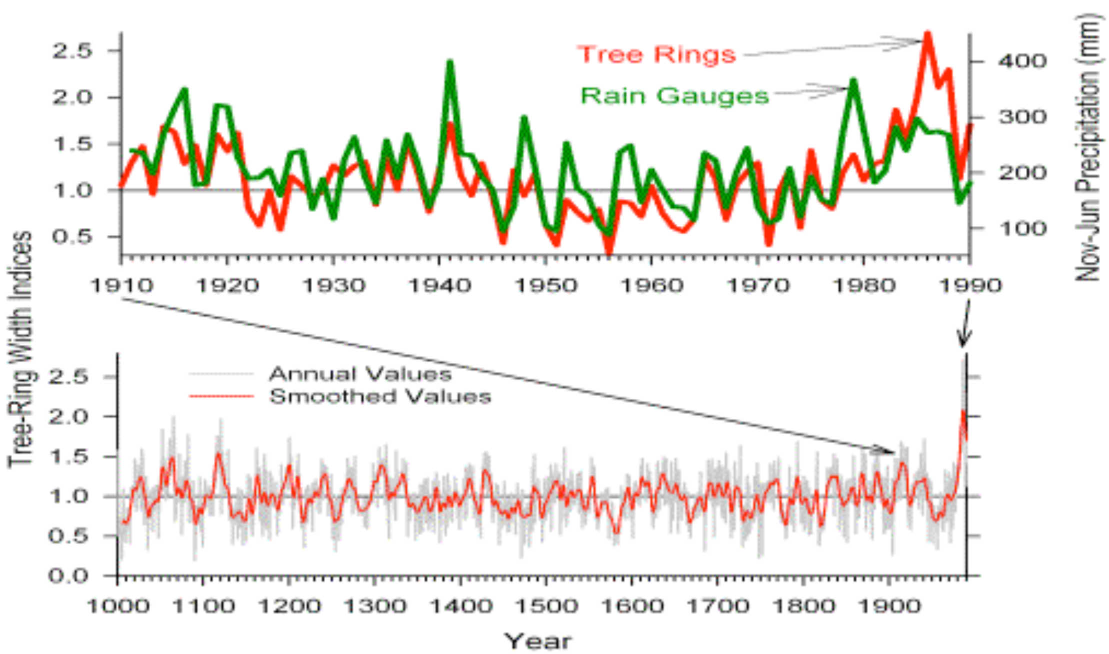


Figure 4. Area burned in the Southwest compared to years when El Niño and La Niña events were active and decreased winter and spring precipitation occurred. Note the y-axis is a logarithmic scale. Although the association is not entirely consistent, El Niño events typically result in wet winters and springs and reduced area burned during the subsequent summer, and the reverse is generally true for La Niña events (Swetnam and Betancourt 1990, 1992). Note that an extreme La Niña event and a very dry winter occurred during the past winter of 1999-2000, and the area burned to date in the Southwest as of August 8 is over 500,000 acres.

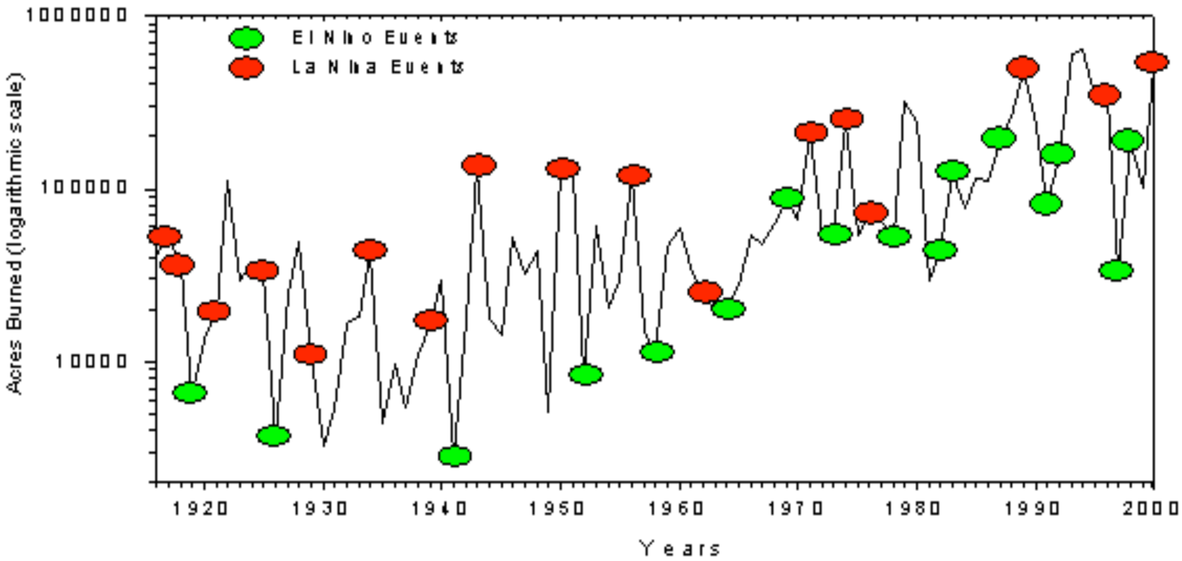
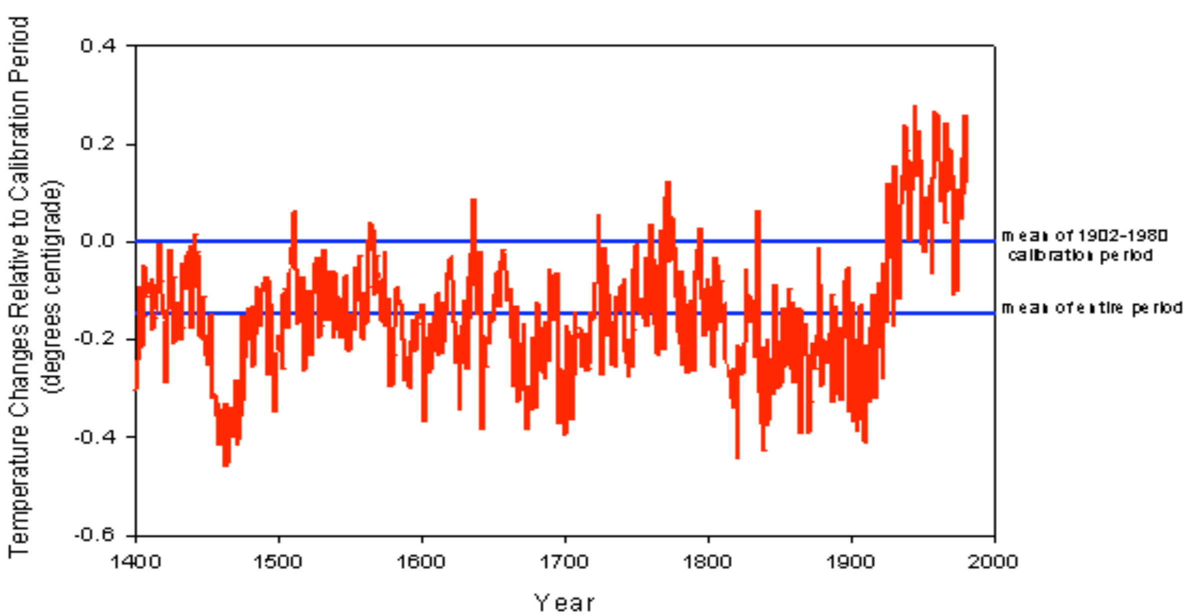


Figure 5. Reconstructed northern hemisphere temperature variations based on a large number of tree-ring, coral, ice core, and documentary records (Mann et al. 1998). Note that warm temperatures in the 20th century are unprecedented in the past 600 years.



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