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Dominant Paradigm of Fire Control: Solution or Problem?

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Abstract

This paper discusses several issues in forest and Wildland management that have become a paradigm with references from the popular press regarding forest and Wildland fire. A number of ideological conceptions of the world construct perceptions and undermine efforts to reduce or control wild fires. These conceptions presuppose events in a "natural world" that is really a human control and limited space. Many of these conceptions structure how human activities are planned in "natural" or "wild" areas as suburban sprawl continues. These conceptions also structure how fires are perceived to originate and spread defeating fire fighting and planning for fire control. This paper shows how these activities actually promote fire and are creating conditions for more expensive and intense fires. One of the central ideas to today's seasonal wild fires is that they have resulted from years of fire suppression and a buildup of biomass. This is contradicted by pollen analysis, fire regimes and the concentration of the most extensive fires in the past 20 years after fire management philosophies had changed to allow for periodic control burns. A human "fire adapted" ecosystem has been created and is being spread and complicated by planning and fire suppression activities. Fire suppression history and its relation to wildfire, defensive space and prescribed burns have become concepts entrenched in the public mind. Whether scientific evidence supports these beliefs and what consequences result is reviewed. Evidence is presented concerning bias in firefighter's choice of homes to defend that may skew data on home survival.

Keywords: Wildfire; Fire suppression; Defensible Space; Fire regimes

Introduction

The recent wild fires in Russia and the very destructive fires in California, Brazil, Greece and Indonesia have illustrated again the human toll and cost of wildfire. However, most discussions today in the media on the subject of forest or wild fire ignore the forest/development industry's history concerning forest and wild fires as influenced by forest management, agriculture and commercial uses of open space. It ignores the dramatic changes that industry has brought to our grasslands and forests over the past 200 years.

Much of the data used to justify logging, defensive space and prescribed burns is based on an unscientific methodology called "fire scars" which identify tissue trauma in trees as fire evidence. This concept is based on a subjective interpretation. Such trauma evidence can be caused by limbs striking trunks, disease, etc. Studies of ancient burns are not verified by carbon analysis as described by scientists such as Goldberg & Edward D [1].

A recent study [2] argued that 1.8 million hectares burned annually in prehistoric California, a tremendous amount that would made difficult the survival of wildlife to support Native Americans and the ability of new biomass to survive to feed wildlife until new growth could take place (see General Surveys in Heizer & Whipple, 1971) [3]. Other commercial changes were engineered by the advance of agriculture from the Colonial period. Not only have our private forest lands been routinely logged over and then had the debris burned off for over one hundred years, thus continuing the process of creating a fire adapted ecology begun with the settlement of the country, but our public forests, both national and state have been subject to commercial logging since their creation with few exceptions. Added to this has been a long history of spraying pesticides onto forests to kill insects that attack trees and herbicides to kill unwanted trees and brush. Dreistadt, et al. [4] documented the extent of this in a study. Herve Jactel [5]; Peter Gorrie [6] and Peter Matthiessen [7] have summarized why pesticides are counterproductive. The issue is not that there is a history of fire, rather that logging and fires are part of a cultural pattern that has created a problem.

Fire Suppression and Prescribed Burns

Another part of this dogma is the idea that the forest industry or the Forest Service has tried to keep fire out of our forests and that this is now responsible for the forest fires we now see. Paul Mellars [8] in an article detailed how our forests have been fired yearly to increase the growth of forage for commercial herds and wild populations of game for hunters for over 100 years. Thus the idea that prescribed burns are new is simply false and Keeley JE, et al. [9] found in a study of prescribed burns that they did not always reduce fire danger and often increased not only the potential but the intensity of wild fires. Riggen JP, et al. [10] found in their studies of prescribed burns that there were significant variations in their effects, just one of which was seen when they burn out of control as in the Cerro Grande Prescribed Fire [11].

One would expect that if natural fire regimes were working they would burn off all the fire fuel and leave areas without return fire. Alternatively, if areas have not burned within established fire regime periods related to fire fuel build up then they would be expected to burn. Minnich RA [12] emulated a very thorough analysis of photographic images taken from the air over the past 60 years in the southern desert areas of California. Their maps indicate that neither expected result can be supported. Some areas never burned and others burned several times over the period 1925 to 1990. While few fires

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were noted between 1955 and 1971, the previous periods from 1925 to 1955 were characterized by many small and large fires. The period of the 1990s which is expected to have attained maximum fire fuel levels from the 1960s fire suppression practice shows fewer overall fires but overlapping fires with periods 1971 to 1985. While Minnich RA [11] argues that overlap fire areas did not result in considerable burned areas, the fact that they did occur would seem to be contradictory to the general theory. Similar evidence is available from the Southwest in the La Mesa publication [13] and from recent Southern California fires especially in the San Diego area where fires have revisited the same areas with devastating results. It is clear that in many locations in the world there is good evidence that wild fires spread unpredictably and that the factors involved are complex for any single fire event [14,15]. Analyses of examples of fire history discovery techniques (e.g., pollen studies, carbon in soil, etc.) are found in Caldararo, 1996. Variations in fire regimes appear to be considerable when relying on "fire scars" in contrast to expected climate driven drying and/or fuel buildup and FHX2 software does not seem to produce explanatory evidence. This is due to the fact that the central feature used, the "fire scar" or "fire char" [16] is not a scientifically defined or described phenomenon [17,18]. The same feature can result from any trauma or infection that can bring on necrosis of tree tissue [19].

The ethno historical data is also biased where Native American memories are affected by histories of contact and no longer "pristine records of past events." This can explain why studies that rely on fire scars and ethno historical data [2] often produce extreme fire histories where up to 88% of California is annually burning. Though more difficult to collect and assess [1], studies of fossil pollen and carbon in the soil produce less biased results [20].

The S.F. Chronicle [21,22] and other news media [23] in their recent coverage of these wild fires in the State of California, and interviews with the victims who lost homes, focus attention on another element of the dogma with the idea of clearing brush around structures to produce what is called "defensible space," and criticism of environmental pressure to limit logging. In both cases there is no scientific support for these practices. Fires do not respect "defensible spaces," as recent fire disasters have proven and yet promoting such practices gives people a false sense of security and may even lead to people believing they can ignore warnings to evacuate. Though staying in a house and saturating the structure and surrounding area do seem to be associated with the survival of some homes, the evidence is not available to provide statistical support. However, a new movement (Shelter-in-Place) has grown up to avoid both evacuation and loss of homes by claiming certain designs of housing can resist any fire or other disaster [24].

Fires do not burn one bush or tree at a time; they consume both organic materials in their path and available oxygen being also driven by wind and contours of the terrain. Studies published from the second La Mesa Fire Symposium by the United States Forest Service in 1994 detail these factors [12]. To believe that a few hundred feet of cleared space (California law changed in 2005 required 100 feet of "fuel clearing" and 30 feet of a "clean and lean zone" with little flammable material present) will save a house is ridiculous in this context. The presence of such space may be a factor in the choice of fire fighters to stay and try and save a fire and may lead to loss of life among them.

The present argument that the Forest Service has created disasters by years of fire suppression is also unfounded. The practice the Forest Service has followed is that of forest management established since the virgin forests of America were burned and logged off by settlers in the 18th and 19th centuries. That practice was to fire the forest undergrowth to promote forage for wild life that supported hunting, both commercial and recreational. The greatest increase in biomass occurs after both burning and logging [25]. Human land conversions greatly increase fire fuel production/consumption cycles and logging is one important process in preconditioning forests for high-intensity fire [26].

The Forest Service has invested huge sums in fighting fires but it is questionable if these efforts contain fires more than natural burning limits would produce, given the samples of fire histories produced in recent years. Pyne SJ (1982) [27] has suggested this same conclusion from his research in terms of cost of fire fighting and the results. Rather the facts are that we have created fire adapted forests by commercial uses of the forests, prescribed burns and by a history of logging. In 1996 New York Times reporter James Brooke [28] published a story arguing that the "total suppression policy of the 1960s has led to big buildup of fuel." Included in the article was a chart from the National Interagency Fire Center he argued showed that fire frequency was most "suppressed" or burned fewer acres in the 1960s, but that fire frequency in the 1970s was no lower than in the 1990s but lower than the 1940s and 1950. Reference to the chart, however, demonstrated that the greatest amount of acreage burned was in the 1950's and the lowest in the 1980's and has again risen after a decade of "let it burn" philosophy and prescribed burns became policy [19].

Mike Davis [29] summarized the fire frequency data for much of California finding that in the Malibu area, the rugged 22 miles coastline "is scourged, on average, by a large (1,000 + acre) fire every two years, and the entire western Santa Monica Mountains has been burnt three-times over this century." He lists the fires and dates with acres affected. James Sweeney noted a similar fire history of reburning areas in his 1956 summary. We must ask, then, what fire suppression? And what is the relation of fire suppression to the frequency of fire?

The fire adapted nature of our forests and Wildland s is the product of 50,000 years of human treatment of the natural environment. I documented this history in a paper on the human ecology of fire [30] and its cultural origins in a larger work [19]. The fire adapted nature of the forests and the lack of prevention by prescribed burns were demonstrated in the recent Los Alamos fires where a prescribed burn turned into a major forest fire. The same is true of the Gray line Fire that also started from a controlled burn (see Stephan Bridge Fire Study). Logging has been found to be one of the factors associated with the highest frequency of fire [25]. This is only logical as once logged, replanted areas simply produce a tree farm with all trees of the same age and grow to the same height supporting "crown fires" of closely spaced trees and interlocked upper stories. Natural forests do not grow this way, and climax forests, often called "old growth" forests are characterized by a distribution of old and young trees. In both cases Marston Bates [31] in his The Forest and the Sea, and Peter Mattheissen [6] in his Wildlife in America, described these relationships. The buildup of fire fuel and the question of fire prevention as opposed to natural regimes have been studied by Johnson et al. [32] in British Columbia. Their study found that in contradiction to the idea that fire suppression was responsible for fire frequency and intensity, they found the fire history to be a natural regime.

World-wide, nearly 80% of all fires are the result of human behavior either by directly setting a blaze as arson, or by accident [19]. In California, the California Department of Forestry and Fire Protection released figures in July 2007 showing that 13.2% of all fires in the State were arson, 29.1% from equipment use; campfires, smoking, playing with fire by adults and children accounted for 5.6%, debris burning 9%, vehicles caused 11.8%, miscellaneous human causes at 12.2% and undetermined at 16.9%. Essentially we are fire bugs. Our activities cause fires and as we build more housing into the rural areas we are the cause of more fires. We should be investing funds to find ways of deterring this propensity, to use education and the media to condition people to avoid use of fire in all but productive enterprises.

For years environmentalists have been trying to get people to live with the land, to reduce the impact of roofs and energy use. Surrounding a home with greenery, an especially tree accomplishes this result. The "defensible space" concept undermines these efforts.

In post-fire studies of surviving vs. burned structures from the 1961 Bel-Air fire and the 1990 Santa Barbara fire three factors affected survival, the most significant was a nonflammable roof, the second a defensible space and third someone home to fight the fire. The last factor accounted for 9% but the nonflammable roof vs. defensible space were not separated as components, though a nonflammable roof was cited as the main factor associated with the pathway of embers causing fire.

When the Cleveland National Forest fire in 2003 in San Diego County was finally put out, over 2,800 homes had been destroyed. There was no statistical difference between those homes that had "defensible space" and those that did not. Data from one of the best studied fires, the Black Tiger Fire published by the National Fire Protection Association, produced tables of survivor qualities for houses in the fire. It was a human caused fire in 1989, covering 2100 acres and destroying 44 homes. Of those houses that survived fire the associated factors were slope characteristics and exterior construction of non-flammable construction. The Stephan Bridge Road Fire burned more rapidly than predicted due to lower fuel loads which points out the illusion that fire fuel loads alone are the single determining factor in fire behavior. We are denuding the landscape in fear of the fire that we are creating ourselves at a time when decreasing municipal and county budgets make available fewer resources and less funding for fire fighting. Clearing space is not the answer; limiting building outside of the urban core is one answer, increasing penalties for causing fires is another. Fines and jail time would result in less spark producing equipment and more careful operation. The boys who started the Mt. Vision fires in Marin [21] were not prosecuted and their parents were not charged for the fire they set. It would seem that policy professionals could intervene to end this tolerance of arson with a variety of methods.

Housing and Developments in Wildlands

A related problem Martin [21] brings up is low cost housing in the Sierra and other forested and Wildland areas. The Sierra counties and cities had the opportunity to employ zoning restrictions and impact fees to provide for low cost housing decades ago. The tradition of anti-government property fanaticism defeated any potential for this and was supported by the poorest and most in need of such housing. The local newspapers attacked all proposals for regional planning to provide affordable housing and limit sprawl that now makes the protection of property in fires so impossible. Greater control of housing developments in Wildland and forest areas is necessary to limit costs of protecting lives and property and the lives of fire fighters.

Bias and Random Factors in Data on House Survival

I think the most significant handicap the public is faced with is the belief (or propensity to imply when speaking to the popular press) among forest science advocates that fires burn one tree or bush at a time. What we see instead, especially from temperature, wind and aerial analysis is a "storm." A fire storm proceeds along the contours of the land and is deflected or drawn by a number of factors. Frederick J. Swanson [33] described this in great detail. Biomass consumption takes place based on the nature of the fuel that the fire storm has consumed and is consuming but also on its directional velocity [25]. The nature of fires thus varies considerably one from another and has been found to be based on the unique climatic, geomorphic and chemical components of the locale. These features result in fractal plasma streams that can be reproduced in the laboratory [34]. In using data from forest fires and applying it to other systems, Kan Chen and Per Bak [35] found that characteristics of forest fires show a novel scaling form for the distribution of dissipation in the forest model. These are turbulent systems of energy that are dissipated (burn) locally. This is why forest fires damage homes in a variety of conditions and why Jack Cohen's tests (a research physical scientist at U.S. Forest Service Fire Sciences Laboratory in Missoula Montana, Cohen and Jack D [36] showed that 10 to 15 meters should be sufficient under some conditions and this is used by many proponents of defensible space as a measure. However, Cohen's research is not published, thus not peer reviewed and not available from the USDA for examination as it is not listed on the USDA index nor the Fire Service abstracts, though related research is summarized by Alexander [37]. Nevertheless, we might assume Cohen has used some standard methods by the USDA scientists (and UC's Forest Products Laboratory) to expose brush and wood to heat and monitor flame generation and kindling point [38]. This is not an effective measure of how a fire storm "dissipates" energy as burning. Heat, duration of exposure and energy transfer is all different in a fire storm than simple exposure of combustibles to heat. This is why the outcomes of actual fires differ so much and show, even within one particular fire, significant variation. For example:

1. The 1961 Belair-Brentwood [39] fire is said to have had homes survive with non-flammable roofs and a clearance of 10- to 18 meters (30 to 60 ft.) (Survival rate 95%).

2. The 1990 Painted Cave Fire found homes with wood roofs had a 20% survival rate, and those with non-wood materials a 70% survival rate, combined with a vegetation clearance of 10 meters or more the survival rate went up to 90%. Still homes with flammable roofs, no clearance and no defense still survived at a rate of 4% [40].

3. The Black Tiger Fire, one of the best studied fires where fire line intensity (FI) was measured found that where FI was at least 500 Btu/feet per second 11.7% of the structures survived. Of these one had a clearance of 10 feet the other 75 feet. Both had non-flammable roofing materials, and were on slopes of 10 to 15%, considered good for survival. With an FI of less than 500 Btu/fs, 18% of the homes survived one with 5 feet of clearance and one with 10 feet. Of the homes that survived 25% had less than 10 feet of clearance and none more than 75%. Average clearance was 25 feet with 75% under 10 feet. At that FI, however, roof construction materials are not significant either as only 16% survived with non-flammable roofs.

What is needed is to define safety, but why also we see homes burn at 50 feet and not at 5 feet. Into this equation we must also figure fire fighter behavior.

In a November 2007 OpEd piece in the Marin Independent Journal Scott Alber and Kent Julin, representatives of Marin County's open space and fire management agencies, answered my earlier discussion in the same paper of the flaws in the concept of "defensible space." This is an issue that requires more public discussion. It was also gratifying to find that they did not refute any of the scientific evidence or studies I used to criticize it. The massive destruction of trees and plant life that results from the creation of "defensible space," is unnecessary. Alber and Julin say that "study after study has shown that the solution to disastrous home loss during wildfires is to prevent buildings from igniting..." No one would contest this conclusion or such studies. Obviously fires burn combustible materials.

The main flaw in the defensible space idea is that its proponents claim that clearing space around a home protects it from wildfire. This is simply not supported by the scientific evidence. As I cited the Black Tiger Fire (though others show the same result), some homes with cleared areas burned and some with no cleared areas (less than 10 feet) did not. Other factors like combustible roofing materials, slope, decks, open eaves, are more significant.

Since Alber and Julin bring up the Oakland Hills fire in 1991, reference to its causes should be examined. First, the fire was started by workers who imprudently operated machinery. Had they followed proper procedures no fire would have occurred? Second, the fire department response team did not put the fire out properly and left before embers were totally dead. Third, when residents called in the revived fire their calls were ignored because the fire department believed they had already put it out. By the time they responded it was out of control. The fire was the result of negligence all round not because people had not cleared trees and brush from the land. If we only denude the land of greenery we will not stop wildfires, but if we stop setting fires and we fight them properly and stop building homes in the Wildland s and forests, we will minimize the problem.

Following this exchange, Mr. Tim Thompson, battalion chief with the Marin County Fire Dept. made a remarkable admission in the November 11th 2007 Independent Journal newspaper about the decisions made on the ground by firefighters. In the face of concerns of property owners about which homes were chosen to defend and those allowed to burn his statement is revealing. He asserts that the primary factor he and his colleagues used to determine which houses to defend was defensive space. One would expect that it is prudent to use all the existing information about which homes survive fires to make such a decision. It is clear from the data on fires in the past 10 years that defensive space is not a major factor. Location on slope is associated with the best survival followed by roof materials, siding, decks, eaves and terrain. Property owners should be able to be confident that their properties are being given equal protection by fire authorities. If Mr. Thompson and his other battalion chiefs are making decisions primarily on defensive space they are skewing the data on survival and influencing outcome as well as following a self-fulfilling prophesy strategy of fire protection practice. This certainly is unexpected from a professional, we would imagine that they would arm themselves with the best available information to execute their jobs, not act ideologically. This tendency may put firefighters more at risk and may result in homeowner deaths if they think that defensive space will protect them no matter what. What Mr. Thompson has done is place the State of California in a tenuous position in upcoming liability issues over the recent fires. One would hope that he and his associates will reevaluate their positions and act in the future with less bias and in response to more evidence. One would expect that the substantial resources applied to restudy fire response by at least the Canadian Forest Service [41], especially in social science research in evaluation of practice and effectiveness of response would nullify such bias and be appreciated by American fire service agencies.

Scarce resources that the public has available for fighting fires should be efficiently utilized, and while we should defer to the expertise of the professionals it is appalling to find their decision-making based on a narrow view. Espousing the defensive space philosophy also simply encourages building in the most fire-vulnerable landscapes and discourages the use of biomass as a means of reducing the impact of existing human built space, providing some coverage for wildlife as well as reducing energy concentrations from roofs and structures that plays a role in global warming.

Conclusion

Vicious cycle: Logging, Fire-adapted ecosystems and fire-fighting

Reporter Mark Prado (IJ 12/20/07) reported on the discovery that a fungus causing brown cubicle heart rot was attacking the redwoods in Muir Woods. While this is a disturbing finding, the response is both typical and wrongheaded. The idea that fire is the answer to all the forestry and Wildland problems we have has become dogma. It is evident that human activities have upset the natural world, but there is no archaeological evidence to prove that fire was more frequent in the past than in the past 400 years of European settlement and there is evidence that it was less frequent prior to the arrival of Native Americans. I produced a critique of this argument and assessed the sources in my 2004 book. Other arguments, like that asserting forests without regular fire are unhealthy systems have no more support than other theories that may better explain the same conditions. For example, Forest Service and commercial forestry use of pesticides may be to blame. Paul Fine and Pyhllis Coley [42] found that herbivores (including insects) control types of forest growth supporting diversity.

From an anthropological perspective this is a rather primitive way of going about to solve problems. The attitude that we must fight this fungus with fire, like the approach that we must muster our forces against wildfires as if we were fighting an enemy is part of a long cultural tradition that we must tame nature. The enemy is out there, and we need to circle the wagons and spray it with pesticides or bomb it with fire retardant, bulldoze fire breaks, and deny it fuel as a defensive measure like armies used to scorch the earth to deny an invader food. Instead we should realize that we are the cause of these problems. If we did not build homes in the forests and Wildland s we would have fewer problems. For nearly one hundred years the forest service, open space and commercial forest products companies have sprayed these lands with pesticides, killing off natural predators of insects and pathogens that affect forest health. They have killed off the game that ate the undergrowth that fuels fire and they have fired adapted our lands by continuous burning both after logging and to produce more game.

In this instance regarding brown cubicle heart rot, the scientific literature tells us that this fungus is spread by human activity. Professor Garbelotto at UC Berkeley in 2004 [43] wrote that the fungus is propagated on the stumps of newly cut down trees and transmitted by infection to the roots of nearby trees. Therefore, across our State, and perhaps the country, loggers are spreading the disease. Further, this may be a product of the new policy of thinning forests now part of the Forest Service under the Bush Administration. If we want to stop this disease, and return our forests and Wildland s to some degree of stability, we need to reduce the level of human activity in them. This means severely reducing public access to Muir Woods and other parks and open space and reducing the level of logging statewide and placing a moratorium on building outside of our current urban areas. Perhaps an analysis of logging equipment is in order, or rigorous cleaning of logging contractor machinery as they move from one location to another. We are the problem, let's stop the war on nature and start thinking about the consequences of what we are doing.

References

1. Edward DG (1985) Black carbon in the environment: properties and distribution. J Wiley, New York.
2. Stephens SL, Martin, Nicholas EC (2007) Prehistoric fire area and emissions from California's forests, woodlands, shrublands and grasslands. Forest ecology and management 251: 205-216.
3. Heizer RF, Whipple MA (1971) The California Indians: A Source Book. (2ndedn), Berkeley: University of California Press, USA.
4. Steve HD, Donald LD, Gordon WF (1990) Urban Forests and Insect Ecology. BioScience 40: 192-198.
5. Jactel Herve Trees and Forests: Living with insects and microorganisms. IUFRO World Series, Protection of World Forests from Insect Pests: Advances in Research 11: 9-12.
6. Gorrie, Peter (1993) Is spruce budworm the real enemy? Canadian Geographic 113: 6-8.
7. Peter Matthiessen (1987) Wildlife in America. Viking, New York.
8. Paul M (1976) Fire ecology, animal populations and man: a study of some ecological relationships in prehistory. Proceedings of the Prehistoric Society 42:15-45.
9. Fotheringham CJ, Keeley JE, Morais M (1999) Reexamining fire suppression impacts on brushland fire regimes. Science 284:1829-1832.
10. Riggen JP, Goode S, Jacks MP, Lockwood NR (1988) Interaction of fire and community development in chaparral of southern California. Ecological Monographs 58: 155-176.
11. National Park Service (2001) Cerro Grande Prescribed Fire, Board of Inquiry Final Report.
12. Minnich RA (2000) An integrated model of two fire regimes. Conservation Biology 15: 1549-1553.
13. Allen CD (1996) Fire Effects in Southwestern Forests. Proceedings of the Second La Mesa Fire Symposium.
14. Melba C, Eric P (1996) Great Victoria Desert, Australia Topic: Wildfire Behavior. CSR/TSGC.
15. Agee, James k (1996) Fire regimes and approaches for determining fire history. GenmTech Report, INT-GTR-34, 12-13.
16. Swetnam TW (1993) Fire history and climate change in giant Sequoia groves. Science 262: 885-889.
17. Lachmund HG (1921) Some phases in the formation of fire scars. J of Forestry 19: 155-168.
18. Baisan CH, Swetnam TW (1990) Fire history on a desert mountain range: Rincon Mountain Wilderness, Arizona, USA. Can J For Res 20: 1559-1569.
19. Blanchard RO, Tattar RA (1981) Field and Laboratory Guide to Tree Pathology. Academic Press N Y.
20. Caldararo N (2004) Sustainability, human ecology, and the collapse of complex societies: economic anthropology and a 21st century adaptation. Edwin Mellen Press.
21. Peter F (2007) Calif. forest fires bigger, hotter, study finds. The San Francisco Chronicle.
22. Martin, Glen (2007) San Francisco Chronicle Magazine, 29 July.
23. Flaccus, Gillian (2006) Wildfire likely triggered by controlled burn. San Francisco Chronicle.
24. Weisberg L, Showley R, Pierce E (2007) Exclusive homes emerge unscathed as fire protection concept is tested. Union-Tribune 619: 293-2251.
25. Longhurst WM (1961) Big game and rodent relationships to forests and grasslands in North America. La Terre et al. Vie 2: 305-319.
26. Stocks BJ, Kauffman JB (1997) Biomass consumption and behavior of wild land fires in boreal, temperate, and tropical ecosystems: perameters necessary to interpret historic fire regimes and future fire scenarios, in Sediment Records of Biomass Burning and Global Change.
27. Pyne SJ (1982) Fire in America,cultural history of wildland and rural fire. Seattle,WA: University of Washington Press.
28. James Brooke (1996) Western wildfires near record season, New York Times.
29. Davis Mike (1995) The case for letting Malibu burn. Environmental History Review 19: 1-36.
30. Caldararo N (2002) Human ecological intervention and the role of forest fires in human ecology. Sci Total Environ 292: 141-165.
31. Martson Bates (1960) The Forest and the Sea, Vintge Books, Random House, New York.
32. Johnson EA, Fryer GI, Heathcott MJ (1990) The influence of man and climate on frequency of fire in the interior wet belt forest, British Columbia. Journal of Ecology 78: 403-412.
33. Swanson FJ (1981) Fire and geomorphic processes. Proceedings to Fire Regimes and Ecosystems Conference.
34. Gaier LN, Lein M, Stockman MI, Knight PL, Corkum PB (2004) Ultrafast multiphoton forest fires and fractals in clusters and dielectrics. J Phys B At Mol Opt Phys 37: L57-L67.
35. Chen K, Bak P (2002) Forest fires and the structure of the universe. Physica A: Statistical Mechanics and its Applications 306: 15-24.
36. Cohen, Jack D (1999) Reducing the wildland fire threat to homes: Where and how much? In: Gonzales-Caban, Armando, Omi, Philip N, technical coordinators. Proceedings of the Symposium on Fire Economics, Planning, and Policy: Bottom Lines; 1999 April 5-9. San Diego, CA. Gen. Tech. Rep. PSW-GTR-173. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station 189-195.
37. Alexander Al (2003) Fire safe structures: Proposed changes to Building codes in California. University of California, Forest Products Laboratory.
38. Cohen, Jack D (2003) Wildland-urban Fire Research: Determining Home Ignition Potential during Wildland Fires. US Forest Service Fire Sciences Lab.
39. Ronald A Howard, Pacific Southwest Forest and Range Experiment Station (Berkeley, Calif.), Stanford Research Institute (1973) Decision analysis of fire protection strategy for the Santa Monica Mountains: an initial assessment: preliminary report. Stanford Research Institute, Menlo Park, Ca 159.
40. Susan Kirsch Preventing Wildfire Home Ignition: Why the Answer is 'over your head. Anchorage Fire Dept Anchorage, Alaska, nd.
41. Alexander ME, Thomas DA (2007) Wildland fire behavior, case studies and analyses: value, approaches, and practical advice. Fire Management Today 63: 4-12.
42. Fine PV, Mesones I, Coley PD (2004) Herbivores promote habitat specialization by trees in Amazonian forests. Science 305: 663-665.
43. Garbelotto M (2004) Root and butt rot diseases. Forest Pathology 1-9.
44. National Fire Protection Association (1992) Black Tiger Fire Case Study. Fire Investigatons Division, Quincy, Massachusetts.
45. Mellen (2004) Studies in Anthropology. The Edwin Mellen Press, Lewiston
46. Clark JS, Cachier H, Goldammer JG, Stocks BJ (eds) ,NATO ASI Series, Subseries 1, "Global Environmental Chang" 51:169-188.