The Future of Fire in Environmental Management

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ABSTRACT

Fire has been a significant force in the evolution of ecosystems since the beginning of life on earth, and has occupied a powerful role in shaping the physical and natural world as we experience it today. Historically, human societies have both feared fire as a natural, destructive force, and used fire to social and technological ends. Indeed, the harnessing of fire by human societies represents one of the most profound changes in the ability of humans to achieve mastery and dominance over the natural world, increasing their safety and well-being. However, the future of fire is uncertain. The great landscape-scale fires that have shaped the natural environment can no longer be allowed to exist. Once thriving on vast uninhabited tracts of forests and grasslands, their existence is now an anathema to the communities that checkerboard most of our national forests. Like threatened and endangered species in the ecological realm, large-scale fire itself is becoming extinct due to intrusions of human habitation into the very forests that provide the fuel for its existence. Modern fire rarely exhibits the qualities of historical fire with its enormous releases of energy, rapid spread, and long duration. When it does, the results are deemed catastrophic and sociopolitical forces intervene to prevent its reoccurrence. Yet, ecosystems are dependent on fire for their vitality and sustainability, creating a conflict between the needs of nature and the fears of human societies. What is the future of a purposive role for fire in ecosystems? How can fire as a historical force continue to play a similar role in the future? This paper examines the relationship between humans and fire, and explores its meaning for how we will make decisions about fire's future as both a property of nature and as a tool for human development.

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"I am the huntsman of the mystery,
The great resource that taught technology,
The secret fount of fire put in the reed
And given to man to minister his need."

Aeschylus – "Prometheus Bound"
(Havelock, 1968)

Ancient Fire

Precisely where and when humankind received the great gift of fire is lost to antiquity. Certainly the Greeks, or at least Aeschylus, understood that fire and humanity are interwoven in such a powerful embrace that it must have been through some act of the Gods that fire ever came down "to man." Only through the cunning of one of their own (or so goes the story of Prometheus) could mortals ever have acquired such a good, for none such was available to others than the Gods.

Prometheus is, allegorically, the first great inventor. By stealing fire from the Gods and giving fire to man, Prometheus becomes a teacher and an intellectual force that imbues humanity not only with technology, but also with the hope and vision that technology inspires. Fire is both the gift and the giver. It is fire that gives to humanity the concept of the "tool" and the means by which its hopes can be realized. Prometheus' gift is not only the gift of a "means" but also the gift of the "ends", the motivations and aspirations, and ultimately the creativity to define both needs and ways to fulfill them.

The Greeks, for all their understanding of man and fire, never managed to extract from fire the secrets that modern science has unlocked and applied to achieve technological ends. Historically, a great deal has been written on the role of fire in the evolution and development of culture and society (e.g., Pyne, 1997). That history will not be repeated here – the brief excursion to Prometheus is sufficient to set the stage for the central questions of this paper, which are cast in terms of a futurist perspective. Our task is to speculate on the future of fire and what role it could or might play in ecosystem management. If the ends we have achieved historically with fire continue to be important in the future, how will decisions about fire be influenced by emerging issues that are central to the relationship between humans and the natural environment?

This perspective on fire is significant today because we have seen in only a very short number of years a rapidly-changing landscape with respect to the relationship between the natural and the "built" environment. By "built" environment I mean the environment as constructed by human societies. This is readily seen in the intrusion of communities into what were formerly forested or natural environments. But, built environments can also includes parks and other environmental set asides that represent purposive or protected environments in which the full range of environmental events, as evident from natural history, cannot be allowed to take place (or are undesirable), including fire. The modern euphemism in the US for the zone between the natural and the built world is the Wildland Urban Interface or WUI (pronounced "Woo-ee"). In other regions of the world less social and ecological congestion is evident – less intermingling of the human and the non-human. But from a more extensive temporal perspective all

regions of the world will eventually face the same challenges as human settlement patterns intrude deeper into forests and grasslands, the historical home of ancient fire.

Modern Fire

Late in the evening of August 11, 1996, a campground supervisor on the Mendocino National Forest in Northern California noticed a distinctive glow on the horizon – a glow that marked the beginning of a wildland fire. In less than an hour, fire personnel were dispatched to investigate. Driving up a rocky creek bed at midnight, and through heavily-fueled rugged terrain, they spotted the fire burning briskly in dry brush and light timber which for over 40 years had not seen fire. The middle of August in Northern California is the midpoint of fire season, and has been for centuries. Long before small rural communities to the south of the fire's location with bucolic names like Upper Lake, Nice and Lucerne existed, fires burned with centenary regularity over the wooded terrain of the coast range mountains in this part of the state. With midnight temperatures in the high 80's, and the relative humidity in the teens, the fire grew rapidly, within a matter of hours exceeding the ability of local fire crews to contain its spread toward the south and east, threatening private homes and communities. By the time the "Fork Incident" was contained, over 82,000 acres had burned and suppression costs exceeded $21 million. Over 6,500 chains of fire line had been constructed – at 66 feet per chain a veritable moat of fuel-deprived ground almost 100 miles long, some cut by bulldozers, but most built by numerous 20-person crews digging by hand in much the same way fire has been suppressed for decades.

The Fork Incident is a modern fire like many other wildland fires that occur each year in the US. We could say that it is a fire that reflects what has happened to forests as a result of almost 90 years of fire exclusion: heavy buildup of volatile fuels, extreme dryness combined with rugged terrain produce a vitriolic brew once ignited. But, we could also say that the incident reflects deferment of "risk" to the future and to the benefit of those who in the past enjoyed no (or relatively few) fires. The precipitating "cause" of the Fork Incident was human – a recreationist on an isolated forest road careless with fire was ultimately responsible. But, we could say that responsibility also rests with the growing attractiveness over several decades of forest recreation that has lead to more opportunities for human carelessness, a modern-day reenactment of the pioneering and frontier spirit that has left in its passing a vestigial longing for life out of doors. The financial cost of the fire was largely due to the protections afforded private residences in the area; protections that necessitated the use of expensive fire-fighting resources such as aircraft, handcrews and even a military battalion. But, we could also say that the cost reflects an externalized economic value associated with land-use decisions (far removed in time from the incident) leading to human settlement in close proximity to forested (and, therefore, fire-vulnerable) lands.

Accounting for modern fire is an exercise that requires more than counting up burned acres. Wildland fires as they are experienced today reflect a legacy of decisions and influences that have brought about the conditions necessary for their occurrence (MacGregor & González-Cabán, 2004). In this way, wildland fire is not unlike failures of technology where social and organizational "meta decisions" may be the ultimate root-

causes of events (Paté-Cornell 1990; 1993). Though it takes fuel to complete the conditions required for fire, forest fuels themselves are in part the result of a legacy of social and political decisions about permissible actions with respect to public lands. These decisions are made in the context of temporally-bound social values, which change over time in response to events and other forces that provoke social change (e.g., demographics) – a change that tends to occur in linear time, while fire and other natural processes occur in exponential time. In a sense, our current social institutions may not be able to keep up with the pace of change in the natural world – we don't change how we manage fuels, for example, at the same rate-of-change as do the properties of the fuel bed in our forests change.

Part of the legacy of wildland fire is captured in forest management policies and practices regarding fire and fire suppression. However, other parts of that legacy are less easily discerned and can be seen in larger social and economic forces that have, for example, capitalized on the value of property that lies either within or adjacent to forest boundaries and that offers an opportunity for homeowners to experience life in a "natural" environment, hopefully bereft of the risks that natural environments can bring or at least risks deferred to some distant future beyond the temporal horizon that most people consider relevant to their life in the present.

Modern fire presents us with a conundrum: The environment as we see it today is the product of fire, but we cannot tolerate fire in the environment to the degree (and in the form) that we have lived with it in the past. How can fire and humans "coexist" in an environment in which large-scale fire, although achieving positive outcomes in the ecosystem, puts in jeopardy elements of the environment that humans value (in the short term), and threatens the "built" environment (e.g., structures, communities)?

Prometheus' "secret fount of fire put in the reed" is contained fire – fire controlled and bounded, and directable toward specific purposes. Contained fire is fire in a vessel from which it cannot escape unless released either by intention or accident. Our concern here is with uncontained or natural fire: fire that exists in a much larger physical context, such as wildland fire. However, the distinction between contained and uncontained fire can become blurred and, indeed, in the future may become even more so. Fire requires the three elements of the fire triangle: fuel, oxygen, and an ignition source. All three must be present for fire to exist. These three elements comprise the "reed" within which all fire is contained regardless of whether we call it contained or uncontained. Even large-scale wildland fires are "contained" by the availability of fuel, and (therefore) the fuel environment describes the fire's containment. Nature provides its own reed, and it is left to humanity to define the environmental boundaries of its size and location.

A second important distinction, and one that greatly influences how we view fire today and (most likely) in the future, is the source of ignition: where the fire comes from and how it begins. Almost (but not) all *unintended* fires that occur in the natural environment result from natural ignitions due to lightning. A small percentage of

unintended fires occur due to human causes, such as carelessness with campfires and the like.[2]

An important category of fires in the natural environment are *intended* fires, as when "prescribed" fire is used to manage the natural environment. Prescribed fire is fire in a predetermined area for the purpose of meeting a set of planned objectives, burning under a specified set of environmental conditions and behaving in a predetermined way. The concepts *predetermined* and *planned* reflect fire as a tool, as an implement to achieve an end. In a sense, prescribed fire is contained fire: contained by the physical boundaries of fuel supply and contained by the intellectual boundaries of our ability to plan for its presence, as well as anticipate and control its behavior. Again, the Prometheian gift of fire comes with the inventiveness to suppose that its behavior can be understood and predicted to a sufficient degree to enable its control.

Natural fire is fire of the Gods: we live with such acts and seek meaning in them, very often finding a greater good; we are less forgiving of acts of humanity and attribute blame when things go wrong. From the Gods we expect the inexplicable (or at least difficult to explain); from humanity we expect the realization of intentions. To paraphrase a modern bumper sticker, "Natural fire happens." Anthropogenic fire does not. The disparity in perception of natural vs. human-caused fire is apparent on a larger scale in how we judge the impacts of natural hazards as compared to those levied upon us by technology, where our evaluations are much more harsh, and true forgiveness seldom evident. However, social reactions to natural and technological hazards can become similar when humans intervene in nature with the intention of managing events and their consequences. The risks of nature and the risks of technology merge at the level of risk management institutions and perceptions of risk are based strongly on perceptions of how risks are managed (e.g., Pidgeon, Kasperson & Slovic, 2003). If the public and forest-bound homeowners come to count on fire management organizations to protect them from wildland fire, then they may be perceived as "recreant" in light of their failures (Freudenberg, 2003), even when no management actions could effectively stem the consequences of wildland fire.

Decisions About Fire: Defining Reference Points. Because we have fire, we have the capability to make decisions about fire. This is a seeming paradox; we would like to say that because we have fire we must make decisions about it. But, the capability we have to field an intelligence capable of decision making is a direct reflection of the fact that we have fire at all – it is fire and our control over it that is one of the most important (and long standing) forces of nature where human capability intersects with the possibility of science and technology. Returning to our allegory, Prometheus did not give humankind the world on a string, or the oceans in a teacup, or the wind in a bottle: he gave fire in a reed. Of the major forces of nature, only fire is perceived as susceptible to human management. As a result, the future of fire is bound up in decisions we make about the meaning of fire, nature and the natural environment.

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[2] The percentage of fires attributable to human causes varies greatly by region. In the western United States, human-cause ignitions account for approximately 10% of fire starts. However, in other parts of the US, notably southeastern states, human-caused ignitions can comprise 40% to 60% of all ignitions.

Like all decisions, decisions about fire hinge around a matter of values and their definition, as well as the alternatives we perceive ourselves as having with respect to fire and those things upon which fire exerts an influence. In our contemporary age, the influences of fire are largely on the environment – ecosystem effects that include ideas like forest health, biodiversity, and environmental sustainability. It is within the context of these concepts that fire is embedded.

One of the most powerful forces exerted upon decision making is that of problem framing or structuring. How we compose a decision problem in terms of its scope and breadth, outcomes and evaluation criteria cements in place an architecture that structures how we reason through the implications of the actions we might take in light of their expect outcomes (Keeney, 1992; von Winterfeldt & Edwards, 1986). Likewise, our decisions about fire are influenced by what we deem possible and favorable, which sometimes means returning ecosystems to historical conditions. These conditions may be perceived strongly as gains in the quality of the environment and count positively toward images of humanity as good environmental managers (e.g., Gregory, Lichtenstein, & MacGregor, 1993).

Indeed, many of the decisions that we make about fire today are heavily driven by the desirability of the historical environment. It is questionable, however, how best to use the historical environment as a benchmark by which to structure fire decisions for the future. One problem is gauging just exactly what point in history represents the state to which present (and future) fire decisions should be referred. Consider as an example the western US[3]: the vast majority of forested lands are heavily interwoven with human habitation and the notion of a "historical forest" is only seen on a highly localized basis. In a very real sense, the forested environment as seen through the eyes of history exists today only on a small scale where museum-like portions of land capture in relatively tiny ecological enclaves what virtually all of the western US must have looked like at one time.

Popular images of the forested environment as eco-wilderness on a grand scale where fire can do its work, can cloud our reference points. For example, the year 2000 was a dramatic fire year all across the US, with approximately 93,000 wildland fires burning almost 7.4 million acres, in addition to destroying numerous structures. For Yellowstone National Park, the year 2000 was an unusually dry one – the driest in the Park's recorded history. Multiple fires burning inside and outside the park combined in an overwhelming conflagration that burned over 35% of the park. At enormous economic cost ($120 million) and human effort (25,000 people involved) the rains and snows of September, nature's fire controls, final stopped the event. Initially viewed as a tragedy and a loss of a national treasure, subsequent years have shown that the mosaic of burns, partial burns and unburned areas resulted in new habitats for plants and animals. Within a few years, grasslands returned to their pre-incident appearance and areas of lodgepole pines reestablished themselves from mature trees that survived. Other species, such as Aspen, were stimulated to renewed growth by the fire. Burning improved grazing areas for large animals such as bear and elk. Dead trees served as new nesting habitat for birds. As a natural environment, Yellowstone has experienced large fires

[3] Australia serves as an additional example.

every 200 to 400 years and the Park's grasslands have burned every 25 to 60 years. But the popular vision of Yellowstone Park is based on human involvement on a narrower temporal scale – major tourist access to the Park began in the early 1950's, only 50 years ago. Given an average 300-year large-fire return interval, the Park had not yet been discovered by settlers from the east the last time the area burned so vigorously. Establishing which is the true reference point for a natural environment such as Yellowstone Park depends very much on which point in history one chooses – indeed, there may be no consistent reference point apart from the transitory ones humans assign that are dependent on temporally localized values and images of nature.

A second problem with historical referents for deciding the future of fire is our lack of information: empirical science is best at telling us where we are today, but functions less well at telling us exactly the quality and extent of historical variability. Consequently, decisions about fire that are based on historical referents actually become decisions about fire based on futures that we believe are a return to history – a rebuilding and a rebirthing of the environment in ways that seem comfortable and predictable – desirable because we believe we have been there before. However, the sense that we have of environmental history may be an illusion arising in part from the subjectification of science, by which the context in which science is done influences its interpretation and meaning (Kuhn, 1970; Lyotard, 1984).

Stewardship vs. Protection as Problem Framing. Decisions about fire and its management often depend on how a decision problem is framed or structured (e.g., Kahneman, Slovic, & Tversky, 1982). A critical form of problem structuring occurs because environmental management inherently involves potentially conflicting problem definitions. Management can take a *stewardship* perspective: this charge is to manage a set of resources to achieve a set of desired future conditions based on a long-term planning process. Policy and other planning directives frame fire management problems in terms of both threats and opportunities: threats to near-term resource values at risk, and opportunities to return fire (as a benefit) to the ecosystem as part of their overall stewardship mission. Those who manage the suppression of fire largely occupy a protectionist role: their charge is to limit the damage done by fire consistent with protecting public and fire fighter safety. Although there is some compatibility between these two perspectives, they do not overlap. For example, from a protectionist framing, outcomes in terms of acres burned reflects a short-term orientation toward evaluating the quality of a fire management action. However, from a stewardship perspective, acres burned may reflect a more positive (or less negative) outcome in light of the degree to which other stewardship goals are met (e.g., noxious weed reduction, improved habitat, biodiversity). These alternative perspectives may pose difficulties for setting well-grounded and consistent direction for fire management, particularly in situations where stewardship objectives are incomplete (e.g., Perrings, et. al., 1994) or inconsistent (e.g., Gale & Corday, 1991).

Emerging Concepts of Fire, Nature and Community Life. A significant dilemma in using fire as part of ecosystem management arises from the complex relationship between fire and community life. For some cultures and communities, fire is almost purely a threat, a hazard to be dealt with through a combination of primary prevention and secondary protection. In the US, western forests are littered with both natural and

anthropogenic fuels, the latter evident in the large numbers of forest-bound homes constructed to building standards decades old and for which the primary concern about fire is from ignition sources internal to the structure, such as from potential faults in electrical wiring or flammable compounds such as heating fuels. Though efforts are underway to make residents of such homes more aware of how they can protect themselves and their structures better through primary prevention efforts, the codification of such measures in terms of building codes and standards is generally lacking. New risk governance structures within communities are needed in the future to address these issues directly and to develop not only better building codes but that also address the land-use issues that motivate and support the continued development of residential living within hazardous fire zones.

The problems of fire and community life are also made more complex by the existence of "fire-dependent communities"; communities for which fire-related activity contributes to their economic vitality and for which seasonal fire suppression activities constitute a source of basic effective income. For fire suppression efforts that can reach upwards of $100 million or more for a single, long-running incident, the short-term, positive economic impacts to a nearby (even potentially threatened) community can be enormous in a relative sense. For example, privately owned Oregon-based firefighting organizations (largely located in a few communities in the southwestern part of the state) earn $80 million to $90 million per year collectively (Brooks, 2004). Individual communities can come to depend on fire-generated revenues as part of their economic base. This poses a conflict of values. On the one hand fire is a threat to the natural environment; but on the other hand, for some communities the absence of fire poses a threat to their economic and social environment. Fire must be administered in small doses. In some circumstances, communities will set fires to create economic activity (e.g., jobs, sales, rentals). It is a matter of balance: some fire is good, too much is bad. Where and when it occurs, for how long, and to the benefit of whom are critical matters that influence how fire is seen. For the future, the challenge is to recognize the divergent roles that fire plays in community life, and the way that fire shapes how communities grow and evolve. The recent trend toward highly private and sequestered communities suggests that we may see a significant role for fire in the evolution of residential private government (e.g., McKenzie, 1994). If this is the case, then there will be a much greater need for community governments to understand not only fire as a natural phenomenon, but also fire as a subject of modern science. That science recognizes fire both in terms of behavior, which influences protective effort, and effects, which influence how such communities will address ecosystem management within the context of their jurisdictions. In the future, environmental management and bioregional planning will require more sophisticated models of the ecosystem that take greater account of the relationship of ecological functioning to human values and living patterns (e.g., Kessler, et. al., 1992).

Impact of New Technology on Fire's Future. Answers to questions about environmental management can hinge on the availability of technological solutions: are there alternatives to fire as a tool for ecosystem management? Can we obtain the effects of fire, but exclude it? These questions assume that we have sufficient understanding of the natural environment to know the full range of effects of fire exclusion, which (for

various reasons) we may not (e.g., Failing & Gregory, 2003; Noss, 1999). They also assume that we can perform the equivalent of ecological engineering to achieve the same outcomes as the application of fire but without fire itself.

One alternative might be to use our newly-developed technologies, such as genetic engineering and nanotechnology, to achieve eco-engineering by developing (for example) new biological species that either accomplish the same ecosystem controls or enhancements as fire, or fill niches that would have been filled had fire existed to create niches into which new species might emerge. The broader question concerns the technological forces that, in the future, will shape our view of the role of fire in ecosystem management, as well as our view of nature itself and what it means to have an experience of nature. Are we heading toward a constructed or "built" natural environment? Given other trends in the environmental realm, such as global warming, is it possible that we are heading toward a definition of the environment that is based on a combination what is accomplished naturally and what *can* be accomplished through engineering? Can we engineer ourselves into a world where fire is no longer needed to facilitate the chemical and biological changes that create biological diversity? In some senses, we are already doing this with the scientific emphasis we have given to the measurement of such concepts as sustainability and the development of sustainability indicators, all of which presume that, like human health, we are able to diagnose and treat (e.g., Hunsaker, 1993). If, like human health and genetic engineering, we see new technologies as a remedy in the hands of environmental management the notion of an engineered "nature" may not be too far away.

Perhaps we should focus attention on the way people experience nature today and what that may imply for the future. It is arguable that our experience of nature is, in many cases, constructed and even simulated: a "Disneyesque" version of the environment. As our culture becomes more used to constructed nature (vis-à-vis films and theme parks, as well as highly managed "natural" areas) we may come to prefer it to the real thing, if we do not already. Where is real nature even to be found? The vast majority of visitors to national parks rarely wander far from parking lots and visitor amenities. Do we really want to hear the "call of the wild" or are we better attuned emotionally to the predictability of an engineered environment where the consequences of nature have been truncated to achieve aesthetic optimality.

Even today (much less the future) we may be managing based on partial images of the environment that is portrayed (romantically) in the media. If we are, fire has almost no role in these portrayals. The media image of the environment is a static one. Change is highly local -- a given event or a single, personifiable element (e.g., "Free Willy"). Fire, when it occurs, is an accident, a freak of nature, an opportunity for human heroics, and a backdrop to romance or adventure. Fire has no place in the popular vision of environment, no role except as the "heavy" who drops in to set askew an otherwise bucolic and balanced scene. The balance that it brings to the environment is not only unrevealed, but unrevealable. Aside from documentaries, media fare has great difficulty dealing with large events on grand temporal scales. Momentary glimpses of nature show fire only in terms of its destructive impacts, on both nature and the people caught up in it. Fire can produce drama, but the drama does little to illuminate fire's real character. Consequently, the image we glean from fire in the media is unidimensional and without

clear motivation other than to promote the fear and dread that give rise to our emotional experience of the human drama that takes place before it. It lacks the systemic referents that would place it within a dynamic context by which ongoing processes refurbish nature and sustain its historical qualities.

The reality of modern environmental management is that its marching orders and direction are taken not only from science but also from broad public values, including the images the public has of environmental quality. It is conceivable that the future of environmental management will bear ever-greater similarity to that of managing municipal parks, where fire has no role.

Fire in a Postmodern Context

In the popular mind, modernity is often associated with technology and the increasing centrality of technology in everyday life. In reality, technology has always been with us and is a hallmark of what it means to be human, for it is our niche (even as expressed in Greek mythology) to be the technological animal. The essence of modernity is more correctly expressed as a form of thought and a worldview that has led to the emergence and even dominance of science as the basis for many of our social endeavors, including management of the environment. Science-based environmental management is very much a modernist theme. And, by implication, fire science is a partner for environmental management, and can be understood as a disciplinary component of that broader scientific enterprise.

It is difficult to say where the modern ends and the something else begins. The notion of postmodernity is the nomic placeholder we use today to describe a change in the way humanity approaches understanding the world, and how it gives meaning to experience. The name we give this postmodern age, the age after modernism, may very well change: modernity began long before it was labeled as such, and we should expect that a lasting definition of the period we are now entering may not emerge for decades or more. But we can say something about these new lines of thinking and their potential impacts on fire.

From the perspective of science, postmodernism is highly critical of the notion of an objectifiable world and calls upon sciences to recognize its cultural referents. For the modernist, science provides a leverage on fundamental knowledge that can serve the ends of understanding, prediction and control. Fire science has been conducted very explicitly along these lines and with these intentions (e.g., Pyne, 1992). For the postmodernist, science is an amalgam of both knowledge and culture, represented in the form of specialized languages and constructions (e.g., models) that are rational within the context of the particular scientific enterprise that created them, but not necessarily rational outside of that context.

The idea of local rationalities with respect to science is, perhaps, one of the most challenging postmodern ideas to the notion of science-based environmental management. Fire has always intersected with society, and it is only through the compartmentalization of modernism that fire as a feature of nature has been made distinct in the form of a natural science rather than a social science. On other fronts, we have already come to question the distinction between natural and technological hazards (e.g., Satterfield,

2002). What does it mean, for example, to say that floods are a natural hazard in light of the technologies we have to construct dams and levies that sometimes fail? Would we build communities in flood plains if science and technology did not offer at least some hope of controlling nature? The hazards of technology come relatively quickly to mind (e.g., air pollution, pesticide residues), but equally important are the ways in which technologies (and, by implication, sciences) interact with individual and social decisions to produce new hazards that are an amalgamation of nature and technology. More directly to the theme of our discussion here, would people build homes, villages and communities in fire-prone ecosystems if fire science (and science-based fire management) did not pursue its ends with respect to understanding, prediction and control of fire? In the postmodern era, old distinctions lapse: humanity, society, and nature are inseparable and cannot be understood except as a single construction with multiple entities arguing for each.

We can read postmodernism as not only critical of modernist science, but also as skeptical of science in general. Not antiscience, but more of an imperative toward accountability for the full range of implications of any scientific enterprise: who gains, who loses, what voices are enabled, what voices silenced? The future of fire in ecosystem management is very much a matter of the future of science-based management. Already we are seeing reservations about the adequacy of science to provide meaningful and timely direction for many of the important environmental management questions society faces. Some of these reservations may come from what many (and particularly the general public) see as short-sighted science of the 20th century and that has lead to many of the environmental problems we have today (e.g., McDaniels, et. al., 1997; Flynn & Slovic, 1999). Postmodernism is acutely attuned to harm, a sensitivity that is evident in the growing attraction of the precautionary principle as (perhaps) the best guide to environmental management. Essentially, the precautionary principle prescribes that it is better to be "safe than sorry" and that people should be protected from possible harm even in the absence of evidence that it may occur (Sandin, 1999; Applegate, 2000; Graham, 2001). In essence, the precautionary principle says that we cannot wait for science to make the important decisions that effect human welfare: the mere risk of harm, even if undemonstrated by science, is a sufficient basis for taking protective action.

For the future, we must consider seriously that fire and its supporting science will take on an ever-increasing social component. The intersection of fire and society has, at present, virtually no scientific voice. The social issues surrounding fire as a tool in environmental management are relatively unarticulated. In the postmodern context, fire is a social issue that is given meaning and interpretation in differing ways depending upon the context in which fire occurs. Strong, unequivocal principles about fire as an environmental management tool are not likely to survive. What is bad for one community may be good for another; what is a loss at one point in time may become a gain from a different temporal vantage point, what benefits one species may threaten another. The thread of inquiry that has gone into considering future generations in other areas of risk and hazard (e.g., Slovic, 2000) is very likely to enter into debates about fire and its uses. The matter is not so much who is better or worse off for fire in the

ecosystem, but which generational components are influenced and how, and how can they be heard.

If in postmodernism we can see fire as a social phenomenon, we can also see fire in political terms as well. Large fire incidents and fire-related events have for decades been influential in bringing about policy changes – the devastating fire season of 2000, for example, led to the National Fire Plan that has established new national priorities concerning fire and natural resource management, and particularly hazardous fuel reduction to reduce fire risk. The 2002 Biscuit Fire in southwestern Oregon, a long-running fire that consumed over 500,000 acres and cost over $150 million to suppress (GAO, 2004), is prototypical of the political influence that a single incident can have: as a result of the Biscuit Fire, national attention was galvanized on the fuels management problem as a top priority for forest management, setting the stage for the *Healthy Forests Restoration Act of 2003* by which timber thinning and harvesting activity has returned to many forests from which it was excluded for over a decade, in the expressed interests of fire-risk reduction. A highly controversial aspect of the Act is the change it introduces in the role and extent of public participation in the stakeholder involvement provisions of the *National Environmental Policy Act (NEPA)*, limiting the requirement for public review for some types of projects, and giving courts greater latitude to balance short term project impacts against the possible effects of undue delay and long-term benefits of reducing fire risk. From a futurist perspective, the Biscuit Fire may constitute a legacy event, one for which influences extend well into the future, perhaps changing for the foreseeable future the way in which the public as well as government and business interact around environmental decisions. Just as the ecological effects of fire can be seen only by adopting a longer temporal perspective, the sociopolitical effects of fire may only emerge well after the last embers have died out. In the postmodern world of fire, large-fire incidents can serve as catalysts that ignite social and political debate over the relative merits of alternative natural resource management values, goals and objectives. Postmodern fire brings, in addition to ecosystem change, social and political change as well.

Coda

The inventor I, who many a shape did show
Of science to mankind, now do not know
What science will my own release allow.

Aeschylus – "Prometheus Bound"
(Havelock, 1968)

And so, Prometheus leaves us. Fire challenges our ideas of nature, what nature means to us, and how we are able to both accommodate fire and use fire to achieve ends in the name of nature. Maybe it is because we believe we can control fire that we believe we can eliminate it if we choose. In reality, both now and in the future, we probably cannot. Just as a matter of technological prowess, we have always been better at creating methods of releasing energy than methods of capturing or absorbing it. And, until we develop better energy "sinks" our ability to control fire will always fall short of perfection.

The more we seek to control fire, the more we must control nature and the forms we can allow nature to take. Which "nature" do we desire? And, once we choose that nature, how will we give it shape? Will we allow it to shape itself with the natural forces that have, through eons of time, shaped it? Or, will we shape with our own hand, with our technologies, our intelligences. If we shape it with our own hand, what images of nature will guide us? Historical images, or images that are gleaned from new ideas of nature and the human role in it? Will we want it to be a "safe" nature? A nature where hazards and harms do not exist, thereby reflecting human values about what nature should or could be? Do we want a simulacrum of nature – a simulation that reflects nature's finer and more benign elements? These are the essential questions that will frame decisions about fire in the future.

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