Resolving the Controversy
Why Large Wildfires in Southern California?

The California Chaparral Institute
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When research accumulates and calls into question an older established idea, the ensuing debate is often portrayed in the popular media as simply a difference of opinion between competing perspectives of equal merit, regardless of the quality and depth of evidence. The current controversy over why there are large shrubland wildfires in Southern California is one such example. The older perspective that such wildfires are unnatural is being challenged by more recent research showing large, infrequent crown fires have always been part of the chaparral dominated landscape.

The older paradigm can be referred to as the Southern California/Baja fire mosaic hypothesis.

According to this hypothesis, past fire suppression efforts in Southern California shrubland ecosystems have caused an unnatural build-up of vegetation, leading to unnaturally large fires. The hypothesis suggests that wildfires in Baja California are small because unsuppressed fires have created a mixed-aged mosaic of vegetation which naturally constrains fire spread. Commonly proposed options to eliminate the hypothesized "fuel" build-up in Southern California include allowing fires to run, conducting prescribed burns, and using mechanical mastication.

Support in the scientific community for the hypothesis since it was published in 1983 has been generally restricted to the original author and his students. In contrast, a significant number of scientists from government agencies and academia have raised serious questions about the hypothesis. More than 40 of their papers are listed in the attached bibliography. These scientists have reached this opinion through their own investigations and **offer substantial scientific evidence that the fire mosaic hypothesis should be rejected.**

The rejection is not a matter of opinion or "consensus," but rather based on an objective analysis of the data. **Science does not work by consensus, it works by weighing the bulk of the evidence.** In fact, government agencies, managers, and society at large never wait for a consensus in science before acting. Otherwise, society would be bogged down in endless debates.

A thorough analysis of the fire mosaic hypothesis is important because it has **two very profound implications** for Southern California urban and wildland systems:

1. **Negative impacts on fire safety and finance.** Supporters of the hypothesis emphasize spending substantial funds on landscape-scale vegetation management. By spending scarce funds to artificially create mixed-aged mosaics across the landscape, dollars will not be available to support efforts that are known to reduce fire risk. Such efforts include creating defensible space zones around homes and communities, strategic fuel treatments near communities, public fire education, design and maintenance actions to reduce structural ignitions, community planning, and funding local fire departments.

2. **Ecological damage.** Adding more fire to backcountry and protected wildlands in an effort to create mosaics will increase the threat of type-conversion, converting many of California's native shrubland ecosystems to flammable, non-native, weedy grasslands.

While an honest cost/benefit analysis will not favor creating mixed-aged mosaics across the natural landscape, *strategically placed* fuel treatments near communities have been shown to be an effective way to reduce fire risk. The location of such fuel treatments can be selected by fire professionals to maximize their effectiveness and minimize their costs, both financially and ecologically.

We have provided the following analysis of the hypothesis and an extensive bibliography of the relevant papers so that others may examine the evidence and draw their own conclusions.

The Hypothesis

Assumptions of the Baja/Southern California fire mosaic hypothesis	Alternative explanations from other research
Large fires are unnatural and are the result of past fire management activities.	Infrequent, large fires are a natural part of the landscape. Fires are now unnaturally frequent due to human-caused ignitions.
Fire suppression has been successful in excluding fires on Southern California landscapes and this has led to an unnatural accumulation of older shrubland vegetation.	Fire suppression has been successful at protecting urban environments, but has not excluded fire on the broader landscape. There is no evidence that the extent of older shrublands is above the historical range of variability.
Large fires can be prevented by creating mixed-aged vegetation mosaics across the landscape.	Large fires are wind-driven and are capable of burning through, over, or around mosaics of mixed-aged vegetation.
Baja can provide a model for how fire should be dealt with in Southern California.	Baja is not comparable to Southern California due to differences in weather, vegetation, and land use practices.
Fire spread is a function of fuel age. Chaparral stands less than 20-years-old will not burn.	Fires spread is determined by numerous variables (e.g. fuel type, fuel moisture, weather, and topography). Young stands burn.
Too frequent fires leading to type-conversion of native chaparral to non-native grasslands is not acknowledged as significant.	Significant type-conversion of all native shrubland ecosystems is occurring due to overly frequent fires.

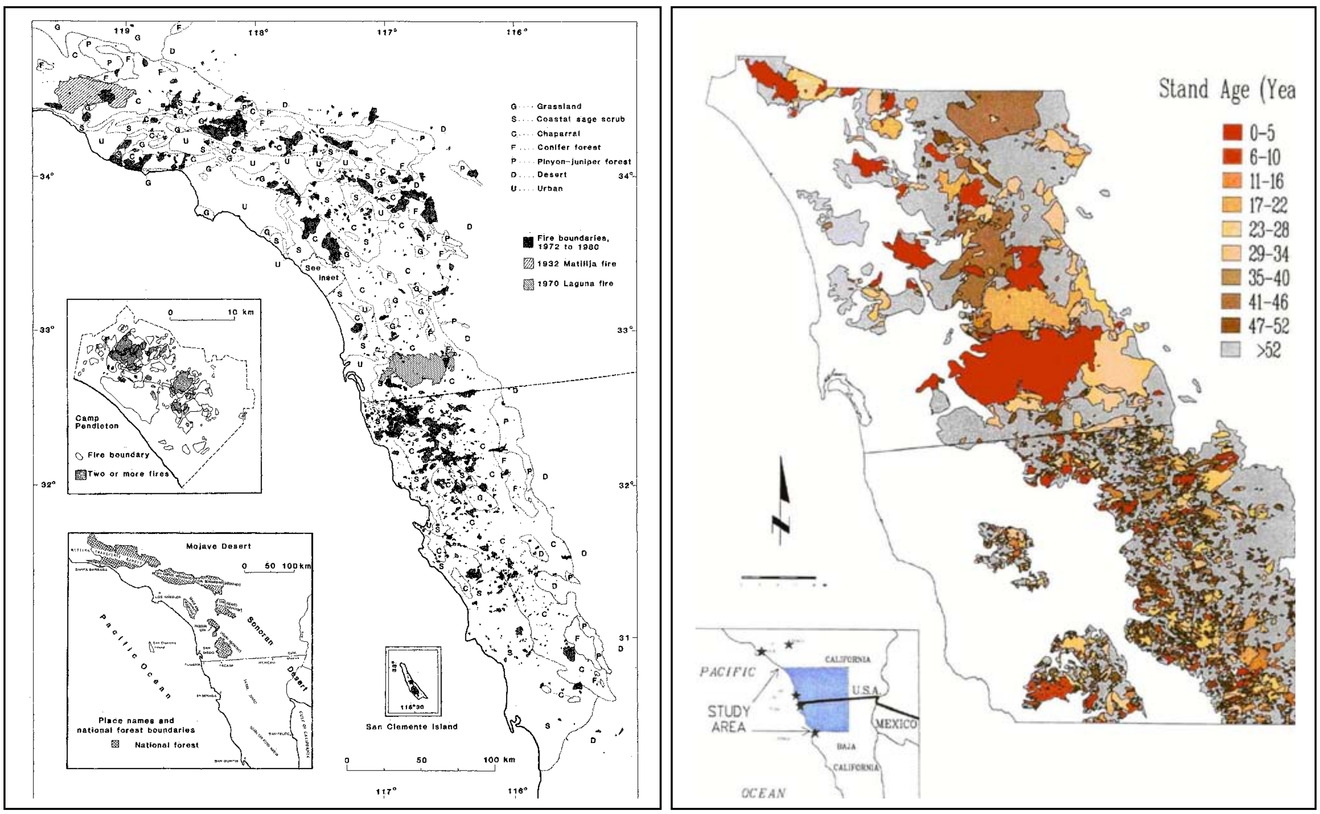
Rejecting the Fire Mosaic Hypothesis

The validity of a hypothesis rests on the ability of scientists to confirm that the methodology used, the data collected, and the predictions made in the original investigation were appropriate and unbiased. The research demonstrates that the data, assumptions, and predictions behind the Baja/Southern California fire mosaic hypothesis are flawed. It also shows that past fire suppression (fuel age), the sole variable in the hypothesis, cannot account for why there are large wildfires in Southern California and small ones in Baja.

I. Flawed Data

The map in the original research paper (Minnich 1983) biases the comparison between Baja and Southern California by including two very large fires north of the border that occurred outside the study period (1932 Matilija and the 1970 Laguna fires).

In a follow-up paper (Minnich 1989), fire perimeter data south of the border were compiled in a completely different manner than north of the border. For Baja, three sets of aerial photographs separated by 16-18 years were used to estimate fire perimeters. There was no validation that fire perimeters could be accurately determined in this manner. North of the border, official state and federal records were used. This data set did not include smaller fires (below 40 acres). Between 1970 and 1979, a time period included in one of the aerial photo sets, 95% of the fires in San Diego County were less than 40 acres.



The Maps. Dark splotches in the left map (1983) represent fire scars as determined by analyzing satellite images. By inserting fires outside the study period (two grey splotches) the reader is left with the biased impression that fires north of the Southern California/Baja border are much larger than they actually were during the period in question. For the map on the right (1989), estimated fire perimeters in Baja were derived by subjectively analyzing aerial photos. Perimeters north of the border were determined by government investigators after the fire event. The different methodologies used raise serious questions about the validity of the maps.

II. Flawed Assumptions

Several assumptions supporting the hypothesis have been proven to be incorrect. The citations listed below reference the scientific studies which falsify these assumptions.

A. Large fires are new to Southern California. Scientific research and historical documents have shown this to be false (Mensing et. al 1999, Keeley and Zedler in press).

B. **Fire suppression has been effective in excluding fire from Southern California shrubland ecosystems over the last century.** Scientific research has clearly shown that fire suppression in these ecosystems has not been successful in excluding fire (Keeley et. al 1999).

C. Baja and Southern California are comparable. This is false as there are a significant number of differences between the two regions. For example:

- There are significant land management differences north and south of the border. Baja has been subjected to hundreds of years of ranching and farming which has resulted in a significant alteration of the natural landscape (Henderson 1964, Dodge 1975).

- Weather patterns are different north and south of the border. The proportion of the area studied in Baja subject to strong Santa Ana winds is small when compared to Southern California. Such wind events gradually diminish south of the border. Precipitation is dramatically greater in Southern California when compared to Baja California (Henderson 1964, Mitchell 1969, Markham 1972).

- As a result of different weather, topography, and soil conditions, plant communities are distinctly different in many areas of Baja when compared to Southern California (Keeley and Fotheringham 2001a).

III. Flawed Predictions

Mixed-aged vegetation mosaics alone have proven to be inadequate barriers to fire spread, especially during wind-driven events. Age of vegetation is not the only variable determining fire size as suggested by the hypothesis. Other variables are important in determining fire spread such as topography, fuel moistures, local weather conditions, and fire suppression efforts (Zedler and Seiger 2000, Moritz et. al 2004, Halsey 2006). Large fires occur in Baja California. More than 37,000 acres burned in Baja during the 2007 firestorm (Hernandez 2007).

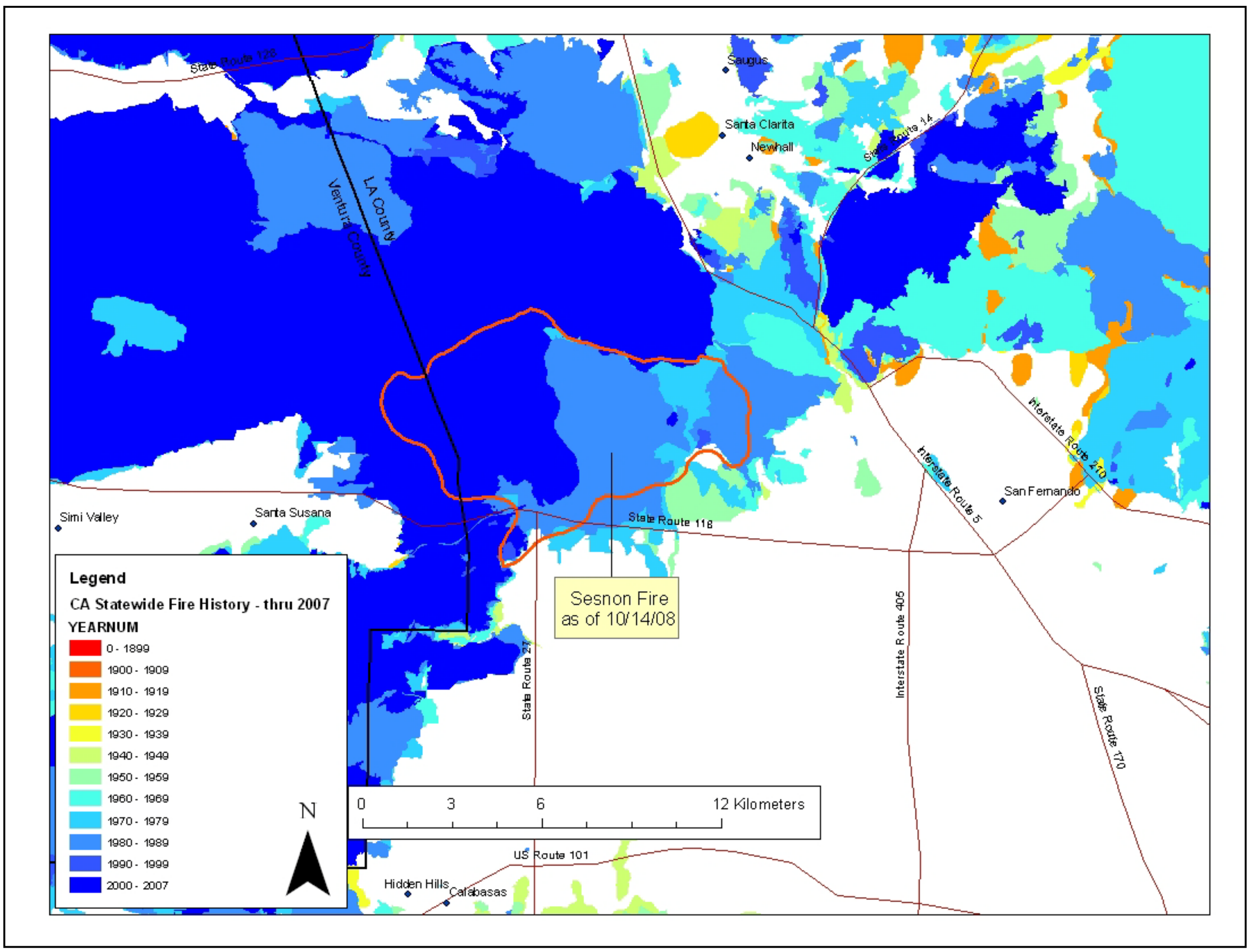
The nearly exclusive focus on fuel age as the sole variable to fire spread often leads to the assumption that all large wildfires are due to the "unnatural" build-up of vegetation. This was demonstrated in an article about the October 2008 fires in the San Fernando Valley in UCLA's newspaper, The Daily Bruin (10/21/08):

> *"The cause of the fires is still unknown, though what caused it is irrelevant, said Richard A. Minnich, a professor of geography at UC Riverside…Fire suppression, Minnich said, has*

increased the severity of the wildfires. He said that since small fires which break out during the summer are typically extinguished, the vegetation which would normally be burned by the fires is still in abundance during the fall season. As a result, fires in the fall have much more fuel to burn, and are increased due to the strong Santa Ana winds. "Because we're putting fires out…we're making the role of the Santa Ana winds (larger)," Minnich said.'

Two fires burned during the San Fernando Valley event in October: the 4,824 acre Marek fire and the 14,703 acre Sesnon fire. As shown in the map below, the larger Sesnon fire burned within an area that had seen multiple fires over the past 27 years. The left one third of the fire scar (dark blue) burned in the 2003 Simi fire. The right portion had last burned in 1988. The central portion had burned in 1981. Fire suppression has not been effective in excluding fire from these areas.

The cause of these fires is relevant because they are all human-caused. Natural, summertime lightning-caused fires are extremely rare. Such an artificial increase in fire frequency threatens native shrublands with type-conversion to highly flammable, non-native grasslands (see pg. 10 for references).



2008 Sesnon fire (central outlined red perimeter) with fire history of the general area. Map by Anne Pfaff and Jon E. Keeley, USGS Western Ecological Research Center.

The Research

(Internet links are provided for most papers)

The following papers provide the basics of the Baja/Southern California fire mosaic hypothesis (Minnich 2001) and a point by point explanation why it is flawed (Keeley and Fotheringham 2001a,b):

Keeley, J. E., and C. J. Fotheringham. 2001a. Historic fire regime in Southern California shrublands. Conservation Biology 15:1536-1548.

Minnich, R. A. 2001. An integrated model of two fire regimes. Conservation Biology 15:1549-1553.

Keeley, J. E., and C. J. Fotheringham. 2001b. History and management of crown fire ecosystems: a summary and response. Conservation Biology 15: 1561-1567.

The Original Paper:

Minnich, R. A. 1983. Fire mosaics in southern California and northern Baja California. Science 219:1287-1294.

Main papers supporting the mosaic hypothesis (by date):

Minnich, R. A. 1989. Chaparral fire history in San Diego County and adjacent northern Baja California: an evaluation of natural fire regimes and effects of suppression management. In, The California Chaparral: Paradigms Reexamined (S. C. Keeley ed.). No. 34 Science Series. Natural History Museum of Los Angeles County.

Minnich, R. A., and R. J. Dezzani. 1991. Suppression, fire behavior, and fire magnitudes in Californian chaparral at the urban/wildland interface. Pages 67-83 in J. J. DeVries, editor. California watersheds at the urban interface, proceedings of the third biennial watershed conference. University of California, Davis, CA.

Minnich, R.A., and C.J. Bahre. 1995. Wildland fire and chaparral succession along the California-Baja California boundary. International Journal of Wildland Fire, *5*:13-24.

Minnich, R. A. and Y. H. Chou. 1997. Wildland fire patch dynamics in the chaparral of southern California and northern Baja California. International Journal of Wildland Fire 7:221-248.

Minnich, R. A., and E. Franco-Vizcaino. 1999. Prescribed mosaic burning in California chaparral. Pages 247-254 In A. Gonzalez-Caban, editor. Proceedings of the symposium on fire economics, planning, and policy: bottom lines. Pacific Southwest Research Station, Albany, CA.

Goforth, B. S., and R. A. Minnich. 2007. Evidence, exaggeration, and error in historical accounts of chaparral wildfires in California. Ecological Applications 17:779-790.

Key research that leads to the rejection of the mosaic hypothesis by testing its data set, assumptions, and/or predictions:

Conard, S. G., and D. R. Weise. 1998. Management of fire regime, fuels, and fire effects in southern California chaparral: lessons from the past and thoughts for the future. In Teresa L. Pruden and Leonard A. Brennan (eds.). Fire in ecosystem management: shifting the paradigm from suppression to prescription: 1996 May 7-10; Boise, ID: Tall Timbers Fire Ecology Conference No. 20. Tallahassee, FL: Tall Timbers Research Station; 342-350.

"For these purposes, landscape mosaics are impractical, unnecessary, and probably not particularly effective. We basically recommend shifting the management focus away from pure mosaic burning toward development (and rejuvenation) of strategically placed fuel management zones."

Keeley, J.E.; Aplet, G.H.; Christensen, N.L.; Conard, S.C.; Johnson, E.A.; Omi, P.N.; Peterson, D.L.; Swetnam, T.W. 2009. Ecological foundations for fire management in North American forest and shrubland ecosystems. Gen. Tech. Rep. PNW-GTR-779. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 92 p.

"The fire regime in this region is dominated by human-caused ignitions, and fire suppression has played a critical role in preventing the ever increasing anthropogenic ignitions from driving the system wildly outside the historical fire return interval. Because the net result has been relatively little change in overall fire regimes, there has not been fuel accumulation in excess of the historical range of variability, and as a result, fuel accumulation or changes in fuel continuity do not explain wildfire patterns."

Keeley, J. E., C. J. Fotheringham, and M. Morais. 1999. Reexamining fire suppression impacts on brushland fire regimes. Science 284:1829-1832.

"In brush-covered landscapes of southern and central-coastal California, there is no evidence that fire suppression has altered the natural stand-replacing fire regime in the manner suggested by others (3, 5)."

Keeley, J.E. and P.H. Zedler. 2009. Large, high-intensity fire events in southern California shrublands: debunking the fine-grain age patch model. Ecological Applications 19: 69-94.

"A review of more than 100 19th-century newspaper reports reveals that large, high-intensity wildfires predate modern fire suppression policy, and extensive newspaper coverage plus first-hand accounts support the conclusion that the 1889 Santiago Canyon Fire was the largest fire in California history."

Lombardo, K.J., T.W. Swetnam, C.H. Baisan, M.I. Borchert. 2009. Using bigcone Douglas-fir fire scars and tree rings to reconstruct interior chaparral fire history. Fire Ecology 5: 32-53.

"*The historical and modern records both imply that large, landscape-scale fires are inevitable in chaparral landscapes."*

Mensing, S. A., J. Michaelsen, and R. Byrne. 1999. A 560-year record of Santa Ana fires reconstructed from charcoal deposited in the Santa Barbara Basin, California. Quaternary Research 51:295-305.

"The fuel and weather conditions necessary for large fires were present prior to fire suppression and are a natural part of chaparral ecology in a Mediterranean climate."

Moritz, M.A., J.E. Keeley, E.A. Johnson, and A.A. Schaffner. 2004. Testing a basic assumption of shrubland fire management: How important is fuel age? Frontiers in Ecology and the Environment 2:67-72.

"Fire frequency analysis of several hundred wildfires over a broad expanse of California shrublands reveals that there is generally not, as is commonly assumed, a strong relationship between fuel age and fire probabilities."

Zedler, P.H., Seiger, L.A. 2000. Age mosaics and fire size in chaparral: A simulation study. In 2nd Interface Between Ecology and Land Development in California. USGS Open-File Report 00-02, pp. 9-18.

" We conclude that age-based mosaics following the strict rules of the fuel/age paradigm are a transient phenomenon, and therefore we question if fine-grained age mosaics are characteristic of natural systems and whether they should be the objective of long-term landscape planning."

Other important research with findings inconsistent with the mosaic hypothesis:

Dodge, J.M. 1975. Vegetational changes associated with land use and fire history in San Diego County. Ph.D. dissertation. University of California, Riverside.

Dunn, A.T., and D. Piirto. 1987. The Wheeler Fire in retrospect: factors affecting fire spread and perimeter formation. Report on file at: U.S. Department of Agriculture, Forest Service, Forest Fire Laboratory, Riverside, CA.

Dunn, A.T. 1989. The effects of prescribed burning on fire hazard in the chaparral: toward a new conceptual synthesis. Pages 23-24 *in* N.H. Berg (technical coordinator). Proceedings of the symposium on fire and watershed management. General Technical Report PSW-109, U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

Halsey, R.W. 2006. Weather, fuels, and suppression during the 2003 Cedar fire: Which variables made the critical difference? In, 2003 Southern California Fires: Science Insights into the Fire Event and Recovery special session (J.E. Keeley, organizer). Proceedings, 3rd International Fire Ecology and Management Conference. Association for Fire Ecology. San Diego, CA.

Halsey, R.W., J.E. Keeley, K. Wilson. 2009. Fuel age and fire spread in southern California chaparral ecosystems: natural conditions vs. opportunities for fire suppression. Fire Management Today 69, #2: 22-28.

Henderson, D.A. 1964. Agriculture and livestock raising in the evolution of the economy and culture of the state of Baja California, Mexico. Ph.D. dissertation, University of California, Los Angeles.

Hernandez, Jorge. 2007. "Incendios forestales arrasan 15 hectareas en BC", Noticieros Televisa. Broadcast Oct. 25, 2007.Retrieved on 2007-11-12.

Keeley, J.E.; Aplet, G.H.; Christensen, N.L.; Conard, S.C.; Johnson, E.A.; Omi, P.N.; Peterson, D.L.; Swetnam, T.W. 2009. Ecological foundations for fire management in North American forest and shrubland ecosystems. Gen. Tech. Rep. PNW-GTR-779. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 92 p.

Keeley, J. E., C. J. Fotheringham, and M. A. Moritz. 2004. Lessons from the 2003 wildfires in southern California. Journal of Forestry 102:26-31.

Markham, C.G. 1972. Baja California's climate. Weatherwise 25: 64-76.

Mitchell, V.L. 1969. The regionalization of climate in montane areas. Ph.D. dissertation. University of Wisconsin, Madison.

Moritz, M. A. 1997. Analyzing extreme disturbance events: fire in the Los PadresNational Forest. Ecological Applications 7:1252-1262.

Moritz, M. A. 2003. Spatiotemporal analysis of controls on shrubland fire regimes: age dependency and fire hazard. Ecology 84:351-361.

Schoenberg F.P, R. Peng, Z. Huang and P. Rundel. 2003. Detection of nonlinearities in the dependence of burn area on fuel age and climatic variables. International Journal of Wildland Fire 12: 1–6.

Syphard, A.D., V.C. Radeloff, J.E. Keeley, T.J. Hawbaker, M.K. Clayton, S.I. Stewart, and R.B. Hammer. 2007. Human influence on California fire regimes. Ecological Applications 17: 1388-1402.

Turner, M. G., and V. H. Dale. 1998. Comparing large, infrequent disturbances: what have we learned? Ecosystems 1:493-496.

Wells, M.L, J.F. O'Leary, J. Franklin, J. Michaelsen, and D.E. McKinsey. 2004. Variations in a regional fire regime related to vegetation type in San Diego County, California. Landscape Ecology 19: 139-152.

Witter, M., and Taylor. 2008. Preserving the future: a case study in fire management and conservation from the Santa Monica Mountains. In R.W. Halsey, Fire, Chaparral, and Survival in Southern California, 2nd edition. Sunbelt publications, pg. 109-115.

Zedler, P.H. 1995. Fire frequency in southern California shrublands: biological effects and management options. Brushfires in California Wildlands: Ecology and Resource Management. Ed. J.E. Keeley and T. Scott. International Association of Wildland Fire, Fairfield, WA.

Research discussing the negative ecological impacts of short fire return intervals in chaparral:

Brooks, M.L., C.M. D'Antonio, D.M. Richardson, J.M. DiTomaso, J.B. Grace, R.J. Hobbs, J.E. Keeley, M. Pellant, D. Pyke. 2004. Effects of invasive alien plants on fire regimes. Bioscience 54:677-688.

Diaz-Delgado, R., F. Lloret, X. Pons, and J. Terradas. Satellite evidence of decreasing resilience in Mediterranean plant communities after recurrent wildfires. 2002. Ecology 83: 2293-2303.

Franklin, J., A.D. Syphard, H.S. He, D.J. Mladenoff. 2005. Altered fire regimes affect landscape patterns of plant succession in the foothills and mountains of southern California. Ecosystems 8: 885-898.

Haidinger, T.L., and J.E. Keeley. 1993. Role of high fire frequency in destruction of mixed chaparral. Madrono 40: 141–147.

Jacobsen A.L., Fabritius S.L. and Davis S.D. 2004. Fire frequency impacts non-sprouting chaparral shrubs in the Santa Monica Mountains of southern California. In Ecology, Conservation and Management of Mediterranean Climate Ecosystems. Eds. Arianoutsou M and Papanastasis VP. Millpress, Rotterdam, Netherlands.

Keeley, J.E. 2005. Fire as a threat to biodiversity in fire-type shrublands, pp. 97-106. Proceedings of the Conference, Planning for Biodiversity: Bringing Research and Management Together. USDA Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-195.

Keeley, J.E. 2006. Fire management impacts on invasive plant species in the western United States. Conservation Biology 20:375-384.

Keeley, J.E., and C.J. Fotheringham. 2003. Impact of past, present, and future fire regimes on North American mediterranean shrublands. Pages 218-262 in T. T. Veblen, W. L. Baker, G. Montenegro, and T. W. Swetnam, (eds). Fire and climatic change in temperate ecosystems of the Western Americas. Springer, New York.

Keeley, J.E., A.H. Pfaff, and H.D. Safford. 2005. Fire suppression impacts on postfire recovery of Sierra Nevada chaparral shrublands. International Journal of Wildland Fire 14: 255-265.

Keeley, J.E., C.J. Fotheringham, and M. Baer-Keeley. 2005. Determinants of postfire recovery and succession in mediterranean-climate shrublands of California. Ecological Applications 15:1515-1534.

Lawson, D., H.M. Regan, P.H. Zedler, J. F. Franklin. 2008. Using Death Assemblages in Extant Stands of an Obligate Postfire Seeding Shrub Ceaonthus verrucosus, to Inform Fire Management. Unpublished study.

Odion, D.C., and F.W. Davis. 2000. Fire, soil heating, and the formation of vegetation patterns in chaparral. Ecological Monographs 70: 149-169.

Odion, D., and C. Tyler. 2002. Are long fire-free periods needed to maintain the endangered, fire-recruiting shrub *Arctostaphylos morroensis* (Ericiaceae)? Conservation Ecology6: 4.

Regelbrugge, J.C. 2000. Role of prescribed burning in the management of chaparral ecosystems in southern California. In J.E. Keeley, M.B. Keeley, and C.J. Fotheringham (eds.) 2nd Interface between Ecology and Land Development in California. Sacramento: US Geological Survey Open-File Rep. 00-02, p. 19 – 26.

Syphard, A.D., J. Franklin, and J.E. Keeley. 2006. Simulating the effects of frequent fire on southern California coastal shrublands. Ecological Applications 16:1744-1756.

van Wagtendonk, J. W.; Keeley, J. E.; Brooks, M. L.; Klinger, R. C. February 2007. Fire in California's Ecosystems. USGS Publication Brief.

Zedler, P.H., C.R. Gautier, G.S. McMaster. 1983. Vegetation change in response to extreme events: the effect of a short interval between fires in California chaparral and coastal sage scrub. Ecology 64:809 – 818.

Zedler, P.H., and T.A. Oberbauer. 1998. Comments on the Minnich and Franco-Vizcaino July 1997 artcle. Letters to the editor. Fremontia 26: 34-35.

And finally, two papers discussing the importance of examining all variables, not just ones that agree with a favored hypothesis:

Chamberlin, T.C. 1890. The method of multiple working hypotheses. Science: Feb. 7. Also reprinted in 1965. Science 148: 754 –759.

Feynman, R.P. 1974. Cargo cult science. Engineering and Science, June.